

Small ruminant research and development in Africa

**Proceedings of the First
Biennial Conference of the African
Small Ruminant Research Network
ILRAD, Nairobi, Kenya
10-14 December 1990**



July 1992

**African Small Ruminant Research Network
Réseau africain de recherche sur les petits ruminants
ILCA, P.O.Box 46847, Nairobi, Kenya**

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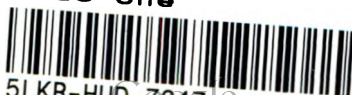
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July 1992

**African Small Ruminant Research Network
Réseau africain de recherche sur les petits ruminants
ILCA, P.O.Box 46847 Nairobi Kenya**

This one



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Abstract

This volume contains papers and abstracts of the First Biennial Conference of the African Small Ruminant Network. Ten papers deal with the Small Ruminant Production System and Policy; Eight papers on Small Ruminant Performance and Reproductive Physiology; eleven papers on Small Ruminant Reproductive Wastage and Health. Another nine describe and analyse feeds and feeding systems and there are 11 papers on Small Ruminant Genetic Resources and Breeding. Four papers on Small Ruminant Development in Africa complete this volume.

Keywords

/Sheep//goats//small ruminant production systems//productivity//economics/
/weaning practices//agropastoral//pastoral//production constraints//feeds//feed
resources//feeding systems//digestibility//nutrition//supplementation//diet/
/reproduction//reproduction wastage//performance evaluation//health//peste
des petits ruminants//infectious diseases//breeds//breeding systems//breed
improvement// Africa/

Résumé

Le présent ouvrage rassemble les communications et les résumés des communications présentées lors de la 1^{re} Conférence biennale du Réseau africain de recherche sur les petits ruminants. Dix documents portent sur les systèmes et les politiques d'élevage des petits ruminants, onze sur les performances des petits ruminants et la physiologie de la reproduction, huit sur les pertes en reproduction et l'état sanitaire des petits ruminants. Par ailleurs, neuf documents sont consacrés à la description et à l'analyse des ressources alimentaires et des systèmes d'alimentation et onze traitent des ressources génétiques et de l'amélioration génétique des petits ruminants. Enfin, le développement de l'élevage des petits ruminants en Afrique est abordé dans quatre autres documents.

Mots-Clés

/Ovins//caprins//systèmes de production de petits ruminants//productivité/
/économie//sevrage//agropastoral//pastoral//contraintes de production/
/alimentation//ressources alimentaires//systèmes alimentaires//digestibilité/
/nutrition//supplémentation//reproduction//perte de potentiel reproductif/
/évaluation des performances//santé//peste des petits ruminants//maladies
infectieuses//races//amélioration//sélection/// Afrique/

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Preface

One of the major aims of the African Small Ruminant Research Network (SRNET) is to promote and improve the exchange of information on small ruminant research and development, particularly among scientists working on small ruminants in Africa.

One of the mechanisms used by the Network in pursuit of this goal is its biennial scientific conference. This brings together scientists working on small ruminants in Africa and elsewhere to share information on their research and development experiences.

This proceedings is an account of the First Biennial Conference, held in Nairobi, Kenya, from 10 to 14 December 1990. The conference comprised six scientific sessions, during which 47 papers were presented and discussed. The sessions focused on production systems and economics, performance and reproductive wastage, feeding and nutrition, genetic resources, reproduction and breeding and small ruminant development projects in Africa and their implications for research. The conference was attended by more than 80 scientists from 33 African and 3 non-African countries.

Although aimed primarily at researchers, we hope that the proceedings will be useful to others involved in development work with small ruminants.

The organisers are grateful to the European Economic Community (EEC) for funding the conference and the publication of the proceedings. Sincere thanks are due to all who worked to make the conference a success. Particular thanks are due to Dr B. Rey, the then acting SRNET Coordinator, on secondment from the Institut d'élevage et de médecine vétérinaire des pays tropicaux (IEMVT), for overall organisation; the International Laboratory for Research on Animal Diseases (ILRAD) for providing the conference facilities and moral support; the untiring and efficient secretarial staff of SRNET at ILCA headquarters, Addis Ababa, Ethiopia; and the administrative and support staff at ILCA's offices in Nairobi for the superb logistical arrangements.

Special thanks are extended to the Government of Kenya for its support of the conference and to the Kenya Agricultural Research Institute (KARI) for co-hosting the conference. Particular thanks go to Dr D. Wachira, Deputy Director of KARI.

Finally, I am grateful to all those who contributed to the production of this proceedings, especially Selamawit Dominique for typing the manuscript and staff of ILCA's Publications Section for production services.

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SRNET Coordinator

Small Ruminant Research in Kenya

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Introduction

Kenya has an estimated 7 and 8 million sheep and goats, respectively. Table 1 gives the breakdown of this important animal resource base into hair and wool sheep and meat- and dairy-goat types. The significance of the small-ruminant sector in the overall agricultural economy was recognised in 1970's with the establishment of the Sheep and Goat Development Project. Due to increasing demand for animal products, a proportionate share of increase in small ruminant productivity is necessary without environmental degradation. This development will inevitably come through research. This paper outlines the small ruminant research trends from the 70's up to the present and projects on what will likely be the research requirements by the year 2000 AD, given the current socio-economic development patterns in the country.

Table 1. *Kenya's sheep and goat population, 1964–1986 ('000s)*

Species/Type	Year			
	1964	1978	1984	1986
Hair sheep	3481	6000	5599	5874
Wool sheep	397	500	551	726
Sheep total	3878	6500	6150	6600
Meat goats	5090	8500	6854	7488
Dairy goats	–	2	–	512
Goat total	5090	8502	6854	8000
Grand total	8568	15002	13004	14600

Source: Ministry of Agriculture and Livestock Development animal reports¹.

The Sheep and Goat Development Project (SGDP) – 1970's

This Project was assisted by FAO/UNDP. It had a broad objective of increasing productivity of small ruminants in all production areas of Kenya. Associated with this broad objective, this long- term Project also addressed the following areas: (1) Establishment of multiplication centres for Galla goats and Dorper sheep; (2) breed comparison trials which included indigenous Red Massai sheep and East African goats; (3) management of small ruminants: housing, dipping, feeding and disease control; (4) establishment of some data base for monitoring and research; (5) implementation of marketing operations; (6) training of production and research scientists.

This Project is still on with Kenya Government funding. Some of the successes of the Project can be listed as follows:-

1. The general awareness of the significance of small ruminant industry to policy makers was enhanced.
2. Research and production scientists were trained to MSc and PhD levels.
3. Long-term breeding programmes were established in some centres.
4. The establishment of basic management principles for sheep and goats on a nationwide scale as opposed to previous individual farmer or communal approaches. Some of these recommendations included:- (a) control of *Haemonchus contortus* and other worms; (b) housing against wind and rain; (c) cleaning the pens; (d) dipping against ectoparasites; (e) appropriate; (f) the complementary nature of sheep and goats to the larger herbivores; raised pen floors; (h) use of *acacia* pods to supplement nutrition.
5. Establishment of breed societies with the Kenya stud book.

The Project also had some shortcomings: It lacked sufficient co- ordination. Progress in the field could not be adequately monitored. Breeding and selection criteria of the studs were not established. Overall production package could not be advanced. The small-scale farmer production system was not addressed. There was marked deterioration in specific production segments like prime lamb and wool production. Most of the work was done on-station and it lacked on-farm socio-economic considerations.

The present – 1980's – 1990

Based on the experience gained from the SGDP, other projects were conceived that had a direct bearing on the research aspects on sheep and goats.

The Small Ruminant Collaborative Research Support Program (SR-CRSP)

The Project is supported by the United States Agency for International Development (USAID) and has been in existence now for about 10 years. The Project's principal objective in Kenya is to develop on systems analysis research basis a dual-purpose goat (DPG) of 40 kg mature weight with a potential of 4 kg daily milk yield at peak lactation to satisfy home milk requirements of families in small-scale farming areas. The selling points of this Project are:

1. To synthesise a DPG from a broad base of adequately sampled two indigenous goats, the Galla and the East African and two exotic dairy goats, the Toggenburg and Anglo-Nubian, based on systems analysis principles and the management capability to small-scale farmers. The parental combination ensures high adaptability to local environmental fertility and high meat and milk production. It also ensures high heterosis retention in the economic traits in the stabilised new DPG. So far, the first composites are in place and breeding is in the correct direction in terms of yields of two kg of milk per day on one milking (Mwandotto et al, n.d.). The use of artificial insemination (AI) for goat production in our environment has been demonstrated in the process of development of this DPG and adaptability of the DPG to different production zones is planned in the development of the Project.
2. The project is multifaceted in that the breeding research is augmented by simultaneous nutrition management, disease and socio-economic research aspects in order to evolve a comprehensive production package for the producers, training institutions and extension agents. That package is now at its final stage of development.
3. The project aims at producing low cost production technologies: (a) use of weigh-band to estimate weight of animals on the farm for on-farm research – see below; (b) development of non-conventional fodders – vines and agroforestry shrubs and farm by-products for goat feeding; (c) use of *Haemonchus contortus* resistant animals to lower the cost of maintenance of breeding flocks. With a heritability estimate of 0.397 for *Haemonchus* resistance in the breeding flock (Rohrer et al, 1990, unpublished), the resistance can be selected for in the future DPG; (d) partial milking for cheap and hygienic feeding and still able to adequately estimate milk yield (Ruvuna et al, 1988).
4. The project has an important aspect of on-farm production and evaluation research aspects where DPG parentals are monitored in terms of acceptability by target farmers, production levels and marketability of the goats and their products.

5. The project is a shining example of institutional collaboration – USAID through, University of California, Davis, Winrock International, Texas A&M University, Missouri University and Washington State University and the Kenya Government through KARI. It is a model for integrated research.
6. The project further trained research scientists to MSc and PhD levels.

The SR-CRSP has its inherent shortcoming as well:

It addresses only goats for small-scale farmers in high potential areas for now. It is, however, clear that there are many animal production systems in Kenya that are dependent on small ruminants (Thorpe et al, n.d.) and with the possibility of genotype- environment interaction and correlations, universal production packages across all production systems cannot be possible.

The Integrated Project in Arid Lands (IPAL) and International Livestock Centre for Africa (ILCA)

The IPAL Project was set in the arid lands of northern Kenya with the Federal Republic of Germany and UNESCO aid. The selling point of this Project was that the small ruminants were researched on in their traditional setting and management and in integration with cattle and camels. Prospective innovations were monitored carefully. One of the notable of the projects knowledge of the resilience of small stock in sustaining its population after drought catastrophes (Blackburn, 1984). The limitation here was that it was also location-specific. The ILCA project in Kajiado showed the importance of marketing small ruminants on weight, body condition and sex basis (Chabari et al, 1987).

The Embu-Meru-Isiolo Goat and Sheep Project

This as a non-governmental organisation (NGO) Project based at Marimanti and sponsored by the Governments of Kenya and the United Kingdom. It is a good example of an NGO conducting research to augment the national efforts of research information generation. It has conducted on-farm recording and breed comparisons. Even though there is some confounding in data structure, it is indicated that there is no difference between the Deguin and the Boran Galla in milk production (Skea, n.d.). As we move to on-farm research activities, apparently care will have to be taken in experimental designs in order to get as much information as possible from trials.

The Universities and Agricultural Development Corporation (ADG) Farms

The University farms do keep some stock for teaching purposes complete with good records especially in purebred dairy goats. Most of these flocks have,

however, tended to be small in size and consistent long-term observations on them have not been possible. Large flocks of both sheep and goats are, however, in the hands of ADG with a possibility of large data sets of pedigree and production kept for long periods. This is an area of ADC flocks and their breeding/management programmes.

Flocks in Other Government Farms

As a result of the first project of the 1970's some data have accumulated on government farms which have been analysed recently to reveal important research information. On crossing the Galla to the East African goat and the Boer (Angwenyi, 1984), the East African superiority in adaptation and the superior mothering ability of the Galla was indicated. Furthermore, a Galla x East African cross dam gave a favourable maternal heterosis that would be useful in raising Boer cross kids. Shortcomings in the experimental designs limited the information on maturing characters that could have also been generated by that study. On the same farm, Maasai and the Dorper with apparently a combination between 47/64 and 7/8 Dorper being ideal. In another study in high altitude areas, the Hampshire Down sheep grew faster than the Red Maasai with the Dorper being in between the two breeds and the carcass characteristic also differed between the breeds (Wachira et al, n.d.) while interactions between breed and sex occurred for meat traits.

The future 1990's

Given the experience of the past and the present, research projection on small ruminants by the year 2000 AD in Kenya may be viewed as follows:-

1. A more integrated and co-ordinated approach will be needed instead of the research being zonal and addressing only small sections of the societies.
2. Well designed studies will be set that have adequate experimental material and without confounding effects in order to generate comprehensive information per unit of resource invested in research. Current methods of data analyses and animal evaluation will also be employed.
3. Products that have so far not been included in our priorities will be addressed – prime lamb and wool. A research laboratory in wool and mohair is envisaged in order to support the natural fibre industry. There should be more research on Merino, Corriedale, Romney mash sheep (which form more than 10% of the sheep population) and Angora goats. A proposal to develop a prime lamb production industry, near urban centres for ease of marketing has been proposed by Angwenyi (n.d.).

4. Revitalization of small ruminant breed societies and formation of new ones to promote and develop the characteristics of individual breeds in order to support any planned crossbreeding programmes.
5. More multidisciplinary approach to research will be in place in line with the example of SR-CRSP with multi-institutional involvement for any possible complementarity and more efficient use of research funds and research expertise and release of technological packages of different production systems.
6. More intensive search for resistant animals against endemic diseases and understanding the mode of inheritance of the possible resistance in order to cut down the cost of drugs in maintaining flocks.
7. More diversified fodder crops for small ruminants i.e. studies on shrubs and agro-forestry trees and use of goats for more efficient control of bush encroachment in range areas.
8. Broaden the definition of small ruminants to include rabbits (in intensive agriculture) and small wildlife species like the undertake (in range areas) and undertake studies on the economic integration of those species in animal agriculture. In ranching situations, wildlife meat is relevant as tourist hotel industry moves into individual ranches and the lean wildlife meat may earn premiums. Harvesting of wildlife products from non-endangered species was recommended in 1985 (IBAR, 1986).
9. Small ruminant meat characteristics will be studied in detail including meat from the (new) species in order to develop objective grading criteria and more use of by-products from the small ruminant industry.
10. Use of biotechnological principles on breeding better animals and development of vaccines (animal health management through biotechnology). Embryo transfer technology will be built on the current AI experience and successful commercialisation of contagious caprine pleuropneumonia (CCPP) vaccines will stimulate the development of multivalent vaccines to cut down cost of production and administration of the drugs.
11. Training in very specialised fields in small ruminant production i.e. reproductive physiology, embryo transfer, development of gene markers and probes etc.

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Session 1

**Small ruminant production
system and policy**

**Systèmes et politiques
d'élevage des
petits ruminants**

Intensification de la production des petits ruminants: pièges et promesses

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Résumé

L'élevage ovin-caprin africain peut apporter plus de viande sur les marchés locaux à condition que cette intensification porte essentiellement sur le travail paysan. Les apports d'alimentation cultivée doivent rester limités à un niveau compatible avec les prix de marché. Les ateliers intensifs spécialisés, concurrencés par la production avicole, et dépendants des disponibilités en céréales, ne peuvent pas connaître un développement significatif.

Which intensification process for small ruminant production in Africa?

J.P. Boutonnet

Abstract

Sheep and goat husbandry in Africa can produce more meat for local markets, only with more labour-intensive systems in small farms. Feedstuffs must be very limited, in relation with market prices. Intensive production systems based on cereals compete with poultry production and are unlikely to develop significantly.

Introduction

L'élevage des petits ruminants présente au niveau mondial, une quadruple spécificité:

- il est mené dans des conditions techniques extrêmement diverses selon les situations agro-économiques dans lesquelles il s'insère, ce que reflète la diversité des prix de sa viande dans le monde;

- il n'a connu nulle part l'évolution vers le type de production intensive de masse qu'ont connue les autres grandes productions animales (volaille, porc, lait de vache);
- c'est un élevage à triple fin: viande, laine, lait dans des proportions très variables selon les situations;
- enfin, le petit format de ces herbivores domestiques exclut leur utilisation en animaux de trait; en revanche, il les rend faciles à manipuler par leur détenteur, mais plus sensibles aux prédateurs que le gros bétail, d'où la nécessité de leur protection.

La production marchande de viande d'herbivores: un sous-produit

De tout temps et dans le monde entier (sauf dans les pays riches depuis quelques dizaines d'années), la consommation de viande est très réduite, réservée aux fêtes ou aux élites, l'alimentation de base étant constituée de féculents (céréales, tubercules) accompagnés de protéines végétales (légumineuses). La viande la plus consommée est issue d'un élevage ayant d'autres fins: laine (ovins); lait; cuir (bovins, caprins, ovins); travail (bovins, équins, camelins); fumier (ovins en zone méditerranéenne). Les viandes de granivores (oiseaux, porcins), qui ne produisent rien d'autre que de la viande, sont un très grand luxe réservé à une élite, ou tout simplement interdites (interdiction du porc par l'islam). Dans cette situation, on peut donc dire qu'il n'y a pas d'animaux élevés spécialement pour la production de viande, si ce n'est quelques unités élevées, en basse-cour, à partir de résidus de culture ou de déchets domestiques, à seule fin d'autoconsommation familiale. Dans tous les cas, la consommation de viande est occasionnelle.

De plus, les animaux dont on mange la viande sont des herbivores. Ainsi, dans l'occupation de l'espace disponible, l'homme ne travaille que les terres consacrées à la production de végétaux destinés à l'alimentation humaine. Les animaux se nourrissent sur les espaces non cultivés. Ils sont d'autant moins abondants que ces espaces sont plus réduits, notamment en cas de pression démographique.

Consommation de masse de viandes: production à base de céréales

En Amérique du Nord, puis en Europe, la croissance démographique urbaine et l'augmentation des revenus ont créé depuis quelques décennies les conditions d'une forte croissance de la demande en viande. Dans le même temps apparaissent des substituts industriels à certaines des productions des

herbivores élevés sur de grands espaces (le coton puis les textiles artificiels remplacent la laine, le caoutchouc et le PVC remplacent les cuirs, la motorisation remplace les chevaux et les boeufs de trait, les engrais chimiques le fumier). Les grands troupeaux d'herbivores sur pâturages spontanés, dont le marché des produits autres que la viande se déprime, ne peuvent pas répondre à l'augmentation très forte de la demande en viande.

En revanche, les progrès techniques importants dans la culture céréalière permettent de consacrer une part de plus en plus importante des terres cultivées à la production d'alimentation animale.

L'élevage intensif de masse, à seule fin de production de viande (volaille, porc), se développe alors dans ce contexte particulier. Il est fondé sur une utilisation massive de céréales ou de fourrages cultivés. Dans les deux cas, il s'agit de cultures impliquant labour, fertilisation, semence, par opposition à l'exploitation de territoires à végétation poussant sans intervention humaine directe.

Les herbivores sont moins efficaces que les granivores pour la transformation des céréales en viande. Le développement d'un élevage d'herbivores à viande exige donc qu'une partie de leur alimentation reste assurée par le pâturage d'herbe spontanée. Si la demande en viande d'herbivores leur attribue un prix plus élevé qu'à celle de granivores, la proportion des céréales dans leur alimentation pourra être d'autant plus importante.

Le développement des élevages marchands d'herbivores pour la viande se fait donc toujours sur la base d'une utilisation combinée de céréales ou de cultures semblables (au moins la phase finale), et de pâturages spontanés. C'est pourquoi, du point de vue du développement de l'élevage et de la gestion de l'espace, ce qui distingue les différentes modalités techniques n'est pas la proportion fourrages concentrés/fourrages grossiers, mais la proportion fourrages cultivés/fourrages spontanés.

Aujourd'hui encore, la majeure partie de la viande d'herbivores consommée dans le monde provient d'élevages conduits à d'autres fins (bovins-lait, ovins-laine) et l'essentiel de la croissance de la consommation de viande des dernières décennies provient d'une production de viande à base de céréales (volaille, porc).

Cette logique de la production de viande, comme produit principal ou sous-produit, et selon l'utilisation d'herbe, est reflétée par les quantités et les prix sur le marché international (tableau 1). Les viandes de granivores s'échangent beaucoup moins (5% de la production mondiale) sur le marché mondial car, fabriquées à base exclusive de céréales, ce sont les céréales qui s'échangent et il n'y a pas d'avantage comparatif à une localisation proche des zones de production. En revanche, les viandes d'herbivores, selon les disponibilités en ressources spontanées et leur statut de sous-produits, peuvent avoir des prix de marché très différents. L'essentiel des exportations mondiales sont le fait de

pays à faible densité de population et à climat tempéré (hémisphère Sud), où, de plus, l'élevage ovin est essentiellement orienté vers la laine. C'est pourquoi, la viande ovine est moins chère sur ce marché que la viande bovine qui est dans ces pays la principale fin de l'élevage bovin.

Tableau 1. Production mondiale et commerce international des viandes monde 1988

	Production totale milliers de t	Importations totales milliers de t	Importations en % de la production	Prix moyen des exportations en dollars E.-U. par kg
Ovine et caprine	9 000	1 200	13	1,8
Bovine	50 200	6 000	12	2,9
Porcine	64 400	3 700	6	2,2
Volaille	36 900	2 000	5	1,4

Source: FAO, (1989).

Les différents types d'élevage ovin-caprin

Toutes les formes d'élevage ressortent de deux grands types, que l'on retrouve dans l'histoire, avec des modifications particulières liées aux systèmes agraires dans lesquels cet élevage est pratiqué:

- **grands élevages spécialisés extensifs**: il s'agit de troupeaux de grandes dimensions, gérés comme un capital, exploités par des éleveurs spécialisés utilisant de très grands espaces, avec peu de travail par unité produite;
- **élevages paysans**: il s'agit des troupeaux de petites dimensions de paysans dont la production est diversifiée. Les ovins, caprins sont l'une des diverses productions mises en jeu pour assurer l'entretien et le renouvellement de la famille.

Les élevages spécialisés extensifs sont de deux types

Les plus anciens sont ceux des pasteurs des régions steppiques. Les populations qui les pratiquent vivent sur des territoires où les cultures sont difficiles, voire impossibles. Les animaux constituent donc leur seul moyen de survie. Le lait (et parfois le sang) est le principal produit, pour l'autoconsommation. Les seuls animaux abattus sont les animaux malades ou réformés, ou ceux que l'on vend en cas de sécheresse ou pour se procurer du grain.

Dans les zones plus arrosées, c'est le pouvoir politique, appuyé éventuellement sur la force militaire, qui impose l'affectation, au détriment des cultures, de grandes parties du territoire à l'élevage du bétail, dans le but d'assurer une base d'approvisionnement dans le produit de cet élevage (laine, cuirs, chevaux, etc.)

quand celui-ci est l'objet d'un enjeu économique stratégique: c'est le cas des grands élevages actuels de l'hémisphère Sud et d'Amérique du Nord. Ce fut le cas dans le passé en Europe et en Asie du Sud-Ouest pour la fourniture de laine et de chevaux de guerre.

Les deux types d'élevage extensif, qui ont besoin de vastes espaces à rente foncière faible, ne sont mis en oeuvre que si la densité de population agricole est très faible, soit en raison de contraintes pédo-climatiques, soit comme résultat d'un processus historique (colonisation, exode rural, etc.). Seule une évolution des structures agraires peut les faire apparaître ou régresser. L'élévation du prix de marché des produits, qui augmente les revenus, ne peut faire croître leurs effectifs que dans des limites très étroites. Toute intensification significative amènerait en effet, une augmentation excessive des besoins en travail; ce surcroît de travail serait mieux valorisé par d'autres productions ou simplement ne peut pas être assuré. Très sensibles aux aléas bioclimatiques, ces élevages connaissent de très amples fluctuations de leurs effectifs, de leurs performances, et des prix de marché. Les variations de valeurs de leur cheptel peuvent être beaucoup plus importantes que le produit qui en est issu. Les éleveurs sont donc souvent à juste titre, plus attentifs au négoce de bétail qu'à une intensification, dans tous les cas coûteuse.

Les éleveurs paysans

Dans les exploitations familiales de petites dimensions et disposant de peu de capitaux, le principal facteur pour assurer les besoins familiaux est l'utilisation du travail. On observe la réalisation d'un ensemble de productions dont l'association permet un renouvellement à moindre coût du potentiel de l'exploitation, et à tout moment une adaptation souple au travail disponible, aux opportunités du marché, aux variations climatiques. Le petit troupeau ovin/caprin joue ici un rôle important pour l'autoconsommation, mais certains des produits sont mis en marché. Dans la palette des différentes productions commercialisables, cet élevage constitue souvent une garantie contraléatoire. La littérature décrit abondamment son rôle de caisse d'épargne. Mais surtout il contribue à la diversité des sources possibles de revenu ou de nourriture. Cette production plus aisément fractionnable que l'élevage bovin, valorise principalement le travail familial, et les ressources fourragères qui n'auraient pas d'autres destinations (jachères, résidus de culture, landes). Les achats sont toujours très limités, et les investissements pratiquement absents.

Comme les types extensifs, ces types d'élevage ovin/caprin peuvent fournir des produits au marché à des coûts peu élevés, mais ils ont peu de capacité de croissance interne des effectifs, même dans le cas d'augmentation du prix perçu.

Ces élevages, dont la rationalité est le produit, et non la rentabilité du capital, et qui sont en outre peu sensibles aux aléas climatiques puisqu'utilisant rarement

la totalité des ressources fourragères disponibles, ont souvent des performances zootechniques élevées (prolificité, rendement laitier). Ils peuvent en outre jouer sur le marché un rôle régulateur (Mounier, 1989), vendant en période de hausse des cours, et accroissant leur autoconsommation ou conservant les animaux en période de cours bas.

Les ateliers intensifs

Dans certains cas bien particuliers se sont développées en Europe, des formes d'élevages intensifs sur un modèle ressemblant à celui de l'aviculture et de la production porcine:

- spécialisation des troupeaux vers la viande ou le lait accompagnée de l'organisation collective de l'amélioration génétique;
- intensification fourragère et moyens de gérer l'exploitation de l'herbe et de contrôler l'alimentation des animaux;
- moyens de contrôle de la reproduction et de l'état sanitaire des brebis;
- équipements, aménagements de locaux améliorant l'efficacité du travail;
- forte liaison, souvent contractuelle, avec l'agro-industrie pour la fourniture de facteurs de production et l'écoulement du produit.

Tous ces moyens ont pour objet d'augmenter la production sans utiliser plus de surface, mais en augmentant la consommation de biens et de services achetés qui permettent une intensification du travail et une diminution de la dépendance des aléas biologiques et agro-climatiques. Ce type d'élevage n'a pu se développer que ponctuellement, dans les cas où le prix du produit (viande ou lait) était élevé grâce à une demande spécifique (fromage de Roquefort, agneau de lait) non concurrencée par les productions plus performantes, et à une protection absolue du marché mondial. Ces élevages sont actuellement en crise en Europe du fait de l'ouverture des marchés et de la baisse des soutiens publics.

Fortement tourné vers le marché, ce type d'élevage est cependant le seul qui puisse, au niveau d'un pays ou d'une zone, répondre à une augmentation du prix des produits par une croissance de la production dont la limite est seulement fonction du prix.

Supériorités et faiblesses de l'atelier intensif

Développé sur une large échelle et aux conditions que l'on a exposées plus haut, le modèle "atelier intensif" offre trois types d'avantages:

- il permet une croissance très importante de la production;
- il fournit des emplois à la population rurale;

- il est moins sensible que l'élevage extensif aux aléas bioclimatiques.

En revanche, il comporte de nombreux dangers.

Manque de souplesse

Même si le revenu global de l'éleveur peut être supérieur à celui de l'élevage paysan, en raison du volume accru, le revenu par unité produite est relativement faible (figure 1) et toute baisse des prix met en cause la survie de l'éleveur, d'autant plus que cet élevage est devenu sa principale source de revenu.

Élément perturbateur du marché

Son succès même accroît les quantités offertes d'une façon telle que le marché connaît une tendance à la baisse des prix. Le produit risque alors de diminuer fortement, engendrant une hausse des prix etc. Ce type de production est générateur d'évolutions cycliques du marché. Pour les deux raisons précédentes, son développement nécessite une stabilité des prix: gestion publique puissante du marché, ou contractualisation des rapports avec l'acheteur garantissant l'écoulement et le prix. En outre, si dans le même espace commercial existe un élevage extensif de grande échelle, celui-ci va être incité à augmenter ses effectifs, aggravant le surpâturage, et accentuant les fluctuations du marché. Cette production intensifiée constitue souvent l'essentiel du revenu des paysans qui s'y adonnent. Les fluctuations du marché provoquent souvent leur ruine, puisque leur marge brute, forte par le volume produit, est faible à l'unité de produit (figure 2). Alors que pour l'élevage paysan cette production représente une faible part de ses ressources, il peut la retenir (stockage "on field") en cas de conjoncture basse, et revendre en cas de conjoncture élevée, d'autant que son système de conduite le lui permet mieux que l'atelier spécialisé, qui doit vendre les animaux dès qu'ils sont prêts.

Productivité du travail inférieure à celle de l'élevage extensif

Comme toute production intensive, c'est-à-dire qui permet d'augmenter le volume produit sur une surface donnée, il est exigeant en travail. Ce modèle ne peut donc être envisagé que si la pression démographique est importante, et que des élevages extensifs, disposant de grandes surfaces, n'ont pas accès au même marché. Il ne peut donc se développer que si les capacités de travail ne sont pas saturées.

Intensif/extensif: une notion macro-économique

Les conditions de l'intensification doivent être examinées non seulement au niveau de l'unité de production, mais également au niveau d'un espace-marché (pays). La différence des prix de la viande ovine (tableau 2) entre la CEE, l'Australie, l'Algérie ne peut s'expliquer complètement qu'au vu des conditions de productivité du travail et de la terre que connaissent ces différents espaces.

Figure 1. Structure des coûts et taille du troupeau selon différents types d'élevages ovins
(UTA: Unité Travail Agricole).

Dollar E.U./kg viande ovine

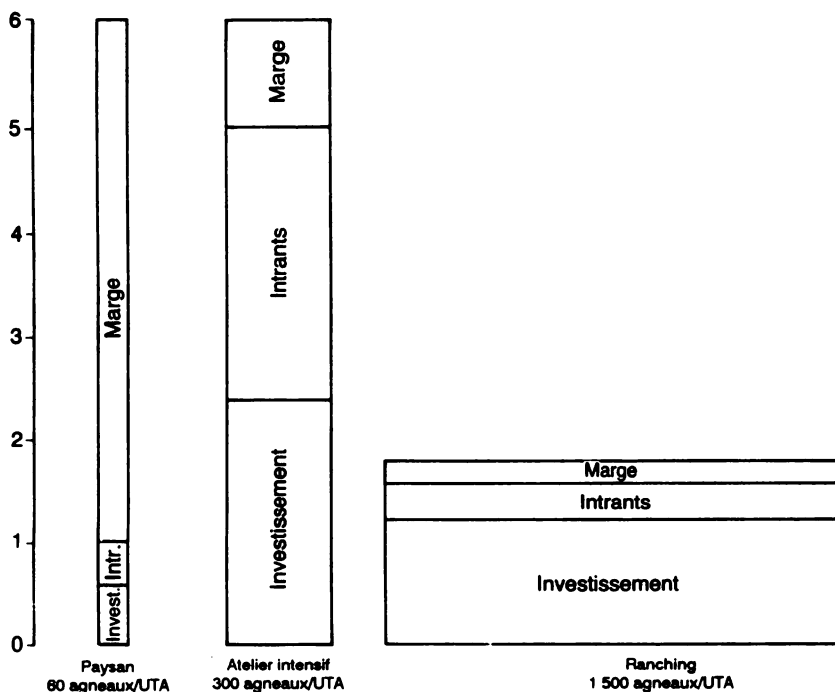


Figure 2. Revenu de l'élevage ovin selon différents types d'élevage

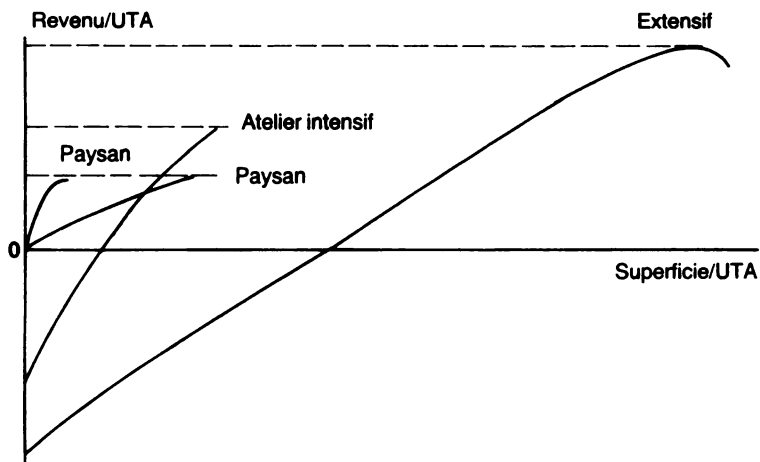


Tableau 2. Prix de marché du kg de viande ovine dans quelques pays -1988

	En dollars des E.-U.	En kg d'orge	Heure de salaire
Australie	1	8	0,2
Europe (CEE)	5	25	1
Algérie	25	70	10

Pour l'ensemble de la production agricole, la productivité du travail diminue quand celle de la terre augmente. Les pays densément peuplés (Algérie) ou ayant opté pour être agro-exportateurs (France) sont condamnés à une forte productivité de la terre, à une faible productivité du travail agricole, et, si la demande existe, à une production ovine chère et intensive (tableau 3).

Tableau 3. Comparaison internationale de critères d'intensivité

	France	Grande- Bretagne	Australie	Algérie
SAU/Population totale (ha/hab)	0,56	0,33	30,6	1,25
SAU/Population active agricole (ha/UTA)	19	30	1 151	1,1
Autosuffisance alimentaire (%)	117	57	308	30
Nombre d'humains nourris/ha	2,08	1,72	0,10	0,24
Nombre d'humains nourris par UTA	40	52	115	0,26
Ovins-caprins/ha SAU	0,38	1,35	0,33	0,45

En revanche, les pays peu densément peuplés (Australie) ou ayant opté pour être agro-importateurs (Grande-Bretagne) peuvent avoir une productivité du travail agricole élevée, une productivité de la terre plus faible, et éventuellement un élevage ovin extensif et de grande dimension, fournissant des produits bon marché.

Dans le cas de l'Algérie, l'élevage ovin, autrefois extensif et steppique, est devenu un élevage intensif fondé sur l'utilisation massive de céréales, grâce à une demande soutenue et la fermeture quasi absolue des frontières au marché mondial de la viande ovine. C'est ainsi que la production agricole totale du pays (tableau 4) a connu une intensification remarquable (+32% entre 1970 et 1987) malgré la stagnation des rendements en céréales, grâce à l'augmentation de la production de viandes rouges et de lait. La productivité pondérale des brebis (tableau 5) y a chuté de 25%.

Tableau 4. Production totale de la sole labourable en Algérie (en milliers de t d'équivalents-grain)

	1970		1987		Indice 1987 (1970 = 100)
Grain	1 740	36%	1 620	25%	93
Viande ovine	1 850		2 940		159
Viande bovine	320	64%	610	75%	191
Lait	880		1 200		136
Total	4 790	100%	6 370	100%	133

Tableau 5. Algérie: Performances techniques du troupeau ovin

	1984/89	1982/87
Nombre total de brebis (millions)	3,9	9,8
Production de viande ovine (milliers de t)	44	83
Agneau/produits/brebis	0,85	0,56
Poids moyen des carcasses (kg)	13,1	15,2
Poids de carcasse produit par brebis (kg)	11,2	8,5

Vers des modèles intermédiaires

Les modèles à proposer et les améliorations techniques à rechercher sont donc extrêmement dépendants:

- Des conditions agro-économiques dans lesquelles s'insèrent les élevages, exposées ci-dessus;
- Des types d'éleveurs, de leurs différentes productions, et de leurs objectifs économiques: autoconsommation; vente sur un marché (dans ce cas valorisation du facteur non saturé: terre, main-d'oeuvre); spéculation sur le cheptel;

En effet, s'agissant de viande, le même animal est en permanence à double statut: animal de boucherie et appareil de production. Il en résulte que dans le cas d'un élevage dépendant des aléas climatiques les cours des animaux sont très fluctuants avec les conditions météorologiques. Les fluctuations de la valeur du cheptel détenu peuvent être, dans une année, beaucoup plus importantes que la valeur de la production finale. Les améliorations zootechniques proposées ne "passeront" que si leur mise en oeuvre ne perturbe pas la faculté d'adaptation de l'éleveur aux aléas du marché et du climat.

c) Des objectifs de l'action d'amélioration: accroissement de l'offre sur le marché et/ou accroissement du revenu des éleveurs.

Le développement massif d'ateliers intensifs peut par exemple recourir à des importations d'aliments du bétail à bas prix, assurant la stabilité de ces ateliers mais provoquant une baisse des prix qui condamne les producteurs paysans locaux.

Ces conditions conduisent à proposer des améliorations techniques en douceur, qui ne perturbent pas les modes d'organisation existants. On peut citer l'exemple de l'Algérie, où au cours des 20 dernières années, la production de viande ovine a doublé, avec une baisse sensible de la productivité numérique des brebis et une augmentation légère du poids des carcasses. Dans la situation actuelle, il est probable que tout effort visant à augmenter la productivité des brebis serait vain, tant que les fluctuations aléatoires des prix du bétail ne sont pas stabilisées. En revanche, on peut dans ce pays rechercher les moyens:

- de stabiliser les ressources alimentaires par l'intensification fourragère;
- d'augmenter encore le poids des carcasses (amélioration génétique, nutrition);
- d'améliorer les indices de consommation de céréales (mode de conduite, action sur le marché).

Dans les pays d'agriculture paysanne dominante, où la majeure partie de la production est autoconsommée, des améliorations douces peuvent accroître notablement les quantités mises en marché sans accroître démesurément la production totale, si elles sont mises en oeuvre par l'ensemble des paysans et si, dans le même temps, les circuits commerciaux s'organisent.

Place du cheptel ovin-caprin africain dans le cheptel mondial

En Afrique, il semble, vu la pénurie généralisée en denrées alimentaires, que la principale viande consommée soit de la viande d'herbivore, et en faible quantité. Le cheptel des ruminants ramené à la population humaine (tableau 6) y est d'ailleurs légèrement plus élevé que la moyenne mondiale, et même que la moyenne européenne. Cinq pays africains figurent parmi les 15 plus gros pays en termes de petits ruminants (tableau 7). Les petits ruminants y sont proportionnellement plus importants qu'ailleurs puisqu'ils représentent 21% du total des ruminants contre 15% en moyenne mondiale. Dans toute une partie du continent, en gros autour du Sahara, la production laitière est conséquente (40% à 65% du lait produit), s'apparentant en cela, à l'élevage du bassin méditerranéen oriental (tableau 8). Ailleurs, sa production principale est la viande, sauf en Afrique du Sud (laine).

Tableau 6. Effectifs des ruminants – monde 1988

	Bovins 10 ⁶	Ovins 10 ⁶	Caprins 10 ⁶	Total unités ovins 10 ⁶	Dont ovins caprins %	Total par habitant	dont ovins caprins	Population humaine totale
Afrique	198	200	167	1 753	21%	2,9	0,6	610
Amérique	421	124	37	3 108	5%	4,4	0,2	702
Asie	522	332	296	4 282	15%	1,4	0,2	2 994
Europe	125	142	12	1 029	15%	2,1	0,3	497
Océanie	32	229	2	455	51%	17,5	8,9	26
URSS	121	141	6	994	15%	3,5	0,5	286
Monde	1 419	1 168	520	11 621	15%	2,3	0,3	5 115

Source: FAO, (1989).

Tableau 7. Effectifs des petits ruminants (15 principaux pays – 1988)

	Ovins 10 ⁶	Caprins 10 ⁶	Total 10 ⁶	Ovins-caprins total ruminants (% unités-ovins)	Ovins-caprins par habitant
Brésil	20	11	31	3%	0,2
Chine	102	78	180	21%	0,2
Inde	52	105	157	8%	0,2
Nigeria	13	26	39	32%	0,4
Pakistan	27	33	60	21%	0,5
URSS	141	6	147	15%	0,5
Iran	35	14	49	47%	0,9
Turquie	40	13	53	39%	1,0
Ethiopie	23	17	40	15%	0,9
Soudan	19	14	33	16%	1,4
Somalie	13	20	33	28%	4,7
Argentine	29	3	32	8%	1,0
Afrique du Sud	30	6	36	30 %	1,1
Australie	164	1	165	50 %	10,4
Nouvelle-Zélande	65	1	66	54 %	20,0
Total 15 pays	773	348	1 121	16 %	0,4
% du total monde	66	67	66	///	///

Source: FAO, (1989).

Tableau 8. Production de lait - monde et principaux pays - 1988 (millions t)

	Vache et bufflone	Brebis	Chèvre	Total	% petits ruminants
Afrique	14	1,5	2,0	18	20
dont					
Algérie	0,6	0,2	0,2	1,0	40
Niger	0,1	—	0,1	0,2	50
Somalie	0,6	0,5	0,6	1,7	65
Soudan	1,8	0,6	0,5	2,9	38
Amérique	114	—	0,5	115	0,4
Asie	85	3,7	3,8	93	8
dont					
Iran	1,7	0,7	0,2	2,6	35
Syrie	0,7	0,5	—	1,2	42
Turquie	3,2	1,2	0,5	4,9	35
Europe	173	3,7	1,7	178	3
dont					
France	28	1,1	0,4	30	5
Grèce	0,6	0,6	0,5	1,7	65
Italie	11	0,6	0,1	12	6
Roumanie	4,3	0,5	—	4,8	10
URSS	106	—	0,4	106	0,4
Océanie	14	—	—	14	—
Monde	506	9,0	8,3	523	3

Source: FAO, (1989).

L'Afrique participe peu aux échanges intercontinentaux des produits de l'élevage ovin (ceux de l'élevage caprin sont pratiquement inexistants, hormis les échanges frontaliers): en animaux vivants (tableau 9), à part les échanges entre Etats voisins du Sahel vers la côte, on doit noter le courant de la corne de l'Afrique vers la péninsule arabique; en viande, un petit courant d'importation de l'Afrique du Nord en provenance d'Océanie. L'essentiel du commerce mondial de viande ovine (tableau 10) provient en effet d'Océanie et va en direction de l'Europe de l'Ouest, du Moyen-Orient, et de l'Asie du Sud-Est.

Tableau 9 . Commerce international d'ovins-caprins vivants – 1988

		(milliers de têtes)	
Principaux importateurs		Principaux exportateurs	
Algérie	600	Ethiopie	200
Côte d'Ivoire	300	Mali	400
Madagascar	1 800	Mauritanie	400
Nigeria	300	Namibie	600
Afrique du Sud	600	Somalie	700
		Soudan	200
Total 5 pays africains ci-dessus	3 600	6 pays africains ci-dessus	2 500
Asie du Sud-Ouest	12 000	Syrie	300
Europe de l'Ouest	1 900	Turquie	3 200
Autres	3 500	Europe de l'Est	4 400
		Australie	6 300
		Nouvelle-Zélande	800
		Autres	3 500
Total	21 000	Total	21 000

Tableau 10. Commerce international de viande ovine et d'ovins vivants 1988 (milliers de t équiv. carcasse)

Principaux importateurs		Principaux exportateurs	
Afrique du Nord	30	Ethiopie–Somalie– Soudan	20
Asie du Sud-Ouest	400	Syrie–Turquie	50
Europe de l'Ouest	230	Europe de l'Est	90
Amérique du Nord	40	Australie–N.Zélande	710
Asie du Sud-Est (Chine incluse)	80		
Japon	80		
Autres	170	Autres	160
Total	1 030	Total	1 030

Contrairement à beaucoup d'autres produits, dont le lait, les céréales, et plus récemment les viandes bovines et de volaille, dont les exportations sont subventionnées (Sarniguet, 1989), les marchés africains des produits de l'élevage ovin-caprin ne sont pas perturbés par les importations et devraient pouvoir connaître un certain développement (d'autant que selon divers auteurs, dont Landais (1985), ils exploitent mieux le milieu que les bovins). Pour cela il faut trois conditions simultanées:

- que l'augmentation de la production soit possible (intensification);
- que la demande spécifique soit suffisante, parmi les non-producteurs, pour offrir des prix attractifs;
- que l'écoulement des produits entre des zones éloignées soit possible et efficace (fonctions commerciales: collecte, transport, allotement, tri, ajustement de l'offre et de la demande dans le temps, l'espace et en qualité).

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Economics of small ruminant meat production and consumption in sub-Saharan Africa

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Abstract

Small ruminants are an integral part of traditional crop–livestock production systems in sub-Saharan Africa (SSA). Meat is one of their major products. This report looks at aggregate patterns and trends in consumption and production of and trade in small ruminant meat in the four regions of SSA (East, West, central and southern).

The preliminary results highlight two important points. Firstly, there are regional differences in the consumption of small ruminant meat. These are differences which may be associated with variation in flock dynamics (size, structure and growth) and productivity, production constraints and trends in the production and consumption of other types of meat. Secondly, there is a strong consumer preference for sheep and goat meat in most regions of SSA, as shown by the increase in small ruminant slaughter offtake over the past two decades.

In East, West and central Africa, relatively large and increasing small ruminant flocks, stable carcass yields and/or sustained production of other meats seem to have offset the potentially negative impact of high small stock offtake on flock growth and productivity. In contrast, in southern Africa growth of sheep and goat flocks is slow and carcass yield is low and slaughter offtake of other meats (e.g. beef) are declining and hence may not sustain the continuing demand for small ruminant meat in this region in coming years.

Tendances de la production et de la consommation de la viande de petits ruminants en Afrique subsaharienne

Senait Seyoum

Résumé

Les petits ruminants font partie intégrante des systèmes de production agricole de l'Afrique subsaharienne. Leur principale fonction est la production de viande. La présente communication étudie les caractéristiques et les tendances globales de la consommation, de la production et de la commercialisation de la viande des petits ruminants dans les quatre principales régions d'Afrique subsaharienne.

On constate des différences marquées entre ces régions en ce qui concerne la consommation. Elles dépendent de paramètres tels que la taille, la composition, la croissance et la productivité des troupeaux, et également des tendances de la production et de la consommation des autres types de viande. A en juger par l'augmentation continue du taux d'exploitation des petits ruminants en Afrique subsaharienne au cours des vingt dernières années, la viande de mouton et de chèvre est plutôt bien appréciée dans la majeure partie de cette région. Toutefois, compte tenu de la faible croissance des rendements à l'abattage des effectifs des petits ruminants ainsi que de la baisse des taux d'exploitation des autres espèces animales (ex: bovins), cette tendance ne pourra vraisemblablement pas se maintenir au cours des prochaines années.

En Afrique de l'Est et en Afrique occidentale et centrale, les effectifs relativement plus nombreux et croissants ajoutés à des rendements à l'abattage plutôt stables et/ou à une production relativement soutenue de viande d'autres espèces, semblent compenser l'effet éventuel des taux d'exploitation élevés sur la croissance et la productivité des troupeaux de petits ruminants. En revanche, en Afrique australe, l'augmentation du taux d'exploitation du troupeau ovin a été très soutenue depuis 1974. Son effectif déjà limité pourra difficilement compenser la baisse du taux d'exploitation du troupeau bovin.

Introduction

In many areas of sub-Saharan Africa (SSA), livestock raising is an important economic activity from which food (meat, milk) and non-food commodities

(manure, traction, hides and skins, wool etc.) and cash income are derived. Meat is one of the most important livestock products. In 1975, meat accounted for about 47% of the gross value of total SSA livestock output (Addis Anteneh et al, 1988).

In spite of this, per caput consumption of all kinds of meats (including beef, small ruminant meat, poultry and pork) averaged 10 kg in 1986/88 in SSA (FAO, 1988; 1989), compared with about 81.8 kg in Europe in 1987 (MLC, 1990). The low level of meat consumption in SSA is primarily due to the low level of meat production per caput which in turn is a consequence of the low productivity of the livestock sub-sector in the region. Between 1974/76 and 1986/88 per caput meat production and per caput consumption increased at annual rates of -0.7% and 0.1%, respectively (FAO, 1988; 1989). Furthermore, given recent developments in the region e.g. rapid population growth and urbanisation, rising input costs, foreign exchange shortages and slow income growth, future prospects seem to be for stagnant or even declining meat consumption, with the likelihood of severe food shortages and growing calorie-protein deficiencies for the bulk of the population (Reutlinger, 1980).

Such prospects underscore the urgent need for increasing food production in SSA. New technologies must be developed that enhance production and appropriate livestock development policies must be designed. A prerequisite to this is an understanding of production consumption of and trade in animal products.

This paper is based on a preliminary study of the nature and scale of small ruminant meat production, consumption and trade in different regions of SSA.

The study focused on small ruminant meat for three reasons: First, present knowledge of small ruminant meat demand patterns in SSA and of factors underlying them, is inadequate. As a result, it has often been difficult to identify potential market opportunities for small ruminant meat and to devise efficient ways of exploiting such opportunities. Second, consumption of beef which has traditionally dominated meat consumption in SSA, is declining relative to consumption of other meats, including mutton and lamb (FAO, 1988). Third although small ruminants currently play a minor role in supplying SSA with meat, they hold promise for increasing meat production and smallholder incomes; compared with cattle, small ruminants require fewer resources, have shorter production cycles, faster rates of growth and greater environmental adaptability. The paper is organised in four sections: Section 1 deals with the small ruminant meat production structure and looks at livestock population, carcass weight, herd/flock offtake and aggregate meat production trends; Section 2 provides information on small ruminant trade flows; in Section 3, aggregate small ruminant meat consumption are determined for the four regions of SSA; in the final section (4), the prospects for increasing small ruminant production and consumption in SSA and their policy implications are discussed.

The Small Ruminant Meat Production Structure

Small ruminant populations, distribution and growth

Populations and distribution

Small ruminants are found throughout SSA. Most small ruminants are found in the arid and semi-arid zones of the Sahel and East Africa (ILCA, 1980), mainly in pastoral and agropastoral systems. Flock in these areas are generally large (up to 100 head per household) and are often kept with other livestock for both meat and milk production.

Small ruminants are comparatively less important in humid and subhumid zones. Nevertheless, it is estimated that in 1981, about a third of SSA's small ruminant population was found in these ecological zones (Onim et al, 1986). In both zones, smallstock are mostly kept by smallholder who rely mainly on crops but keep small ruminants as a subsidiary source of income and meat and a safeguard against crop failure and low crop prices.

Table 1 shows the regional distribution of cattle and small ruminants in SSA in 1988. Small ruminants outnumber cattle by 1.6:1 in SSA as a whole and by 2.7:1 in West Africa.

The main concentrations of small ruminants in 1988 were in East and West Africa, which accounted for 88 and 93% of the sub-continent's goats and sheep. It probably reflects environmental (drought, feed availability, disease) and socio-economic (land scarcity, management system, profitability of sheep/goat production, consumer preferences) conditions.

Goats are more numerous than sheep in SSA (Table 1) particularly in southern and central Africa. The reasons for these distribution patterns are not very clear but seem to be related to differences in physiological/adaptation characteristics and socio-economic roles of sheep and goats. In much of Africa, sheep production is a relatively market-oriented activity aimed mainly at satisfying urban and ceremonial demand for meat (CRED, 1980; Nestel, 1986). In contrast, goat production tends to be subsistence oriented and to cater to the needs of a larger number of rural and lower income consumers (Zimbabwe Government, 1987).

Growth rates

Table 2 shows the annual growth rates of cattle and small ruminant populations in the four regions of SSA between 1961/65 and 1986/88. It appears that over the past two decades, the overall population of cattle, sheep and goats has grown slowly in SSA, at annual rates averaging 1.5, 1.8 and 1.5%, respectively. However, small ruminant populations in SSA increased faster than cattle populations, between 1974/76 and 1986/88 when they grew at an average annual rate of about

Table 1. *Distribution of sheep and goat populations in sub-Saharan Africa, 1988.*

	Cattle	Sheep	Goats	SR/ cattle ratios	Goat/ Sheep Ratios	Cattle	Sheep	Goats	Cattle	Sheep	Goats
	----- ('000 heads) -----					----- (no/km ²) -----			----- (no/pers) -----		
Central Africa	12 663	5 020	10 279	1.2	2.0	2.4	1.0	2.0	0.2	0.1	0.1
East Africa	85 710	69 140	68 900	1.6	1.0	14.9	12.0	12.0	0.6	0.5	0.5
Southern Africa	24 899	3 302	7 020	0.4	2.1	7.8	1.0	2.2	0.4	0.1	0.1
SSA	160 713	120 066	144 687	1.6	1.2	7.5	5.6	6.7	0.3	0.3	0.3

Notes

Regional groupings are based on ILCA's classification of sub-Saharan African countries. SSA is taken to include 39 countries, West Africa 16, central Africa 8, East Africa 6 and southern Africa 9. Regional totals and averages were computed using FAO (1989) data for these countries.

SR (small ruminants) = sheep stocks + goat stocks.

SSA = sub-Saharan Africa.

Source: FAO (1989) Production Tapes and own calculations.

2%, compared to 1.5% for cattle stocks. The consistently higher growth of small ruminants relative to cattle in West Africa suggests that a major shift, from cattle to smallstock, has occurred in this region, where considerable constraints inhibit expansion in cattle numbers.

Carcass weights, offtake and meat production

Carcass weights

The meat production of different livestock species is reflected in their carcass weights. Information on carcass yields is therefore useful in comparing and determining the actual and potential values of different meat-producing animals.

Average small ruminant carcass weights, estimated from aggregate FAO meat production and slaughter data, are highest in southern Africa and lowest in central Africa. In 1986/88, goat carcasses weighed an average 12.2, 11.7, 10.8 and 10.3 kg, respectively, in southern, West, East and central Africa. The equivalent regional figures for sheep carcasses were 11.6, 11.8, 12.9 and 11.8 kg, respectively.

Figure 1 shows the evolution of cattle, sheep and goat carcass weight indices in different regions of SSA between 1961 and 1988. Indices for these figures were calculated by taking 1961/65 annual carcass weight averages, for each species and region, as a base. Thus, on an equivalent basis, small ruminant carcass weights have generally been maintained at higher levels than beef carcass weights. The marked fall in carcass weight indices in the early 1970's particularly evident for West and East Africa reflects a period of draught. On the whole, the trends described above suggest that small ruminants have a great potential for meat production than do cattle especially in traditional production systems.

Offtake rates

Although definitions vary, "offtake" is generally taken to represent the proportion of animals annually leaving the total herd/flock due to deaths, slaughters, sales or other transactions e.g. exchanges, gifts, loans. In SSA the measurement of smallstock offtake is subject to a high degree of inaccuracy, partly because of lack of reliable data on small ruminant population, growth and production parameters but also because this largely rural and unofficial nature of smallstock slaughter and marketing makes data collection difficult. The estimates of offtake and conclusions presented in this section should therefore be interpreted with caution.

While not exactly quantifying offtake, estimates of offtake, obtained rather arbitrarily by dividing FAO data on slaughters by total livestock numbers give a rough idea of offtake patterns and trends in SSA. These estimates indicate that in 1986/88, sheep offtake rates were highest in central and East Africa (32.1%

Table 2. Annual growth rates (%) of cattle, sheep and goat populations in SSA between 1961/65-1974/76 and 1974/76-1986/88.

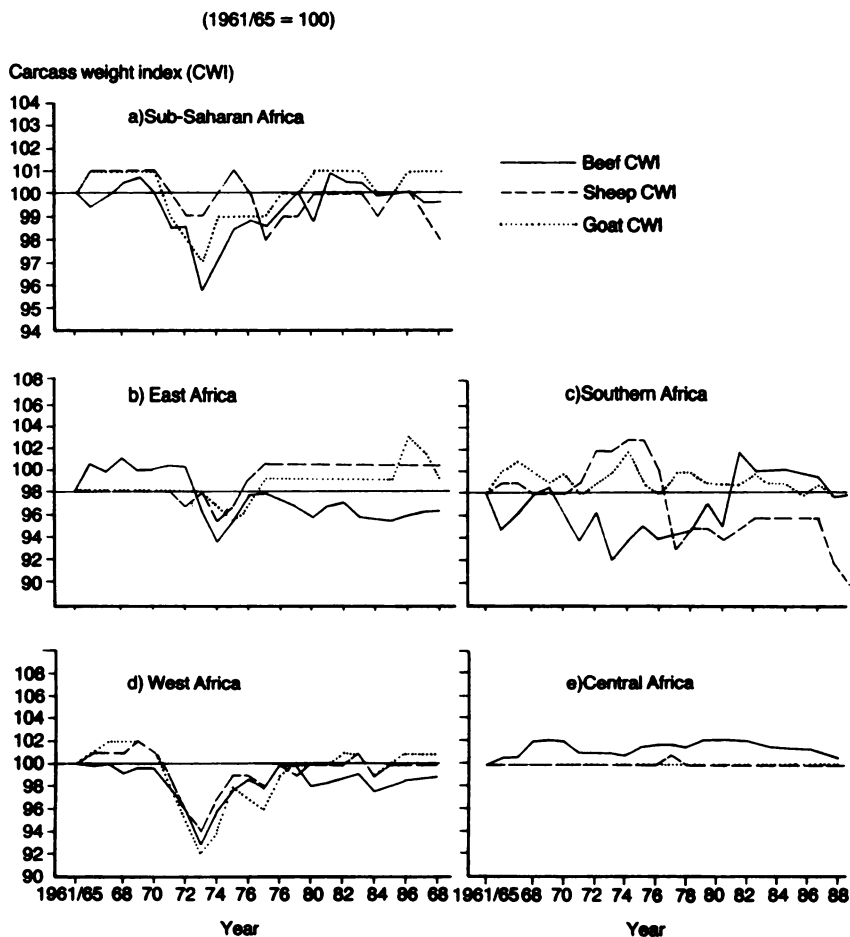
	Cattle			Sheep			Goats			Small ruminants		
	1961/6	1974/7	1961/6	1961/6	1974/7	1961/6	1961/6	1974/7	1961/6	1961/6	1974/7	1961/6
West Africa	-0.25	1.36	0.55	2.16	2.30	2.23	0.86	1.70	1.28	1.36	1.95	1.65
Central Africa	4.00	2.80	3.40	2.29	2.07	2.18	4.34	1.94	3.13	3.62	1.98	2.80
East Africa	1.93	1.55	1.74	1.14	2.01	1.58	0.87	2.07	1.47	1.01	2.04	1.52
Southern Africa	2.50	0.92	1.70	2.70	-0.26	1.21	5.00	0.55	2.75	4.13	0.28	2.19
SSA	1.56	1.49	1.53	1.58	2.04	1.81	1.25	1.83	1.54	1.39	1.93	1.66

Regional groupings are as defined in Table 1; growth rates are per cent annual growth rates calculated on the basis of 1961/65, 1974/76 and 1986/88 annual averages.

Source: Own computations based on FAO (1989) Production Tapes.

and 29.6%, respectively) and lowest in West and southern Africa (27.4% and 25.7%). A different picture presents itself for goat offtake rates in 1986/88, these being highest in West and southern Africa (35.6% and 31.3%, respectively) and lowest in East and central Africa (26.9% and 29.9%, respectively).

Figure 1. *Indices of mean beef, sheep and goat carcass weights in different regions of sub-Saharan Africa, 1961–88 (1961/65=100).*



Source: Drawn on the basis of FAO data (FAO 1989 Production Tape).

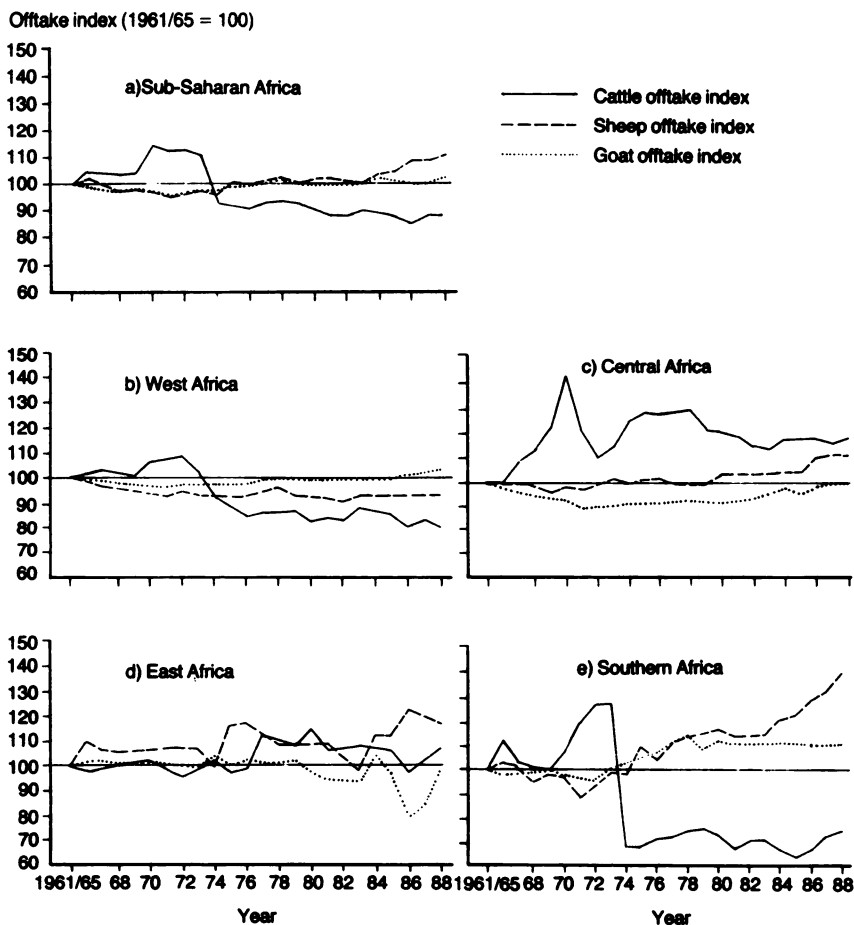
Figure 2 shows the evolution of small ruminant and cattle offtake indices in each region of SSA. From 1961/65 to 1973/74, smallstock offtake indices in SSA as a whole were lower than cattle offtake indices, but thereafter smallstock offtake indices was higher than cattle offtake indices. This trend was most pronounced in southern Africa, but was also evident in West Africa. Differences in the evolution of sheep and goat offtake rates are also apparent. For much of the 1960s and 1970s, sheep and goat offtake indices for SSA as a whole were similar. Around 1982 sheep offtake indices started to exceed goat offtake indices. The only exception to this generalisation was West Africa where goat offtake, though low, consistently exceeded sheep offtake.

While all this implies that smallstock, particularly sheep, are being slaughtered to a greater extent than cattle, the population and carcass weight trends that have accompanied offtake trends in some regions are cause for concern. Table 3 provides regional population, offtake and carcass weight growth rates for cattle, sheep and goats between 1974/76 and 1986/88. In West Africa, cattle offtake growth (1.15% p.a.) almost equalled growth in cattle population (1.36% p.a.) and exceeded growth in carcass yields (0.37% p.a.). In contrast, small ruminant offtake grow slower (at 0.39% p.a.) than either small ruminant numbers (1.95% p.a.) or carcass yields (0.69% p.a. on average). In view of this, the prospects for meeting future meat demand in this region through increased goat/sheep production may be envisaged.

The slow growth of cattle offtake (0.09% p.a.), in central Africa, was accompanied by an increase in cattle stocks (2.80% p.a.), and decline in carcass weights (-0.05% p.a.). This probably reflects this use of cattle for purposes other than meat production and factors constraining productivity increases in this predominantly humid region. Smallstock offtake grew at a relatively faster rate (0.53% p.a. for goats and 0.76% p.a. for sheep) in this region, and does not seem to have been detrimental to flock growth and productivity since small ruminant stocks increased (1.98% p.a.) and carcass weights were relatively stable (0.03% p.a. for sheep and 0.12% p.a. for goats). There would thus seem to be room for increasing small stock, particularly sheep, in this region provided that population and carcass weight trends remain favourable.

In East Africa, cattle offtake is declining (at -0.20% p.a.) and cattle number and carcass yield are increasing slowly (1.55% and 0.02% p.a., respectively). In spite of this region having large and growing small ruminant populations (2.03% p.a.) and rather favourable carcass weight trends (0.38% p.a.), small stock offtake has also grown slowly. The observed decline in goat offtake (-0.59% p.a.) is probably due to low demand for goat meat. The growth in sheep offtake (0.56% p.a.) suggests a greater reliance on sheep than on goats in this region. However, there is a need for more country-specific studies looking at unofficial slaughter, trade and constraints e.g. low productivity and vulnerability of smallstock to changing environmental, management and market conditions, before coming to definite conclusions about small stock offtake in East Africa.

Figure 2. Indices of mean cattle, sheep and goat offtake rates in different regions of sub-Saharan Africa, 1961–88 (1961/65=100).



* Offtake index = Slaughters as % of total stocks divided by 1961/65 annual base offtake rate times 100.

Source: Drawn on the basis of FAO data (FAO Production Tape 1988).

In southern Africa, cattle offtake is declining (-0.72% p.a.), as are carcass yields (-0.27% p.a.), and small offtake rates are increasing (at 1.14% p.a. for sheep and 0.75% p.a. for goats). This suggests some substitution of sheep/goat meat for beef. However, the slow growth, or declining of small ruminant stocks (0.55% p.a. for goats and -0.07% for sheep) indicates that current levels of offtake cannot be supported unless flock productivity is increased.

Table 3. Comparison of livestock offtake, population and carcass weight growth rates (% p.a between 1974/76 and 1986/88) in different regions of SSA.

	Cattle			Sheep			Goats		
	Offtake rate	Stocks	Carcass weight	Offtake rate	Stocks	Carcass weight	Offtake rate	Stocks	Carcass weight
West Africa	1.15	1.36	0.37	0.37	2.30	0.62	0.41	1.70	0.76
Central Africa	0.09	2.80	-0.05	0.76	2.07	0.03	0.53	1.94	0.12
East Africa	-0.20	1.55	0.02	0.56	2.01	0.48	-0.59	2.07	0.27
Southern Africa	-0.72	0.92	-0.27	1.14	-0.26	-0.07	0.75	0.55	0.01
SSA	0.14	1.49	0.03	0.53	2.04	0.49	-0.01	1.83	0.48

Offtake and carcass weights are as defined in text. Growth rates calculated on the basis of 1974/76 and 1986/88 average cattle, sheep and goat offtake rates, stocks and carcass weights.

Source: Own computations based on FAO (1989) Production Tapes.

Overall, the emerging picture is one of substantial regional differences in the evolution of offtake rates in SSA. Over the past decade, cattle offtake increased in West and central Africa while it declined in southern and East Africa. In contrast, small stock offtake increased in almost all regions, the only exception being East Africa where goat offtake declined between 1979 and 1986. Southern Africa had the fastest growing rates of offtake of small ruminants.

Meat production

Domestic production of small ruminant meat in SSA is hard to quantify because of lack of reliable data. The most complete available data on small ruminant meat production come from FAO which defines meat production as meat from animals slaughtered within national boundaries, irrespective of their origin. This includes the meat equivalent of imported animals and excludes that of exported animals. As such, it does not accurately represent domestic production. However, FAO production statistics adjusted for net trade in meat provide general indications of regional small ruminant meat production patterns and trends in SSA.

Table 4 presents 1986/88 estimates of total and per caput domestic production of sheep, goat and small ruminant meat in the four regions of SSA. East and West Africa accounted for 92% of domestic small ruminant meat production in 1986/88. A similar pattern was observed for per caput production. Goat meat production generally exceeded sheep meat production except in East Africa.

Table 4 also gives growth rates of per caput small ruminant meat production between 1961/65 and 1974/76, 1974/76 and 1986/88 and 1961/65 and 1986/88. Over the 1961/65–1974/76 period, per caput production declined at an average annual rate of 1.49% in SSA as a whole, annual growth rates being negative in East and West Africa (-1.89% and -1.71%, respectively) and positive in southern and central Africa (2.63% and 0.37%, respectively). Between 1974/76 and central Africa (2.63% and 0.3%, respectively). Between 1974/76 and 1986/88, per caput production declined in all regions of SSA. Considering that human populations grew fastest in East and West Africa between 1974/76 and 1986/88 (at rates averaging 3.08 and 3.19% p.a.), this suggests an increase in domestic small ruminant meat production in these regions.

Small Ruminant Trade

In most traditional systems of SSA, small stock are kept as a means of generating cash income, as well as a source of meat/milk for direct household consumption. A sizeable proportion of small ruminant trade is also carried out through unofficial marketing channels, at either village or regional levels. Given this production, consumption and marketing traits, reliable data on small ruminant trade flows in SSA are difficult to come by. The small ruminant trade presented in this section are based on aggregate FAO statistics and thus should be viewed with caution.

Table 4. Total and per caput small ruminant meat production¹ in SSA, 1986/88 and per caput small ruminant meat production growth rates between 1961/65 and 1986/88.

	Total production			Per caput production			Per capita SR meat prod. growth rates (% p.a)		
	Sheep meat	Goat meat	SR meat ²	Sheep meat	Goat meat	SR meat	1961/65-1974/76	1974/76-1986/88	1961/65-1986/88
	---('000 MT)---			---Kg/pers.)---					
West Africa	135	241	375	0.73	1.30	2.02	-1.71	-0.26	-0.99
Central Africa	17	30	47	0.25	0.44	0.68	0.37	-0.26	0.05
East Africa	263	201	487	1.91	1.46	3.46	-1.89	-0.77	-1.33
Southern Africa	6	26	32	0.19	0.71	0.90	2.63	-1.97	0.31
SSA	422	498	941	0.98	1.16	2.17	-1.49	-0.58	-1.03

1. SR meat production is defined as meat from sheep and goats slaughtered within national boundaries irrespective of their origin plus net exports of small stock (as live and meat). As goat trade figures were not available no such adjustment was made for goat meat.

2. SR meat production totals do not add up to the sum of sheep and goat meat production since they include net exports of live sheep and goats which are not disaggregated by species in FAO data.

Source: Own computations based on FAO (1988 and 1989).

Figures 3 and 4 show total imports and exports of sheep and goats in SSA and its four regions. Since FAO statistics do not differentiate between live sheep and goats and do not cover trade in goat meat, the information provided relates to imports/exports of fresh sheep meat and of live sheep and goats combined.

Small ruminant trade in SSA is not very substantial (Figure 3). In 1987, it involved a total of 44,118 t, almost 5% of the sub-continent's estimated total production of small ruminant meat in that year. However, differences are apparent in the composition and evolution of exports and imports. Of the total volume traded in 1987, 26 493 t, or 60%, consisted of exports and 17 625 t, or 40%, of imports. Small ruminant exports in SSA also appear to be subject to fluctuation which may reflect the influence of drought.

East and West Africa account for the majority of small ruminant exports (Figure 4). However, exports declined from 17 556 t in 1961/65 to 10 061 t in 1985/87 in West Africa, and rose from 12 559 t in 1961/65 to 23 326 t in 1985/87 in East Africa. This rapid expansion of exports in East Africa was probably the result of growing demand for small ruminant meat in the Near East in the late 1970s and 1980s (Schluter, 1984). Whether this demand was met through increased local small ruminant production or curtailment of domestic demand in this region cannot, however, be clearly ascertained.

West Africa accounted for the majority at small ruminant imports (Figure 4), although imports were markedly lower after 1961/65.

Between 1961/65 and 1987, West Africa moved from being a net exporter of live sheep and goats to being a net importer. The reverse was true in East Africa where net exports, especially of live sheep and goats, increased substantially. In southern Africa, small ruminant trade was limited; in the 1980's exports of live small stock virtually came to a standstill in this region while fresh sheep meat imports increased substantially. In central Africa small ruminant trade is insignificant.

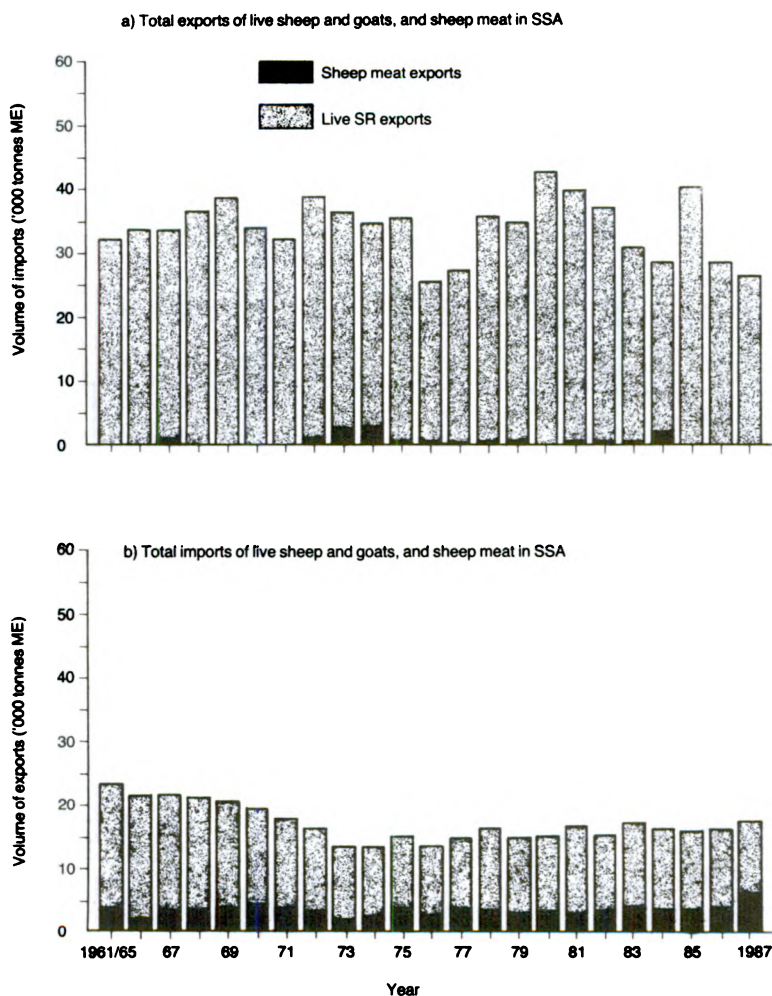
Consumption of Small Ruminant Meat

Total and per caput consumption

Aggregate consumption of small ruminant meat can be roughly estimated by adding up small ruminant meat production and net trade figures. However, in the particular context of SSA, limited coverage and unreliability of data render measurement of consumption difficult. The estimates of small ruminant meat consumption presented in this section are based on FAO data on slaughtered production and net trade in small ruminants and should therefore be seen as only rough indicators of consumption. Since FAO trade data were not available

Figure 3. Total imports and exports of small ruminants in SSA, 1961/65–87.

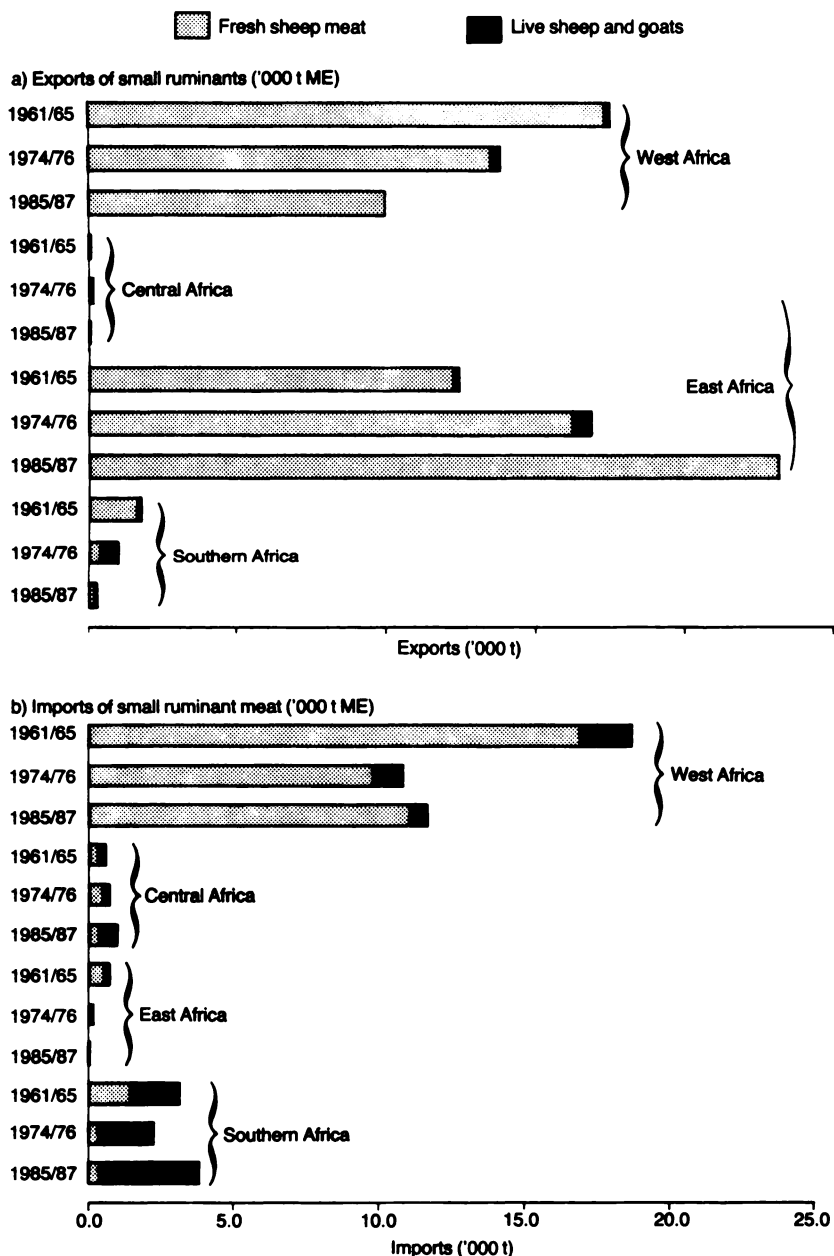
(in '000 tonnes of meat or equivalent)*



* Trade in live sheep and goats, and in sheep meat expressed in thousand metric tonnes of meat equivalent (ME)

Source: FAO Trade Tape (FAO 1988).

Figure 4. Regional trade in small ruminants in SSA, 1961/65, 1974/76 and 1985/87.



Source: FAO Trade Tape (FAO, 1988).

for 1988, average annual 1985/87 net export figures were deducted from 1986/88 production figures to get estimates of 1986/88 small ruminant meat consumption.

Table 5 presents 1986/88 estimates of total and per caput consumption of sheep, goat and small ruminant meat in different regions of SSA. In total, annual consumption of small ruminant meat in SSA amounted to 906 000 t, most of which was consumed in East (440 000 t) and West Africa (378 000). Goat meat consumption exceeded sheep meat consumption except in East Africa. Much of the same picture is observed for per caput small ruminant meat consumption (Table 5).

Growth rates

Based on the previous estimates, Table 6 presents annual growth rates of total and per caput small ruminant meat consumption in different regions of SSA between 1961/65 and 1986/88, and during the two split periods of 1961/65–1974/76 and 1974/76–1986/88. Between 1961/65 and 1986/88, total consumption of small ruminant meat in SSA grew at an average annual rate of 1.86%, growing faster in the 1974/76–1986/88 period (2.72% p.a.) than in the 1961/65–1974/76 period (1% p.a.). These rates reflect trends in West and East Africa, where total consumption growth was very slow between 1961/65–1974/76 (0.86% and 0.68% p.a., respectively), but picked up between 1974/76 and 1986/88 (3.18% and 2.45% p.a., respectively). In sharp contrast to East and West Africa, total consumption growth in southern Africa was very fast between 1961/65 and 1974/76 (4.41% p.a.), but slowed down substantially between 1974/76 and 1986/88 (1.62% p.a.). In central Africa, growth rates did not differ much between the two periods and total small ruminant consumption grew at an average rate of 2.69% p.a. 1961/65–1986/88. Though mostly negative, regional growth rates in per caput consumption of ruminant meat show similar trends.

The place of small ruminants in overall meat consumption

Given the previous picture of small ruminant meat consumption in SSA, there is a need to determine its importance in overall meat consumption. Figure 5, which is based on 1961/65, 1974/76 and 1986/88 average annual estimates of per caput consumption of the four major types of meat consumed in SSA i.e. beef, small ruminant, poultry and pig meat, gives an idea of the composition and evolution of meat consumption in SSA.

Beef is the dominant meat consumed in SSA, its share in meat consumption in 1986/88 ranging from as high as 57% in southern Africa to as low as 38% in West Africa. However, beef consumption seems to be declining in most regions of SSA, particularly in West Africa where its share in overall meat consumption fell from about 50% in 1961/65 to 38% in 1986/88.

Table 5. Total and per caput small ruminant meat consumption¹ in SSA, 1986/88.

	Total consumption			Per caput consumption		
	Sheep meat	Goat meat	SR meat ²	Sheep meat	Goat meat	SR meat ²
	----- ('000 t) -----			----- (kg/pers.) -----		
West Africa	136	241	378	0.73	1.30	2.03
Central Africa	18	30	49	0.26	0.44	0.70
East Africa	263	201	440	1.91	1.46	3.29
Southern Africa	13	26	39	0.33	0.71	1.04
SSA	430	498	906	1.00	1.16	2.13

1. Meat consumption is defined as meat from sheep and goats slaughtered within national boundaries irrespective of their origin minus net exports of sheep and goat meat. As goat trade figures are not available no such adjustment was made for goat meat consumption.

2. Totals do not add up to the sum of sheep and goat meat consumption due to deduction of net exports of live sheep and goats (carcass weight). FAO trade figures are not provided separately for sheep and goats.

Source: Own computations based on FAO (1989 and 1988).

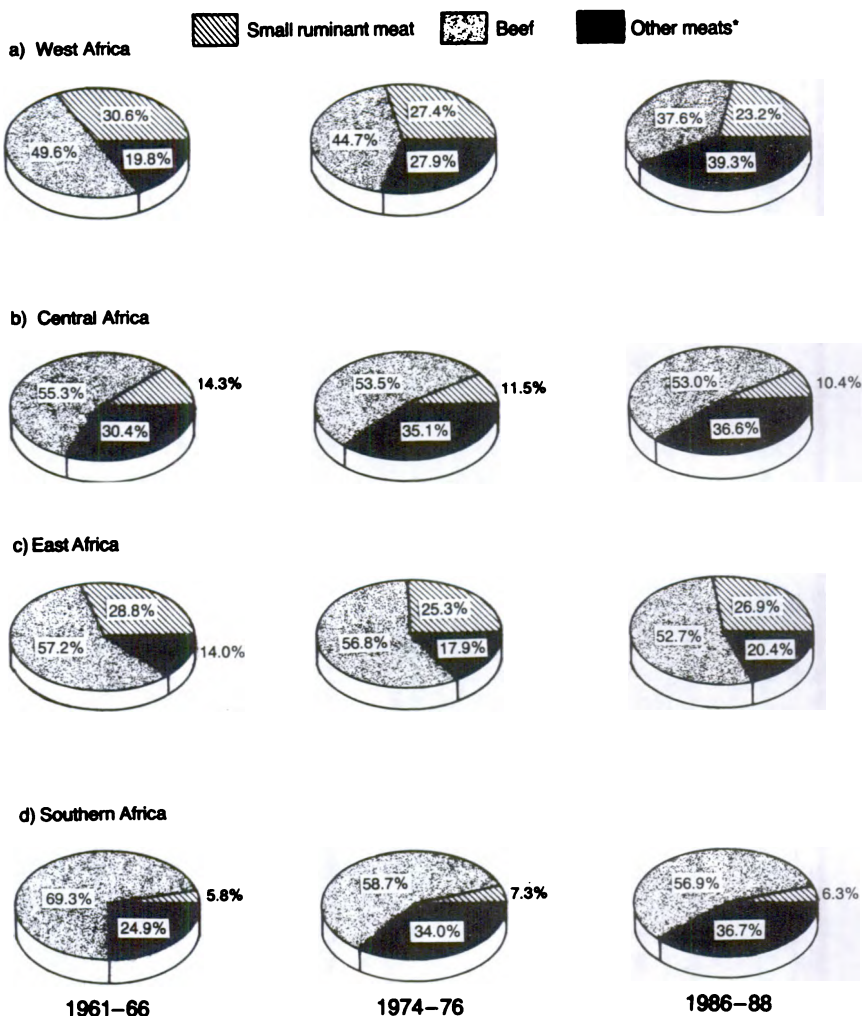
Table 6. Annual growth rates ¹ of total and per caput small ruminant meat consumption in SSA between 1961/65 and 1986/88.

	Total SR meat consumption			Per caput SR meat consumption		
	1961/65- 1974/76	1974/76- 1986/88	1961/65- 1986/88	1961/65- 1974/76	1974/76- 1986/88	1961/65- 1986/88
West Africa	0.86	3.18	2.01	-1.98	-0.01	-1.00
Central Africa	2.63	2.75	2.69	0.33	-0.31	0.01
East Africa	0.68	2.45	1.56	-2.07	-0.39	-1.23
Southern Africa	4.41	1.62	3.00	1.97	1.43	0.26
SSA	1.00	2.72	1.86	-1.68	-0.26	-0.98

1. Growth rates are per cent annual growth rates calculated on the basis of 1961/65, 1974/76 and 1986/88 annual average total and per caput SR meat consumption levels.

Source: Table 5 and own computations.

Figure 5. Structure of meat consumption in SSA by region, 1961/65, 1974/76 and 1985/87.



* Other meats include pig and poultry meat.

Source: Adapted from FAO data (FAO 1988 and 1889).

In 1961/65, small ruminant meat accounted for between 6% and 31% of total meat consumption in the four regions. In recent years, poultry and pig meat have come to account for a significant and increasing portion of meat consumption, especially in West and southern Africa. The reasons behind these consumption patterns and trends are not very clear.

Conclusion

This report has looked at aggregate patterns and trends in production, and trade in and consumption of small ruminant meat in SSA between 1961 and 1988. The evidence presented shows that small ruminant meat production and consumption are greatest in East and West Africa, and are of only minor importance in central and southern Africa.

Observed regional trends indicate that domestic production of small ruminant meat has failed to keep pace with demand, especially in southern Africa. Over the past decade, southern Africa's meat production performance has been particularly poor, calculated growth rates for beef, pig and small ruminant meat production in this region between 1974/76 and 1986/88 averaging -0.81, 1.96 and 0.65% p.a., respectively. Only poultry meat production growth (4.14% p.a.) exceeded the region's human population growth rate of 2.89% p.a. Thus per caput production and consumption of small ruminant meat appear to be declining in most regions of SSA.

This situation is largely the result of production, environmental and socio-economic constraints bearing upon a traditional production system which has been accorded a low priority in livestock and agricultural development plans in SSA. Almost all small ruminant meat comes from traditional production systems.

In some areas of SSA, regular offtake of sheep/goats appears to have been excessive in relation to such parameters as the size, structure, growth and productivity of flocks. In other areas, however, there appears to be room for increasing small stock offtake. All this emphasises the need for viewing the means by which sustained small ruminant production and consumption in SSA are to be achieved in the wider context of the varying and changing environmental and socio-economic conditions prevailing in the sub-continent.

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Short-run demand for goat meat in Cameroon

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Abstract

An analysis of the quantity-price and income relationship, and consumer reactions at the retail level of goat meat is presented. A demand model was developed using either the linear, semi-logarithmic or double-logarithmic functional forms.

Demande à court terme de viande caprine au Cameroun

J.P. Ayissi Mbala

Résumé

Cette communication présente une analyse des relations entre la consommation de viande de chèvres, son prix et le revenu au Cameroun, ainsi que les réactions des consommateurs au niveau du commerce de détail. Un modèle de demande est développé en utilisant des fonctions linéaires, semi-logarithmique et logarithmique double.

Introduction

In Cameroon, the consumption of meat and other livestock products is particularly affected by the geographical setting of the country. The livestock producing areas are located far away from the main consumption areas of the South. This situation, coupled with the poor system of husbandry and the inadequate marketing infrastructure, has resulted in an insufficient supply of meat from all types of livestock.

During the early part of the past decade, Cameroon experienced a rapid increase in population (3.0%) as well as a steady increase in the Gross Domestic Products. Recent estimates indicate that the domestic meat supply has not been able to meet the internal demand. Table 1 reveals a shortage of 55.7 thousand tons of meat from all livestock species. Another factor which affects the consumption of meat in the country is the uneven distribution of the available supply. This situation is indicated in Table 2. Regions situated further away from the producing areas receive very little meat from any source. Consequently, it is evident that as a result of its geographical setting and other related problems, the country's domestic demand for meat and livestock products is unlikely to be met, if emphasis is placed as it is at present, on cattle production alone.

Table 1. *Supply and demand for meat by province (1986/87).*

Provinces	Population 1986 ('000)	Total meat demand (tons)	Total meat production (tons)	Balance (tons)
Extreme north	1 727.5	26 586.2	22 396.5	- 4 189.2
North	607.5	9 349.4	7 876.5	- 1 472.6
Adamaoua	422.5	6 502.3	26 270.0	19 767.7
East	475.9	7 324.0	7 144.0	- 180.1
North-west	1 221.5	18 798.9	16 967.4	- 1 831.5
West	1 330.3	20 473.3	9 111.3	-11 362.1
Subtotal	5 785.2	89 034.2	89 766.0	731.7
South-west	824.7	12 692.1	1 517.2	-11 175.0
South	406.6	6 257.6	1 344.6	- 4 913.0
Littoral	1 677.6	25 818.3	4 176.2	-21 642.0
Central	1 742.3	26 967.9	8 248.1	-18 719.8
Subtotal	4 661.2	71 735.9	15 286.0	-56 449.9
Total	10 446.4	160 770.1	105 052.0	-55 718.1

In Cameroon, sheep and goat production ranks first among ruminants in terms of numbers, although in terms of total meat output they are second to cattle. According to recent estimates there is a total of 437 thousand goat and 240 thousand sheep farms with populations of 3.5 million and 1.5 million, respectively

(MOA, 1984). The figures indicate that goat and sheep production is a major economic activity in terms of the number of people employed and as a source of revenue, especially in the main producing areas of the country. Consequently, it is imperative that all the available types of livestock be exploited. It is also important that the potential demand for the various types of meat should be estimated so as to evaluate their marketing potential. This is necessary for effective planning of future livestock development programmes.

Table 2. *Total meat production and animal species by region (1986/1987).*

Provinces	Beef (tons)	Mutton (tons)	Goat meat (tons)	Pork (tons)	Poultry (tons)	Total (tons)
Extreme north	13 408	4 378	2 831	346	1 333	22 396
North	5 492	727	780	344	534	7 877
Adamaoua	25 360	375	303	38	194	26 270
East	3 795	465	608	1 798	478	7 144
North-west	11 640	718	328	2 140	2 142	16 967
West	3 991	628	1 729	1 852	912	9 111
Subtotal	63 686	7 291	6 678	6 518	5 593	89 766
South-west	93	73	153	923	275	1 517
South	6	251	424	395	269	1 345
Littoral	55	12	9	1 983	2 118	4 176
Central	514	192	432	1 365	5 745	8 248
Subtotal	668	528	1 017	4 666	8 407	15 286
Total	64 354	7 819	7 695	11 184	14 000	105 052
Per cent	61.3	7.4	7.3	10.6	14.3	100

If the production of goat meat has to be increased as a measure for alleviating the shortage in the present meat supply, it is important to determine its demand in relation to other types of meat in the country. This is necessary because consumer reaction to goat meat should be taken into consideration by government and other interested bodies in planning future investments in livestock development. This paper attempts to evaluate consumers' response with respect to price changes in goat meat and other types of meat as well as the effects of increasing income on consumption. Due to lack of accurate data relating to the consumption of all types of meat, the analysis is limited to only two principal types of meat (goat meat and beef) for which data were available.

Materials and Methods

The analysis is based on official time series data covering a period of twelve years. This period may statistically be regarded as inadequate to guarantee a satisfactory estimate of the demand for the product. It may be argued that such an exercise which has the initial constraint of limited data is subject to a wide margin of error. On the other hand, it is also a fact that observations covering a long period of time pose some statistical and economic problems of analysis. In this respect, it is important to note that factors affecting demand do change over time and therefore estimates based on long periods of observations may not reflect these changes. However, it is hoped that subject to the methodology and the analytical techniques used, the results obtained here will be indicative of the true situation and will serve as a pioneering attempt.

The principal factors affecting the demand for meat in general include:

- a) the amount and distribution of per capita income in the population
- b) the availability and prices of substitutes
- c) the retail price of the commodity.

There are, however, other factors such as tastes, consumer preferences for different cuts of meat, religious and traditional affiliations of the people and other not easily quantifiable factors. In this paper, the demand for goat meat and the effects of income, price and substitutes on consumption are the major consideration in the analysis.

The per capita consumption of goat meat is taken as the dependent variable. The total consumption figures used are the annual time-series data of the official slaughter of goats. These are published in the annual reports of the Ministry of Livestock and Animal Industries. It is perhaps important to mention that these slaughter figures may not represent the actual consumption of goat meat. This is because a substantial number of goats is slaughtered privately for home consumption especially during festivities such as funeral ceremonies, marriages etc. However, since these private slaughters do not enter the marketing system, they are not directly guided by the normal market forces of supply that only the official marketed stock may be affected by the main factors that cause variations in demand.

In order to obtain the per capita consumption, the recorded number of goats slaughtered is converted into kg equivalent for fresh goat meat by using a mean carcass weight, which in the case of goats in Cameroon has officially been estimated at 12 kg (1966–1979). The yearly totals of fresh goat meat are then divided by the estimated population to obtain the per capita consumption.

The independent variables constitute the per capita income and prices. Income is a very important factor in the study of the demand for food and other agricultural

products but the problems it presents in most demand studies result from the concept and actual definition of income. However, for the purpose of this paper, income is defined as the "real income". This means that the actual money incomes as represented by the values of the GDP have to be deflated by an inflation factor. This inflation factor is taken to be the consumer price index. In other words, the formula for estimating 'real income' is as follows:

$$\text{Real income} = \frac{\text{Per capita income}}{\text{Consumer price index}} \times 100$$

The prices used in this analysis are the average annual retail prices of the various types of fresh meat. These are also published by the Office of Statistics in the Ministry of Livestock and Animal Industries. These prices were also deflated by the consumer price index in order to make adjustments for changes in the money values. The prices obtained can therefore be termed 'real price'. According to the theory of consumption, an equal percentage change in the prices of all commodities as well as in the money incomes of consumers should not disturb the pattern of quantities demanded or consumed (Fox, 1968).

The demand model developed for analysis is based on the fact that the quantity of purchased goat meat consumed per head of the population can be said to be a function of the price of goat meat, the real per capita income of the population, the price of beef and a disturbance term (U). Beef has been chosen as a substitute since it is, from *a priori* knowledge, the most popular though expensive type of meat in the country. The production and marketing of mutton is comparatively marginal relative to goat meat and the pork consumption is also heavily influenced by religious inclinations. These two types of meat have not been considered in the analysis. The demand model can, therefore, be represented in the following function form:

$$C_{gmt} = f(P_{gmt}, P_{bt}, Y_t, U) \quad (1)$$

Where:

C_{gmt} = per capita consumption of goat meat in time t

P_{gmt} = price of goat meat in time t (in francs CFA)

Y_t = income per capita in time t

P_{bt} = price of beef in time t

U = disturbance term. The term is assumed to be normally and independently distributed with a mean zero and unit variance.

In estimating the demand for meat and other food products, several statistical methods and techniques have been developed to determine the relationship between consumption, income and prices. These methods and techniques have

their advantages and limitations. For this paper, the linear function, the semi-logarithmic function, and the double-logarithmic function were tried.

The functions were employed in a least square multiple regression analysis so as to find out which of the function best fits the available data. The three functional forms were then transformed into the following estimating equations:

a) Linear equations:-

$$Cgm = a + b_1 Pgmt + b_2 pbt + b_3 Yt \quad (2)$$

b) Semi-logarithmic equation:-

$$Cgm = a + b_1 \text{Log } Pgmt + \text{Log } Pbt + b_3 \text{Log } Yt \quad (3)$$

c) Double-logarithmic equation:-

$$\text{Log } Cgm = a + b_1 \text{Log } Pgmt + b_2 \text{Log } Pbt + b_3 \text{Log } Yt \quad (4)$$

Where a = the constant term (point of intercept)

$b_1, \dots, b_3$ = regression coefficients of the explanatory variables.

It is believed that statistical data can only trace a theoretical demand curve if that curve (demand) remains fixed while the supply curve shifts (Oni, 1972). In the present case, it cannot be claimed that the demand schedule for goat meat in the country has remained fixed, but the slaughter data exhibits a less violent fluctuation when compared with the limited market offtake by the producers. Consequently, it can be assumed that the statistically derived demand function will trace out the true demand for goat meat in the country. This identification problem and the possible remedies have been considered by Johnston (1963) and Fox (1968).

Furthermore, from *a priori* knowledge of the situation, the price of goat meat at the retail does not bear any relationship to producer prices. This is because the producer prices are somewhat officially predetermined and there is also the limitation of the willingness of producers to sell a set of drawings at each point of time. In other words, the impossibility of repeated drawing as envisaged in the notions of probability and statistical inference would not necessarily constitute any serious obstacle to make generalisations on the results obtained from the data used.

Results and Discussion

Of the three estimating equations tested, the linear and double-log functions were selected for further analysis. This is because they largely satisfied the *a priori* expectations of the demand for goat meat. The results obtained from the two equations are presented in Tables 3 and 4, respectively. The two equations were

further subjected to a series of combinations. Since one of the major objectives of the analysis was to determine the effects of price and income on the consumption of goat meat, it is important to know their separate effects upon the dependent variables. This would be difficult if the explanatory variables are highly correlated.

Table 3. *Regression results explaining the demand for goat meat using the linear function.*

Dependent variable	Constant term	Real income per capita (y)	Price of goat meat (Pgmt)	Price of beef (pbt)	Price ratio	R ²	Drot statistics
i) Cgmt ¹	-3.820	0.189 ⁺⁺	-	-	-	0.88	1.31
	SE						
	t. ratio						
ii) Cgmt	-3.690	0.260 ⁺⁺	-1.595	-	-	0.92	2.06
	SE	(0.035)	(0.672)				
	t. ratio	7.43	2.37				
iii) Cgmt	-3.832	0.256 ⁺⁺	-1.618	0.114	-	0.93	2.05
	SE	(0.041)	(0.720)	(0.053)	-		
	t. ratio	6.24	2.25	0.21			
iv) Cgmt	-6.491	0.197 ⁺⁺	-	-	1.508 ⁺	0.92	2.07
	SE	(0.019)			(0.666)		
	t. ratio	10.36			2.26		

++ = significant at the 1 per cent level.

+ = significant at the 5 per cent level.

1. Cgmt = per capita consumption of goat meat in time t.

Nonetheless, in order to carry out the exercise of identifying the individual effects of the independent variables, the stepwise multiple regression technique has been employed in the two estimating equations.

Furthermore, the price ratio of beef and goat meat was introduced into the equations as a separate explanatory variable. This technique makes it possible to identify the individual as well as the cumulative or additional effects of the regressors on the dependent variable. The process of eliminating some of the variables from the equations also served as a means of reducing the multi-collinearity between them. In view of the fact that time-series data are susceptible to auto-correlated errors, the residual were also calculated and the various equations were tested for their presence by the Durbin-Watson statistics (Dwt).

Table 4. Regression results explaining the demand for goat meat-using the double log function.

Dependent variable	Constant term	Log per capita income (Yt)	Log price of goat meat (pgmt)	Log price of beef (pbt)	Log price ratio beef/ goat meat Pb/pgmt	R ²	Drot statistics
i) Log Cgmt ¹	-2.605	1.973 ⁺⁺	-	-	-	0.83	1.11
	SE	(0.285)					
	t. ratio	6.92					
ii) Log Cgmt	-3.393	2.566 ⁺⁺	-0.602	-	-	0.85	1.28
	SE	(0.565)	(0.499)				
	t. ratio	4.54	1.21				
iii) Log Cgmt	-2.929	2.058 ⁺⁺	-0.901 ⁺	0.947 ⁺	-	0.90	2.32
	SE	(0.533)	(0.444)	(0.441)	-		
	t. ratio	3.86	2.03	2.15			
iv) Log Cgmt	-2.954	2.084 ⁺⁺	-	-	0.898 ⁺⁺	0.89	2.12
	SE	(0.239)			(0.264)		
	t. ratio	8.72					

++ = significant at 1 per cent level.

+ = significant at 5 per cent level.

1. Cgmt = per capita consumption of goat meat in time t.

From the estimating functions of the equations presented in Tables 3 and 4, the equation (iii) in Table 4 from the double-log function was selected as the lead equation. This is because it contains all the important explanatory variables and fulfills most of the *a priori* expectations on the demand for goat meat. The coefficient of the price variables and that of income have the correct negative and positive signs, respectively, and they are significantly different from zero and statistically significant at 1 per cent. Their residuals are not auto-correlated as tested by the Durbin Watson statistics (Dwt). The joint effects of all the explanatory variables of the equation is to explain 90 per cent of the variation in the dependent variable and coefficient of multiple determination (R²) is highly significant (0.90). Furthermore, the standard errors of estimates are relatively low.

In order to properly analyse and draw reasonable conclusions on the consumption of goat meat in terms of quantity-price and income relationships, it

is necessary to estimate also the price and income elasticities of demand. The different elasticities from the estimating functions were consequently calculated as follows:-

From the linear function:

$$\text{Direct price elasticity} = \frac{dcgm}{dpgm} \times \frac{Pgm}{cgm}$$

$$\text{Cross price elasticity} = \frac{dcgm}{dpb} \times \frac{Pb}{cgm}$$

$$\text{Income elasticity (Ey)} = \frac{dcgm}{dy} \times \frac{y}{cgm}$$

The various elasticities were calculated at the mean values of the variables. In the double-logarithmic function, the regression estimates of the coefficients of the appropriate variables are taken as the direct elasticities. The various elasticity estimates from the two functions are presented in Table 5.

In the literature, very little attention has been given to goats in economic research. Consequently, there are few estimates of income elasticity of demand for goat meat. In many cases, even in countries where goat is popular, the income elasticity is calculated jointly with mutton and lamb. Table 6 shows various estimates of the income elasticities of demand for the different types of meat in some African countries. The income elasticity estimates for mutton and lamb (which often includes goat meat) in some of these countries are similar to those obtained from our equations and it might be said that the consistency of the results presented in Table 5 leads to some credibility to the estimates.

The direct price elasticity of demand for goat meat (EPgm) has the correct negative sign in each of the estimating equations. With reference to the lead equation (iii) of the double-log-function, the direct price elasticity is -0.90. This can be taken as almost unit elasticity in terms of price. It indicates that goat consumption will increase by 0.9 per cent if the price falls by 1 per cent. The cross price elasticity of goat meat and beef has the correct positive sign and is also close to unity (0.95). This implies that the demand for goat meat has approximately unit elasticity in relation to the price of beef. This agrees with *a priori* expectations and knowledge of the actual marketing situation of goat meat in the country. As a result of the limited supply of beef in most parts of the country and the consequent increase in beef prices, the demand for goat meat has increased rapidly in recent years. Furthermore, the positive sign of the cross price elasticity with (Epb) confirms the fact that beef and goat meat can be taken as substitute products.

Table 5. *Estimates of price and income elasticities of demand for goat meat.*

Functional form	Direct price elasticity (E _p gm)	Cross price elasticity with beef (E _{Pb/pgmt})	Income elasticity (E _y)
Linear function	-0.85	0.84	2.3
Double-log function	-0.90	0.95	2.05

Table 6. *Some estimates of income elasticity of demand for different types of meat in some African countries.*

Country	All meat	Beef	Lamb	Pork	Poultry
Sudan	0.90	0.60	1.50	—	1.00
Gabon	0.82	1.20	1.00	1.00	1.00
Chad	0.85	0.90	0.80	1.00	1.00
Nigeria	1.13	1.30	1.20	1.20	1.00
Ghana	0.98	1.30	1.50	1.00	1.00
Sierra Leone	1.20	1.50	1.50	1.20	1.00

Source: FAO (1974).

The income elasticity of demand for goat meat is also positive and far greater than unity (2.1). It signifies that with any 1-per cent increase in income, the consumption of goat meat is likely to increase by 2.1 per cent. On the whole, the demand estimates indicate that goat meat is almost price- and highly income-elastic.

Policy Implications

Although the demand estimates reveal a high income elasticity, it is perhaps important to remark that the estimated increase in the consumption of goat meat will occur only if the distribution of income continue in the present proportion. On the other hand, if the increased income goes to the wealthier section of the population, the increased consumption of goat meat will involve only the privileged few who can afford it rather than the majority of the population. Furthermore, with almost a unit cross-price elasticity with beef, increased consumption of goat meat will depend on the price of beef which generally is regarded as a superior type of meat. The implication of this situation is that if the production of goat meat is to be increased as a measure of increasing the overall supply of meat in the country, it is important to adopt a cheaper and efficient method of production and marketing than it is at present. This is necessary

because any increase in the consumption of goat meat will depend greatly on its price relation with beef. Goat meat has to be produced and marketed at competitive prices with beef and perhaps that of meat. It is also important to note that government policy of fixing producer prices may not necessarily serve as incentive for increasing production, especially if the fixed prices do not bear any relationship with prices at the retail level.

The importance of goats as a source of meat supply in the country has been revealed and from the demand analysis, there is the need to determine the cost effectiveness in goat production as a necessary condition for increased output. Finally, it is important to remark that any effort undertaken by the State or individuals at stepping up inter-regional production and improving the efficiency and distribution of goat meat will be consistent with the economic growth as well as the nutritional requirements of the country as a whole.

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Intra-annual sheep price patterns and factors underlying price variations in the central highlands of Ethiopia

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Abstract

Nine key Ethiopian central highland markets were surveyed for a period of one year beginning in January and ending in December of 1989 to determine the effects of certain animal and market characteristics on price and the pattern of sheep prices in relation to seasons. Each market was surveyed once a week on the main market day. Price, weight, sex, age, colour, condition score, breed and buyers' purpose were recorded for all completed transactions. A total of 50 062 cases were recorded.

Three markets, each representing redistributive, intermediate and terminal markets, as identified by buyers' purpose were chosen for further analysis. Considerable weekly price variation was evident. Animal characteristics (weight, age, condition, sex, colour) as well as buyers' purpose and seasons were variably important in explaining variations in price among animals within weeks. Variations in the composition of these characteristics from week to week were among factors underlying changes in weekly mean prices. R^2 varied from 0.2659 to 0.3583 for price-per-kilogram model and from 0.7822 to 0.8413 for price-per-head model in the three markets.

Facteurs affectant les variations intra-annuelles du prix des ovins dans les hauts plateaux éthiopiens

Kebede Andargachew et Ray Brokken

Résumé

Neuf marchés des hauts plateaux éthiopiens ont été suivis en 1989 pour analyser l'effet des caractéristiques des animaux des marchés et des saisons sur le prix des moutons. Le principal jour de marché chaque semaine, le prix, le poids, le sexe, l'âge, la robe, l'état corporel, la race et la raison d'achat de tous les animaux vendus ont été enregistrés (50 062 ventes au total).

Trois marchés, chacun représentant un marché de redistribution, intermédiaire et terminal, ont été choisis pour l'analyse. Les variations hebdomadaires de prix sont importantes. Les caractéristiques des moutons (âge, poids, robe, sexe, état corporel), la raison d'achat et les fêtes expliquent de façon variable les variations de prix chaque semaine. D'une semaine à l'autre, le prix hebdomadaire moyen varie avec la composition de ces caractéristiques. Pour les trois marchés, R^2 varie de 0,2659 à 0,3583 pour le modèle du prix au kg et de 0,7822 à 0,8413 pour celui du prix par animal.

Introduction

The central highlands of Ethiopia represent an important sheep producing area accounting for 75 per cent of the nation's flock. Central highland farmers generally consider livestock a more reliable form of wealth than other alternatives. An average of three head of sheep are slaughtered per year per family. About 40 per cent of farmers' cash income from animal trade is accounted for by sale of sheep (Gryseels, 1988).

Development activities of the Ministry of Agriculture (MOA) have focused mainly on distribution of crossbred rams in limited parts of the country. The Institute of Agricultural Research (IAR) and the International Livestock Centre for Africa (ILCA) undertake research activities with the aim of improving productivity of indigenous sheep through a combination of improved management, feeding, genetic selection and health care. The ultimate goal of such interventions is to improve the welfare of producers through increased production and income. Interventions addressing increased production need to consider the market aspect simultaneously.

Farmers benefit from efficient markets which transmit information and ensure minimum marketing margins. Farmers need to be aware of the preferred characteristics of animals as well as price patterns so that they can plan breeding and fattening programmes and breed selection consistent with the best seasonal prices and consumers' preferences.

There is very little literature on marketing of small ruminants in Ethiopia. Ayele Gebre-Mariam and Hillmann (1975, unpublished) tried to determine, factors affecting differences in price levels in a given market and between markets at various rounds of (a central highlands livestock) survey. The most vivid shortcoming of this study was that the data were collected during an abnormal (drought) year and as a result its conclusions may not necessarily be representative.

The objectives of the present study are to: (i) determine overall market composition by basic animal characteristics, (ii) determine intra-annual price patterns and factors underlying intra-annual price variations.

In the central highlands, as in nearly all other parts of the country, there is no regular market information on prices and supplies, nor formalised grades and standards. Agreement on price is reached by a long one-on-one bargaining between a seller and a buyer. Animals are sold on a per-head basis. Under such circumstances, prices paid will reflect buyers' preference for various animal characteristics (sex, weight, age, condition, breed, colour), the purpose as to whether the animals are purchased for consumption, breeding, the season of the year and the bargaining skills of buyers and sellers.

Materials and Methods

Nine key central highland markets most of them purposively selected to capture the main pattern of movement of sheep and benefit from ILCA's outreach research stations were included in a sheep market survey. The survey was undertaken on the main weekly market day for a period of one year (January to December 1989). Due to technical reasons, the survey in a few markets was started and completed a few weeks later. The survey at Degollo was interrupted much earlier due to security problems.

All completed transactions on ordinary market days and as many completed transactions as could be tracked on festival market days were recorded at the exit gate if fenced, or at one or two of the most frequented departure routes if open market places. This procedure minimised enumerators' decisions about sampling. A festival market was represented by two market days: the market falling on the festival day (or the market closest to the festival day) and the one preceding it. Price, weight, sex, age, condition, colour, number offered and sold, buyers' purpose, buyer and seller type, and time of sale were recorded. In all, 50 062 animals were recorded (Shola 6453, Addisu Shola 1922, Debre Berhan

8609, Deneba 7326, Enewari 3638, Degollo 7808, Ginchi 9263, Debre Zeit 3619, Dejen 1424).

Age was approximated by the type and number of teeth. Condition was assessed by the different degrees of fatness on and around the back bone, in the loin area and the last rib, and above the kidney (Carles, 1983). While Carles discussed six conditions scores, only four ranging from one for poor to four for very fat sheep were used in the present study.

This condition scoring technique was designed for thin-tailed sheep and might not be the most appropriate for the type of sheep found in the central highlands. However, uniformity of condition scores was ensured by repeated comparisons of the scores of different enumerators for given flock of sheep. No official scoring technique has been established for Ethiopian fat-tailed sheep, to the authors' knowledge.

Due to the difficulty in identifying specific breeds in the market place, sheep were classified into: hairy thin-tailed, woolled thin-tailed, fat-tailed and fat-rumped (Minutes of the National Technical Committee on National Sheep Research and Development Policy, Addis Ababa, 1974 unpublished).

To select representative markets for analysis the markets included in the survey were classified on the basis of buyers' purpose (for approaches used in market classification see for example: Herman Tilahun, 1979; Solomon Bekure and Negussie, 1983). All the markets included in the survey fall into terminal or redistributive categories (Table 1). Although classified as a terminal, the Debre Berhan market was almost equally important as a redistributive market. Shola and Degollo, the most typical terminal and redistributive markets, respectively, and Debre Berhan, an intermediate market, were selected for analysis.

Table 1. *Classification of markets by major purpose of purchasing.*

	Purpose of purchasing (%)		
	Reproduction & fattening	Slaughtering	Resale
Redistributive markets			
Degollo	10.40	8.50	81.10
Ginchi	16.20	26.10	57.70
Enewari	12.30	34.70	53.00
Deneba	25.00	25.90	49.10
Terminal markets			
Addisu Shola	0.20	98.80	1.00
Shola	1.20	98.50	0.30
Dejen	2.00	97.00	1.0
Debre Zeit	9.40	90.10	0.50
Debre Berhan	7.70	46.70	45.60

The following equation was estimated in order to determine factors affecting sheep prices for each of the markets selected for analysis.

$$\begin{aligned}
 P = & b_0 + b_1W + b_2W^2 + b_3T + \overset{9}{Eb_1F_1} + \overset{11}{Eb_1S_1} + \overset{16}{Eb_1A_1} \\
 & + \overset{19}{Eb_1C_1} + \overset{22}{Eb_1K_1} + \overset{25}{Eb_1R_1} + b_{26}(W*T) + \overset{28}{Eb_1(W*S_1)} \\
 & + \overset{33}{Eb_1(W*A_1)} + \overset{36}{Eb_1(W*C_1)} + \overset{39}{Eb_1(W*R_1)} + \overset{45}{Eb_1(W*F_1)} \\
 & + \overset{47}{Eb_1(T*S_1)} + \overset{52}{Eb_1(T*A_1)} + \overset{55}{Eb_1(T*C_1)} + e_i
 \end{aligned}$$

Where:

P = price per kilogram in Ethiopian Birr, W is weight in kilogram, T is time in week; F, S, A, C, K and R are dummy sets signifying season, sex, age condition, colour, and purpose of buying, respectively. The b_i s are structural parameter of the equation.

Results and Discussion

Overall market composition by basic animal characteristics

Sex distribution of sheep sold varied from market to market (Table 2). Male sheep were dominant at the terminal and redistributive markets. Female sheep made the largest proportion in the intermediate market. Castrated sheep were second in importance to entire males in the terminal market but of little significance in the other markets.

In general, sheep sold in the central highlands were mainly lambs of less than a year age. Relatively higher proportions of young sheep were recorded in the redistributive market. Sheep of average condition were dominant in all markets. The terminal market had the largest proportion of fat and very fat sheep. The largest proportion of poor sheep were recorded at the intermediate market. Colour variability was less pronounced than other animal characteristics. All sheep were fat-tailed type at the intermediate and redistributive markets and this type also predominated in the terminal market. Fat-rumped sheep represented only a very small proportion in the terminal market.

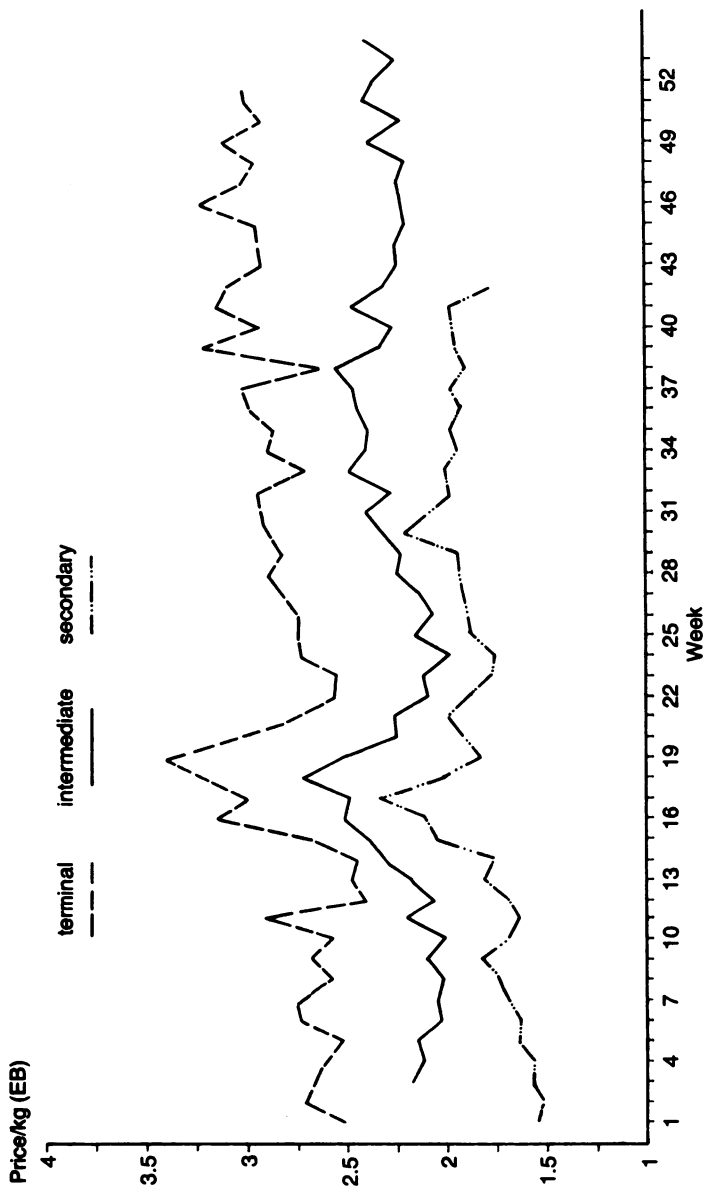
Table 2. *Percentage market composition of central highland markets by animal characteristics and type of market.*

Animal characteristics	Type of market		
	Terminal market	Intermediate market	Redistributive market
A. Sex:			
Male	50.5	43.0	56.4
Castrate	38.5	9.9	4.2
Female	11.0	47.1	39.4
B. Age (year):			
< 1	62.4	72.8	86.0
2	26.6	6.9	4.8
3	2.4	6.1	2.1
> 4	8.6	14.2	7.1
C. Condition:			
Poor	13.6	29.8	5.6
Average	55.3	64.9	90.0
Fat	21.1	4.9	4.1
Very fat	10.0	0.4	0.3
D. Colour:			
White	28.0	19.0	20.6
Brown	29.0	35.3	34.4
Black and white	11.6	24.0	11.6
Black and other	31.4	21.7	33.4

Intra-annual sheep price pattern

Considerable weekly mean price variation was apparent in the three markets (Figure 1). Average prices were highest in the terminal market and lowest in the redistributive market throughout the survey period. Overall annual mean prices per kilogram for the terminal, intermediate and redistributive markets were 2.84, 2.26 and 1.85 Birr, respectively. The highest weekly mean price per kilogram for the terminal market occurred during Id-al-fater (Ramadan) which fell a week after the Ethiopian Easter. The highest price per kilogram for the intermediate market occurred during the Ethiopian Easter.

Figure 1. Weekly mean price of sheep in three markets



Both the quantity purchased and offered for sale considerably increase during religious festivals. The lowest demand for sheep is expected to occur during fasting periods. Apart from producers' response to increased demand for sheep during festivals, seasonality of supply is affected by producers need for cash and lambing pattern. Gryseels (1988) noted that small ruminants were the first to be considered for sale when food and seed grain stocks were depleted. The highest demand for grain seed and the lowest stock of food grain occurs during June to end of September. In addition cash needs are high before the harvests begin. Gryseels (1988) also reported that the peak lambing season was from September to November and relatively equally distributed during the rest of the year.

Factors underlying intra-annual price variations

Table 3 presents probability levels of (F) tests of significance of the variables included in the price/kg equation for each of the markets under consideration. The results indicate that most factors are significant in two out of the three markets and that all variables are significant in at least one market. The R^2 s from this model (0.3238, 0.2659, and 0.3583 for the terminal, intermediate and redistributive markets, respectively) were superior to those calculated using antilogs from a log-linear model (0.3047, 0.2596 and 0.3583). A price-per-head equation fitted with variation generated R^2 s of 0.7822, 0.7973 and 0.8413 for the terminal, intermediate, and redistributive markets, respectively. However, because of the large week-to-week variation in weight, to be seen later, price per kg was used in the analysis. Moreover, price per head was predicted equally well by estimated price per kg multiplied by actual weights. The R^2 s calculated from the alternative price per head estimate (0.7852, 0.7971, and 0.8415 for the terminal, intermediate & redistributive markets, respectively) were almost equal to the R^2 generated from the actual price-per-head equation.

$$R^2 = 1 - (E(P_i - p_i W_{i2} / E(P_i - P))^2)$$

where:

P_i is observed price per head of the i th sheep; p_i is the predicted price per kg; W_i is the observed weight of the i th sheep.

Annex 1 records estimated parameters of the price-per-kg equation for the terminal, intermediate and redistributive markets. Positive and negative coefficients within a set of dummy variables signify premiums and discounts, respectively, relative to the dummy in the base in Ethiopian birr (EB). The t test was used to check whether the individual premiums or discounts were different from zero.

The different patterns of variation in price per head and price per kg caused by week to week variation in average weights is shown by plotting mean price per head and mean price per kg on the same graph (Figure 2) for the terminal market.

If the weights did not vary at all from week to week, the two price lines would maintain a constant difference. Sheep sold in the terminal market were on the average heavier than in either of the other two markets (Figure 3). The overall annual mean weight for the terminal, intermediate and redistributive markets were 26.6, 20.2 and 19.7 kilograms, respectively.

Table 3. *Probability levels ($Pr > F$) of tests of significance of factors included in price per kg equation for the terminal, intermediate and redistributive markets.*

	Terminal market	Intermediate market	Redistributive market
Weight	0.0001	0.0041	0.0105
Weight	0.0001	0.0032	0.0001
Week	0.0054	0.0147	0.0001
Season	0.0001	0.0001	0.0617
Sex	0.0012	0.0017	0.5284
Age	0.5601	0.0001	0.0022
Condition	0.5961	0.0001	0.0001
Colour	0.0001	0.0001	0.0001
Buyer's purpose	na	0.0064	0.0001
Weight x time	0.9905	0.1483	0.0322
Weight x sex	0.0281	0.0972	0.1488
Weight x age	0.6965	0.0001	0.0577
Weight x condition	0.7998	0.0001	0.0060
Weight x buyer's purp.	na	0.0154	0.0016
Weight x season	0.0001	0.0001	0.0001
Week x sex	0.0011	0.0007	0.0001
Week x age	0.2381	0.4499	0.0164
Week x condition	0.0006	0.0383	0.0003

na = not applicable, virtually all for slaughtering.

Figure 2. *Weekly mean prices of sheep in a terminal market.*

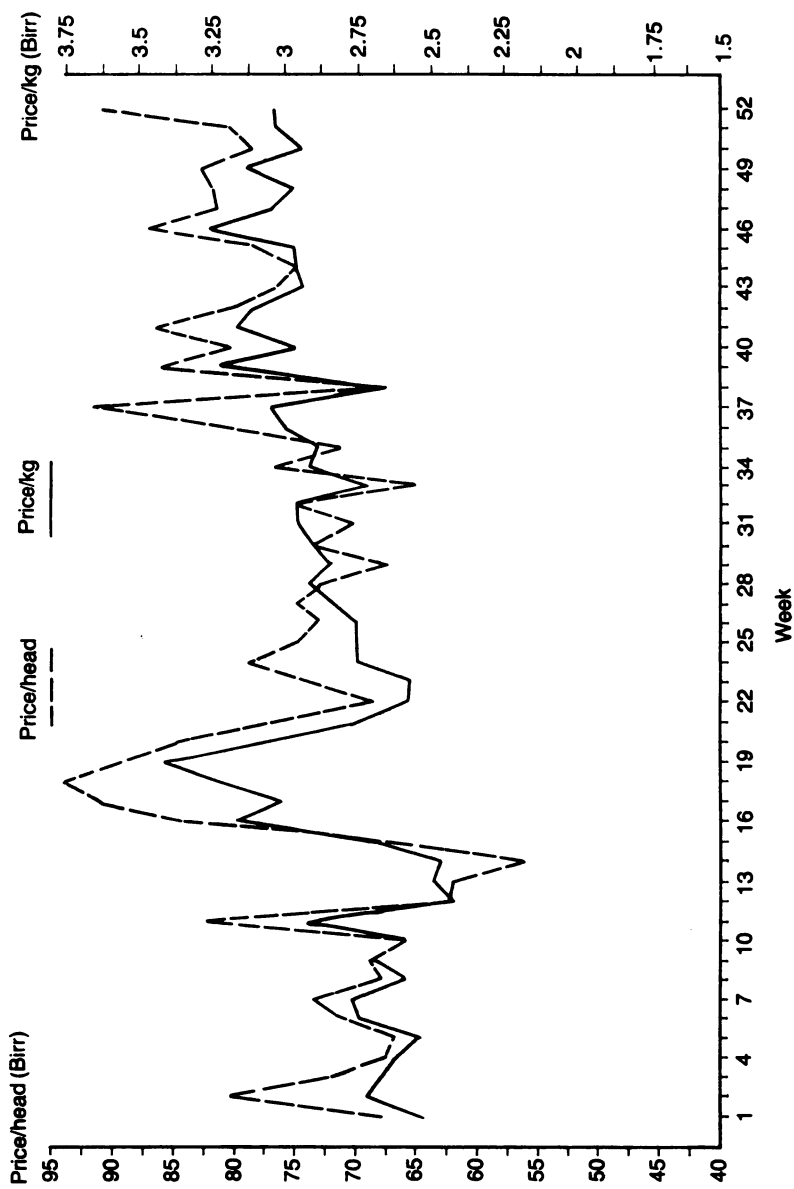
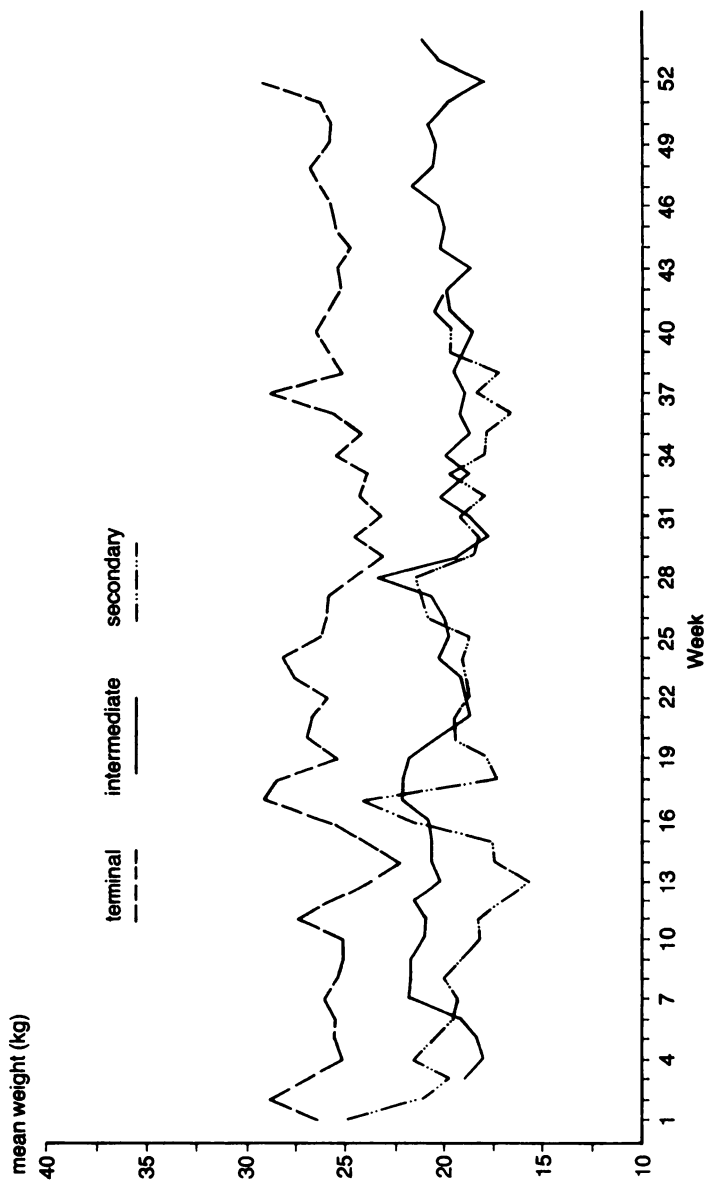


Figure 3. *Weekly mean weight of sheep in three markets.*



The quadratic structure of the effect of weight on price per kg indicates that prices first decline to a minimum and increase as weight increases. The equations for males, castrates and females were calculated and plotted for each of the three markets in order to determine the pattern of price variation in relation to animal weight (figures not included). Most of the males and females in the terminal market were less than one year of age. Their weights ranged both above and below w^* . The mean weight of the male group was slightly smaller than w^* while, for females, mean weight was slightly larger than w^* . Thus for males and females premiums in price per kg were offered both as weights decreased below w^* and increased above w^* . The mean weight of castrates was well above w^* indicating that price per kg was strongly rising with increasing weights. This reflects a higher demand for castrates that are both fat and heavy and results in higher per animal price for castrates.

The picture is similar in the intermediate market but somewhat different in the redistributive market. In the redistributive market, prices per kg of all three sex categories are strongly rising as weights increase. One can only speculate as to why the relationship between price per kg and weight are so different from the other two markets. The redistributive market is quite remote and animals are purchased mainly for resale where as they are nearly all purchased for slaughtering in the terminal market and for slaughtering and resale in the intermediate market. Animals purchased for resale must be trekked a long distance from the country to terminal markets. Perhaps these conditions explain the emphasis favouring higher weights in the redistributive market.

A significantly higher premium offered for castrates in all the three markets was not unexpected. Castrated and fattened sheep locally known as *mukit* (also applicable to goats) are on the average the heaviest group.

Castrates are relatively old, 70 per cent of them between two and four years, and fat to very fat in condition (55 per cent of them fall in this category). Gryseels (1988) noted that farmers castrate sheep for fattening in order to fetch prices.

Generally, consumers prefer lambs because of their tenderness and low weight. The low weight translates to low price per head. Certain colours are preferred to others and especially so for some localised occasions. Sheep sold during the Easter and Id-al-fater weeks received the highest premiums in all the markets. The purpose for which sheep were bought made significant overall price differentials in the intermediate and redistributive markets. Virtually all sheep were bought for slaughter at the terminal market. A significant time trend was indicated in the three markets. However, this was not considered as a regular within-year cyclical phenomenon.

1. Signifies the weights at which minimum price per kg occurs.

Summary and Implications

Characteristics of sheep varied among the central highland markets, partly reflecting consumers' preference. For example, in contrast to the terminal market where sheep were purchased mainly for slaughter, relatively higher proportion of female sheep were observed in the intermediate and redistributive markets. Female sheep predominated in the intermediate market. The proportion of castrates, fat and very fat sheep was highest in the terminal market. However, most sheep sold in the central highland markets were of average condition and lambs of less than a year age.

There is a considerable week-to-week variation throughout the year in sheep prices per kg in the central highland markets. These variations are related to variations in overall supply and demand as well as in characteristics of animals offered for sale. Factors affecting the number offered for sale include taking advantage of high demand during festivals, lambing season, as well as cash needs for crop inputs and later for food purchases just before harvest when grain stores are low.

Animal characteristics that affect price per kg are weight, sex, age, condition and colour. In addition, the purpose for which the animal was purchased, whether for resale, slaughter, fattening or reproduction, affected price. Market composition with respect to these characteristics varied from week to week which suggests that weekly mean prices per kg vary partly due to varying market composition effect. A significant time trend over the year was also observed in two of the three markets analysed. Though this trend may continue into the next year, it is not regarded as a within-year cyclical phenomenon.

Calculation of predicted price per kg multiplied by the observed weight demonstrated that the price-per-kilogram model is of equal predictive value for price per head when weight is known. Given the high variation in weights both within and between weeks, the price per kg would seem to be more useful market information than price per head.

The results suggest that there may be some benefit from co-ordinating fattening, breeding and marketing programmes to take the best advantage from some preferred animal characteristics and selected festival markets. However, further analysis will be needed for optimising fattening and controlled breeding programmes. For example, production analysis is needed on costs as well as animal response to alternative fattening programmes and seasonal grazing to use in combination with information generated in the present study on effects of weight, age, condition, and seasons on prices.

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Annex 1. Estimated parameters of price/kg equation for the terminal, intermediate and redistributive markets.

	Terminal market	Intermediate market	Redistributive market
Intercept	2.9967**	3.0769**	1.6915*
Weight	-0.0595**	-0.0496	-0.0425
Weight ²	0.0015**	0.0008**	0.0008**
Time	0.0115	0.0024	0.0504
Sex :			
Male	0.3134**	0.1856**	-0.0010
Castrate	0.5037**	0.2607	0.1374
Female	0.0000	0.0000	0.0000
Age (year):			
Less than 1	0.2078	0.9619**	0.4526**
1	0.1293	0.6331**	0.4273**
2	-0.0070	0.4099*	0.7036**
3	-0.2094	0.6306**	0.3545
4	-0.0259	0.0781	0.4760**
Over 4	0.0000	0.0000	0.0000
Condition :			
Poor	-0.4272	-1.1680	-0.4633
Average	-0.3303	-1.6154	-0.4452
Fat	-0.2619	-0.7811	0.3283
Very fat	0.0000	0.0000	0.0000
Colour :			
White	0.0805**	0.1197**	0.0563**
Brown	0.0544**	0.1029**	0.0217*
Black and white	-0.0018	0.0276	-0.0455**
Black	0.0000	0.0000	0.0000
Buyer's purp:			
Resale	na	-0.1361	-0.1201*
Slaughter	na	-0.1417	-0.2942**
Fattening	na	0.2724	-0.0349
Reproduction	na	0.0000	0.0000
Season :			
Christmas	-0.2202*	-0.3758**	0.0022
Easter	0.1804	0.3179**	-0.0079
Id-al-fater	0.5626**	0.3139**	0.2809

Annex 1 (Continued)

	Terminal market	Intermediate market	Redistributive market
Id-al-adha	0.2886	-0.2129*	0.0321
New Year	-0.4876**	-0.3139**	-0.0456
Maulid	-0.2702	-0.0391**	-0.2401**
Lent	-0.1456	-0.2799**	0.0055
Non-festival	0.0000	0.0000	0.0000
Interaction with weight:			
Weight X time	0.0000	-0.0001	-0.0001
Weight X sex :			
Male	-0.0107*	-0.0055*	0.0033
Castrate	-0.0122*	-0.0045	0.0041
Female	0.0000	0.0000	0.0000
Weight X age (year):			
Less than 1	-0.0070	-0.0172*	-0.0047
1	-0.0030	-0.0061	-0.0060
2	0.0004	0.0012	-0.0148*
3	0.0050	-0.0049	-0.0030
4	0.0003	0.0109	-0.0089
over 4	0.0000	0.0000	0.0000
Weight x condition:			
Poor	0.0106	-0.0042	0.0115
Average	0.0059	0.0253	0.0204
Fat	0.0041	0.0058	0.0074
Very fat	0.0000	0.0000	0.0000
Weight x buyer's purpose:			
Resale	na	0.0101	0.0076**
Slaughter	na	0.0127*	0.0131**
Fattening	na	-0.0053	0.0031
Reproduction	na	0.0000	0.0000
Weight x season:			
Christmas	0.0096*	0.0138**	-0.0070
Easter	0.0051	-0.0037	0.0144**
Id-al-fater	0.0023	-0.0061	-0.0102
Id-al-adha	-0.0096	0.0074	-0.0011
New Year	0.0199**	0.0249**	0.0016

Annex 1 (Continued)

	Terminal market	Intermediate market	Redistributive market
Maulid	0.0123	0.0060	0.0070
Lent	0.0045	0.0165**	0.0054**
Non-festival	0.0000	0.0000	0.0000
Interaction with week:			
Week x sex:			
Male	-0.0055**	-0.0013	-0.0040**
Castrate	-0.0015	0.0055**	-0.0013
Female	0.0000	0.0000	0.0000
Week x age:			
Less than 1	0.0041	-0.0044	0.0030
1	0.0044	-0.0026	0.0078**
2	0.0059*	-0.0027	0.0038
3	0.0042	-0.0033	0.0088*
4	0.0030	-0.0030	0.0052*
Over 4	0.0000	0.0000	0.0000
Week x condition:			
Poor	-0.0039	0.0088	-0.0321*
Average	-0.0017	0.0111	-0.0342**
Fat	0.0040	0.0126	-0.0409**
Very fat	0.0000	0.0000	0.0000
N	6221	8546	7779
R ² (price/kg)	0.3238	0.2659	0.3583

* P < 0.05; ** P < 0.01.

na = not applicable, virtually all for slaughter.

Differences by geo-climatic zone in the economic returns from wool productivity and quality in Lesotho

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Abstract

This report presents an analysis of data obtained from a survey of approximately 1700 sheep at shearing sheds throughout Lesotho during the 1987/88 wool shearing seasons. It focuses specifically on regional differences in wool productivity and quality, the factors accounting for these differences and on the implications of these differences for farmers' wool returns and for livestock development policy.

Effet des différences géoclimatiques sur les rendements économiques et la qualité de la laine au Lesotho

John P. Hunter

Résumé

Ce rapport présente une analyse des données rassemblées dans le cadre d'une enquête effectuée au cours de la campagne 1987-1988 au Lesotho sur environ 1 700 moutons tondus dans des ateliers de tonte. L'auteur met en particulier l'accent sur les différences régionales observées dans la production et la qualité de la laine, les facteurs à l'origine de ces différences et leurs conséquences pour les politiques de développement de l'élevage et le revenu tiré de la laine par le paysan.

Introduction

Wool and mohair are the most important outputs, by value, of Lesotho's agricultural sector and are strategically important to Lesotho's economy. Over 20 per cent of the value of agricultural output can be attributed to wool and mohair sales alone and, if the value of the joint products of sheep and goats (skins, meat and offspring) were taken into account, their contribution to the agricultural economy would be even greater. To farmers, wool and mohair sales constitute their largest single component of domestically generated monetary income. A study of the Sehlabathebe Range Management Area showed that 75% of the gross cash income generated by livestock was generated by sheep and goats and that they still contributed the major proportion of income even if all cash and non-cash livestock income were included (Lawry, 1986). The 1985 Livestock Holders Survey found a similar pattern nationally (Swallow et al, 1987a). Lesotho's wool and mohair exports comprise over 43 per cent of the value of all exports and, since the decline of diamond production in the early 1980s, have been the largest export items. In addition to their role in generating income, the purchase of sheep and goats provide an important investment outlet for migrants' savings and, as such, are a major repository of rural wealth. At mean 1989 sale prices of 104 maloti per sheep and 80 maloti per goat, Lesotho's small ruminant flocks represent a total value to their owners of some 254 million maloti (approximately US \$100 million).

Livestock keeping and migrant labour are close complements in the rural Lesotho economy. The rapid increase in livestock numbers and the enthusiasm shown by Basotho for Merino wool and mohair production in the early 20th Century followed the transformation of the Lesotho economy from one exporting grain to regional markets to one exporting labour to South African mines and farms. Since, unlike crop production, extensive livestock production does not require adult male labour (it can be undertaken with adolescent herders), it thus permits men to absent themselves from the farmstead for long periods. Livestock and migratory labour are complementary in other ways, as well. They provide a ready (and in many cases, only practical) form of investment for a migrant's savings which can be liquidated in times of need or upon retirement. Livestock are normally a very profitable investment: research in 1985/86 found that, on average, Lesotho cattle, sheep and goats paid a real rate of return of between six and ten per cent (Swallow et al, 1987b). Changes in product prices have recently altered these rates of return but, for the most part, they are still well above the rates paid by most alternative investments available to rural Basotho and, like any good investment, they provide current income and capital appreciation. This income is but a subsidiary to a rural household's main income source from wages, however. Data from the mid-1970s from the Thaba Tseka Mountain Development Project and the Phutiatsana Irrigation Project indicate that only about 30% of a typical rural household's income is derived from all domestic sources, with

agriculture accounting for about 60% of this. Two-thirds of this agricultural income (or 12% of the total) is contributed by livestock (van der Wiel, 1977). Thus, livestock-derived income provides an income supplement which may make a household's well-being easier and more secure but it is the rare, and invariably very poor household, which is reliant, solely or largely, on livestock for its existence. Although, according to rural surveys, farmers are not indifferent to the low productivity of their livestock (Hunter, 1987), they may have neither the labour resources nor sufficiently strong incentives to do much about it.

Added to the socio-economic constraints on livestock production are a variety of ecological constraints. Lesotho's harsh winters take their toll on livestock condition with adverse effects on survival, reproduction and fleece quality. According to Range Management Division estimates (Chris Weaver, personal communication), the commonly owned range is about 40% overgrazed and able to provide only relatively meagre nutrition to the animals grazing on it. The rugged terrain hinders livestock marketing which, in turn, makes culling difficult. As a result of these constraints, livestock productivity is low. In an attempt to better evaluate this low productivity with an aim to designing more effective improvement programmes, some 1700 sheep and 2000 goats were sampled at a cross-section of government and private shearing sheds throughout Lesotho during 1987/88. Animals and fleeces were weighed, age and sex were determined, and samples of wool and mohair were taken from the side fleece for further laboratory testing. This paper analyses some of the regional disparities in wool production revealed by this effort. Additional results and data on mohair production, as well as research procedure and methodology may be found in Hunter (1990a and 1990b).

Geo-climatic Zones of Lesotho

Lesotho is conventionally divided into four geo-climatic zones (World Bank, 1985). Tables 1 and 2 provide basic statistics on these regions. Along the western and southern edge of the country, below 1830 meters in altitude, lie the lowlands. This zone is relatively flat and contains most of the arable land, about 43% of the rural households and virtually all of the urban population. Over 50% of the harvested maize land and 57% of the harvested land devoted to sorghum in Lesotho is in the lowlands (BOS, 1987). Because of the urban concentrations, the lowland zone contains most of the employment opportunities and is more economically diverse than the other zones. This zone is often divided, on the basis of mean annual rainfall, into subzones (de Baulny, 1981). The northern lowlands (NL), roughly from the Maseru-Berea District border northwards, normally receives between 650 and 850 mm of rainfall per annum. The southern lowlands (SL), south of this border, is rather drier—receiving a mean rainfall of between 600 and 750 mm per annum. Some areas, such as parts of Mafeteng and Mophale's Hoek districts may receive less than 650 mm per annum.

Table 1. *Land-use pattern in Lesotho region.*

	Cropping	Livestock grazing	Others
Lowlands	53	33	14
Mountain	14	80	6
Foothill	35	55	10
Senqu river valley	25	70	5

Source: Ministry of Agriculture, Lesotho (1988).

Table 2. *Distribution of rural households and livestock by region, Lesotho (%).*

	Rural households	Sheep	Goat	Cattle
Lowlands (LL)	43	17	19	32
Mountains (MTN)	20	68	44	37
Foothills	25	8	22	22
Senqu river valley	12	7	15	9

Source: BOS (1987); Bureau of Statistics, Maseru, Lesotho, unpublished data.

The Mountain (MTN) zone comprises about 60% of the total land area and lies above 2130 meters. Rainfall is highly variable in this zone, ranging from over 1000 mm per annum in the higher elevation along the front range of the Maluti and northern Drakensberg to about 600 mm on the fringes of the Senqu river valley (de Baulny, 1981). Summers are short and winters may be bitterly cold. As a result of both the rugged terrain and the short growing season, there is relatively little arable land in this zone, although field crops are possible in protected valleys. A little over 80% of the land, mostly rangeland, is devoted to livestock production. Although the mountain zone contains only about 20% of the rural households, they own 68% of the sheep, 44% of the goats and 37% of the cattle in Lesotho (Table 2). Virtually all adult rural males engage in labour migration at some point in their lives but, according to data from several development projects, the mean length of a mountain male's migrant career (20 years) is almost 20% shorter than that of his lowland counterpart (van der Wiel, 1977).

The Foothill (FTL) zone lies between the lowland and mountain zones at an altitude of 1830 to 2130 meters and comprises about 10% of the total land area of the country. It receives rather higher rainfall than the Lowland areas: most of this zone gets between 800 and 950 mm mean annual precipitation (de Baulny, 1981). As in the lowlands, maize production predominates, followed by sorghum

and beans. While not as economically diverse as the lowlands, the foothills' close proximity to the lowland zone gives it economic opportunities that are lacking in the mountains and Senqu river valley.

The Senqu River Valley (SRV), which divides the mountain zone, lies in a "rain shadow" and receives the least rainfall of all zones: normally between 500 and 600 mm per annum (de Baulny, 1981). It contains only about 11% of the country's total land area. Only slightly less so than in the mountains, the land is devoted overwhelmingly to livestock grazing (Table 2). Although maize production utilises the largest proportion of the harvested area, sorghum production is relatively much more important in this zone, as befits its rather drier climate.

Implication of Zonal Differences for Small Ruminant Production and Development

These differences in zonal resources and characteristics have a number of implications for the productivity of small ruminants and the quality of their fleeces. The much higher population density and relatively small proportion of the land area devoted to grazing means that lowland village grazing areas are under heavy pressure. Although this can be relieved to some extent by taking livestock to seasonal mountain cattle posts, survey data from the 1985 Livestock Holders Survey suggest that this practice is not as common as is often supposed (Swallow et al, 1987a). Of the 250 sheep-owning households surveyed nation-wide, 54% kept their sheep in village grazing areas or dry-lots year round. This involved about 50% of the sheep in the survey. Examination of the raw data indicates that these practices are somewhat more common in the lowlands than in the other areas. Distances are often long between lowland villages and their mountain cattle-posts. Trekking costs, in terms of time and lost animal condition, are high. In addition, the distance may make careful management by the owner difficult, thus increasing the threat of loss by theft. Finally, the higher per flock costs of keeping smaller lowland flocks at cattle-posts may encourage their being kept year-round near the village. Thus, because of poorer grazing resources, lowland flocks are relatively small and unproductive. Small flocks mean, in turn, that selective breeding is more difficult and the use of improved breeding stock is less cost-effective. Also, because lowland residents have a number of alternative domestic income-earning options, such as crop production or wage employment, their flocks are less important to them as income earners. Mountain residents, by contrast, have few alternative domestic income-earning options to livestock. Because of this, livestock ownership is more widespread, flocks are much larger and the better pastures in this zone provide a more solid foundation for a livestock industry. On most counts, mountain flocks are much more productive and much higher income earners than flocks from other zones.

The dominant sheep breed in Lesotho is the wool Merino. Table 3 summarises the zonal differences in mean measures of wool productivity and quality. The superiority of the MTN and NL zones in wool production is particularly evident in their higher greasy fleece weights and clean wool yields and in their longer staple lengths.

Table 3. *Zonal differences in wool productivity and quality.*

Mean characteristic	Lesotho	NL ¹	SL	SRV	FTL	MTN
Shorn body wt (kg)	31.4	29.9	29.5	30.8	29.8	32.3
Greasy fleece wt (kg)	2.6	2.5	2.4	2.2	2.1	2.9
Clean oven dry yield (%)	53.3	54.2	48.4	52.8	54.1	54.1
Clean fleece wt (kg)	1.4	1.4	1.2	1.2	1.1	1.6
Staple length (cm)	6.4	6.5	6.2	6.0	5.7	6.8
Crimps (per inch)	16.2	15.4	16.3	17.0	15.5	15.6
Fibre diameter	20.0	19.6	20.1	19.5	20.0	20.2

Note: All measures are for adult (2-teeth and older) Merinos.

1. NL = Northern lowlands; SL = Southern lowlands; SRV = Senqu river valley;
FTL = Foothills; MTN = Mountain.

The clean-yield measure (the proportion of clean wool obtained from a unit of greasy wool) is of particular importance since wool is sold in the clean state and yield is generally rather low. The SL and SRV—the driest and dustiest areas of the country—register the lowest yields. Along with the FTL zone, they also have the poorest mean greasy fleece weights. The multiple of these measures, the clean-fleece weight, looks especially poor for these zones. Generally, the SL and SRV produce 26% lighter clean fleeces than the MTN zone. The FTL zone performs even more poorly—producing an average clean fleece only 43% as heavy as the MTN zone. Compared to the second-best wool producing area, the NL zone, these poor productivity areas produce about 15% lighter clean fleeces per sheep.

In addition to the purely quantitative differences, differences in the qualitative measures are also important. Although there are little differences in mean fibre diameter (all are fine), there is a statistically significant difference (at the 95% level) in staple lengths. Since this is a key determinant of wool style or type, this affects the quality and, hence, the wool price offered. In general, sheep from FTL and SRV, in particular, produce markedly shorter (12% and 16%, respectively) staples than those from MTN. Indeed, FTL staples are an average of one centimetre shorter than MTN staples.

While these differences in mean measures highlight some marked zonal differences in productivity and quality, these averages conceal several important distinctions. To highlight these, it is necessary to focus on the distribution of these measures within each of the zones. This is done in the next section.

Clean wool fleece weights

Table 4 focuses on differences in the distribution of the quantitative measure of clean fleece weights. Over 40% of the fleeces in the two poorest wool-growing zones, FTL and SL, weigh less than one kilogram. In the SRV, the intermediate zone, 36.5% fall into this category. By contrast, only about 23% of fleeces in the two best zones are below one kilogram in weight.

Table 4. *Zonal distributions of clean wool fleece weights (per cent by class).*

Weight classes	Lesotho	NL ¹	SL	SRV	FTL	MTN
1. <0.75 kg	9.9	6.9	15.0	9.1	16.8	8.0
2. 0.75–1.00 kg	19.3	15.9	26.6	27.4	26.6	15.1
3. 1.00–1.25 kg	20.3	24.8	28.3	29.6	20.7	16.3
4. 1.25–1.50 kg	16.5	19.3	15.0	16.1	16.8	16.3
5. 1.50–2.00 kg	17.8	19.0	13.4	14.5	15.2	19.7
6. >2.00 kg	16.2	4.1	1.7	3.3	3.9	24.6

1. NL = Northern lowlands; SL = Southern lowlands; SRV = Senqu river valley; FTL = Foothills; MTN = Mountain.

Note: All measures for Tables 2, 3 and 4 are for adult 2-teeth and older) Merinos.

Lesotho figures are weighted averages of zonal figures.

Columns may fail to add to 100 because of rounding.

While these two zones have relatively few low-weight fleeces, they have a high proportion of relatively heavy fleeces. Almost 45% of MTN fleeces weigh over 1.5 kg and almost one-quarter of them are over 2 kg in weight. No other zone has more than 5% as heavy. Although NL does not score as high in heavy-weight fleeces, almost 45% of its fleeces are over 1.25 kg in weight.

Wool staple length

Wool's style or type is largely determined by the length of its staple. Longer (combing) wools are more suitable for weaving and use in the worsted trade while shorter (carding) wools are used for knitting. Normally, the longer wools fetch higher prices. Table 5 presents the zonal distribution of sample staple lengths. As with clean fleece weights, the superiority of the MTN and NL zones is evident. Almost one quarter of the fleeces have staples falling into the longest class and

almost 70% of MTN fleeces and over 60% of NL fleeces have staples 60 mm or longer. By contrast, none of the other zones have more than 12% of their fleeces with staples 75 mm or longer and only about 45% are over 60 mm. Fortunately, very few fleeces have staples of less than 30 mm and, with the exception of FTL and SRV, the incidence of clearly definable carding wools (i.e. less than 45 mm) is not great.

Table 5. *Zonal distributions of wool staple lengths (per cent by class).*

Length classes	Lesotho	NL ¹	SL	SRV	FTL	MTN
Class A: > 75 mm	18.8	23.5	10.1	12.0	11.0	23.0
Class B: 60–75 mm	41.9	37.5	44.5	33.9	30.4	46.8
Class C: 45–60 mm	30.9	28.7	34.5	41.0	40.9	26.1
Class D: 30–45 mm	7.7	8.8	9.2	13.1	16.6	4.0
Class E: < 30 mm	0.7	1.5	1.7	0.0	1.1	0.2

1. NL = Northern lowlands; SL = Southern lowlands; SRV = Senqu river valley; FTL = Foothills; MTN = Mountain

Staple length is not the only factor determining whether or not a wool is suitable for combing or carding. Tenderness, which can cause breakages in the wool, can also cause a longer wool to be unsuitable for combing. No data exist on the degree of soundness in Lesotho's wool although the extreme nutritional stress from Lesotho's cold winters combined with the added stress of reproduction, suggest that it is likely to be particularly problematic for ewes. It may also be more prevalent in lowland village grazing areas, as well.

Wool fibre diameter

A key component of wool quality is its fineness measured by mean fibre diameter. This is also a key determinant of a wool's price. In general, all of Lesotho's wools are fine (all of the zonal mean fibre diameters are less than 20.5 microns) and this accounts for their generally good market acceptance. By general agreement within the trade, however, this fineness is less the result of genetics and more the result of the poor nutrition offered by Lesotho's overgrazed range. Because of this, it is often referred to as "hunger-fineness".

Despite this general fineness, there is some zonal variation in the distribution of fineness classes. This is evident from Table 6.

In this measure, the performance of the two best zones diverges. The second-best NL zone has over 70% of its wool in the two finest categories and very little in the two coarsest classes. The MTN zone, by contrast, has less than

60% in the finest and almost 20% in the coarsest classes. Two reasons for these differences suggest themselves. One may be nutritional. Despite the relatively high rainfall in the NL zone and its close proximity to mountain grazing, high population density in this zone may restrict grazing, particularly in village areas, and make the impact of hunger-fineness more acutely felt. The other may be an unintended effect of the 50-year-old Livestock Department programme of supplying improved rams to farmers for breeding. Although these are supplied at cost, they are only cost-effective when put to relatively large flocks and, as a result, they go disproportionately to MTN stock keepers. Rams are selected for body conformation, size, fleece weight, and staple length but rarely for the fineness of their wool. As a result, many of the rams are characterised by medium to medium-coarse wools. The higher proportion of coarser wools in the MTN zone may be the effect of this breeding policy.

Table 6. *Zonal distributions of wool fibre diameters (per cent by class).*

Diameter classes	Lesotho	NL ¹	SL	SRV	FTL	MTN
1. < 19.5 microns	45.8	51.0	42.9	54.3	48.9	42.9
2. 19.5–20.5 microns	16.4	19.6	20.6	16.3	15.9	15.4
3. 20.5–21.5 microns	14.0	18.2	15.1	17.9	13.7	12.5
4. 21.5–22.5 microns	8.9	8.4	7.9	5.4	8.2	10.1
5. 22.5–23.5 microns	6.2	2.1	9.5	3.8	5.5	7.1
6. > 23.5 microns	8.5	0.7	4.0	2.2	7.7	11.9

1. NL = Northern lowlands; SL Southern lowlands; SRV = Senqu river valley;
FTL = Foothills; MTN = Mountain

Economic returns

These zonal differences in wool and mohair productivity and quality translate into marked differences in the zonal economic returns from keeping Merinos. LPMS data (from government wool-sheds only) for the 1985/86 wool and mohair seasons were analysed, using ordinary least-squares regression, for zonal differences and for the impact of membership in a Wool and Mohair Growers Association (WMGA) on a grower's economic returns (Hunter, 1987). Results of this analysis are reported in Table 7.

This table refers only to non-WMGA members (73% of sheep owners marketing through LPMS) who own 57% of sheep shearing at government wool-sheds. WMGA membership narrows, but does not eliminate, these zonal economic differences.

Mountain wool producers receive an 18–37% price advantage over other wool producers. Despite the fact that MTN wool is generally rather coarser (stronger)

than wool from other zones, the combination of heavier fleece weights, relatively high yields and long staples translate into higher gross incomes per sheep. In this regard, MTN producers have a 25% advantage over the next-best zone, the NL, and a 32–50% advantage over the remaining zones. When the substantial differences in flock size (relating mostly to the different options and opportunities available to the residents of the different zones) are taken into account, MTN flocks earn 3–8 times as much for their owners as flocks from other zones. Although NL flocks generally produce relatively heavy fleeces and relatively high quality wool, the small average flock size probably makes them only marginal-income supplements for their owners.

Table 7. *Zonal differences in wool prices and incomes and ranking of rates of return for sheep enterprises.*

Mean characteristic	NL ¹	SL	SRV	FTL	MTN
Flock size (animals)	20	18	35	36	100
Flock size (index no.) ²	32	29	56	57	100
Wool price (index no.)	81	73	85	83	100
Income/sheep (index no.)	80	67	76	76	100
Income/flock (index no.)	19	12	37	34	100
Ranking	2	4	3	5	1

1. NL = Northern lowlands; SL = Southern lowlands; SRV = Senqu river valley; FTL = Foothills; MTN = Mountain.

2. Index numbers are calculated as percentage of Mountain values. Data apply to non-WMGA members only.

Another way of evaluating the economic effect of zonal differences terms is to focus on the rates of return generated by a sheep enterprise. Livestock budgets, originally prepared by Swallow et al (1987b) and updated and revised by Hunter and Carvalho (1990, unpublished) were used to generate zonal rates of return. It was assumed that all zones had similar costs and non-wool returns from livestock. This assumption is probably unrealistic, however. Stock keepers with larger flocks would gain certain economies of scale in herding costs but, because of higher levels of flock management, may spend more on veterinary costs or supplemental feed. Smaller stock keepers may have higher average herding costs but may spend less on other aspects of flock maintenance. From the standpoint of returns, larger stock keepers may have a higher marketed offtake from their flocks than smaller counterparts. However, while these adjustments should alter the absolute magnitude of the rates of return, they probably would not affect the overall rankings. Using 1985/86 data, rates of return to a typical sheep enterprise ranged from 6% in the foothills to 11% in the mountains. The zonal rankings are presented in Table 7.

The extremely close correspondence in rankings by both methods is evident. Since 1985/86, wool prices have increased dramatically (although the market has recently reversed). As a result, the average sheep enterprise returned 14.5% on investment in 1988/89.

Conclusions and Recommendations

Generally speaking, wool productivity in Lesotho is rather low. Because of the practices of kraaling animals at night and grazing cultivated fields, Lesotho's wool is dirty and clean wool yields are low. Clean fleece weights are also low because of overgrazing and poor nutrition and, perhaps, for genetic reasons. Only 60% of the nation's clip is longer than 60 mm in length for which poor nutrition, genetics and climatic stress are principally responsible. No matter which perspective one takes, whether that of productivity, quality or economic returns, there are clearly identifiable rankings of wool production by zone, however. The MTN zone is unambiguously most favourable to wool production. Fleece weights are heavier, yields are higher, staples are longer, wool prices are higher, and farmers' incomes per animal are larger. The FTL zone, from almost all perspectives, is the worst wool-producing zone. The SRV is an intermediate zone and its performance is, indeed, fairly representative of the "average" for Lesotho. In the lowlands, the SL zone is the second-worst for wool production while the NL zone is the second-best.

Both conceptually and because of data limitations, it is difficult to disentangle the relative effects of genetics and of environment and management on these rankings. From the environmental perspective, village grazing areas in the lowlands are invariably crowded and heavily organised. If lowland animals use mountain cattle-posts, the trekking between village and highland pastures imposes its own form of stress on fibre production. Although highland pastures are also overgrazed, the quality of their vegetative cover is generally much higher and stocking rates rather lower than in lowland grazing areas. The better nutrition in the mountains contributes to longer staples, larger body mass and higher fleece mass.

Other factors may play a role too. Mean sheep flock size in the mountains is about two to three times larger than in other zones. The purchase of improved Merino rams for breeding is much more cost effective for larger flocks than for small ones. Not surprisingly, most of the improved rams procured by the government from South Africa go to mountain producers. Further, because mountain residents have few alternative domestic income-making opportunities, they are more income-dependent on their flocks and may practice more careful husbandry than their lowland counterparts. Survey results indicate that larger stock keepers are more likely to dose their animals more frequently and more likely to dip them twice as recommended (Hunter, 1987). They also show the

strongest commitment to keeping sheep primarily for wool production (Hunter, 1987). Interviews with farmers indicate that many of the larger mountain producers employ adult herders, a practice that would not be cost-effective for a small flock.

According to agricultural census data, there has been a steady reduction over the last 30 years in the proportion of sheep in the highly productive MTN zone and an increase in the less productive SRV and FTL zones. Not only has this shift put increased pressure on grazing areas least able to support them but, other things being equal, it would have reduced overall wool productivity and quality measures.

Although the reasons for these shifts are probably complex and may be associated with the upsurge in economic activity in the lowlands in the Post-Independence era, livestock policy decisions can have an impact on the geographical distribution of sheep in the future. The following policy directions may be worthy of consideration:

- a. Wool production in the southern lowlands should be discouraged. Generally, animals in this zone are so unproductive, wool quality is so poor, and flocks are so small that the income received from fibre production is minimal. It is likely that wool production is but a secondary function of livestock production and that repositories for savings and meat production are primary functions. Merinos are not particularly well-suited to either of these latter functions. In this zone, livestock development funds would have a greater impact on farms incomes if they were redirected from wool production to activities with higher potential.
- b. Wool production in the foothills should be discouraged also. Development funds would have a higher pay-off if money for wool development were concentrated in the mountains and northern lowlands. Angora goats perform very well in this zone, however, and should receive greater development emphasis (Hunter, 1990b).
- c. Although the Senqu river valley is a marginal wool producer, there are limited alternative economic activities for residents of this zone. Therefore, it is probably desirable to continue to direct small ruminant development funds to this zone.
- d. Much-discussed restrictions on transhumance movement of livestock from lowland areas to highland cattle-posts would discourage extensive livestock production in the lowlands. Careful thought should be given to the impact of this restriction on wool production in the northern lowlands, however.
- e. Although administrative and enforcement constraints may be large, consideration might be given to a discriminatory grazing fee which imposes

higher fees against small ruminants in those areas in which they are particularly unproductive.

Although wool productivity in Lesotho is generally low, there are zones where performance is reasonably good. Concentrating wool production and Merino development resources, including funds, extension efforts and physical infrastructure in these areas while de-emphasising the low productivity areas would raise overall productivity measures and lead to a more productive utilisation of scarce resources.

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Partial budget analysis for on-station and on-farm small ruminant production systems research: Method and data requirements

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Abstract

*Economic constraints and opportunities for improving small ruminant production systems in sub-Saharan Africa must be understood as the basis for developing interventions. However, most national agricultural research systems (NARS) face a shortage of livestock economists, and biological scientists often lack the skills needed to conduct an economic evaluation of the results of their work. This study presents the partial budget analysis (PBA) framework for the economic analysis of small ruminant interventions for use by livestock specialists. The logic of the PBA and the data needs are discussed first. This is followed by an empirical example which analyses the economics of endoparasite control in sheep production system of the Ethiopian highlands. The analysis is based on experimental data from ILCA's Debre Birhan station. The experiment consisted of four treatments: I. Grazing natural pasture; II. Drenching with anthelmintics; III. Supplemental feeding with wheat bran and noug (*Guizotia abyssinica*) cake; IV. Supplemental feeding and drenching. Results show that net returns per ewe of treatments II, III and IV exceeded the net return of the control by Ethiopian birr (EB) 4.86, 8.56 and 9.35, respectively (US\$ 1 = EB 2.07). The increase in cost for treatment II relative to the control was EB 1.44; the added net benefit from this treatment was EB 4.86 per ewe, giving a marginal rate of return of 334%. The increase in cost of treatment III relative to treatment II was EB 19.60, while the increase in net return was EB 3.71 per ewe, giving a marginal rate of return on the increased expenditure of 19%. The cost of adding drenching to treatment III (treatment IV) was EB 3.58 per ewe, while the increase in net return relative to treatment III was EB 0.78 for a marginal rate of return of 22%. The marginal rate of return of treatment IV relative to treatment III was*

19.4%. Given the high cost of capital, treatments III and IV cannot be recommended. Drenching alone (treatment II) yielded a very high marginal rate of return under experimental conditions and should be tested under on-farm conditions.

L'analyse par budgets partiels dans la recherche en station et en exploitation sur les systèmes de production ovins et caprins: méthode et données

S. Ehui et B. Rey

Résumé

Les contraintes et les opportunités économiques relatives à l'amélioration de la production des petits ruminants en Afrique au sud du Sahara doivent être à la base du développement d'interventions technologiques. La plupart des systèmes nationaux de recherche agronomique en Afrique sont cependant fréquemment confrontés à une carence en économistes, et les autres chercheurs ne sont pas toujours équipés pour faire l'analyse économique de leurs résultats. Nous présentons ici la méthode des budgets partiels comme un cadre d'analyse économique d'interventions à la disposition des chercheurs zootechniciens. La logique de la méthode et les données nécessaires seront d'abord présentées. Un exemple empirique d'application sera ensuite discuté. Il se base sur une expérimentation de contrôle de l'endoparasitisme de moutons des hauts plateaux éthiopiens à la station de Debre Berhan du CIPEA, avec quatre traitements: 1. pâturage naturel, 2. déparasitage interne, 3. supplémentation au son de blé et au tourteau de Guizotia abyssinica, 4. supplémentation et déparasitage interne. La marge nette des traitements 2, 3 et 4 a dépassé celui du témoin de 4,86; 8,56 et 9,35 Birr éthiopien (EB). Le surcoût du traitement 2 par rapport au contrôle est de 1,44 EB, et la différence de marge nette de 4,86 EB par brebis traitée; donnant un taux de rentabilité marginale de l'intervention de 334%. Par rapport au traitement 2, le traitement 3 coûte 19, EB de plus et procure 3,71 EB de marge nette supplémentaire, ce qui lui donne une rentabilité marginale de 19%. Le déparasitage ajouté au traitement 3 coûte 3,58 EB par brebis et rapporte 0,78 EB de plus, fournissant un taux de rentabilité marginale de 22%. Le taux de rentabilité du traitement 4 comparé au traitement 3 est de 19,4%. Au vu du coût élevé du capital, la supplémentation seule ou associée ne

peut être recommandée. Le déparasitage seul offre un taux de rentabilité marginal très élevé en conditions expérimentales et devrait être testé en exploitation.

Introduction

Small ruminants (i.e. sheep and goats) are essential components of farming systems in tropical Africa. They are raised mainly for meat, milk, and skin providing a flexible financial reserve (Social Security) in bad crop years for the rural population (Sumberg and Cassaday, 1985). Tropical Africa contains about one-third of the world's goats and one-sixth of its sheep. On average there is one goat or sheep on every 10 ha of tropical Africa and there are about 1.1 head of goats and sheep per person employed in agriculture. Available estimates also show that sheep and goats are equivalent in weight terms, to about 17% of the total domestic ruminant biomass of tropical Africa (Wilson, 1988). Sheep and goats are important also because: (1) they require minimal inputs and maintenance costs; (2) they are less susceptible to stress due adverse changes in climatic conditions (e.g. drought); and (3) they have a relatively high reproduction rate and are easy to dispose of (Winrock International, 1983). Thus in face of the declining crop yields due to movement of cropping onto marginal soil types and diminishing fallow periods, improvement in the production of sheep and goats is likely to improve the welfare of smallholders (Peacock, 1987).

A number of national research organisations in partnership with the International Livestock Centre for Africa (ILCA) are conducting research to improve the productivity of small ruminants on the continent. However, although they provide insights into improving small ruminants productivity, some new technologies are not adopted because of lack of economic advantage over current production methods (Amir and Knipscheer, 1987). Increased animal yield is a necessary but insufficient condition for adoption. A new technology must also be profitable (Nagy and Sanders, 1990). For example, the economic benefits of innovation aimed at reducing reproductive wastage and of improved health, nutrition and management must be determined as a basis for recommending such to farmers.

One problem faced by most NARS, however, is an acute shortage of livestock economists, and biological scientists often lack the skills to conduct an economic evaluation of the results of their work. Moreover, most manuals on economic analysis of biological interventions are crop-oriented (e.g. CIMMYT, 1988; MSTAT-C, 1988). Animals, however, have different characteristics making the use of these manuals not immediately accessible to animal scientists. It is therefore necessary that livestock specialists acquaint themselves with basic economic methods for the economic evaluation of small ruminant technologies.

This paper presents the Partial Budget Analysis (PBA) approach for analysing the economic benefits of alternative small ruminant technologies. While there are

other types of budgeting (e.g. whole farm and enterprise budgeting), the partial budgeting procedure is the most useful in farming system research (Worman et al, 1990).

The next section presents the logic of the partial budget approach. The third section describes the data-set required to perform the analysis. Special attention is paid to the direct and indirect benefits and cost necessary for a correct evaluation of small ruminant technologies. In the fourth section an example is provided which is based on experimental data collected in the Ethiopian highlands. The last section presents some concluding qualifications and comments.

Logic of the partial budget approach

Partial budgeting is a method of organising experimental data and information about the cost and benefits from some change in the technologies being used on the farm. The aim is to estimate the change that will occur in farm profit or loss from some change in the farm plan (Boehlje and Eidman, 1984). Partial budgets do not calculate the total income and expenses for each of the alternative plan but list only those items of income and expense that change. They measure changes in income and returns to limited resources, provide a limited assessment of risk and, through sensitivity analysis, suggest a range of prices or costs at which a technology becomes profitable (Mutsaers et al, 1986).

Assuming for simplicity that the farmer's objective is to maximise returns, the method is as follows: Let NI denote the net income from the sale of animals, or animal products, i.e. the amount of money which is left when total costs (TC) are subtracted from total returns (TR):

$$NI = TR - TC \quad (1)$$

Total costs include the costs of all inputs such as feed, non-feed inputs (e.g. veterinary costs, wages of hired labour, etc.). TC can be separated into two categories: Fixed costs (FC) and variable costs (VC):

$$TC = FC + VC. \quad (2)$$

Fixed costs represent the costs that do not vary when comparing alternative technologies (e.g. land). Variable costs are those that do vary between the technologies, such as the amount of feed or labour used.

In deciding whether or not to adopt a new technology, a farmer will want to know if it will increase his or her income. Similarly in order to properly screen among alternative technologies for further testing, a researcher will want to know which of the interventions is potentially economically more attractive. The increase of changes in net income (ΔNI) is the difference between the change in total returns (ΔTR) and the change in total costs (ΔTC):

$$\begin{aligned}
 \Delta NI &= \Delta TR - \Delta TC \\
 &= \Delta TR - \Delta VC - \Delta FC \\
 &= \Delta TR - \Delta VC, \\
 \text{since, } \Delta FC &= 0
 \end{aligned}
 \tag{3}$$

ΔFC is equal to zero because by definition fixed costs do not vary. Assuming that capital is not a constraint, the technology with the highest ΔNI will be recommended. However, higher benefits may not be attractive if they require very much higher costs. New technologies typically require a package of increased inputs (thus additional costs), and farmers will want to consider the increase in costs in their decision. Thus, it is necessary to compare the extra (or marginal) costs with the extra (or marginal) net benefits.

Another criterion which takes the cost factor into account is the marginal rate of return (MRR). MRR measures the increase in net income (ΔNI) which is generated by each additional unit of expenditure (ΔVC):

$$MRR = \Delta NI / \Delta VC \tag{4}$$

In other words MRR measures the effect on net return of additional capital invested in a new technology, compared to the present one (CIMMYT, 1988). It is not necessary to calculate MRR if the new technology costs less than the farmer's present technology, or if the new technology yields a lower benefit than the present one for a comparatively higher cost. When this occurs, the technology is said to be "dominated". For practical purposes Table 1 summarises the methodology for conducting partial budget and marginal analyses.

In making recommendations, three criteria must be observed: First, if net income remains the same or decreases, the new technology should not be recommended because it is not more profitable than the farmer's present technology; second, if net income increases and variable costs remain the same or decrease, the new technology should be recommended because it is clearly more profitable than the farmer's technology; and third if both net income and variable cost increase (this is usually the case), the marginal rate of return should be looked at. The greater the increase in net income and the higher the marginal rate of return, the more economically attractive the alternative technology is.

Identification of costs and benefits for small ruminants

The most difficult task in performing partial budget analysis, is the proper identification of the costs and benefits associated with the alternative technologies. Using poor data can lead to wrong recommendations. The minimum amount of data which must be collected depends on the design of the trial and the questions for which answer are required. Once it has been decided

Table 1. Partial budgeting format.

1. **Additional income:** List the items of income from the alternative plan that will not be received from the base plan.
2. **Reduced expenses:** List the items of expense for the base plan that will be avoided with the alternative plan.
3. **Subtotal:** 1 + 2.
4. **Reduced Income:** List the items of income from the base plan that will not be received from the alternative.
5. **Additional expenses:** List the items of expense from the alternative plan that are not require with the base plan.
6. **Subtotal:** 4 + 5.
7. **Difference:** 3 - 6: A positive (negative) difference indicates that the net income of the alternative exceeds (is less than) the net income of the base plan by the amount shown.

Source: Adapted from Boehije and Eidman (1984).

what questions need answers, it is possible to identify the variables which will provide the necessary data use in conducting the analysis. Generally the following data are required for partial budget analysis: (1) quantities of inputs which vary between alternative technologies; (2) prices of these variable inputs; (3) yields or productivity levels resulting from the alternative technologies; and (4) prices of the outputs.

All benefits and costs should be calculated using farm-gate prices. That is, the actual price which the farmer pays for the inputs or receives for his products. Thus all inputs prices should account for any cost, such as transportation required to bring the input to the production site. Similarly if the farmer sells his animal off the farm, then the transportation and, storage charges, and/or marketing costs in delivering it to the sale point should be deducted from the market price of the animal. If a technology affects the quality of the animal (e.g. attractiveness of the colour, fattened tail, appearance), different market prices should be applied for the different qualities. Sometimes it is necessary to value the fixed assets (e.g. facilities, equipment). These are usually valued using the depreciation technique. A simple formula for depreciation is the original cost minus any expected salvage value divided by the number of years of useful life (Worman et al, 1990).

Table 2 presents a breakdown of the benefits for the economic analysis of small ruminants. Four products are generally considered important : (1) reproductive capacity of animals, (2) weight gain; (3) milk yield , (4) meat yield; and (5) manure. The importance of input depends on the technologies being evaluated. But both cash and non-cash costs should be identified. Cash costs include items like feed costs (e.g. grain, wheat bran), non-feed costs (e.g. veterinary charges, wages for hired labour). Non-cash costs include items like family labour, capital costs, depreciation costs (equipment and animals) and other non-market feed costs (e.g. crop residues, household wastes).

Table 2. *Breakdown of benefits and costs for economic analysis of small ruminants.*

Benefits	Costs
Primary,	Primary
Increase milk yield	Cash costs
Increase litter size	Feed costs: hay, salt and
Culls (ewes, rams, does, bucks)	minerals, concentrates
Goat meat and lamb or mutton	grains and feeds for the
Mohair and wool	young
Hides	Non-feed costs: veterinary,
Manure	medicine and drugs, vaccine
Horn and hooves for processing	
into feed supplements and	Wages for hired labour
other products	Pasture rent
Meat and milk by products	
	Non-cash costs
	Family labour
Secondary	Depreciation facilities,
	(of equipment etc.)
Urine	Other non-market feed costs
Weight increase (realised	
when the animal is sold)	Secondary
Weeding—grazing	Carry disease
Farmers' preference	Destruction of crops and trees
Attractiveness of colour	Trampling of land (which causes
and appearance	ecological imbalance)
Pet	Foul odour
Seed distribution	Noise pollution
Research	

Source: Adapted from Amir and Knipsheer (1987).

One of the major problems in performing a partial budget or an economic analysis is what value to assign to the inputs in a trial and output from the trial. Determining the field price of inputs and outputs can become a difficult exercise especially when dealing with non-market inputs or products. In this case, opportunity cost (which is the value of the resource or product in its best alternative use) should be employed. One example is manure. Because it provides a low cost source of fertiliser for crop, it can be given a value equivalent to the reduced use of chemical fertiliser. Another example is family labour. Assuming labour market is competitive, rural wages for hired labour can be used as a proxy. At this point it is important to note that labour (though it is the primary input most farmers make into agriculture), is one of the more difficult items to value. This is because for most farm household members off-farm employment is not really an option. Also for most household members (e.g. women, children, old men and young boys), there are no paying alternative to on-farm work (see Worman et al, 1990 for more discussion on labour valuation). Finally, if the animal or the animal product (e.g. milk) is consumed at home, the opportunity cost is the amount the household would have to pay to purchase that meat or milk instead of using their own product.

An empirical example

This example is based on experimental trials conducted in the Ethiopian highlands. The purpose of the experiment was to assess the impact of drenching and feed supplementation on sheep productivity. The experiment was designed in response to nutritional and health problems (e.g. liverfluke, coenuris, diarrhoea, anthrax, lungworm) faced by sheep in the region. Data used in this study were from several sources. Biological and input price data were adapted from Ngategize and Brokken (1990, ILCA, Addis Ababa, unpublished data) and Ngategize et al (n.d.) which report on the stimulated effects of interventions on flock productivity and the economic of endoparasites control in the Ethiopian highlands, respectively. Animal price data (by head, and sex) were determined using a general linear model which describes the effect of animal characteristics on the price of sheep in the Ethiopian highlands (Andargachew, 1990).

There were four treatments with 50 ewes in each treatment group. In treatment I (the control) animals were under normal grazing practice with no drenching or feed supplementation. Treatment II included drenching with anthelmintics. In Treatment III, animals received feed supplementation with wheat bran and noug cake in addition to normal grazing. Treatment IV included both drenching and feed supplementation. The feed supplements were composed of 300 g of wheat bran and 150 g of noug cake (*Guizotia abyssinica*) per ewe per day. The drenching scheme was composed of Ranide (a *Fasciola*-specific anthelmintic) and Panacur (a broad spectrum anthelmintic which is effective against gastrointestinal nematodes and lungworms). Both were administered three times a

returns was EB 3.71 per ewe for a marginal rate of return on increased expenditure of 19%. The cost of adding drenching to treatment III in combination with supplemental feeding (treatment IV) was EB 3.58 per ewe while the increase in net returns relative to treatment III was EB 0.78 per ewe for a marginal rate of return of 22%. The marginal rate of return of treatment IV relative to treatment III was 19.4%.

Table 5. *Results of feeding and health management experiments for sheep, Debre Birhan, Ethiopia, 1989.*

	Treatment ¹	Treatment	Treatment	Treatment
	I	II	III	IV
Gross returns (EB) ²	91.41	97.72	121.03	125.40
Cash costs				
Feeds				
Noug cake	-	-	8.94	8.94
Wheat bran	-	-	6.98	6.98
Veterinary				
Ranide	-	0.41	-	0.41
Panacur	-	1.23	-	1.23
Labour	-	0.54	-	0.54
Non-cash costs				
Capital cost (at 30% per annum)	-	0.65	4.78	5.43
Breeding stock depreciation charges	12.35	10.98	12.7	13.46
Total cost that vary	12.35	13.81	33.41	36.99
Net return	79.06	83.92	87.62	88.41
Net return over control	-	4.86	8.56	5.35
Marginal rate of return (%)	-	334.00	19.00	22.00

1. Treatment I denotes normal grazing; treatment II represents drenching with anthelmintics; treatment III represents feed supplementation; and treatment IV includes both drenching and feed supplementation.

2. See Table 4.

Given the high cost of capital, treatments with supplemental feeding and supplemental feeding with drenching cannot be recommended. However, drenching alone yields a very high marginal rate of return under the experimental conditions (334%) and can be suggested for on-farm testing.

Concluding comments

Economics constraints and opportunities for small ruminant systems in sub-Saharan Africa must be understood as a basis for developing interventions. For example, the economic benefits of innovations aimed at reducing reproductive wastage and improved health, nutrition and management must be determined as a basis for recommending such to farmers. The problem is that most national agricultural research systems face an acute shortage of livestock economists and biological scientists lack the skills to conduct an economic evaluation of the results of their work. In order to properly evaluate alternative small ruminant interventions, livestock specialists will need to acquaint themselves with basic economic methods. In this paper, the partial budgeting analysis approach is presented. It is a simple but powerful approach which consists of organising experimental data and information about costs and benefits of various alternative technologies. Partial budgeting also allows the researcher to carry out marginal analysis which is needed for a correct evaluation of alternative interventions. Marginal analysis is important because although the calculation of net benefits accounts for the costs that vary, a technology may not be attractive to farmers because of the extra cost involved.

In performing partial budgeting the first step is the identification of costs and benefits. This requires: (1) proper quantification of the production parameters; (2) proper elicitation of the inputs used, and outputs produced; and (3) proper recording of the (farm-gate) prices of outputs and inputs. The second step is to convert the identified quantities into costs and returns. All other non-cash costs (e.g. family labour, capital cost, and depreciation charges) must be properly valued. Non-market inputs and costs should be valued at their opportunity cost. In the case of small ruminants four products are generally considered important: they include (1) reproductive capacity of animals, (2) milk yield; (3) weight gain; (4) meat yield; and (5) manure. On the input side, cash and non-cash costs must be determined. Cash costs include feed and non-feed costs, wages for hired labour. Non-cash costs include family labour, capital costs, depreciation charges and other non-market feed costs.

Using partial budgeting, an example is provided which compares the economic potential of a sheep breed under alternative health (endoparasitic control) and feeding systems. There were four treatments including: (I) grazing on natural pasture (the control); (II) drenching; (III) feed supplementation; and (IV) feed supplementation and drenching. Despite the fact that treatments (III) and (IV) yielded higher liveweight animal productivity per ewe than drenching alone (treatment II), economic analysis using marginal analysis has shown that endoparasites control with anthelmintics was economically more attractive. This result clearly highlights the importance of economic analysis in the process of technology evaluation. However, it is important to note that before doing economic analysis, the researcher must properly assess the experimental data

to verify that the observed response makes sense from an animal science standpoint.

Before concluding, a few words are worth mentioning. Although the partial budget may indicate that the new technology is "better" than the traditional, it will not show that both technologies produce a loss. Also, a partial budget (though it is easy to interpret) is rarely presented with a statement of the farmer's objectives, the farmer's resource base, and important non-cash consideration. For example, the partial budget does not tell us if labour is available to the farmer to feed the animals. Partial budgets ignore the substitutability of inputs and how they are allocated based on fixed endowments and the implicit prices of the resources. Although they yield important insights into the economic attractiveness of a new technology versus a traditional one, result of partial budgets should therefore be treated with caution.

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Comparison of consumer attitude towards and acceptance of goat, sheep and cow milk in Malawi

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Abstract

Two sets of questionnaires were administered to 206 individuals at three locations in Salima District, Central Malawi, in order to evaluate and compare consumer attitude and acceptance of goat and sheep milk relative to identically prepared cow's milk. One hundred and seventy-two goat farmers around Bunda College, Lilongwe, Central Malawi, were also included in the study to assess their general attitude towards the consumption of goat milk.

About 38% and 4% of the respondents in Salima had tasted or consumed goat and sheep milk, respectively, compared to 24% for goat milk at Lilongwe. Unavailability was the major factor ($P < 0.001$) influencing the attitudes of the people towards consumption of goat and sheep milk in Salima followed by the fact that it is not traditional to milk goats and sheep and consume their milk, a reason which was major ($P < 0.001$) in Lilongwe. Strong flavour and taste was a tertiary factor in the study. Respondents failed to associate coded milk samples with actual sources. Mean taste scores (based on a 5-point scale of 1 = like very much to 5 = dislike very much) for goat, sheep and cow's milk were 1.81, 2.12 and 2.77, respectively. There were no significant differences among milk sources in these scores. The results indicate that goat and sheep milk is just as acceptable as cow's milk.

Composition, production et acceptation du lait de caprins et d'ovins non laitiers au Malawi

J.W. Banda

Résumé

206 personnes de trois lieux du District de Salima, dans le Centre du Malawi, ont été enquêtées pour évaluer et comparer l'attitude des consommateurs et l'acceptation du lait de chèvre et de brebis par rapport à celui de vache. 172 éleveurs de chèvres, proches du Collège de Bunda à Lilongwe ont été approchés pour évaluer leur attitude vis-à-vis du lait de chèvres.

38% des enquêtés à Salima avaient goûté ou consommé du lait de chèvre (4% du lait de brebis), contre 24% à Lilongwe. A Salima, le principal facteur influençant l'attitude vis-à-vis de la consommation de lait de chèvre et de brebis est sa non-disponibilité ($P < 0.001$), suivi du fait que la traite des chèvres et des brebis n'est pas une pratique traditionnelle. Ce second facteur est le principal à Lilongwe ($P < 0.001$). Les forts goût et odeur étaient le troisième facteur.

Les personnes enquêtées n'ont pas pu identifier des échantillons de lait des trois espèces. La moyenne des tests organoleptiques (1: aime beaucoup; 5 déteste), s'est située à 1,81 (lait de chèvre); 2,12 (brebis) et 2,77 (lait de vache), sans qu'il y ait de différences significative dans ces appréciations. Les laits de chèvre et de brebis apparaissent donc être aussi acceptables que le lait de vache.

Introduction

In the tropics, milk is obtained mostly from cattle. Small ruminants (goats and sheep), however, are an important source of milk in Asia, the Middle East, north Africa and the Caribbean where the contribution of goats and sheep to total milk production is estimated at 15–50% (Matthewman, 1985; Treacher, 1985). South of the Sahara, until recently, goats and sheep were not by tradition, milked for human consumption.

FAO (1987) estimates that there are 250 and 300 million goats and sheep, respectively, in the tropics. About 60 and 30% of the world population of goats and sheep, respectively, are found in villages of the developing countries. Of the 1.6 million goats and 0.8 million sheep in Malawi, over 90% are owned by small-scale producers in rural areas (Malawi Government, n.d.). In 1987, dairy goats were introduced in Malawi as supplementary sources of milk.

Goat and sheep milk is said to have important advantages over cow, milk for human nutrition. For example, Jenness (1980), and Devendra and Burns (1983) reported that compared to cow's milk, goat and sheep milk has higher protein, energy and fat contents. It has adequate amino-acids content. The higher proportions of short-and medium-chain fatty acids are of greater significance for ease of digestion. Goat milk is an excellent source of calcium, phosphorus and chlorine. Although goat and sheep milk has excess potassium and chloride which cause acidosis, and is deficient in vitamins C and D and folic acid, this milk would be beneficial to children in early postweaning periods. If supplemented with iron and folic acid, infants and pregnant mothers would benefit from these milk sources. However, strong flavour and taste of goat and sheep milk, and issues connected with witchcraft and lower social status are said to prevent people from consuming goat and sheep milk (Manyenga, 1987) despite the belief by others that goat milk has therapeutic properties. Manyenga (1987) further reported that other people believe goat udders are too small to be milked. These controversies and the introduction of dairy goats in Malawi raised fundamental questions on milking of goats and sheep and peoples' attitudes towards an acceptance of milk from these sources. Information on these questions would help evaluate the feasibility of goat milk production programmes not only in Malawi, but also in the whole of sub-Saharan Africa and other tropical countries where small ruminant milk production has recently been introduced.

The objectives of this study were:

- (a) to assess peoples' attitudes towards goat and sheep milk and its consumption and the factors associated with these attitudes.
- (b) to compare the acceptance of goat and sheep milk relative to identically prepared cow's milk.

Experimental Method

Two areas, namely Salima and Lilongwe where dairy goat projects have been initiated, were chosen for these studies. In Salima, two sets of questionnaires were administered by a trained research assistant at Mangochi Enterprises (site S1), Chipoka-Malawi College of Distant Education Centre (site S2) and at Salima Secondary School (site S3). The questionnaires used were written both in English and a local language. To capture information on milk consumption in general and the attitude of people towards goat and sheep milk, the first questionnaire was to be administered to as many individuals at each site as possible a day before the taste-test exercise was carried out. In the end, 31, 104 and 71 respondents were covered at sites S1, S2 and S3, respectively. Based on responses on the first day at each survey site, 28, 59 and 47 respondents at sites S1, S2 and S3, respectively, were selected to participate on the taste-test day.

For the taste-test exercise, fresh milk from zebu cows, local and Boer x local crossbred goats and from local and Dorper x local crossbred sheep was used. The milk was obtained from a goat breeding centre managed by the Malawi-German Livestock Development Programme at Lifidzi in Salima. The milk was passed through a milk strainer. The milk was then heated in clean sauce pans, while preventing burning, to near-boiling point and later cooled to body temperature. One hundred millilitre containers with lids were used. These containers were labelled X, Y and Z. Using random numbers, goat milk was allocated to X, sheep milk to Y and cow's milk to Z. About 100 ml of milk was poured in each container. They were kept at 35–40°C by placing them in an insulated box. During the taste-test exercise, respondents were again told they were tasting cow's, sheep and goat milk but the actual identities of samples were disclosed only after the taste exercise was completed. Each respondent was given a second questionnaire together with three samples of milk. They were encouraged to ask questions regarding test procedures. Each respondent was asked to taste the three coded samples, one at a time in the order indicated on the questionnaire. Information required was the identity of the tester, identity of milk and reasons for this. They were also requested to score the taste for each milk sample on a 5-point scale as used by Boor et al (1987):

1. Like very much
2. Like
3. Neither like nor dislike
4. Dislike
5. Dislike very much.

General comments about the milk were invited at the end of each questionnaire. In another similar survey undertaken to assess the consumption and acceptance of goat milk and evaluate the factors limiting goat milk production/consumption among goat farmers, 172 individuals were interviewed in villages around Bunda College, Lilongwe, Central Malawi. Information collected was similar to that collected using the first questionnaire in Salima area.

Milk samples from goats and sheep were analysed and have been presented in a separate paper (Banda et al, 1990). The composition of zebu cow's milk (Kasowanjete, 1982) is not much different from that of goats. Data collected were analysed using contingency tables to provide a measure of association or fitness of fit (Gill, 1986).

Results

Consumption of milk and general attitude towards goat and sheep milk

About 85.9% of the respondents in Salima claimed to have tasted milk. However, only 78.2% claimed to drink milk on a regular basis, i.e., at least once per week

(Table 1). Of those who drink milk, over half (56.5%) claimed to drink milk every day and 27.3% drank milk once per week.

Table 1. *Frequency of milk consumption among consumers in Salima.*

	Site			Total	%
	S1	S2	S3		
Daily (over 3 times/week)	13	63	15	91	44.2
3 times per week	2	8	7	17	8.3
2 times per week	4	2	3	9	4.4
Once per week	11	13	20	44	21.4
None	1	18	26	45	21.8
Total	31	104	71	206	100.0

$\chi^2 = 43.2$ ($P < 0.001$).

About 96% had tasted or consumed cow's milk compared to only 38% and 4% for goat and sheep milk, respectively. There were no significant ($P > 0.001$) variations in responses among sites. Since most respondents had consumed cow's milk, reasons for not having consumed cow's milk were removed from the statistical analysis. Results on reasons for not having consumed goat and sheep milk are presented in Table 2.

Table 2. *Reasons for not consuming goat and sheep milk in Salima.*

	Milk source		Total	%
	Goat	Sheep		
Strong smell/taste	22	13	35	10.9
Allergic	6	4	10	3.1
Not available	64	118	182	56.9
Not traditional	17	36	53	16.6
Never heard of it	5	35	40	12.5
Total	114	206	320	100.0

$\chi^2 = 21.9$ ($P < 0.001$).

Generally it is quite clear that the unavailability of the milk ($P < 0.001$) was the major reason why most respondents (56.9%) in Salima have never consumed milk from goats and sheep, followed by the fact that goat and sheep milk

consumption is not traditional. There was a significant ($P < 0.001$) milk source difference in the ranking of reasons on non-consumption. With goat milk, the second most important reason (19.3% of consumers) was that goat milk had a very strong smell and taste whereas for sheep, the lack of tradition of sheep milk consumption and knowledge that sheep could be milked were both equally the second most important (17% of respondents) reasons for not consuming sheep milk.

About 68.5% and 62.5% of the respondents showed willingness to taste goat and sheep milk, respectively. About 63.0% were willing to buy and consume goat milk, while the proportion for sheep fell to 56.6%. Minor, but nonetheless culturally important, reasons were also identified. With sheep milk, people of the Malawi lakeshore origin never want to consume sheep milk because of the religious taboo of not consuming mutton. They also believe that the intensity of sneezing in sheep makes their milk psychologically unhygienic.

Of the 172 farmers interviewed in Lilongwe, central Malawi, only 24% had ever tasted goat milk. Of those who had never tasted or consumed goat milk, 91% said that it was not traditional to consume goat milk, 4.5% were allergic to it while 2.3% claimed that the small amounts obtained from goats did not warrant the consumption of their milk. However, over half (56.5) were willing to consume goat milk and over 90% were willing to produce and sell goat milk if dairy goats and a milk market were available.

Comparison of consumer acceptance of goat, sheep and cow milk

Data collected using the second questionnaire were analysed to initially find out whether respondents could associate the coded samples with the actual sources of milk. Results are shown in Table 3. Sample X was goat milk, sample Y was sheep milk and sample Z was cow's milk. It is quite evident ($P < 0.001$) that sample X was associated more with cow's milk. Both samples Y and Z were associated more ($P < 0.001$) with sheep milk.

Table 3. *Frequency of responses regarding sources of milk.*

Milk code	Source according to respondent			Total
	Cow	Goat	Sheep	
X (Goat)	61	51	23	135
Y (Sheep)	37	45	55	137
Z (Cow)	35	45	54	134
Total	133	141	132	406

$\chi^2 = 25.0$ ($P < 0.001$).

Frequencies of taste-test scores for all the milk types are presented in Table 4. Irrespective of the source of milk, a significant ($P < 0.001$) proportion (66.9%) gave scores of 1 and 2. There were significant interactions ($P < 0.001$) with source of milk. Goat and sheep milk received scores of 1 and 2 from 71– 72% of the respondents while the proportion for cow's milk was only 59.2%. About 21–23% of the respondents gave scores of 4 and 5 for goat and sheep milk and that for cow's milk was 30.0%.

Table 4. Frequency of taste-test scores for goat, sheep and cow's milk in Salima District.

Taste score	Milk source			Total	%
	Goat	Sheep	Cow		
1	69	43	49	161	40.0
2	26	53	29	108	26.9
3	10	7	15	32	8.0
4	25	22	19	66	16.4
5	5	8	22	35	8.7
Total	135	133	134	402	100.0

$\chi^2 = 37.0$ ($P < 0.001$).

Taste-test results in the form of mean scores for goat, sheep and cow's milk are presented in Table 5. The mean scores for goat, sheep and cattle milk were 1.81, 2.12 and 2.77, respectively. There were no significant differences ($P > 0.001$) among these scores between the sources and sites of the study. The poorest score was for cow's milk at site S1.

Table 5. Mean taste-test scores for goat, sheep and cow's milk at three sites in Salima.

	S1	S2	S3	Average
No. people interviewed	31	104	71	
No. people on taste-test day	28	59	47	
Mean scores:				
Goat milk	1.08	2.83	1.51	1.81
Sheep milk	2.11	2.62	1.64	2.12
Cow's milk	4.00	1.83	2.47	2.77

At the three sites the respondents felt that goat and sheep milk was sweeter than cow's milk but that goat milk was sweetest. Those with more sensitive palates

claimed that goat and sheep milk was creamier in taste. About 49.1% of the respondents claimed that goat and sheep milk was better, but whether this was with respect to nutritional value or not was not clear in this study; 16.5% were for cow's milk, 15.4 were indifferent and the rest did not give comments. After this taste-test exercise, the proportion of respondents claiming that goat and sheep milk has a strong smell fell to 3.8%.

Discussion

In this study, about 78.2% of the respondents claimed to consume milk at least once a week and 56.5% claimed to consume milk everyday. About 21.8% never consume milk. The major factor responsible for 21.8% of the respondents not consuming milk was their low incomes and or financial status. These results correspond favourably with those given by Banda and Phiri (1990) for the Lilongwe urban area in the Central Region of the country. Milk consumed was exclusively cow's milk and the regular consumption here may refer to consumption during breakfast or as snacks.

About 38% and 4% of the respondents in Salima had never tasted or consumed goat and sheep milk, respectively, because of unavailability. The high proportion of respondents in Lilongwe (91%) claiming not to consume milk because it was not traditional to milk goats and consume their milk, could perhaps allow to infer that unavailability may be strongly associated with the non-milking of goats as a tradition (Boor et al, 1987). One underlying factor is the claim that the udder of sheep or goat was too small to produce enough milk for human consumption. Another factor is perhaps the termination of goat milking by the few who did after the introduction of dairy cows in the early 1960s in Malawi. For cow's milk, on the other hand, Banda and Phiri (1990) found that incomes and prices were the main factors limiting the choice and consumption of cow's milk and milk products. It seems, therefore, that in milk production projects, one must isolate the limiting factors for small ruminants from those for cattle.

A general problem that has been shown to limit the consumption of goat and sheep milk is its strong flavour and taste as reported previously in Zimbabwe (Manyenga, 1987) and in Kenya (Boor et al, 1987). Goat milk need not have a strong smell and taste. The strong smell/taste of milk from small ruminants, e.g., from goats, might be due to unclean milking procedures, utensils and milk itself. In addition, Skjevdal (1979) reported that the content of short-and medium-chain fatty acids (especially C6-C10), potassium chloride and the presence of some cresols (ortho-, meta- and para-cresols) may be responsible for the strong flavour and taste of the milk from goats and not necessarily the presence of the buck. In the present study, the strong flavour/taste was a secondary factor for goat milk and was a very minor factor for sheep milk, reflecting perhaps, better milking procedures and handling of the milk. This is confirmed by the results of the

taste-test exercise which showed that respondents could not really associate the coded samples with actual sources of milk. In addition, no differences in taste scores were detected between goat and sheep milk on the one hand and cow's milk on the other. If anything could be said at all, it was obvious that the respondents showed the least preference for cow's milk. The claim, therefore, that goat and sheep milk has a strong flavour is based on unsubstantiated reports or purely an aesthetic bias. Although the presence of the bucks may not be responsible for the strong flavour in goats, it is nevertheless advisable to prevent contact between males and lactating females immediately before milking and hair from falling into the milk. The specific flavour of goat and sheep milk, if not caused by unhygienic conditions, may not be important for direct human consumption, but is desirable in cheese production.

Although goat milk ranked highest and cow's milk lowest on a double blind taste-test exercise, the mean taste-test scores were not statistically different between the sources. The higher number of best scores of 1 and 2 for all the milk and the mean scores of less than 3 reflect high consumer opinion of all the milk types. Goat milk was the best in flavour and taste followed by sheep milk. Acceptability therefore, may not be a limiting factor to consumption of goat and sheep milk as was observed in Kenya (Boor et al, 1987). This tends to confirm the indication that unavailability of the milk may be the major overriding factor. Malawi local goats produce between 250 and 640 ml of milk per day using hand-milking (Mwenefumbo and Phoya, 1982; Mchiela, 1989; Banda et al, 1990). This is not even enough for kids and lambs. To improve milk production to levels that will provide a surplus for human consumption, dairy goat breeds such as the Saanen, Alpine and Anglo-Nubian could be crossed with local breeds while selecting for slightly better producing local genotypes.

The sweeter taste of goat and sheep milk as claimed by some respondents might be due to the 4.5–5.1% lactose content observed in the milk used in the study and the creaminess could have been due to the high (6.0–7.0%) fat content. The real effects due to these chemical constituents on the use of goat and sheep milk for infant feeding and as emergency milk sources in cases of breast failure should be studied. Since the composition of cow's milk was not determined, there is a need to do the survey again, but now backed by nutritional and medical studies in order to evaluate intolerance of consumers to the use of these three different milk types.

It is concluded that unavailability was the major problem influencing the consumption of goat and sheep milk. Acceptability for these milk types was high. Strong flavour/taste was a tertiary factor in this study and of little or no consequence. However, in order to increase the scope and general validity of the results of this type of investigation, there is need to include other locations likely to be affected by the goat milk production research and development programmes.

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Panurge: système d'investigation en recherche sur les systèmes d'élevage traditionnel

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Résumé

Une rapide description du "Système d'investigation pluridisciplinaire" mis en oeuvre au Sénégal permet de montrer comment s'articulent les contributions des diverses disciplines des sciences de l'élevage autour d'un objet d'étude commun: l'animal. L'exemple de l'investigation en matière d'affections respiratoires des petits ruminants illustre une démarche progressive qui comporte:

- 1. Identification et dimensionnement du problème: taux de mortalité par pneumopathies suivant les régions.*
- 2. Protocole spécifique ciblé sur le problème identifié pour préciser les éléments déjà connus: examen clinique systématisé de la sphère respiratoire à chaque visite dans le but de préciser quelles classes d'âge sont atteintes, à quelle époque, avec quelle incidence.*
- 3. Protocole spécifique pour approfondir la connaissance de l'origine du problème: suivi sérologique de cohortes de jeunes animaux pour préciser l'étiologie des affections rencontrées (mise en relation avec les examens cliniques).*
- 4. Protocole d'étude de l'environnement pour identifier les facteurs liés à ce problème: conditions de logement, d'alimentation, etc., liées aux affections respiratoires.*
- 5. Mise en relation des informations des quatre points précédents avec les données de performances de reproduction et de croissance pour donner une estimation complète du problème.*

6. *Formulation de propositions d'amélioration issues des investigations précédentes à tester sur le terrain.*
7. *Expérimentations en milieu villageois des propositions d'amélioration pour en évaluer le coût-bénéfice.*
8. *Formulation de recommandations aux agents du développement.*

Cette démarche conduit les chercheurs à utiliser un nombre croissant d'informations issues des protocoles de recherche des autres chercheurs, ce qui est rendu possible par le fait que le matériel de travail est commun et qu'il est étudié par tous à l'échelle individuelle.

Panurge: Survey system used in research activities on traditional livestock production systems in Africa

O. Faugère, B. Faugère, Ch. Moulin and M. Ndiaye

Abstract

A brief description of the "Multidisciplinary survey system", which has been introduced in Senegal, outlines how the various disciplines in livestock production science have linked in the study of a common subject: the animal. The example of the investigation of respiratory diseases in small ruminants illustrates a progression of steps comprising:

1. *Identification and localisation of the problem: mortality rate by disease and region*
2. *Study of the problem identified to determine the extent of the known components: Clinical examination of the respiratory tract during each visit to determine and identify the age-classes affected, when they are infected and the incidence of the disease*
3. *Study of the causal agents: Serological survey of groups of young animals to establish the aetiology of the disease*
4. *Environmental study to identify other factors associated with respiratory diseases: housing, feeding practices etc*
5. *Relation of data on the four points mentioned above to data on reproduction and growth performances to give a complete evaluation of the problem*

6. *Development of improvements, based on earlier surveys, to be tested in the field*
7. *Village studies to determine the costs and benefits of the proposed improvements*
8. *Formulation of recommendations for development agents.*

This process led the researchers to use a growing number of results arising from research protocols of other researchers, which was made possible by the fact that material studied was common to all studies.

Introduction

Un "système d'investigation pluridisciplinaire" est mis en oeuvre au Sénégal dans le cadre du programme de recherches "Pathologie et productivité des petits ruminants" (programme PPR) réalisé par l'Institut sénégalais de recherches agricoles (ISRA) et l'Institut d'élevage et de médecine vétérinaire des pays tropicaux (IEMVT).

Après une rapide description du système d'investigation, nous verrons, à partir de l'exemple des affections respiratoires des petits ruminants, comment on peut mener une démarche de recherche progressive, impliquant un nombre croissant de chercheurs de différentes disciplines des sciences de l'élevage, élaborant chacun des protocoles d'investigation centrés sur un même objet.

Présentation du système d'investigation

L'architecture du système est basée sur un suivi démographique et le contrôle des performances individuelles. Les produits qui en sont attendus sont:

- une parfaite connaissance de la population objet d'étude (effectifs, structure, mouvements);
- une évaluation précise et fiable des performances des animaux;
- une identification rigoureuse des facteurs de variation des performances, notamment ceux d'ordre pathologique et ceux liés aux pratiques d'élevage.

Les animaux suivis sont identifiés individuellement à l'aide d'une boucle auriculaire numérotée. Les troupeaux de petits ruminants sont visités chaque quinzaine par des observateurs ayant une bonne formation de base en zootechnie et en pathologie.

Trois éléments sont considérés comme fondamentaux et représentent le noyau de base du système: un suivi démographique, un suivi pondéral et un suivi

sanitaire. Ce noyau, support de travail de tous les chercheurs impliqués, doit être maintenu plusieurs années sans rupture de suivi.

Un suivi démographique

L'unité d'observation est l'animal, mais l'unité de travail est le troupeau de concession: c'est le premier niveau de regroupement observable sur le terrain; il correspond aux animaux séjournant la nuit dans un même enclos. L'objet du suivi est de saisir, à la frontière de ces troupeaux, tous les flux d'entrée (naissance, immigration, achat, troc, etc.) et de sortie (mort, exploitation, vente, don, etc.). Les performances de reproduction, les caractéristiques de l'exploitation et de la mortalité des animaux sont ainsi appréhendés à l'échelle de l'individu.

Un suivi pondéral

Il permet de caractériser la carrière de croissance de l'individu par l'évaluation des poids à âge type et des gains moyens quotidiens.

Un suivi sanitaire

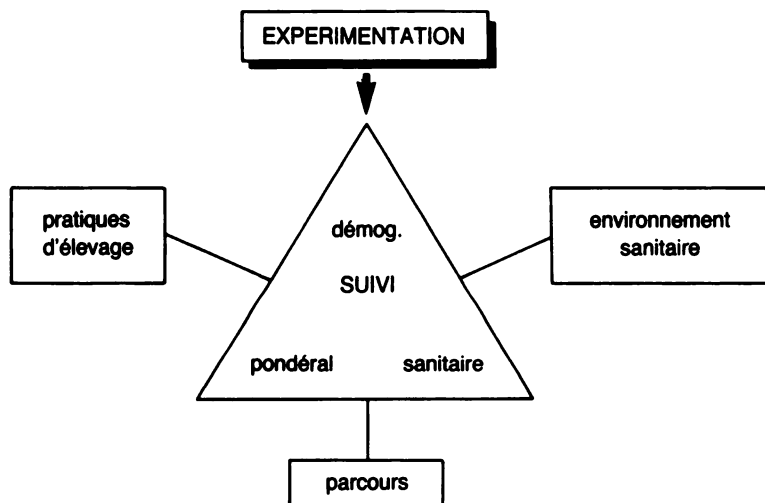
Son objet est d'identifier les causes de mortalité et de décrire l'évolution de l'état sanitaire de l'animal au cours de son existence. Il apporte ainsi un élément de caractérisation de la carrière d'un individu au même titre que sa reproduction ou sa croissance.

Investigations complémentaires

Parallèlement à ces trois suivis, il se développe des modules d'investigation considérés comme complémentaires (figure 1) et destinés à renseigner la base de données pluridisciplinaire, en ce qui concerne par exemple les pratiques d'élevage, l'environnement sanitaire, ou les parcours. Ces modules dits "périphériques" s'articulent autour du noyau de base et correspondent à autant de protocoles de durée limitée, mis en place pour répondre à des questions soulevées par les chercheurs thématiques.

Enfin, il est possible de greffer sur cet ensemble des modules expérimentaux correspondant à des actions volontairement menées par l'équipe de recherche pour modifier le milieu d'étude, en introduisant un élément supposé améliorateur. Leurs effets sont ensuite évalués à travers la structure d'investigation. Il s'agit par exemple d'actions prophylactiques (vermifugation, vaccination, etc.) ou d'actions de complémentation alimentaire.

Figure 1. Schéma du modèle d'investigation



Ce système d'investigation est mis en place au niveau de différents sites géographiques au Sénégal, constituant ainsi un véritable réseau de suivi (figure 2). Cette notion de sites d'investigation multiples complète la présentation de l'architecture d'ensemble.

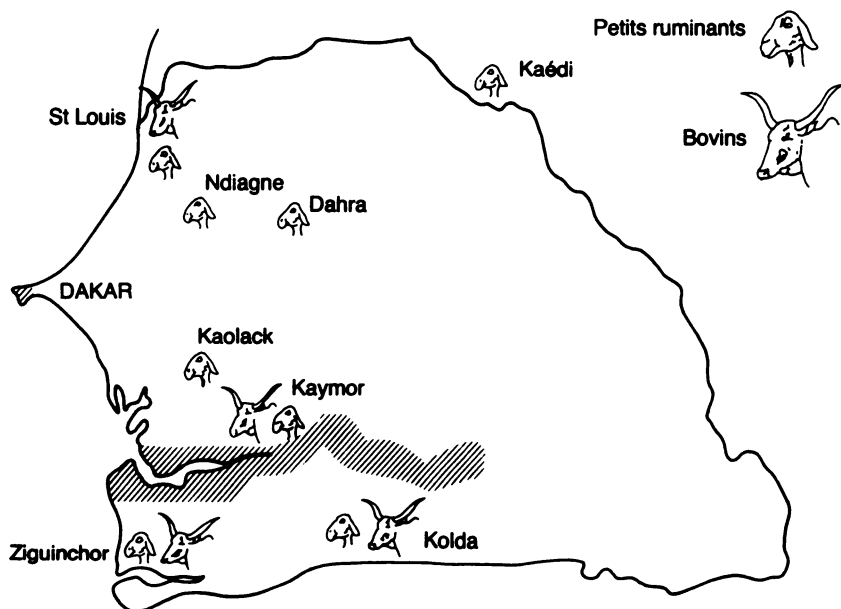
Précisons encore que la gestion de l'information est nécessairement informatisée et qu'elle est réalisée à l'aide d'un progiciel élaboré pour les besoins de ce système, dénommé PANURGE. Ses caractéristiques principales sont : une utilisation conversationnelle, de très nombreuses procédures de validation de l'information, et l'organisation de l'information après un prétraitement de manière à la rendre accessible et directement utilisable.

Investigations sur les affections respiratoires des petits ruminants

Les affections respiratoires des petits ruminants, dominante pathologique au Sénégal, permettent d'illustrer l'articulation entre les modules d'investigation. Pour l'étude de ce thème, les modules impliqués sont :

- ceux du noyau de base : les suivis démographique, sanitaire et pondéral ;
- un module de suivi clinique spécifique centré sur la sphère respiratoire ;

Figure 2. Implantation des suivis au Sénégal



- un module de suivi sérologique;
- un module d'étude de l'environnement et des pratiques d'élevage, en fait impliqué dans un grand nombre de thèmes de recherche.

La démarche retenue procède en cinq étapes :

- identifier, décrire et dimensionner cette entité morbide (épidémiologie descriptive);
- rechercher un indicateur simple à observer, fiable, permettant de procéder à des investigations exhaustives;
- analyser la pathogénie de ces affections en mettant en oeuvre des protocoles d'étude ponctuels (épidémiologie analytique);
- évaluer l'impact de ces affections en termes de production en reliant cet ensemble d'informations aux données concernant les performances (épidémiologie synthétique);
- expérimenter des méthodes de lutte.

La première phase, descriptive, est abordée grâce aux suivis démographique et sanitaire et permet de préciser l'évolution dans l'espace, l'évolution dans le temps, les classes d'animaux atteints, etc.

Il est ainsi possible d'établir (tableau 1) les points suivants:

- les mortalités à la suite d'affections respiratoires intéressent les ovins et les caprins dans des proportions comparables;
- cette pathologie est plus meurtrière dans le centre et le sud du pays que dans le nord;
- les mortalités sont surtout importantes entre novembre et avril, durant la saison sèche fraîche;
- les mortalités interviennent surtout dans le jeune âge, dans les mois qui suivent le sevrage (4 à 8 mois d'âge).

Tableau 1. *Part des mortalités liées à des affections respiratoires parmi les mortalités d'origine pathologique*

	Ovins		Caprins	
Nord	10%	(13%)	7%	(16%)
Centre	41%	(19%)	49%	(23%)
Sud	25%	(27%)	40%	(29%)

(Entre parenthèses = quotient de mortalité globale toutes circonstances confondues)

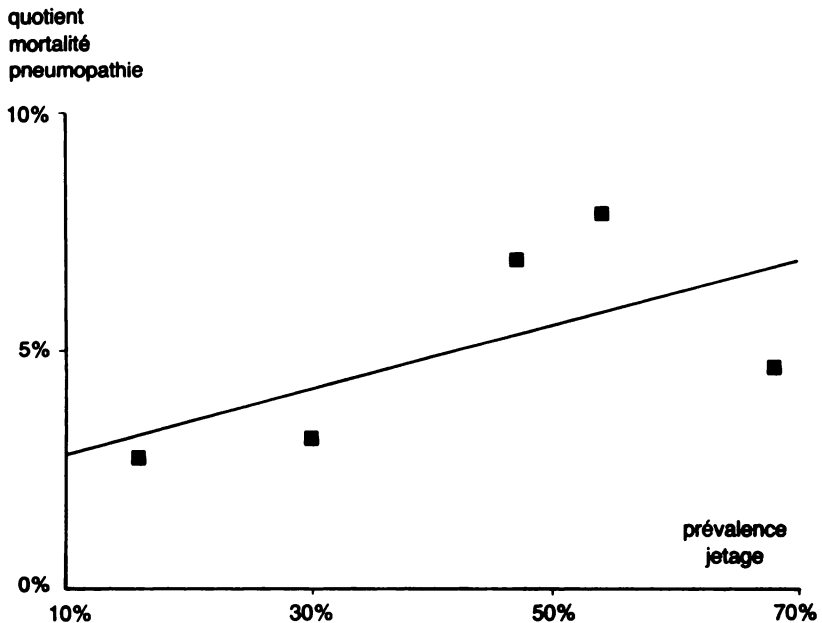
La seconde phase, l'identification d'un indicateur clinique, est abordée en réalisant un suivi clinique spécifique centré sur la sphère respiratoire. En pratique, il s'agit d'examiner chacun des animaux, à chaque visite bimensuelle, pour relever la présence ou l'absence de jetage nasal, de toux, de dyspnée et de diarrhée, cette dernière étant fréquemment associée aux symptômes respiratoires. Les premiers résultats obtenus nous portent à penser que la prévalence moyenne du jetage dans un troupeau pourrait être l'un de ces indicateurs. Elle est en effet corrélée, comme le montre la figure 3, au quotient de mortalité à la suite d'affection respiratoire.

La troisième phase, l'étude de la pathogénie, est abordée par deux voies: l'étiologie et l'écopathologie.

Une investigation étiologique

Un échantillon de 600 jeunes animaux nés sur une période de 18 mois a fait l'objet d'un suivi sérologique en vue d'établir la cinétique de l'infection par les principaux agents infectieux des pneumopathies. Les prélèvements ont été effectués à intervalle de 45 jours, de l'âge de 15 jours à l'âge de 1 an. Lors du premier prélèvement sur le jeune, la mère faisait aussi l'objet d'un prélèvement.

Figure 3. Prévalence du jetage et quotient de mortalité dû aux pneumopathies dans les troupeaux suivis



L'analyse de ces suivis permettra de :

- calculer la prévalence et l'incidence sérologique des différents agents infectieux;
- observer leurs associations et leur ordre d'apparition;
- suivre la cinétique des anticorps animal par animal, et d'interpréter la réponse sérologique du jeune en tenant compte de celle de la mère;
- suivre l'évolution dans le troupeau et de noter les variations saisonnières.

En reliant ces informations à celles du suivi clinique spécifique, il sera possible d'établir la liaison (ou au contraire l'absence de liaison) entre une conversion sérologique (une infection) et une expression clinique (une affection) ou une issue mortelle.

Il serait bien entendu intéressant de compléter cette investigation par l'analyse de prélèvements biologiques réalisés sur animaux malades ou sur cadavres. Ce protocole, complexe à mettre en oeuvre compte tenu des contraintes de terrain, n'est pas encore réalisé au Sénégal.

Une investigation écopathologique

Des enquêtes répétées dans les troupeaux suivis permettent d'établir pour chaque éleveur les pratiques d'élevage qu'il met en oeuvre: logement, conduite sur parcours, complémentation, traite, etc.

En reliant ces informations aux informations issues du suivi clinique spécifique et du suivi démographique (mortalité) il est possible d'identifier des facteurs de risque des affections respiratoires.

Il a par exemple été possible, dans la partie sud du pays, d'établir une liaison entre l'état de propreté du logement et sa protection des intempéries d'une part, et la prévalence du jetage dans un troupeau d'autre part.

La quatrième phase, l'évaluation de l'impact, pourra être abordée lorsque nous disposerons de l'ensemble des informations précédentes. Elles seront reliées aux données de performances de reproduction (suivi démographique) et de croissance (suivi pondéral) pour établir avec précision le coût réel (affections bénignes comprises) de ces affections en termes de mortalité et en termes de baisse de performances.

La cinquième phase, expérimentale, pourra être abordée:

- pour établir la liaison de cause à effet entre un facteur de risque et ces affections. Par exemple, l'amélioration des conditions de logement dans les troupeaux dans lesquels on enregistre une forte prévalence du jetage, conduit-elle à une réduction sensible de l'incidence des affections respiratoires et une amélioration des performances zootechniques?
- pour établir le coût-bénéfice et la faisabilité d'actions de lutte contre les affections respiratoires telles que:
- la vaccination contre certains agents pathogènes;
- la modification de certaines pratiques d'élevage impliquées dans la pathogénie de ces affections.

Conclusion

Nous ne pouvons pas conclure cet exposé qui souligne les avantages d'une démarche de ce type sans en souligner également les contraintes.

Les plus frappantes sont :

- la nécessité de disposer d'un financement suffisant pour mener un programme de recherche sur un terme de plusieurs années;
- un partage du temps entre les activités de recherche et les activités de gestion et de maintenance du système, indispensables au fonctionnement du programme;

- la forme, la diversité et l'importance du nombre de données collectées, qu'il faut articuler entre elles, posent des problèmes méthodologiques nouveaux de gestion et d'analyse de l'information.

On ne peut pas non plus conclure sans souligner la dynamique originale et les pratiques de recherche nouvelles que génère ce type de système, ne serait-ce qu'en amenant les chercheurs de différentes disciplines à concevoir et à conduire conjointement des protocoles sur un même matériel animal.

La succession des phases de recherche présentées dans la deuxième section de cet article peut subir quelques modifications. Il est ainsi possible, lorsque l'on est astreint à des résultats rapides, et c'est toujours le cas, de mettre en place des expérimentations prophylactiques avant que les résultats des phases précédentes soient acquis. C'est ce que nous avons réalisé au Sénégal et qui fait l'objet d'une autre communication à cette conférence

Synthèse des résultats de suivi et des essais zoosanitaires chez les petits ruminants effectués par le volet recherche du Projet sectoriel d'élevage au Mali

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Résumé

Différentes études ont eu pour objectif de cerner les contraintes liées à l'élevage dans les petites exploitations agropastorales de la zone semi-aride de Banamba. Le suivi a porté sur un effectif moyen de 1 200 petits ruminants (700 caprins et 500 ovins) appartenant à 35 unités de production agricole dans 8 villages autour de Banamba. La caractérisation des systèmes de production a montré que 95% des animaux sont soumis au régime de la libre pâture pendant la saison sèche. L'apport d'une complémentation alimentaire se fait peu ou presque pas. Les petits ruminants ne font pas l'objet de préoccupations sanitaires de la part des paysans. Le taux d'exploitation du cheptel reste inférieur à 20%. Les traitements sanitaires testés ont considérablement diminué le taux de mortalité: de 14,2% à 9,19% chez les ovins et de 18,6% à 7,69% chez les caprins, et amélioré le taux d'exploitation de 10%. Des observations ont été effectuées pour déterminer les performances de 101 ovins mâles engraisés en stabulation de 1987 à 1989 à l'approche de la fête de Tabaski. La durée moyenne de l'engraissement et le gain moyen quotidien ont été respectivement de 70 jours et de 67 grammes. Parmi les animaux engraisés, 37% ont été prélevés des troupeaux d'élevage personnels et 63% achetés sur les différents marchés.

Results of the Mali Livestock Sector Project research programme for small ruminant health monitoring and trials

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Abstract

Various studies have focussed on identifying constraints to livestock production in agropastoral smallholdings of the semi-arid zone of Banamba. A sample population of 1200 small ruminants (700 goats and 500 sheep) from 36 agricultural production units in eight villages around Banamba was monitored. Production system characterization shows that 95% of the animals are roaming freely during the dry season. Supplementary feeding is hardly, if at all, practised. Farmers are not concerned about the health of their small ruminants. Flock offtake is less than 20%. Tested treatments significantly reduced mortality: from 14.2% to 9.19% in sheep and from 18.6% to 7.69% in goats, and increased offtake by 10%. Between 1987 to 1989, the performance of 101 fattening males was recorded as the Tabaski feast was approaching. Mean fattening period and daily weight gain were 70 days and 67 g respectively. 37% of the fattening animals were taken from individual flocks and 63% had been bought on the markets.

Introduction

Malgré l'importance socio-économique de l'élevage des petits ruminants dans la zone sahélienne du Mali, les connaissances le concernant restent fragmentaires dans de nombreux domaines. Parmi les contraintes à son amélioration, il faut citer les problèmes sanitaires qui restent quasi-entiers, les conditions d'élevage et d'alimentation mal perçues par les techniciens, les possibilités alimentaires qui demeurent incomplètement inventoriées et testées. Les qualités bouchères des races locales restent par ailleurs mal connues.

Le Volet Recherche du Projet sectoriel de l'élevage 1988 au Mali a étudié dans la zone semi-aride de Banamba, où les services vétérinaires estimaient en 1988 l'effectif des petits ruminants à 300 000 têtes, les systèmes d'élevage des petits ruminants, et leur productivité en milieu rural.

Matériel et méthodes

Dans huit villages autour de Banamba, 35 unités de production agricole ont été choisies sur la base de leur niveau d'équipements pour constituer un échantillon

représentatif de la zone d'étude. Tous les animaux de ces exploitations ont été identifiés. Les entrées d'animaux dans les troupeaux (naissances, achats et animaux gardés pour autrui) et les sorties (morts, abattages, ventes, prêts, dons, sacrifices cérémoniels et animaux rendus aux propriétaires après la période de garde) ont été relevées chaque mois de juin 1987 à juillet 1988.

L'impact de traitements sanitaires prophylactiques sur la productivité des petits ruminants a été étudié sur les 1 200 petits ruminants appartenant à ces 35 unités de production agricole, (700 caprins et 500 ovins). Parmi ces animaux une moyenne de 750 têtes ont fait l'objet de mesures de poids mensuelles pendant 12 mois.

Les animaux ont été répartis entre 3 groupes de traitement par choix aléatoire pendant toute la durée du suivi.

- T0 : lot témoin ne recevant aucun soin vétérinaire
- T1 : lot vacciné à l'antipasteurellique (juin et novembre), à l'antipeste e à l'antibactérien (juin).
- T2 : lot vacciné (aux 3 vaccins précités) et déparasité au Panacur ND ou à l'Exhelm II. ND. (en juin et en octobre).

Le suivi de l'embouche ovine a concerné de 1987 à 1989 un effectif de 101 béliers, appartenant à 28 des 35 unités de production agricole, en observant l'alimentation, la santé et les performances pondérales.

Résultats

Systèmes de production des petits ruminants

Taille et composition des troupeaux ovins et caprins

La taille moyenne des troupeaux est de 13,1 ovins et 21 caprins par unité de production agricole (tableau 1). Les caprins appartiennent généralement aux femmes.

Tableau 1. *Composition moyenne des troupeaux ovins et caprins*

Sexe	Femelles				Mâle			
	0-18	18-24	>24	TOTAL	0-18	18-24	>24	TOTAL
Classe d'âge (en mois)								
Ovins	3,4	1,9	5,1	10,4	1,9	0,5	0,3	2,7
Caprins	6,2	2,8	7,8	16,8	3,5	0,6	0,1	4,2

Parmi la population ovine la race Djallonké prédomine (près de 90%). Les autres races ovines élevées en faible proportion sont: le Maure, le Balibali et le Peulh ou Toronké. Les caprins appartiennent à la race naine de Guinée originaire du Fouta-Djallon.

Mode de conduite des troupeaux

Le pâturage naturel constitue l'essentiel de l'alimentation des troupeaux de petits ruminants. Plus de 95% des animaux sont soumis au régime de la libre pâture pendant la saison sèche et conduits sous surveillance pendant la saison des cultures. Pour diminuer les problèmes que pose l'insuffisance de la main d'œuvre, les troupeaux sont regroupés et conduits surtout par des enfants. Sur un échantillon de 1 200 petits ruminants, 9% des pertes enregistrées étaient dues au manque de surveillance régulière. La complémentation alimentaire est distribuée seulement aux animaux malades, lactants et ceux soumis à un régime d'embouche. Les aliments généralement offerts sont: son de mil, aliment Huicoma, fanes de niébé ou arachide, paille de brousse, feuilles et fruits d'arbres.

La castration (quand elle est pratiquée) se fait à partir de 18 mois chez les ovins et les caprins. Les possibilités de contrôle des saillies sont limitées et les paysans ne semblent pas avoir d'objectifs précis dans ce domaine.

Santé des petits ruminants

Les paysans apportent très peu de soins sanitaires, pour lesquels moins de 1% du coût total des dépenses liées à l'élevage est alloué.

En fin d'année 1986 la pasteurellose a frappé près de 80% de troupeaux ovins et caprins de l'échantillon d'étude avec un taux de mortalité de 30 à 40%. Des cas de listériose et d'echtyma contagieux ont été confirmés également au laboratoire. Sur des coproscopies effectuées, les trychostrongyloses ont été décelées sur près de 47% des animaux, les coccides sur 18% et les douves sur 5%. Outre ces pathologies la part d'autres infections telles la peste des petits ruminants le charbon bactérien a été reconnue, suggérant l'expérimentation présentée ci-dessous. La consommation excessive du *Zornia glochidiata* au début de la saison pluvieuse a aussi été reconnue comme une cause de mortalité chez les ovins.

Evolution pondérale

De janvier à juin, le gain moyen quotidien enregistré pour les animaux de moins de 18 mois était de 52,1 g/j et pour les mâles de plus de 18 mois 37,4 g/j. Jusqu'à l'âge de 18 mois, les ovins gagnaient en moyenne 60,0 g/j tandis que les caprins ne gagnaient que 39,3 g/j.

Exploitation des troupeaux petits ruminants

Le taux global d'exploitation calculé sur des prélèvements d'animaux dans le troupeau a été inférieur à 20%. Le poids moyen à la vente des moutons et des chèvres était respectivement de 29,3 et 19,9 kg. Pendant la fête de Tabaski le nombre de moutons sur le marché est presque doublé et le prix unitaire à la vente des ovins mâles augmente de près de 50%. Une enquête menée à la fin de l'hivernage 1987 a montré que 28% du lait prélevé dans la zone provient des petits ruminants. Sur ce pourcentage 24% sont imputables aux caprins et 14% aux ovins. La part des petits ruminants dans le revenu en espèces des petits exploitants a été de 32,9%.

Impact de traitements prophylactiques (Ba B. Souleymane, 1990).

Des résultats préliminaires sur l'évolution pondérale, l'exploitation et la mortalité ont été obtenus.

Evolution pondérale des animaux

La vaccination et le déparasitage permettent un gain pondéral plus rapide dans les deux espèces ($P < 0,05$) et plus notablement chez les ovins qui croissent plus que les caprins (tableau 2).

Tableau 2. Effet de la vaccination et du déparasitage sur le gain pondéral (g/jour) des petits ruminants suivis en milieu villageois. (Juin 1987–juillet 1988)

Traitement	Ovins	Caprins
Aucun traitement	42,5	26,1
Vaccination	43,5	28,6
Vaccination + déparasitage interne	67,6	28,4
Moyenne	51,2	27,7
	n = 359	n = 289

Mortalité et exploitation

Au cours de l'étude, le nombre de sorties s'est chiffré à 35% de la population originelle, se décomposant en 66% pour les prélèvements (vente, abattage, cadeaux) et 34% pour les taux de mortalité.

Les modifications de la structure des sorties imputables aux soins vétérinaires dans cette expérience sont résumés dans le tableau 3. On y voit que les traitements diminuent l'influence de la mortalité au profit des prélèvements, en notant une acuité supérieure du phénomène pour les ovins.

Tableau 3. Effet de la vaccination et du traitement antiparasitaires sur les taux de prélèvement et de mortalité chez les différentes espèces animales

Traitement	Ovins		Caprins	
	Prélèvement %	Mortalité %	Prélèvement %	Mortalité %
Aucun traitement	50	50	65	35
Vaccination	65	35	69	31
Vaccination + traitement antiparasitaire interne	77	23	69	31

Il fut également noté que la mortalité dans les troupeaux sous abri permanent a considérablement diminué. Ce taux a chuté de 6% chez les ovins et les caprins (tous traitements confondus).

Embouche

Type animal

Les animaux les plus utilisés au cours des trois campagnes de suivi de l'embouche étaient de race Djallonké (85%) de race Bali-bali (8%); métissages Djallonké/Maure ou Djallonké/Bali-bali (7%).

L'âge moyen de l'ensemble des animaux était de 21 mois avec des variations individuelles de 12 à 36 mois. Celui des ovins de race Djallonké était généralement compris entre 18 et 30 mois. Les ovins engraisés étaient en majorité des mâles entiers.

Alimentation

Les principaux types d'aliments offerts sont: paille de brousse, feuilles et branchettes d'arbres (*Tamarindus indica*, *Ficus gnaphalocarpa*, *Pterocarpus erinaccus*), graines de mil, son de mil, fanes de niébé, fanes d'arachide, fanes de dolique, gousses de *Piliostigma reticula*, aliment Huicoma.

Gain pondéral

Le poids moyen de départ a été de 33,25 kg pour l'ensemble des 101 têtes. La moyenne de poids de démarrage des ovins mâles de race Djallonké (race la plus représentée dans la zone de Banamba) engraisés au cours des trois campagnes a été de 29,12 kg.

Le poids à la fin de l'embouche a été de 37,80 kg toutes races confondues. Le gain moyen quotidien était de 65 g pour une durée moyenne de 70 jours (toutes races comprises).

Résultats économiques de l'embouche ovine

Les marchés à bétail locaux constituent des sources d'approvisionnement pour les ovins. Les résultats du suivi de quatre marchés dans la zone de Banamba ont révélé qu'il y a une augmentation de l'offre globale en petits ruminants au cours de la période de janvier à juin. Au cours de cette période le nombre total d'ovins augmente de 1,5% par mois et celui des caprins d'environ 8% par mois (Tangara et Sissoko, 1990).

Quant aux sources de financement, certains paysans procèdent à la vente d'autres animaux (vieilles femelles etc.) pour acheter les ovins mâles d'embouche et d'autres investissements des produits d'exode ou prélèvent sur leur troupeaux d'élevage. La commercialisation des animaux embouchés est beaucoup liée à la fête de Tabaski. Les paysans vendaient directement leurs animaux sur les marchés locaux. Cependant certains d'entre eux acheminent leurs animaux jusqu'au niveau des centres urbains tels que Bamako où il existe une forte demande.

Parmi les animaux engraisés au cours des campagnes de suivi 37% ont été prélevés des troupeaux d'élevage personnels et 63% achetés sur les différents marchés. Le prix d'achat moyen des ovins mâles était de 9 955 F CFA et le prix de vente moyen a été de 20 598 F CFA.

L'analyse de la structure des coûts d'embouche ovine révèle que les coûts d'alimentation représente 80%. Le coût d'intervention de la main-d'oeuvre familiale dans les travaux (tels que la distribution des aliments, l'abreuvement, le nettoyage des enclos etc.) représente 9% des coûts, les frais d'achat et de commercialisation représentent 11% des coûts d'embouche.

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Black Head Ogaden sheep under traditional management practices in south-eastern Ethiopia

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Abstract

An attempt was made to study the traditional Black Head Ogaden sheep management practices by the nomadic and semi-nomadic people in the Ogaden plateau of south-eastern Ethiopia. The methods employed were a predesigned questionnaire, observations and sampling of relevant elements.

The management aspect was found to be rather specialised in that breeding is controlled to achieve both selection and synchronisation of lambing season with rainy season (which starts around the month of April). Lamb crop is once per year and most of the ewes (96%) give birth to a single lamb. Watering interval is 4–10 days based on water scarcity in a locality. Supplementary feeding and pasture conservation are not practised. As management, nutrition and disease in the Black Ogaden sheep closely interact, an approach encompassing such elements to see into the problems of the pastoralists would be much rewarding.

Méthodes d'élevage traditionnel du mouton Somali à tête noire dans le sud-est de l'Ethiopie

Girma Adugna

Résumé

Cette étude explore les méthodes d'élevage traditionnel du mouton Somali à tête noire pratiquées par les populations nomades et

semi-nomades du plateau de l'Ogaden dans l'est de l'Ethiopie. Elle repose sur un questionnaire, des observations effectuées sur le terrain et l'échantillonnage de paramètres pertinents.

Les pratiques de gestion sont relativement précises: l'accouplement est contrôlé de manière à opérer une sélection et à synchroniser les naissances avec la saison des pluies commençant en avril. Les brebis n'ont agnelé qu'une fois par an et la majorité d'entre elles (96%) n'ont donné naissance qu'à un agneau à la fois. Les animaux ont été abreuvés tous les 4 à 10 jours en fonction des disponibilités en eau de la région considérée. Ni la complémentation alimentaire ni aucune technique de conservation des pâturages n'a été observée. Etant donné les interactions entre la gestion, l'alimentation et la santé, tous ces éléments devraient entrer en ligne de compte dans la recherche de solutions aux problèmes des éleveurs traditionnels du mouton Somali à tête noire.

Introduction

The Black Head Ogaden (BHO) sheep comprise most of the sheep population of the Ogaden region and they stand in number second to camels. This sheep breed/type forms the greater proportion of the small ruminant population in the region and contributes a great deal to the national economy as it has special merits in the Middle East and Arabian countries.

It is, nevertheless, raised by the pastoralists under harsh environmental conditions, with seasonal under-nourishment or malnourishment, long watering intervals, long walks, heat stress and little or no protection against diseases.

In this paper, the methods of feeding, watering, and housing and control of breeding to synchronise the lambing season with the rainy season are discussed. Flock structures, herding, castration, marking (identification) and miscellaneous operations are presented. Major diseases and ailments as known to the pastoralists and the inherent drawbacks of disease control measures generally practised in the region as well as the veterinary extension and services to the region are examined.

Materials and Methods

The sheep type

The BHO sheep are fat-rumped, have a black head, white body and limbs and on the average weigh 30–35 kg at maturity (MOA, 1985). They are polled.

In Ethiopia, the BHO are found in the lowland areas of Hararghe, Bale and Sidamo Administrative Regions (Gonzalez, 1981, unpublished).

They are also indigenous to Somalia and Kenya where they are known as the Black Head Somalia (Osman, 1985).

Data collection

Information on the sheep management practices in the traditional sector of the region was collected through a predesigned questionnaire. Ninety-seven owners were interviewed from nine different localities in the region. Two different occasions, namely the beginning of the dry season (late October) and the last third of the short rainy season (mid-May), were chosen to conduct the interview as well as to watch the actual management practices.

Results

Feeding, watering and housing

The feed resource for sheep is native pasture. Supplementary feeding and forage conservation are not practised. Nevertheless, some soil types at some specific points are said to be provided to the sheep at 3–6-month intervals. These soil types known locally as “Arabi”, may contain some mineral elements.

All animal species (cattle, camels, goats and sheep) graze in the same field. Grazing time is from 9 a.m. to 6 p.m. When the heat gets unbearable around noon, sheep collect under shades or simply congregate at a point and hide their heads under each other's body.

During feed scarcity, which is usually in the dry season (October to March), the pastoralists migrate with their flocks to other localities where forage is available. The distance covered during such migrations may be in the range of 50 to 200 km. The site selection is largely dictated by the availability of water in the area.

Water scarcity is the basic problem for the pastoralists and the frequency of watering is determined by the distance from water points and the availability of water which is scarce during the dry season. Table 1 shows watering frequencies for different localities. Delay can be made for as long as 10 days in such areas as Aware where water scarcity is greatest. The distance covered to the watering points can be as long as 20–40 km (an equivalent of a 6-hour journey, single trip) during periods of severe water scarcity.

The pastoralists enclose their sheep and goats together at night. But where the number of goats is large, a separate pen is built for them. From the beginning of April to the end of October males are kept in a separate pen for the purpose of breeding control.

Table 1. Watering frequencies for different localities.

Place	Elevation (m above sea level)	Intervals between watering (days)
Jijiga	1650	4
Lefe Isa	1650	4-5
Harshin	1470	7-5
Duria	na*	6-7
Aware	na	10
Degahabur	na	7-8

* not available.

The enclosure can be built from wood or even stones. During the rainy season the enclosure may get muddy and another is built if the materials are available.

Flock structure and herding

Different age groups are identified by the pastoralists (Table 2). Likewise, sex group identification is practised. A female sheep ready to breed or is pregnant for the first time is termed as "Sebyeno", a breeding ewe is "Laha" and "Sumel (cka)" is a ram used for breeding purposes.

Table 2. Age group identification and names.

Age	Name
0-4 months	Mekel
5-12 months	Berar
1 year	Gujir
2 years	Lebejir
3 years	Sedhajir
4 years	Afarjir

A general overview of the flock structure is shown in Table 3. Males form only a smaller proportion of the flocks and they are castrated if intended to be sold later. One to four entire males per flock are used for breeding purposes.

Only a few lambs were observed to be born between October and March, and these are termed as "Gera" (the bastards); they are "unwanted" because they were conceived during the separation of males from females due to faulty herding by shepherds.

All age and sex groups are mixed and herded together after November. After the start of the lambing season (around the month of April) the sumel is herded separately in the field or it is tethered around homesteads. After a while, it is kept

with the lambs, at least for sometime, till the next mating season (November to April) when it again joins the rest of the flock.

On some occasions, the "sumel" may be sold or even slaughtered if the breeder cannot afford to keep it for some reason. Then he has to borrow a "sumel" from a friend till he raises one from his own flock.

Table 3. *Flock structure.*

Age(months)		Late October		Mid-May	
		% flock	% sex	% flock	% sex
Males	Over 24	1.3	6.84	1.1	5.37
	12 – 24	4.4	23.16	3.0	14.63
	6 – 12	11.0	57.89	4.4	21.46
	Below 6	2.3	12.11	12.0	58.54
	Total	19.0	100.00	20.5	100.00
Females	Over 24	48.2	59.51	42.1	52.96
	12 – 24	19.1	23.58	15.0	18.87
	6 – 12	12.0	14.81	7.4	9.31
	Below 6	1.7	2.10	15.0	18.86
	Total	81.0	100.00	79.50	100.00

Breeding control and lamb rearing

Breeding is controlled to achieve both selection and synchronisation of lambing season with that of rainy season.

Selection is largely biased towards the performance of male sheep. The common practice among the pastoralists is to select the fastest growing male for breeding. The number of "sumels" in a flock vary from one to four based on flock size, but usually two are kept in a flock. The "sumel" can be used for breeding at one year of age but preferably at two years or more.

The lambing season starts around the month of April to mid-May after few weeks of the start of rains. Lamb crop is thus only once in a year (at least per ewe) with 96% of births attributed to singles.

Most farmers claimed that they check the lambs for receiving the first milk (colostrum). They help weak lambs by putting their little fingers into the mouths of the lambs (in order to elicit the suckling reflex) and immediately providing the dam's teat. During the next 30 days (after birth), the lambs are kept at home during the day either tied, if small in number, or kept in an enclosure, if large in number.

At 30–40 days of age, the lambs would start to graze and are kept with the “sumels”. Weaning is at 4–5 months of age usually before the mating season so as to allow the ewe sufficient time to regain its body condition for successful breeding. In some localities, however, weaning is not practised especially where there is labour scarcity for separately herding the weaned lambs, now termed as “Berars”.

Castration, marking (identification) and miscellaneous practices

Castration is performed for two reasons, namely, breeding control and fattening but little importance is attached to the latter in some localities.

The time for castration is usually at about 5–6 months of age. Attrition of the spermatic cord is achieved by beating it between two sticks specially designed for the procedure.

Each owner marks his sheep to identify his flock because sheep of different owners may get mixed at watering points or during migrations. The marking is usually made on ears, but less frequently on other sites such as the face, the base of the ears, the upper region of the fore limbs and the perineal area (Figure 1). The marking is done using a fire-heated metal as early as 3–4 months of age but it can also be done at the time of weaning (4–5 months of age). Alternatively, some cuts are made on the tips or sides of ears using a sharp knife. Members of a flock bear the same mark(s); combinations of markings may be made on a sheep.

Apart from the markings, each member of a flock, particularly the breeding females are identified by names. Most of the pastoralists noted that each female has its own name no matter how large a flock size may be. Some of the names include: “Merkebo” the big, “Siyaha” moving rump while walking, “Odyer” low-voiced, “Afyer” small-mouthed and “Donyo” resemblance to a boat.

Overgrown hoof is trimmed with simple and local materials. First the hoof is heated with fire at the site to be cut. Then the overgrown hoof is cut off using a sharp knife leaving a reasonable proportion to the proximal region of the hoof.

Parturition difficulties are usually relieved by local “midwives” who are specially skilled in the field.

Diseases and disease control

The most commonly reported disease condition by the pastoralists is a condition locally known as “Shillin”. It refers to tick lameness, other tick damages and some non-specific conditions. People in the region tend to attribute most animal disease (particularly the “Shillin”) to ticks.

Figure 1. Identification marks of sheep in Ogaden.

a) MARKS ON EARS



"HAYIL"



"CULBED"



"FUR"



"HARIR"



"HARIRO"



"LANKAYIR"



"SERIN"



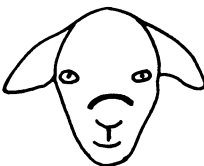
"SERMO"



"LAAG"



b)... ON FACES



"SHUMI"



c)... ON BACK OF HEAD



d)... ON LOWER PERINEAL REGION



e)... ON UPPER REGIONS OF THE FRONT LIMBS



"DACTIN"



"DADMO"

Other disease conditions known to the breeders range from the more important parasitic-gastroenteritis (Aal or Gaedanoley) to orf to which little importance is attached. Diseases reported of importance which were noted with several suitable descriptions are to be found in Table 4 along with their respective Somali names. Mortalities were reported to be greater among the lambs, particularly during the dry season.

Table 4. *Somali names for major ovine diseases.*

Tick lameness, other tick damages and some, non-specific ovine conditions	Shillin
Parasitic gastroenteritis .	Aal
Mange mite infestation	Addo
Dermatophilus infection of the body	Dulgup
Dermatophilus infection of head, ears and feet	Ericke
Pneumonias	Sambub
Sheep pox	Furok
Anthrax	Kood, Kut
Nasal oestrids	Duri
Jackal (hyena) bite	Dowa (Duruwa)
Orf	Ericke
Pasteurellosis .	Gororsa
Unknowns .	Hube

Apart from the disease conditions, predators were also reported to create problems especially around Aware and Druale where people blamed hyenas for heavy production losses. Pastoralists of Harshin and Duria localities reported jackals as major predator problems.

The pastoralists are quite aware of the effects of the disease conditions. The concepts of animal diseases and treatment traditionally held by the breeders are often scientifically sound. Those in the vicinity of veterinary clinics seek official drug supply, while others, either due to lack of veterinary service or the high price of drugs resort to purchase of drug supplies through black markets. Lirophen (an acaricide), panacur and levamisol boli (anthelmintics) were observed in open markets in a number of places. There are rumours that some breeders have their own syringes and needles which they use to inject the sick animals with antibiotics. Indeed, one owner admitted that he used to inject his animals with penicillin.

The veterinary section of the region vaccinates the sheep of the region against anthrax, pasteurellosis and sheep pox, but not on a regular basis.

Discussion

The pastoralists of the Ogaden region have evolved a management practice which enables them to sustain livestock production under the prevailing harsh environment and scarce natural resources. According to Wilson (1983), "Nomadism is a sophisticated management response to a resource base which is always seasonally and often totally deficient." Similarly, Owen (1976) thinks that "Nomadism is one of the most interesting systems of farming that has ever evolved which is still widely practised in some sheep breeding areas and dates back in history right to the threshold of domestication; yet," he continued, "the elements of this method of farming developed over centuries as a balanced ecological system, still make sound sense in terms of using land resource."

The main nutritional constraint in the semi-arid zone is that of bridging the gap between wet and dry seasons (Onim et al, 1985). The length of watering intervals, long walks to reach watering point and the forage scarcity during the dry season adversely affect the productivity of the BHO sheep.

Better results may be achieved through improved management of the grazing land. The communal grazing land tenure prevents an individual from making any effort to use the land efficiently (Jahnke, 1982) but the trend of the nomads to form associations under "Livestock Breeding Association", as being facilitated by the Range Land Development Unit of the region, can greatly enhance efforts made to introduce pasture conservation principles into the nomadic way of life.

As the search for grazing land is closely related to water requirements, water developments can be attempted but caution is necessary in doing so. Any attempt to develop water supply has to be seen in the context of resource management as a whole.

Flock structures are more heavily weighed to females which is the case in the flocks of Darfur in the Sudan and Afar in Ethiopia (Wilson, 1975).

The control of the lambing season is also in response to the resource availability. This practice may, however, have some adverse effects on the pregnant ewes and the lambs which are born around the start of the rainy season. The ewe gestation period coincides with that of inadequate nutrition and under such conditions even quite low worm burdens can have a detrimental effect on the food conversion efficiency of the dam which in turn influences foetal growth and subsequently the neonate through poor milk production by dam. Furthermore, the free living stages of most helminths can develop to infective stages during the lambing season since the environmental conditions would favour the parasitic egg development during this period. Urquhart et al (1987) suggest that the epidemiology can be worsened by the increased numbers of susceptible lambs and dams, the latter being due to periparturient relaxation of immunity.

Despite the mentioned drawbacks, the breeding practices of the pastoralists are reasonable and have their own merits. Frequent lambing puts more strain on the ewe and unless she is fed a superior diet she loses weight (Sahni and Tiwari, 1974).

A seasonal production of lambs results in high lamb mortality (Labban and Ghali, 1969) and poor growth rates (Ganese kale, 1975) for those lambs born in the unfavourable season of the year. The breeders of the Ogaden region are therefore practising in line with this principle. The other element of their breeding practices worthy of notice is the selection of breeding animals. Selection of breeding male is done from generation to generation in the same flock. As flocks do not mix and even if they do so in the field, the males are not allowed to mount the females, in-breeding depression may be assumed to occur.

On the other hand, the principle of selecting the fastest growing male lamb for breeding is worthy of encouragement. There is more scope for the improvement of growth traits than of reproductive traits because of higher heritability and phenotypic variations of growth traits within a breed (Gatenby, 1986). Better results could be achieved if breeders exchange their "Sumels".

Regarding disease control and veterinary services, it is doubtless that an optimum disease control scheme is needed in a given production system for maximum productivity. Moreover, as the innovations like the introduction of exotic sheep breeds or massive supplementary feeding are of a purely hypothetical nature for the Ogaden region, disease control would be a more practical approach to the watchful and suspicious pastoralists.

The indiscriminate use of drugs available through black markets may impose drug failures due to underdosing or inappropriate treatments. Proper veterinary extensions and services should be adopted to alleviate such problems.

Conclusions and Recommendations

The pastoralists of the Ogaden region are doing their best with regard to management in order to maximise the use of the resource base at their disposal. The real effect of watering frequencies on the production of the Black Head Ogaden sheep and the optimum range for the areas concerned need further investigation.

The nutrient requirements, and the incidence, prevalence and seasonality of BHO sheep diseases are not yet fully documented. Unless the spectrum of the sheep diseases is established it would be difficult to undertake appropriate disease control schemes.

Some points which should be given due emphasis include:

- Judicious water development at certain points after careful consideration of the ecological implication

- Exchange of "Sumels" among pastoralists
- Adequate disease control measures through the intervention of the veterinary unit.

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Session 2

Small ruminant performance and reproductive physiology

Performances des petits ruminants et physiologie de la reproduction

Paramètres de production des ovins Mossi de Gampèla

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Résumé

Les mises-bas et poids à âge type des produits ont été relevés de 1983 à 1989 sur un troupeau de 30 brebis et de 3 béliers Djallonké de type Mossi, à la station expérimentale de Gampèla.

Le sexe, le mode de naissance, le mois, la saison et l'année de naissance ont eu un effet significatif sur les poids à âge type et les GMQ des agneaux. Sur 960 agneaux nés, les poids à 0, 15, 30, 60, 90, 180, 360 et 540 jours étaient de 2,33; 3,86; 5,51; 8,14; 10,32; 14,37; 20,43 et 24,87 kg pour les mâles, et de 2,13; 3,66; 5,07; 7,64; 9,50; 12,94; 17,63; et 20,79 kg pour les femelles. Tous sexes confondus, le poids des agneaux à 90 jours était de 10,55 kg pour les simples, 8,10 kg pour les jumeaux et 8,68 kg pour les triplets. Le poids à 90 jours était de 10,77; 10,11 et 8,37 kg pour les agneaux nés en saison pluvieuse, en saison sèche fraîche et en saison sèche chaude, respectivement.

Sur 213 primipares nées entre 1983 et 1987, l'âge moyen à la première mise-bas s'élève à 16,62 mois. L'année et la saison de naissance de la femelle ont eu un effet significatif sur l'âge à la première mise-bas; les mises-bas les plus précoces (15,46 mois) ont été observées chez les femelles nées en saison sèche chaude tandis que les plus tardives (17,40 mois) ont été observées chez celles nées en saison sèche froide. L'intervalle moyen entre mises-bas a connu une baisse régulière, du premier (9,14 mois) au cinquième intervalle (7,27 mois); par la suite, ce paramètre a varié de manière irrégulière. Les taux de fertilité, de fécondité et de prolificité étaient de 122%; 139%; et 116%. Le pic de naissance le plus important de l'année se situe au mois de novembre, et le suivant au mois de mai.

Production traits of Mossi sheep in Gampela

A.J. Nianogo

Abstract

Data on parturitions and weight at specified age of offspring were collected from 1983 till 1989 on a herd of 30 West African dwarf ewes and three West African dwarf rams of Mossi-type at the Gampela experimental station.

Sex, type of birth, month, season and year of birth had a significant effect on weights at specified age and on daily weight gains of lambs. On 960 lambs born, weights at 0, 15, 30, 60, 90, 180, 360 and 540 days were 2.33; 3.86; 5.51; 8.14; 10.32; 14.37; 20.43 and 24.87 kg, respectively, for males and 2.13; 3.66; 5.07; 7.64; 9.50; 12.94; 17.63 and 20.79 kg, respectively, for females. All sexes combined, lamb weights at 90 days were 10.55 kg for singles, 8.10 kg for twins and 8.68 kg for triplets. Weights at 90 days were 10.77 kg for lambs born during the rainy season, 10.11 kg for lambs born during the cold dry season and 8.37 kg for lambs born during the hot dry season.

On 213 primiparous dams born between 1983 and 1987, average age at first parturition was 16.62 months. The year and season of birth of the dam had a significant effect on age at first parturition, the earliest parturitions (15.46 months) being observed for dams born in the hot dry season while the latest parturitions (17.40 months) were observed for dams born in the cold dry season. The mean parturition interval declined steadily from the first (9.14 months) till the fifth interval (7.27 months). Thereafter, this parameter varied irregularly. Fertility, fecundity and prolificacy were 122%, 139% and 116%, respectively. Births reached their highest peak in November, and then in May.

Introduction

Les paramètres de production des ovins Djallonké du Burkina ont été étudiés par quelques auteurs (Dianda, 1981; IEMVT, 1980; MAE, 1990). Cependant, la plupart des résultats publiés jusqu'à présent proviennent d'enquêtes réalisées en milieu villageois.

Les ovins Djallonké de type Mossi ont été introduits sur la station expérimentale de Gampela (SEG), dans le but de favoriser les études sur cette race de mouton; cet article, qui est basé sur des observations faites entre 1983 et 1989, fait le point sur divers paramètres de production.

Protocole expérimental

La SEG dispose d'un parcours de 400 ha de savane claire arborée et arbustive, en zone Nord-soudanienne (pluviométrie moyenne 670 mm). Un troupeau de moutons Mossi (parent du mouton Djallonké) y a été constitué par l'achat, dans les villages environnant la station, et sur le marché de Pouytenga (140 km au sud-est de Ouagadougou), d'une trentaine de brebis présentant soit des dents de lait usées, soit deux dents adultes, et de trois béliers de 2 à 3 ans d'âge.

L'alimentation est basée sur le pâturage (7 heures par jour), avec une complémentation à base de drèches de brasserie égouttées (57 g/jour de matière sèche en moyenne). Après chaque mise-bas, les brebis mères reçoivent environ 250 g de matière sèche de drèches, plus du foin tout-venant de graminées, de ligneux ou bien des fanes d'arachide, selon la saison; cette alimentation se poursuit pendant environ deux semaines, puis les animaux sont remis au pâturage.

Les animaux ont été régulièrement vaccinés contre la peste des petits ruminants et la pasteurellose, et ont subi un déparasitage interne au début et à la fin de chaque saison pluvieuse et un détiquage périodique.

La lutte est naturelle, les béliers restant en permanence avec les brebis. Les jeunes mâles non destinés à la reproduction sont castrés vers l'âge de 6 mois. Des fiches individuelles ont permis le suivi de la carrière des femelles, et de l'évolution pondérale des produits. Les poids à âge type ont été déterminés grâce à des pesées périodiques. Les mortalités périnatales et les naissances ont également été enregistrées.

Pour l'étude des facteurs de variation, la séparation des moyennes a été faite à l'aide du test de Scheffe du logiciel SAS. L'année a été divisée en trois saisons: la saison dite pluvieuse (SPL) de juin à octobre, la saison sèche fraîche (SSF) de novembre à février, et la saison sèche chaude (SSC) de mars à mai. Les taux de fertilité, de fécondité et de prolificité ont été calculés selon les méthodes décrites par l'ITEMVT (1980).

Résultats et discussions

Structure du troupeau

Au 12 juillet 1989 la bergerie comptait 335 têtes dont 65,64% de femelles, avec une forte proportion de jeunes de moins de 1 an (tableau 1). Le poids et la taille au garrot des adultes étaient respectivement de $42,11 \pm 2,65$ kg et $66,56 \pm 5,14$ cm pour les béliers, et de $27,34 \pm 4,62$ kg et $58,48 \pm 3,50$ cm pour les brebis. Quatre principaux types de robe composaient le troupeau: blanc dominant (53,13%), pie noir (33,13%), pie marron (12,83%), noir (0,89%).

Tableau 1. Composition du troupeau au 12-07-89

Classe d'âge	Femelles		Mâles	
	Nombre	%	Nombre	%
> 5 ans	5	2,27	0	0
4 – 5 ans	24	10,91	3	2,61
3 – 4 ans	50	22,73	10	8,70
2 – 3 ans	35	15,91	20	17,39
1 – 2 ans	42	19,09	34	29,57
0 – 1 an	64	29,09	49	41,37
Total	220	100,00	116	100,00

Croissance des agneaux

Influence du sexe

Le tableau 2 montre l'influence du sexe sur la croissance des agneaux de la naissance jusqu'à 540 jours. On observe que, sur cette période, les mâles gardent un poids supérieur ($P < 0,05$) à celui des femelles. Ces résultats sont comparables à ceux obtenus par Berger (1979) chez les agneaux Djallonké de Côte d'Ivoire. Cependant, Berger n'observe de différence significative qu'à des âges compris entre 3 et 7 mois.

D'autre part, les poids à âge type observés à Gampèla sont légèrement supérieurs à ceux rapportés par Bourzat (1979); celui-ci trouve des poids à 3, 6, 12 et 18 mois de 8,6; 13,5; 19,0; et 20,8 kg respectivement, chez les mâles.

La supériorité des mâles est également apparente au niveau des gains de poids quotidiens (GMQ). Les GMQ importants observés entre 0 et 90 jours sont dus en grande partie à la contribution de l'alimentation lactée, qui est importante à cette période (Yoni, 1989). La corrélation entre la production laitière de la mère et la croissance des agneaux allaités est importante durant les six premières semaines de lactation.

Influence du mode de naissance

Les agneaux simples sont plus lourds que les jumeaux de la naissance jusqu'à l'âge de 180 jours ($P < 0,05$). Par la suite, la différence devient minime. Cependant, dès le quinzième jour, les triplets pèsent autant que les jumeaux, et la différence de poids grandit ensuite en faveur des triplets (tableau 3).

Tableau 2. Influence du sexe, du mode de naissance, et de l'année de naissance sur l'évolution pondérale des agneaux de 0 à 540 jours*

Age (jours)	Sexe		Mode de naissance			Année			
	Mâles	Femelles	Simplex	Jumeaux	Triplets	1984	1985	1986	1987
Nombre de naissances	463	485	719	116	3	94	144	191	261
Poids (kg)									
0	2,33a	2,13b	2,31a	2,01b	1,80b	2,24ab	2,09b	2,26a	2,28a
30	5,51a	5,07b	5,60a	4,43bc	5,28ac	6,24a	5,20b	5,74c	4,63d
60	8,14a	7,64b	8,40a	6,48bc	7,00ac				
90	10,32a	9,50b	10,55a	8,10bc	8,68ac	12,54a	9,66b	10,56c	8,50d
180	14,37a	12,94b	14,20a	11,85bc	14,15ac	16,97a	13,46b	14,79c	10,62d
360	20,43a	17,63b	19,31a	17,49ab	20,02a	22,93a	20,05b	19,40cb	13,66d
540	24,87a	20,79b	22,53a	21,09a	25,53a	25,72a	24,70a	20,36c	17,62d
GMQ (g/j)									
0-30	112,77a	103,21b	116,01a	85,87bc	106,80ac	142,53a	110,32b	122,02c	82,39d
0-90	88,82a	88,82a	91,58a	68,39bc	76,52ac	116,03a	84,07b	92,31c	68,48d
0-540	41,51a	41,51a	37,21ab	35,14b	43,62a	43,41a	41,41a	33,43c	28,24d
90-540	31,71a	31,71a	25,15b	29,31b	37,13b	28,51a	33,04a	23,43c	20,67d

* Les moyennes figurant sur la même ligne et portant un indice commun ne sont pas significativement différentes ($P < 0,05$), pour le facteur sexe, ou mode de naissance ou année indépendamment.

Tableau 3. Influence du mois et de la saison de naissance sur l'évolution pondérale (kg) des agneaux de 0 à 90 jours*

Mois et saison de naissance	Age (jours)					
	0	15	30	60	90	
Janvier	01	2,25 ^{abce}	3,85 ^{acefg}	5,90 ^{abghi}	8,14 ^{abeg}	9,23 ^{ab}
Février	02	2,02 ^b	3,74 ^{acdefg}	5,05 ^{bcde}	6,79 ^{bcd}	7,78 ^{bc}
Mars	03	2,05 ^{bc}	3,66 ^{cdef}	4,76 ^{cde}	6,36 ^{cd}	7,84 ^{bcd}
Avril	04	2,19 ^{abce}	3,16 ^d	4,09 ^d	5,85 ^d	7,27 ^d
Mai	05	2,08 ^{abce}	3,37 ^{de}	4,46 ^{de}	7,10 ^{bce}	9,56 ^{aek}
Juin	06	2,17 ^{abce}	3,59 ^{def}	5,07 ^{bcdef}	8,64 ^{agj}	10,85 ^{aek}
Juillet	07	2,27 ^{abce}	3,66 ^{cdefg}	5,42 ^{befghi}	7,84 ^{bge}	10,57 ^{aek}
Août	08	2,36 ^a	3,87 ^{cdg}	5,24 ^{bcefh}	8,16 ^{abgej}	10,29 ^{aek}
Septembre	09	2,43 ^a	3,85 ^{acefg}	5,44 ^{bcfghi}	8,17 ^{abgej}	10,73 ^{aek}
Octobre	10	2,43 ^{abce}	4,39 ^a	6,62 ^a	9,12 ^{aj}	11,33 ^k
Novembre	11	2,34 ^{abce}	4,33 ^{ag}	6,35 ^{ai}	9,39 ^j	11,80 ^k
Décembre	12	2,16 ^{abce}	3,83 ^{acdefg}	5,29 ^{bcefh}	9,02 ^{agj}	10,49 ^{aek}
Saison pluvieuse		2,32	-	5,56 ^y	-	10,77
Saison sèche chaude		2,10	-	4,45	-	8,37
Saison sèche froide		2,22	-	5,74 ^y	-	10,11

* Les moyennes figurant sur la même colonne et portant un indice commun ne sont pas significativement différentes ($P < 0,05$).

Ces résultats se rapprochent de ceux obtenus par Berger (cité par IEMVT, 1980). D'autre part, nos observations rejoignent celles de Murayi *et al.* (1987), qui en station au Rwanda constatent que les agneaux simples sont plus lourds que les jumeaux jusqu'à 2 ans d'âge. A la naissance, les agneaux nés triples sont moins lourds que leurs homologues jumeaux de 10,45% mais semblent les surpasser dès le quinzième jour. Le petit nombre de naissances triples ne rend pas cette différence significative.

Ces observations s'opposent d'ailleurs à celle de Bourzat (1979), qui constate des performances de croissance des triplets de race Mossi inférieures à celles des jumeaux et des simples.

Influence de l'année de naissance

1984 a été l'année la plus favorable pour le poids à 90 jours et le GMQ entre 0 et 90 jours. Les agneaux nés en 1985 ont cependant eu les meilleurs GMQ entre 90 et 540 jours. On observe également une baisse du poids à 540 jours de 1984 à 1987 (tableau 2). 1989 fut l'année la plus sèche (494,6 mm de pluies): le pâturage apportant l'essentiel de l'alimentation aux ruminants sur la station, on peut penser que les brebis mettant bas en 1985 ont été moins favorisées durant leur gestation que les autres sur le plan nutritionnel. Cela expliquerait que les animaux nés en 1984 aient des poids et des GMQ largement inférieurs à ceux observés en 1985 et 1986. Cependant, la pluviométrie a été acceptable en 1985 (619,5 mm) et bonne en 1986 (708,5 mm), ce qui permet aux agneaux nés en 1985 de connaître une croissance postsevrage normale.

Les performances des agneaux nés en 1987 sont moins bonnes que celles des agneaux nés en 1984, 1985 et 1986, malgré une pluviométrie plutôt bonne en 1986 et moyenne en 1987 (658,7 mm). Cependant, il faut signaler qu'avec l'augmentation du nombre de mises-bas par an (observée de 1983 à 1987), le suivi des animaux sur les plans sanitaire et alimentaire peut devenir un facteur limitant. Lorsque les animaux deviennent très nombreux, la promiscuité augmente, de même que la compétition à la bergerie et sur le pâturage pour les meilleurs aliments. La baisse de performance de 1984 à 1987 pourrait aussi être en partie attribuée à une augmentation de la consanguinité; en effet, le rythme de renouvellement des béliers, en principe tous les trois ans avec un ratio mâle/femelle de 1 pour 30, n'a pas été suffisamment rationnel.

Influence de la saison et du mois de naissance sur la croissance de 0 à 90 jours

On observe une supériorité pondérale des agneaux nés en saison pluvieuse par rapport aux autres agneaux (tableau 3). Les agneaux nés en saison sèche chaude sont les plus défavorisés, depuis la naissance jusqu'à l'âge de 90 jours.

La supériorité des agneaux de saison pluvieuse s'explique par l'abondance de pâturages riches et diversifiés. En saison sèche chaude par contre, les herbacées sont à l'état de paille et fournissent peu ou pas de matière azotée digestible (Ouédraogo, 1990). Seuls certains ligneux fournissent encore une quantité significative de nutriments. D'autre part, l'appétit des mères et des agneaux peut être inhibé par les températures élevées qui prévalent pendant cette période.

Les performances des agneaux de SSF se rapprochent de celles des agneaux de SPL; ceci peut signifier que les conditions (qualité et disponibilité des fourrages, température, etc.) qui prévalent à cette période sont relativement bonnes.

Des variations importantes peuvent cependant exister à l'intérieur d'une même saison. Ainsi, les poids à la naissance les plus élevés sont ceux des mois de septembre et octobre; ceci se justifie car pour les mères de ces agneaux, les derniers mois de la gestation ont coïncidé avec une période d'abondance sur le plan alimentaire. On note d'ailleurs que chez les agneaux nés en février, mars et avril, le poids à 90 jours a été faible (inférieur à 8 kg); pour ces agneaux, les derniers mois de gestation ont coïncidé avec une période où la baisse de qualité du pâturage commence à se faire sentir. De plus, ces agneaux doivent encore traverser la SSC avant d'atteindre la SPL.

Le GMQ le plus élevé entre 0 et 90 jours (105,4 g) est observé chez les agneaux nés en novembre; le plus faible (56,8 g) est observé chez les agneaux nés en avril.

Paramètres de reproduction

Age au premier agnelage

L'âge à la première mise-bas de 213 primipares nées entre 1983 et 1987 était de 16,6 mois, indiquant un âge moyen à la première saillie fécondante de l'ordre de 11,6 mois (tableau 4). Ce paramètre varie largement en fonction de l'année de naissance de la mère: de 365,43 jours en moyenne pour les antenaises nées en 1983, il a régulièrement augmenté pour atteindre 643,29 jours en 1987. Il est possible que l'augmentation du nombre d'animaux ait entraîné un accroissement des contraintes comme nous l'avons mentionné à propos du poids à 540 jours (compétition à la bergerie et sur le pâturage pour l'alimentation, espace disponible par animal, problèmes sanitaires, suivi du troupeau, etc.). Il y a également le problème de l'augmentation de la consanguinité: l'âge moyen à la première saillie fécondante étant de 11,6 mois, on peut estimer que le temps de séjour d'un géniteur mâle dans le troupeau devrait être de l'ordre de 16 à 17 mois.

Tableau 4. Moyennes annuelles de l'âge à la première mise-bas de brebis antenaises Mossi

Naissance Mère	Nombre	Age à la 1 ^{re} mise-bas	Erreur type
1983	16	365,43	18,98
1984	39	393,33	9,82
1985	69	472,04	12,39
1986	65	569,83	15,73
1987	24	643,29	20,77
1983-1987	213	498,76	9,26

L'âge au premier agnelage était de 498,5, 530,6 et 471,5 jours chez les agnelles nées en SPL, SSF et SSC, respectivement. Pourtant, les animaux nés en SSC sont les moins favorisés au départ; ils ont en effet le poids à la naissance et à 90 jours le plus faible des trois saisons (tableau 3). Il est possible que les animaux nés en SSC rattrapent les autres au-delà de 90 jours d'âge; l'influence de la saison de naissance sur la croissance postsevrage n'a pas été évaluée dans cette étude, mais Murayi *et al.* (1987) ont trouvé que l'effet de la saison cesse d'être significatif à 550 jours d'âge.

L'âge au premier agnelage des moutons Djallonké varie beaucoup en fonction du milieu et de l'année. En 1974, Dumas et Raymond rapportent un âge de 11 mois pour le nord-ouest du Burkina. En 1983 à Toma, Obulbiga (cité par Kaboré, 1986) trouve 16,8 mois en milieu traditionnel et 15,3 mois en station. Sur 21 agnelles Mossi à la station de Sondré-Est, Kaboré trouve un âge moyen de 14,26 mois. Ces derniers résultats se rapprochent beaucoup des nôtres. Le Ministère de l'agriculture et de l'élevage (1990) rapporte des âges à la première mise-bas variant de 20 à 37 mois en fonction de la zone d'enquête, mais il prend en compte toutes les races ovines rencontrées.

Intervalle entre agnelages

Sur 246 brebis nées entre 1982 et 1987 et dont les dernières mises-bas ont eu lieu en juin 1989, une seule brebis a atteint onze agnelages. L'intervalle moyen calculé sur toutes les mises-bas enregistrées était de 217,60 jours, soit 7,23 mois, avec des extrêmes de 278,7 à 209 jours respectivement au premier et au dixième intervalle (tableau 5). Les résultats rapportés ici se rapprochent de ceux de la station de Zouma, où Obulbiga (cité par Kaboré, 1986) trouve une moyenne de 7,8 mois pour 40 observations, et de ceux des Djallonké du Cameroun où Vallerand et Branckaert (1975) trouvent une moyenne de 7,9 mois.

Tableau 5. Moyennes des intervalles entre mises-bas

Intervalle (N°)	Nombre	Moyenne	Erreur type
1	171	278,87	7,24
2	140	245,44	6,75
3	110	240,50	7,02
4	85	235,45	6,83
5	61	221,82	8,99
6	48	232,35	15,35
7	29	253,38	15,66
8	18	247,56	16,41
9	6	222,67	7,85
10	1	209,00	—

Par contre, l'intervalle entre agnelages est plus court que celui rapporté par certains auteurs; le MAE (1990) trouve des intervalles allant de 8 à 13 mois en milieu villageois; Dianda (1981) à Sondré-Est donne une moyenne de 9,3 mois.

D'autre part, l'intervalle est passé progressivement de 278,87 jours entre le premier et le deuxième agnelage à 221,82 jours entre le cinquième et le sixième agnelage. Par la suite on observe des variations moins ordonnées entre le sixième et le onzième agnelage.

Répartition des naissances dans l'année

La répartition mensuelle des 838 naissances enregistrées de 1983 à 1988 figure au tableau 6. On ne note que peu de variation d'une saison à l'autre: 35,68% naissent en SPL, 34,96% en SSF et 29,36% en SSC. Pour l'ensemble du troupeau, les naissances sont plus fréquentes en janvier (9,82% du total), mars (11,14%), mai (10,54%) et novembre (11,50%). Le mois le moins propice semble être le mois de juillet (6,59%). On peut penser que la présence d'un pâturage très jeune et de très bonne qualité en juin crée une situation favorable à la fertilité chez les femelles vides. Quant au pic de mai, il résulterait des luttes de décembre, correspondant aux premières chaleurs fécondes après les agnelages de novembre.

Plus de la moitié des mises-bas des primipares se situe entre janvier et mai, avec un pic au mois de mars.

Tableau 6. Répartition mensuelle des mises-bas des antenaises et de l'ensemble des brebis

Mois	Primipares	Troupeau
Janvier	13,0	9,8
Février	9,1	6,8
Mars	14,2	11,1
Avril	8,7	7,8
Mai	11,8	10,6
Juin	9,1	7,7
Juillet	4,3	6,6
Août	6,3	6,8
Septembre	4,7	6,7
Octobre	4,7	7,9
Novembre	6,7	11,5
Décembre	7,5	6,7

La saison pluvieuse joue donc un rôle important pour la puberté des primipares, puisque la plupart des saillies fécondantes ont lieu entre septembre et janvier. Les bonnes conditions de la saison humide y favoriseraient chez les agnelles une accélération de croissance permettant l'entrée en puberté.

Wilson (1988) a observé chez les ovins Peuls transhumants du Nord-Burkina des pics de naissance en novembre et décembre. Bourzat (1979) a également observé dans la même région pour le mouton Mossi un pic d'agnelage en novembre et décembre et émet l'hypothèse d'un flushing naturel en juin et en juillet.

L'absence d'un saisonnement réel (lié aux variations du rythme nycthéméral) a été également noté par Vallerand et Branckaert (1975) sur les Djallonké au Cameroun. Ils ont en effet observé une répartition statistiquement uniforme sur toute l'année.

Fertilité, fécondité et prolificité

Les observations portent sur 689 femelles reproductrices, 838 agnelages et 960 agneaux enregistrés entre 1983 et 1988. Les résultats globaux et par année sont présentés sur le tableau 7.

Tableau 7. Résumé des paramètres de reproduction

Paramètre	Année						Total
	1983	1984	1985	1986	1987	1988	
Taux de fertilité	100	136	124	118	128	117	122
Taux de fécondité	100	162	156	132	152	125	139
Taux de prolificité	100	119	125	112	119	107	116
Taux de naissances multiples	–	17,72	24,35	12,35	18,72	6,78	14,2
Taux de mortalité périnatale (0–7 jours)	14,70	8,51	8,33	6,28	4,98	8,05	7,18

Le taux global de fertilité sur la période était de 122%. Ce taux est élevé en comparaison avec d'autres observations sur la même race de moutons: à Sondré, Dianda (1981) trouve un taux de 97%; le MAE (1990) trouve un taux moyen de 80%. Berger et Ginisty (1980) relèvent des taux allant de 68 à 95,5% chez les Djallonké de Côte d'Ivoire. Cependant, des taux variant de 136 à 178% ont été rapportés par Hadzi (1988) à Kolokopé au Togo. Ces variations sont en relation avec l'intervalle entre mises-bas et avec les conditions sanitaires et d'alimentation, qui peuvent varier énormément d'un milieu à l'autre.

Le tableau 7 montre une très grande variabilité interannuelle: de 100% (1983) à 136% (1984). Cela pourrait s'expliquer par la conduite même de l'élevage et par les conditions de milieu, qui ont quelque peu varié entre 1983 et 1988. 1984 fut ainsi l'année où les animaux ont bénéficié du plus d'entretien (effectif réduit), surtout au niveau de la complémentation.

Le taux de fécondité était de 139%, avec des variations allant de 100 à 162%. Ce taux est beaucoup plus important que ceux donnés par Dianda (1981) à Sondé-Est (104%) et par le MAE (1990) pour des ovins de race indéterminée et en milieu villageois (79 à 123%). Cependant, Vallerand et Branckaert (1975) trouvent des valeurs moyennes de 168% au Cameroun, tandis que Hadzi (1988) trouve des résultats allant de 157 à 203% par an.

Le taux de prolificité a varié de 100 à 125%, avec une moyenne de 116%. Là encore ces performances sont meilleures que celles observées par Dianda (1981) et que celles rapportées par le MAE (1990), qui trouve 101 à 119%. Sur la SEG les agnelages étaient surtout simples (85, 80%); le pourcentage d'agnelages doubles et triples était de 13,84 et 0,36%, respectivement.

Le taux moyen de mortalité périnatale (à 7 jours) était de 7,18%, avec des variations interannuelles (tableau 6) allant de 4,98% (1987) à 14,70% (1983). La répartition est presque la même pour les deux sexes: 31 mâles et 29 femelles pour 60 agneaux morts.

La cause essentielle de ces mortalités est généralement la subviabilité à la naissance, liée à un faible poids. Dans certains cas, la mortalité a été entraînée par un rejet de l'agneau par la mère ou par une insuffisance de la production lactée de la mère. Mais bien souvent les causes des mortalités n'ont pas pu être déterminées.

Conclusions

Les ovins Djallonké du Burkina Faso ont une croissance relativement lente dans les systèmes extensifs d'élevage, inférieure aux performances des moutons du Sahel et des ovins de race européenne. L'étude a confirmé l'influence essentielle de l'année et du mois de naissance sur les performances de croissance et de reproduction des moutons Mossi du Burkina Faso. A travers ces facteurs, on note surtout l'influence des conditions du milieu (évolution de la qualité et de la disponibilité du pâturage, température ambiante, conduite de l'élevage, etc.). Les résultats obtenus montrent aussi que les mâles devraient être renouvelés tous les 16 à 17 mois.

Indépendamment de ces facteurs, on note aussi beaucoup de variations pour des groupes d'animaux relativement homogènes. Un programme rationnel de sélection permettrait donc probablement d'aboutir à une amélioration des performances. D'autre part, les performances rapportées ici proviennent d'une situation où l'alimentation repose essentiellement sur le pâturage naturel, et où la reproduction n'est pas gérée; une gestion rigoureuse de la carrière des géniteurs, une intensification de l'alimentation, et une amélioration des conditions d'élevage sont susceptibles de permettre une productivité plus importante, comme l'ont démontré les essais d'embouche menés au nord-ouest du Burkina (Bourzat *et al.*, 1987) et dans notre laboratoire à Gampèla (Nassa, 1990).

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Principaux paramètres démographiques des ovins et caprins des parcours du centre de la Somalie

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Résumé

L'étude des performances zootechniques des moutons Somali à tête noire et des chèvres blanches Somali montre un niveau de productivité très lié aux conditions climatiques particulièrement sévères au cours des trois années du suivi: l'âge à la première mise-bas est supérieur à 2 ans; l'intervalle entre parturitions, voisin de 14 mois, dépend de la saison de mise-bas précédente; la fécondité est faible chez les deux espèces (62% chez les ovins et 65% chez les caprins); la mortalité est élevée chez les jeunes animaux avant le sevrage (13 à 51% selon la saison). Ces paramètres conduisent à une baisse sensible du cheptel pendant la sécheresse. L'étude de ces mêmes paramètres en période postsécheresse devrait fournir des indications importantes sur la capacité de ces populations à surmonter les aléas climatiques.

Major demographic parameters for White Somali goat and Blackheaded Somali sheep in the Somalia central rangelands

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Abstract

Evaluation of the reproductive performance of the Blackheaded somali sheep and the White Somali goat indicates that their

productivity was strongly affected by the harsh climatic conditions experienced during the three years of the survey: age at first parturition was over two years; the length of the parturition interval, mean of about 14 months, was influenced by the season of the preceding birth; conception rate was low in both species (62% in sheep and 65% in goats); young-stock mortality was high, ranging from 13% to 51% depending on the season.

Population growth rates calculated from these parameters indicated a marked drop in the livestock population during the drought period. A study of these parameters following the period of drought should provide important information on the capacity of these populations to withstand climatic changes.

Introduction

Le Central Rangeland Development Project (CRDP) opère dans une zone située au centre de la Somalie entre 3°10' et 7°40'N. Limitée à l'est par l'océan Indien et à l'ouest par la frontière avec l'Éthiopie, elle couvre les régions administratives de Hiran, Galgadud et Mudug, soit une superficie de 149 000 km².

Les parcours de cette zone (Central Rangelands) ont toujours joué un rôle important entre le nord du pays (régions d'Hargeisa) et la partie sud-sud-est (régions de Mogadiscio et de la vallée du Shebele). Cette étude devait fournir aux organismes en charge du développement de l'élevage un référentiel technique le plus précis possible sur la productivité des petits ruminants de la zone. La race ovine Somali à tête noire (Blackhead Somali Sheep), également appelée mouton de l'Ogaden ou mouton de Berbera, peuple la zone du CRDP. Classé dans le groupe des ovins à queue grasse, ce mouton est élevé essentiellement pour la production de viande et accessoirement pour la peau. Le poids adulte, sexes confondus, varie de 33 à 45 kg. La population locale caprine est la race Mudugh (Rosetti et Congiu, 1955), également appelée Galla, Deghier ou Digit yer, ou communément chèvre blanche Somali (White Somali Goat), par référence à sa robe d'un blanc très pur quelquefois tachetée de noir. Cette race se rencontre dans la partie la plus aride du pays. Son format est intermédiaire entre la grande chèvre du désert du Soudan et la petite chèvre d'Afrique de l'Est (Devendra et McLeroy, 1982). Ses longues pattes en font une bonne marcheuse. Elle est élevée pour ses productions de viande et de lait.

Matériel et méthode

La Somalie a un régime des pluies de type bimodal (Griffiths et Hemming, 1963) très erratique. Le régime thermique est unimodal, de type austral avec des températures moyennes annuelles supérieures à 30 °C et une amplitude sur

l'année n'excédant pas 3 à 5 °C. Nous avons retenu le découpage suivant entre les différentes saisons au cours de l'année:

- *dayr* (petite saison des pluies): 22 septembre au 21 décembre.
- *jilaal* (longue saison sèche): 22 décembre au 21 mars.
- *gu* (grande saison des pluies): 22 mars au 21 juin.
- *hagaa* (petite saison sèche): 22 juin au 21 septembre.

Plan de sondage

Le programme couvre six entités administratives (districts):

- deux districts de la zone centrale: Dusa Mareb et Galakayo;
- deux districts de la vallée du Shebele: Belet Weyne et Bulo Burti. La végétation du district de Bulo Burti a été décrite par Kuchar *et al.* (1985). Les épineux dominent largement cette steppe arbustive;
- deux districts côtiers : El Dhere et Hobyo. La végétation du district d'El Dhere se caractérise par deux formations remarquables: les steppes herbeuses de la plaine côtière, et les steppes arbustives de l'intérieur, qu'ont prospectées et décrites Herlocker et Ahmed (1986).

Le peuplement humain est constitué en majorité par des éleveurs nomades et quelques agriculteurs sédentaires le long de la vallée du Shebele. 30 villages ont été choisis pour chaque zone par tirage au sort (sur 150 environ) en fonction des contraintes d'accès, climatiques ou militaires. Le tirage au sort des unités familiales n'a pas été possible compte tenu de l'impossibilité d'obtenir les listes des familles. Un certain nombre de chefs de famille ont refusé de participer à nos travaux, d'autres se sont déplacés et il nous fut impossible de retrouver leurs troupeaux. Finalement, l'enquête a porté sur 361 exploitations dont la répartition par zone est résumée dans le tableau 1.

Tableau 1. Répartition des différentes enquêtes menées dans les trois zones du projet CRDP

Zone	Questionnaire	Fiche barymétrique	Fiche carrière de femelle
Vallée du Shebele	177	1813	276
Côtière	83	1383	531
Centrale	101	1457	198
Total	361	4653	1005

Les fiches d'enquêtes et leur mise en oeuvre

Trois enquêtes se complétant ont été réalisées auprès des unités de production sélectionnées:

- les données relatives au système d'élevage ont été collectées à l'aide d'un questionnaire d'enquête mis au point au Burkina Faso (Bourzat, 1984), et complété pour pouvoir être utilisé dans toutes les zones écologiques;
- les données barymétriques ont été recueillies grâce à une fiche individuelle. Les mesures et contrôles des animaux ont été effectués au parc de nuit près du campement, soit le soir avant la tombée de la nuit, ou le matin avant le départ des animaux au pâturage;
- les données recueillies par une fiche de carrière de femelle ont servi à évaluer les paramètres de reproduction.

Cette dernière fiche permet de reconstituer la carrière d'une reproductrice à partir des données mémorisées par son propriétaire. Pour chaque saison de reproduction, le nombre, le sexe de chaque produit ainsi que leur devenir sont enregistrés. Les nombreux travaux menés à partir de ce type d'enquête (Coulomb, 1982; Dumas, 1975) montrent que les données restent fiables tant que l'entretien est mené avec une personne directement impliquée dans la gestion quotidienne du troupeau. La fiabilité décroît avec la diminution d'intérêt porté par le propriétaire à son cheptel et avec l'espèce considérée (les espèces à portées multiples, à cycles de production courts et dont les valeurs unitaires des produits sont relativement faibles sont moins bien connues des éleveurs).

La taille de l'échantillon ($n=1000$) permet une bonne évaluation des paramètres de base de la reproduction des petits ruminants dans la zone du CRDP, qui sont présentés dans ce document.

Résultats

Répartition des naissances au cours de l'année

Le pic de mise-bas correspond à la grande saison des pluies *gu*, ce qui signifie que la plupart des saillies fécondantes ont lieu pendant la petite saison des pluies ou au début de la saison sèche alors que le pâturage est encore abondant et de bonne qualité (tableau 2). Un deuxième pic moins important apparaît pendant la petite saison des pluies *dayr*, qui correspond à des accouplements pendant la saison *gu*. Les chèvres sur toutes les zones, et les ovins et caprins de la vallée du Shebele, présentent des parturitions plus étalées sur les différentes saisons. Ce phénomène peut s'expliquer par un spectre alimentaire des caprins plus large que celui des ovins ainsi que par les pratiques de contrôle des accouplements. Pour assurer un approvisionnement régulier en lait, la reproduction des caprins n'est pas contrôlée et la lutte a lieu toute l'année. En revanche, chez les ovins qui

Tableau 2. Répartition des mises-bas par saison, par espèce et par zone (en %)

Zone	Espèce	n	Jilaal	Gu	Hagaa	Dayr
Intérieure	Ovins	156	12,2	54,5	5,8	27,5
	Caprins	166	15,1	37,3	11,5	36,1
Vallée du	Ovins	154	28,6	40,9	16,2	14,3
Shebele	Caprins	246	20,7	34,6	16,7	28,0
Littorale	Ovins	475	6,5	20,4	35,0	38,1
	Caprins	350	15,1	48,0	16,6	20,3
CRDP	Ovins	785	12,0	31,2	25,5	31,3
	Caprins	762	16,9	41,4	15,5	26,2

sont essentiellement élevés pour la production de viande, les éleveurs essayent d'avoir des agneaux aux périodes favorables et pratiquent en ce sens le contrôle de la lutte à l'aide d'un tablier placé en avant du pénis ou par une ficelle entourant le fourreau du pénis et attachée à la base du scrotum. Sur la zone littorale où les éleveurs de moutons sont plus spécialisés, les brebis agnèlent surtout pendant les saisons de *hagaa* et *dayr*.

Age moyen à la première mise-bas

Le tableau 3 montre que les caprins sont moins précoces que les ovins, alors que la situation inverse est généralement admise. Les brebis et les chèvres de la vallée du Shebele sont plus jeunes à la première parturition que celles de l'intérieur et de la côte. La situation nutritionnelle moins sévère de la vallée explique peut-être cette observation. La variation de l'âge moyen à la première mise-bas de la région intérieure, représentée par l'écart type, est plus importante que dans les autres zones.

Tableau 3. Age moyen à la première mise-bas par zone et par espèce (en mois)

Zone	Espèce	n	Age moyen	s
Intérieure	Ovins	99	28,3	12,1
	Caprins	99	29,6	10,2
Vallée du	Ovins	106	24,8	6,8
Shebele	Caprins	167	28,2	6,9
Littorale	Ovins	299	26,9	5,5
	Caprins	232	31,2	8,9
CRDP	Ovins	507	26,8	7,6
	Caprins	498	29,9	8,6

Intervalle entre mises-bas

Le tableau 4 montre que les intervalles entre mises-bas chez les ovins et les caprins sont très voisins. Les ovins de la vallée du Shebele semblent avoir des intervalles entre parturitions plus courts que ceux élevés dans les autres zones. La période de mise-bas précédente a un effet très marqué sur la longueur de l'intervalle suivant: les ovins et les caprins de la zone intérieure et de la vallée Shebele qui ont mis bas pendant les petites saisons des pluies et sèches, *hagaa* et *dayr*, présentent les intervalles les plus courts. Les femelles qui mettent bas pendant la longue saison sèche de *jilaal* ont les intervalles suivants les plus longs. En revanche, il ne semble pas que les caprins de la zone littorale soient sensibles à ce phénomène.

Tableau 4. Intervalle entre mises-bas par zone, par espèce et par saison de mises-bas précédente (en mois)

Zone	Espèce	Saison	n	Moyenne	s
Intérieure	Ovins	<i>Jilaal</i>	13	19,5	7,0
		<i>Gu</i>	53	16,3	6,2
		<i>Hagaa</i>	5	11,4	7,4
		<i>Dayr</i>	9	10,7	5,3
	Caprins	<i>Jilaal</i>	19	17,4	5,3
		<i>Gu</i>	49	15,6	6,0
		<i>Hagaa</i>	9	13,0	7,0
		<i>Dayr</i>	26	10,9	5,5
Vallée du Shebele	Ovins	<i>Jilaal</i>	27	17,0	4,4
		<i>Gu</i>	48	13,8	5,3
		<i>Gu</i>	64	13,9	4,7
		<i>Hagaa</i>	25	12,3	4,6
		<i>Dayr</i>	51	12,9	5,4
Côtière	Ovins	<i>Jilaal</i>	22	19,7	4,0
		<i>Gu</i>	59	14,5	5,9
		<i>Hagaa</i>	132	12,7	2,3
		<i>Dayr</i>	123	12,8	3,6
	Caprins	<i>Jilaal</i>	45	14,6	3,9
		<i>Gu</i>	130	13,3	4,8
		<i>Hagaa</i>	52	15,0	4,7
		<i>Dayr</i>	59	15,2	6,8

Taux de fécondité moyen annuel

Compte tenu du type d'enquête utilisé pour évaluer le taux de fécondité moyen annuel, seules les femelles ayant eu au moins une mise-bas dans leur vie ont été prises en compte. En général, le taux de fécondité des animaux de la zone intérieure semble plus faible que les taux observés dans les autres zones (tableau 5).

Tableau 5. *Taux de fécondité moyen par zone, par espèce et par classe d'âge des femelles*

Zone		Intérieure		Shebele		Littorale	
Classe d'âge	Espèce	Ovins	Caprins	Ovins	Caprins	Ovins	Caprins
0	n	97	99	109	167	299	232
	X	3	1	—	—	—	—
	s	17	10	—	—	—	—
1	n	97	99	109	167	299	232
	X	12	8	11	2	—	—
	s	33	27	31	15	—	—
2	n	95	99	109	167	299	232
	X	54	53	77	63	78	55
	s	50	50	42	48	42	50
3	n	87	90	86	153	281	217
	X	53	69	70	67	60	53
	s	50	47	46	47	49	50
4	n	60	73	54	108	190	168
	X	53	63	61	67	76	79
	s	50	49	49	47	43	41
5	n	37	42	28	61	94	106
	X	49	62	64	72	74	77
	s	51	49	49	45	44	42
6	n	24	24	11	29	32	57
	X	71	42	91	66	44	89
	s	46	50	30	48	50	31
7	n	13	6	1	5	10	21
	X	31	67	—	80	60	71
	s	48	52	—	45	52	46

Dans les régions littorale et de la vallée du Shebele, les ovins et les caprins ont pratiquement les mêmes taux de fécondité.

Très peu de parturitions ont lieu avant 2 ans. Après ce stade, il ne semble pas que l'âge ait une influence sur le taux de fécondité moyen annuel à l'exception des caprins de la zone littorale, où la fécondité augmenterait avec l'âge.

Avortement et mortalité des jeunes

Les taux d'avortement et de mortalité des jeunes sont calculés à partir des fiches de carrière de femelles. Le tableau 6 donne une estimation et la description de la situation de la mortalité chez les jeunes.

Tableau 6. Taux d'avortement* et de mortalité des jeunes à 1 et à 4 mois, par zone, espèce et saison de naissance (%)

Zone	Espèce	Saison de naissance	n	Avort.	Mort. à 1 mois	Mort. à 4 mois
Intérieure	Ovins	<i>Jilaal</i>	19	—	47	74
		<i>Gu</i>	85	—	33	45
		<i>Hagaa</i>	5	—	—	—
		<i>Dayr</i>	43	—	35	60
	Caprins	<i>Jilaal</i>	25	—	33	50
		<i>Gu</i>	62	2	30	39
		<i>Hagaa</i>	12	—	36	36
		<i>Dayr</i>	60	3	43	58
Vallée du Shebele	Ovins	<i>Jilaal</i>	44	5	41	45
		<i>Gu</i>	63	2	25	28
		<i>Hagaa</i>	17	6	25	38
	Caprins	<i>Jilaal</i>	51	4	63	65
		<i>Gu</i>	85	4	22	22
		<i>Hagaa</i>	25	—	28	28
		<i>Dayr</i>	69	10	27	29
Littorale	Ovins	<i>Jilaal</i>	31	3	30	43
		<i>Dayr</i>	182	3	5	8
	Caprins	<i>Jilaal</i>	53	6	17	24
		<i>Gu</i>	168	2	3	4
		<i>Hagaa</i>	56	2	10	10
		<i>Dayr</i>	71	7	12	20
CRDP	Ovins	<i>Jilaal</i>	94	3	39	51
		<i>Gu</i>	246	—	19	25
		<i>Hagaa</i>	122	5	8	13
		<i>Dayr</i>	247	4	12	18
	Caprins	<i>Jilaal</i>	129	4	38	45
		<i>Gu</i>	315	2	13	15
		<i>Hagaa</i>	93	1	18	18
		<i>Dayr</i>	200	7	27	35

* Calculé comme le rapport du nombre d'avortements sur le nombre de parturitions, avortements inclus.

Aucune donnée sur les avortements ne fut disponible pour la zone intérieure. Les taux d'avortement les plus élevés pour les deux espèces semblent être ceux enregistrés dans la vallée du Shebele pendant la petite saison des pluies *dayr*. La mortalité des jeunes des deux espèces à 1 mois ou à 4 mois est plus élevée dans les zones de l'intérieur et de la vallée que sur la zone littorale. La saison la plus meurtrière quels que soient le taux de mortalité ou l'espèce considérée s'avère être la grande saison sèche *jilaal*.

La mortalité à 1 mois représente la majeure partie de la mortalité cumulée à 4 mois. Le premier mois est crucial pour les chances de survie du jeune, à l'exception des agneaux et chevreaux nés pendant la grande saison sèche dans la zone intérieure. Relativement protégés par l'allaitement maternel durant le premier mois de leur vie, ils souffrent ensuite très gravement de la situation de disette de *jilaal* (abreuvement très précaire, pâturage rare et de faible valeur nutritive, prélèvement de lait très important pour l'autoconsommation de la famille).

Discussion

La répartition des mises-bas au cours de l'année obéit aux mêmes tendances que celles observées dans d'autres régions arides ou semi-arides: le maximum de parturitions intervient quatre à cinq mois après la saison des pluies. Bourzat (1984) a décrit ce phénomène pour le nord du Burkina Faso et Wilson (1988) pour le Mali central.

L'âge à la première mise-bas, de plus de 2 ans aussi bien pour les ovins que pour les caprins, est très élevé par rapport aux résultats obtenus chez d'autres races de la zone semi-aride. Dans le nord du Burkina Faso, Bourzat (1980) mesure un âge moyen à la première mise-bas de 13,8 mois et Ouedraogo (1984) de $13,5 \pm 1,7$ mois. Wilson et Durkin (1983) enregistrent au Mali central un âge moyen à la première parturition de $15,8 \pm 3,8$ mois et Haumesser et Gerbaldi (1979) calculent un intervalle de 13,0 à 16,6 mois chez les petits ruminants du Niger. Les moutons Massaï au Kenya, avec un contrôle de lutte, mettent bas pour la première fois à $18,0 \pm 3,7$ mois; les mises-bas commencent chez la petite chèvre Massaï d'Afrique de l'Est à $18,3 \pm 3,9$ mois (Wilson *et al.*, 1984).

L'intervalle entre mise-bas varie de $10,9 \pm 2,1$ mois à $17,5 \pm 1,6$ mois pour les caprins et de $9,2 \pm 1,9$ mois à $19,7 \pm 2,5$ mois pour les ovins. Ces grandes amplitudes traduisent les effets des conditions écologiques et de la saison sur la précédente parturition. Les intervalles les plus courts correspondent bien aux observations faites au Soudan occidental où Wilson (1976a, 1976b) rapporte des intervalles de 9,2 mois, et à celles du même auteur (Wilson, 1988) au Mali où les caprins présentaient des intervalles de mises-bas de $9,7 \pm 3,5$ mois et les ovins, de $8,7 \pm 2,5$ mois.

Compte tenu de l'âge élevé à la première parturition, la fécondité moyenne annuelle par classe d'âge varie de 53%, chez les deux espèces à 3 ans, jusqu'à 71% chez les ovins et 89% chez les caprins de 6 ans. L'influence des différentes zones est très marquée. Chez les moutons Mossi, Ouedraogo (1984) calcule des taux de fécondité de 145,9% en 1981/82, 85,7% en 1982/83 et 82% en 1983/84; pour les caprins Mossi, ces taux étaient respectivement de 169,4, 162,5 et 94,6%. De 1982 à 1984, cette région du Burkina fut très durement frappée par la sécheresse. En Somalie, 1983 fut considérée comme une année de sécheresse (Huebl, 1986) et 1986 peut aussi être considérée comme une année difficile (Zessin *et al.*, 1988). Ces années anormalement sèches transparaissent dans les faibles performances de reproduction calculées à partir de l'enquête rétrospective menée sur les carrières de femelles. Le marché pratiquement inexistant pour les vieilles femelles ne permet pas aux éleveurs de se débarrasser des femelles improductives, ce qui contribue à diminuer la productivité du troupeau.

Le taux d'avortement varie de 3 à 5% chez les ovins et de 1 à 7% chez les caprins. Le maximum d'avortement apparaît pour les deux espèces de la vallée du Shebele pendant la petite saison des pluies *dayr* chez 14% des brebis et 10% des chèvres. Au Mali, Wilson (1988) note 5,1% d'avortements (sur l'ensemble des naissances) chez le mouton du Sahel et 12,6% chez la chèvre sahélienne. Au Burkina Faso, Ouedraogo (1984) calcule un taux de 6,2% sur un échantillon de 113 brebis Mossi et de 13,3% chez 75 chèvres Mossi. Comparés à ces exemples, les taux d'avortement observés en Somalie centrale apparaissent faibles.

Le taux de mortalité à 4 mois chez les caprins varie de 13 à 51% (moyenne: 24%), taux dans lequel la mortalité à 1 mois représente 62 à 77%. 15 à 55% des jeunes agneaux meurent avant 4 mois (moyenne: 26%). Parmi ceux-ci, 77 à 100% disparaissent le premier mois de vie. Au Mali, (Wilson, 1988) constate une mortalité avant sevrage de 23,4% chez les ovins et 34,4% chez les caprins.

Conclusion

L'enquête réalisée a porté sur une période de trois années particulièrement sèches. Les résultats obtenus reflètent les performances d'animaux soumis à un stress climatique particulièrement profond.

La mortalité élevée associée à un intervalle entre mises-bas long et à un taux de fécondité faible sont responsables d'une faible productivité des troupeaux. Ces paramètres utilisés dans un modèle de simulation démographique du croît du troupeau montrent que sans intervention, il n'est pas possible de maintenir les effectifs du troupeau. Les interventions d'amélioration devront s'attacher à réduire la mortalité des jeunes et à augmenter la fécondité.

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Productivité du mouton Djallonké dans le système agroforestier traditionnel du Mayombe congolais

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Résumé

La productivité zootechnique des ovins en élevage traditionnel dans la région de forêt subéquatoriale du Mayombe au Congo a été étudiée pendant trois années, de 1988 à 1990 dans un village à partir d'un échantillon de 104 animaux. Les résultats ont permis d'évaluer le quotient de fertilité apparent, le taux de prolificité, les quotients de fécondité, de productivité numérique, et de mortalité chez les jeunes. L'étude a aussi évalué l'âge à la première mise-bas, l'intervalle entre mises-bas et les poids à la naissance. Cette productivité est assez faible en raison de la forte mortalité des jeunes. Le mode d'élevage basé sur le vagabondage ne favorise pas une bonne productivité, en dépit du taux de fertilité moyennement satisfaisant et des conditions écologiques assez favorables.

Productivity of the West African Dwarf sheep in the traditional agro-forestry system of Mayombe, Congo

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Abstract

The productivity of sheep under traditional management in the subequatorial forest area of Mayombe, Congo, has been evaluated over a 3-year period from 1988 till 1990. Data was collected in one village on a sample of 104 animals. Fertility, prolificacy, fecundity, reproductive efficiency and mortality of the young were calculated. Age at first parturition, parturition intervals and weights at birth were

also recorded. Productivity is relatively low due to high mortality rates in the young. A management system which is based on free-roaming does not promote productivity in spite of satisfactory fertility rates and fairly good environmental conditions.

Introduction

La région du Mayombe est une zone montagneuse de forêt sempervirente subéquatoriale à climat fortement pluvieux (1 800–2 200 mm/an). Depuis 1988, une Réserve de la biosphère y a été créée, contraignant les populations à limiter l'activité cynégétique et à diversifier leurs sources d'approvisionnement en produits carnés. Le petit élevage familial est donc encouragé dans le cadre d'un système de production agricole où les petits ruminants pourraient jouer un rôle socio-économique important.

Une étude réalisée en 1987–1988 sur la connaissance du système agroforestier traditionnel du Mayombe a permis d'y situer l'importance de l'élevage. Celui-ci est une activité de cueillette portant sur les races dites locales d'ovins, de caprins, de porcins et de volaille. Son rôle économique est par conséquent très marginal, bien que ces animaux pourraient trouver ici un environnement propice pour une contribution efficace au revenu monétaire de l'exploitant. Le gibier est la principale source de protéines animales et la chasse une activité économique très importante, occasionnant une forte pression sur la faune sauvage. Cette étude a également conclu que les principales contraintes à cette spéculation sont liées au manque de tradition pastorale et à l'abondance du gibier. Ce manque de tradition ne signifie cependant pas un manque d'intérêt pour cette activité, comme le montrent les conseils sollicités auprès des agents techniques.

L'assistance aux populations est aussi fortement handicapée par l'inexistence de références sur la productivité des animaux ainsi que sur les méthodes appropriées de conduite des troupeaux dans cet écosystème. C'est dans cette perspective qu'un suivi de troupeaux paysans a été mis en place en 1988 pour évaluer la productivité des moutons Djallonké, dont nous rapportons ici quelques résultats relevés sur trois années.

Matériel et méthodes

L'étude s'est, pour des raisons matérielles, limitée aux ovins dans le seul village de Makaba, qui compte 68 familles dont 83% possèdent au moins un ovin. Chez tous ces éleveurs, chaque femelle a été identifiée par une boucle d'oreille, dont le numéro a été reporté sur une fiche individuelle de suivi construite de manière à enregistrer les événements de reproduction (les dates des mises-bas ultérieures, le nombre de produits à chaque mise-bas, le sexe des produits); l'évolution pondérale de tous les produits nés; les causes éventuelles de sorties

des mères et des produits du troupeau. Tous les mâles au temps initial n'ont pas été pris en compte et sont restés en dehors de nos effectifs jusqu'à la fin du suivi.

Les événements qui se produisent au sein du troupeau sont régulièrement enregistrés par un jeune paysan lettré du village. Des enclos ont été construits pour faciliter les opérations de marquage et de pesée; les animaux y sont parqués la veille de chaque visite mensuelle du technicien chargé du suivi.

Les données enregistrées ont permis de calculer chaque année les indices de productivité suivants: quotient de fertilité (100 x nombre de mises-bas/nombre de femelles à la lutte); taux de prolificité (100 x nombre de produits/nombre de mises-bas); quotient de fécondité (100 x nombre de produits/nombre de femelles à la lutte); quotient de productivité numérique (100 x nombre de produits vendus, conservés ou consommés/nombre de brebis à la lutte); taux de mortalité des agneaux (100 x nombre d'agneaux morts/nombre total de produits nés).

Résultats et discussion

Au début du suivi, 104 femelles ont été enregistrées, réparties entre 48 brebis, 23 antenaises, et 23 agnelles. Le tableau 1 présente le nombre de femelles sorties en cours d'année, le nombre de naissance simples et gémellaires, le nombre de produits par sexe et ceux morts ou sortis pour d'autres causes pendant l'année. On note en particulier un taux de mortalité des agneaux très élevé (plus de 50%). Ces morts sont occasionnées en grande partie par des accidents de tout genre comme les noyades, les empoisonnements, les écrasements par véhicules. Les causes pathologiques se limitent aux parasitoses gastro-intestinales et aux gales. Les grandes épizooties sont pour l'instant inexistantes dans la région. Le tableau 2 présente les indices calculés annuellement à partir des informations recueillies.

L'âge à la première mise-bas a été calculé à partir d'un échantillon de 56 antenaises (tableau 3). L'intervalle entre mises-bas (tableau 4) a été calculé pour

Tableau 1. *Evolution démographique du cheptel*

	Femelles mises à la lutte	Femelles sorties	Agneaux nés		Agneaux morts		Total mises-bas	
			F	M	F	M	Simplex	Doublex
Année 1	104	11	70	59	38	37	115	7
Année 2	125	19	73	66	47	32	131	4
Année 3	132	28	88	73	53	30	145	8

deux échantillons de femelles: le premier est un groupe de 100 femelles dont les agneaux de la première mise-bas sont morts avant l'âge de 1 mois, et le second un groupe de 100 femelles dont les agneaux étaient vivants au sevrage. Le mode d'élevage, qui est essentiellement sous forme de vagabondage, prédispose à la monte libre, provoquant la précocité des mises-bas et la réduction des intervalles entre mises-bas.

Tableau 2. Indicateurs de productivité des Djallonké au Mayombe

	Année 1	Année 2	Année 3
Quotient de fertilité apparente	117,3	108,0	115,9
Taux de prolificité	105,7	102,9	105,5
Quotient de fécondité	124,0	111,2	121,9
Quotient de productivité numérique	51,9	48,0	59,0
Quotient de mortalité des agneaux	58,0	56,8	51,5

Tableau 3. Répartition de l'âge à la première mise-bas de 56 antenaises.

	Age à la première mise-bas (mois)			
	8	9	10	11
Antenaises mises à la lutte				
N	4	17	20	15
%	7,2	30,3	36,7	26,8

Tableau 4. Répartition de 100 intervalles entre mises-bas selon la survie des agneaux à un mois

IMB (mois)	6	7	8	9	10	11	12	n =
Agneaux morts avant l'âge de 1 mois	12	33	21	14	8	8	4	100
Agneaux vivants au sevrage	—	2	20	35	22	16	15	100

Le poids moyen à la naissance des agneaux a été évalué sur un échantillon de 35 mises-bas simples pour plusieurs rangs de mises-bas (tableau 5). Les faibles poids à la naissance chez les primipares amenuisent les chances de survie des jeunes agneaux qui naissent pour la plupart avec des poids inférieurs à 1,5 kg.

Tableau 5. Répartition des poids à la naissance en fonction du rang de mise-bas

Poids (kg)	Mise-bas 1		Mise-bas 2		Mise-bas 3		Mise-bas 4	
	N	%	N	%	N	%	N	%
P < 1 kg	2	5,7	–	–	–	–	–	–
1 < P < 1,2	8	22,8	3	8,6	1	3	–	–
1,2 < P < 1,4	15	42,8	7	20	3	8,5	2	5,7
1,4 < P < 1,6	6	17	13	37	17	48,6	20	57
1,6 < P < 1,8	4	11,4	8	22,8	10	28,5	10	28,5
1,8 < P < 2	–	–	1	3	3	8,5	1	3
P > 2	–	–	3	8,5	1	3	2	5,7

Conclusion

Ces données préliminaires sur un échantillon réduit permettent néanmoins d'avoir une première estimation de la productivité des Djallonké en milieu forestier au Mayombe. Il apparaît en particulier que la forte mortalité des jeunes est la cause majeure de la faible productivité des ovins Mayombe, elle-même conséquence du mode d'élevage.

Toute tentative d'amélioration de la productivité de cette spéculation paraît difficile dans les conditions d'élevage actuelles. L'instauration de bergeries permettrait de procéder à un meilleur suivi des animaux. Ceci n'est cependant envisageable que pour un troupeau familial de taille optimale pour que les conditions alimentaires et hygiéniques minimales soient assurées en enclos, sans que les autres activités paysannes ne soient perturbées. En effet, les paysans trop sollicités par les travaux agricoles ne disposent pas d'assez de temps à consacrer au suivi des animaux et préfèrent les abandonner à la divagation pour s'alimenter. La mise en enclos des animaux s'accompagne d'une alimentation à l'auge par apport de fourrages verts et de déchets de cuisine, qui n'est possible qu'avec des troupeaux de taille suffisante. En fixant la taille d'un troupeau familial, l'éleveur évite de garder inutilement des têtes supplémentaires qu'il vend régulièrement pour se procurer des revenus monétaires. Les prochaines études s'orienteront donc vers la proposition de meilleures méthodes de gestion des ovins Djallonké.

Remerciements

Cette étude a été réalisée grâce au concours du CIPEA à qui nous présentons nos sincères remerciements et nous souhaitons que cette assistance se poursuive dans le cadre de notre réseau. Nous exprimons notre profonde gratitude au docteur Daniel Bourzat pour l'encadrement efficace sur le terrain.

Reproductive performance of indigenous goats in traditionally managed flocks in north-east of Zimbabwe

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Abstract

A study was conducted to define kidding intervals and identify causes for long kidding intervals in communal area flocks. Two flocks were selected in the north-eastern part of Zimbabwe and were monitored over two years. Flock entries and exits were recorded, body-mass changes measured fortnightly and blood samples collected in five consecutive weekly intervals in August–September 1988 and March–April 1989. The average kidding interval for does that kidded in August–December (382 ± 90 days) was longer ($P < 0.01$) than that for does that kidded in March–April (265 ± 48 days). The overall average kidding interval was 370 ± 122 days. Serum progesterone levels also indicated that of the 26 goats that kidded in October–December 1988, 65% were non-pregnant 5–6 months after kidding. It is suggested that nutritional stress could be the cause of these long kidding intervals.

Performances de la reproduction des caprins de race locale en élevage traditionnel dans le nord-est du Zimbabwe

L.R. Ndlovu

Résumé

Cette étude effectuée sur les troupeaux caprins des zones communales visait à déterminer l'intervalle entre parturitions et à identifier les facteurs à l'origine de l'accroissement de ce paramètre. A cet effet, deux troupeaux caprins ont été sélectionnés et suivis

pendant deux ans dans le nord-est du Zimbabwe. Les entrées et les sorties d'animaux ont été régulièrement enregistrées et les variations de leur poids vif déterminées tous les 15 jours. Par ailleurs, des échantillons de sang ont été prélevés une fois par semaine pendant cinq semaines en août-septembre 1988 et en mars-avril 1989 en vue de la détermination du taux de progestérone. L'intervalle moyen entre parturitions des chèvres ayant mis bas entre août et décembre (382 ± 90 jours) est significativement plus élevé ($P < 0,01$) que celui enregistré pour les chèvres ayant mis bas entre mars et avril (265 ± 48 jours). Sur la population totale, l'IMB est de 370 ± 122 jours. Par ailleurs, le taux de progestérone indiquait que 65% des 26 femelles qui avaient mis bas au cours de la période considérée n'étaient toujours pas en gestation 5-6 mois après. Ces longs intervalles entre parturitions étaient peut-être dus au stress nutritionnel.

Introduction

There are about 1.8 million goats in Zimbabwe, comprising about 28% of the total livestock population (Central Statistics Office, 1987). Over 98% of the goats are owned by subsistence farmers found mainly in Natural Regions 4-5 which are characterised by low and erratic rainfall.

The indigenous goat has been found to be prolific (Sibanda, 1988, unpublished) but there is a lot of reproductive wastage due to kid mortalities and long kidding intervals (Ndlovu and Royer, 1988, unpublished). Although most of the reported kidding intervals of the Zimbabwean Small East African goat seem to range from 213 to 270 days (Hale, 1986; Royer, 1988, unpublished) there are indications of longer kidding intervals (Hale, 1987). These long kidding intervals could be due to one or a combination of several causes, including acyclicity of does, early embryonic losses of foetuses, abortions that are not noted by enumerators, and shortage of bucks in communal area herds.

In order to suggest intervention strategies, it is necessary to better define the kidding interval and identify which of the putative causes of long kidding intervals are involved. This experiment was carried out in order to monitor the cyclicity of does in two communal flocks and to determine kidding intervals specific to these flocks.

Materials and Methods

Location

The flocks monitored were kept at Tsengerai Communal Lands in Nyanga North in the north-eastern part of Zimbabwe. The area lies within Natural Region 5 and is bordered by hills which provide a discrete limit to the area.

The main rains fell between December and February and totalled 663 mm and 547 mm for the 1987/88 and 1988/89 seasons, respectively. The temperature ranged from 9 to 35°C with October, November, December and January being the hottest months whilst April, May and June were the coldest. The relative humidity was lowest in September (23%) and highest in December and January (87%).

Flocks

Farmers were persuaded to amalgamate their flocks into a larger unit: in return they were offered large-size bucks from a local research station. Amalgamation also served as a labour-reducing incentive as the farmers took turns in herding the flocks. Two amalgamated flocks were created which were managed and housed identically and in juxtaposition. In one flock (Yellow), the does were mated to bucks bought by the project from Matopos Research Station whilst in the other (Blue) the does were mated to local bucks. All goats were ear-tagged using plastic ear tags appropriately coloured for each flock. Ownership still lay with each individual farmer who was free to sell, slaughter or dispose of the animals in any way desired and at any time.

Measurements

The rainfall, humidity and temperature in the area were monitored. The animals in the flocks were weighed fortnightly and births, deaths, sales and purchases were noted by project-employed enumerators.

In August–September 1988 and March–April 1989, blood samples were collected for five consecutive weeks from all adult females (15 kg or more), for determination of serum progesterone level.

Results

Flock structure

On average, the flocks consisted of 52.2% adult females, 3.1% entire males and 39.7% kids of both sexes (Table 1). In the Yellow flock only two adult entire males were allowed though this was not always possible to enforce as farmers did not want to castrate progeny from the larger Matopos bucks.

Kiddings

The kidding pattern showed two distinct peaks in March–April and August–December (Figure 1) which, between them, accounted for over 75% of the kiddings. The March–April peak is quite sharp and compact whilst the

August–December one is more diffuse and broad. Of the total births, about 30% were twins and 70% were singles (Table 2).

Table 1. *Monitored flock size during 1987 and 1988.*

	1987			
	April		October	
	Yellow	Blue	Yellow	Blue
Females	69	42	57	37
Males	2	2	2	2
Castrates	1	14	4	5
Female kids	33	23	16	29
Male kids	19	20	10	5
	1988			
	Yellow	Blue	Yellow	Blue
Females	42	35	58	40
Males	4	2	4	3
Castrates	2	2	3	6
Female kids	13	25	18	15
Male kids	10	3	16	15

Figure 1. *Monthly kidding incidences in the monitored flocks, 1987–1988.*

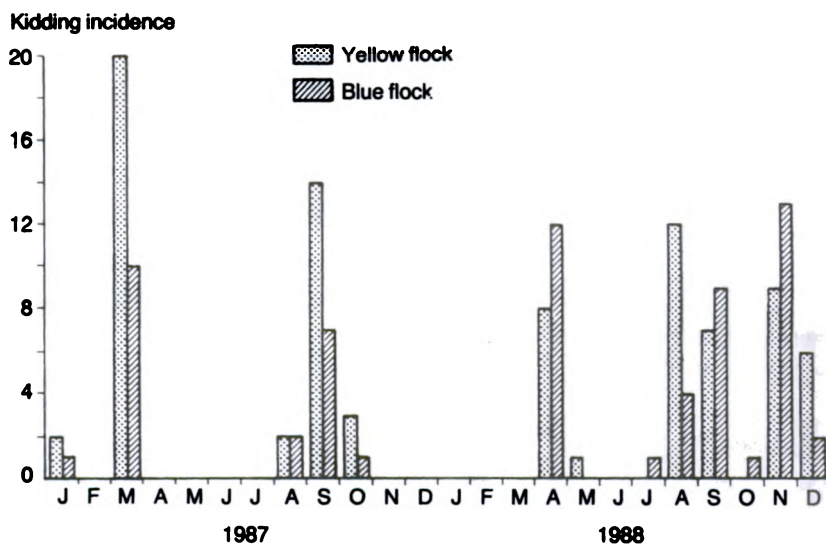


Table 2. *Litter size in 1987 and 1988 in the monitored flocks.*

	Flock			
	Yellow		Blue	
	1987	1988	1987	1988
Singles	29	30	19	28
Twins	12	13	2	14
Total kiddings	41	43	21	42
% twinning	29.3	30.2	9.5	33.3

Doe cyclicity in the flocks

Of the females that completed the August/September 1988 sampling period, 64% were pregnant, 20% were acyclical and 16% were cycling (Table 3). This depicts over a third of the flock as being non-pregnant. Of the 13 acyclic animals, eight had kidded in August prior to sampling. In the follow-up sampling period (March/April, 1989), of the 26 does that had kidded in October–December 1988 and were still in the flock, about 54% were acyclical and a total of 65.4% of the does were not pregnant five months after kidding (Table 4).

Table 3. *Incidences of pregnancy and non-pregnancy in the monitored flocks as at August/September 1988¹.*

Flock	Non-pregnant		
	Pregnant	Acyclic	Cycling
Yellow	24	4	5
Blue	19	9	6
Total	43	13	11

1. Total adult females (15 kg or more) were 61 and 43 for Yellow and Blue herds, respectively. Those unaccounted for above were either sold, withdrawn or slaughtered before the sampling period was completed.

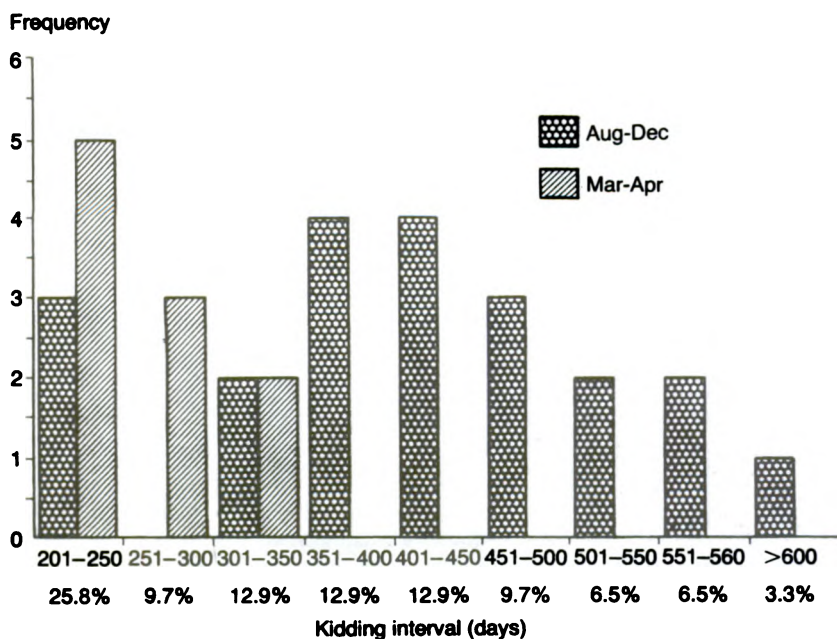
Table 4. *Incidences of pregnancy and non-pregnancy in does that kidded during October–December 1988 as at March–April 1989.*

Flock	Non-pregnant		
	Pregnant	Acyclical	Cycling
Yellow	6	6	3
Blue	3	8	0
Total	9	14	3

Kidding intervals

About 26% of the animals had kidding intervals of less than or equal to 250 days and about 35% had kidding intervals of less than or equal to 300 days (Figure 2). The majority (39%) had kidding intervals between 301 and 450 days. The data are based on 31 females that kidded at least twice during the study period. The mean kidding interval was 370 ± 122 days. However, if season of kidding is taken into consideration, the average kidding interval for does kidding in March–April was 265 ± 48 days whilst that for does kidding in August–December was 382 ± 90 days. Seasonal differences were significant ($P < 0.01$).

Figure 2. Frequency of kidding intervals in monitored flocks (31 does that kidded twice).



Body-mass Changes

Does that kidded in March–April had slightly increased (mean $5\% \pm 3.37$) in body mass from kidding to weaning (24 weeks post-kidding) while does that kidded in August–December had slight losses (mean $4\% \pm 1.74$) in body mass over the

same period. The regression of body-mass change at 24 weeks post-kidding on kidding interval was significant ($P < 0.01$) and the resultant regression equation was:

$$\text{Kidding interval} = 395 - 7.29 \text{ percentage body-mass change at 24 weeks post-kidding.}$$

Discussion

The erratic rainfall pattern noted over the two-year study period is typical of Natural Region 5 areas in Zimbabwe. This has dire implications for cropping, especially the lack of rainfall in January 1988 which is a crucial month for maize production. It also has adverse implications for feed availability to goats and might account for the conspicuous shift of the kidding peak from August–September to November–December in 1988.

The flock composition would suggest that even though the buck:female ratio is low, shortage of bucks is unlikely to be a major cause of long kidding intervals as kidding was spread over two seasons.

The twinning rates observed here are lower than those reported by Sibanda (1988) using research station data but agree with those reported by Hale (1986) and Ndlovu and Royer (1988, unpublished) based on communal area data. It would appear that nutritional stress limits the number of foetuses that the animals in communal areas can carry to term.

The percentage of acyclical does five months after kidding reflects the long kidding intervals obtained. The kidding interval of 370 days is about 100 days more than that reported by Royer (1988, unpublished) working on the Small East African goats in Bikita District, south-east of Zimbabwe. It also differs greatly from the figure of 243 days reported by Hale (1987). It should be noted though, that a deliberate effort was made to exclude all observations that showed kidding intervals of over 300 days in the data reported by Hale (1987). The diverse kidding intervals shown in Figure 2 are typical of unselected populations but could also be due to the fact that the does were of different age groups.

Assuming that the data reported by Hale (1986, 1987) and Royer (1988, unpublished) represent the genetic potential of Zimbabwean Small East African goats, it would appear that there is some environmental factor that is suppressing the full expression of this potential in Tsengerai flocks. Animals kidding in August/September kid at a time when feed resources are at their lowest and lactate for about two months under such conditions. Thus nutritional stress appears to be a prime probable cause of acyclicity and long kidding intervals in these animals.

Body-mass changes support this hypothesis. Animals kidding in March–April on average had lower body-mass losses compared to those kidding in August–December. The large standard errors associated with the means are due to the fact that the flock was unselected and the data were not corrected for age of the doe. Doe age would affect the doe's susceptibility to stress. Nevertheless, the regression equation indicates that one percentage unit loss in bodyweight at 24 weeks post-kidding increases the kidding interval by about seven days. Body-mass changes at 24 weeks post-kidding are important as does should be mated at this stage if they are to conceive within 365 days. Body condition at mating has been shown to influence conception (Henniawati and Fletcher, 1986).

Conclusion

The monitored flocks showed long kidding intervals which were mostly due to extended periods of acyclicity which seemed to be due to kidding during periods of greatest nutritional stress. Follow-up studies will investigate the possible role of strategic nutritional interventions in reducing kidding intervals.

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An analysis of lambing records of West African Dwarf sheep kept at Ile-Ife, Nigeria

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Abstract

Six hundred and ten lambing records of the West African Dwarf sheep kept in the sheep unit of the Obafemi Awolowo University Teaching and Research Farm, Ile-Ife, Nigeria from 1981–1987 were analysed. Year of birth significantly influenced birthweight and litter birthweight ($P<0.001$) and type of birth ($P<0.01$). Males were heavier ($P<0.01$) than the females. Lambs delivered in the dry season were lighter ($P<0.001$) than their wet season counterpart. Litter composition had significant effect on birthweight ($P<0.05$) and litter birthweight ($P<0.01$).

Male:female ratio was equal while the ratio of single:twin:triplet was 68:31:1. Mean birthweight, litter birthweight and litter size at birth were 2.15 ± 0.46 kg, 4.06 ± 0.77 kg and 1.33 ± 0.41 kg, respectively. Significant correlation coefficients of -0.62 and $+0.87$ ($P<0.001$) were obtained when type of birth was correlated with birthweight and litter birthweight, respectively. Adjustment factors for the significant effects were provided.

Performances d'agnelage des moutons Djallonké à Ile Ife (Nigéria)

I.K. Odubote

Résumé

L'analyse de six cent dix agnelages enregistrés de 1981 à 1987 sur le troupeau de moutons Djallonké élevés à la ferme expérimentale de l'Université Obafemi Awolowo d'Ile Ife (Nigéria) est rapportée ici.

L'année de la naissance eut un effet significatif sur le poids de l'agneau, celui de la portée ($P<0,001$), ainsi que sur le type de naissance ($P<0,01$). Le poids des mâles fut supérieur ($P<0,01$) à celui des femelles, tandis que celui des agneaux nés pendant la saison sèche était plus léger ($P<0,001$) que leurs homologues nés pendant la saison humide. La composition par sexe de la portée avait un effet significatif sur le poids à la naissance ($P<0,05$) et sur celui de l'ensemble de la portée ($P<0,01$).

La proportion des sexes était égale à 1, mais, sur l'ensemble de la période considérée, on a dénombré 68 naissances simples, 31 naissances gémellaires et 1 triplet. Le poids moyen à la naissance, celui de l'ensemble de la portée à la naissance et la taille moyenne de la portée furent respectivement de $2,15 \pm 0,46$ kg, $4,06 \pm 0,77$ kg et $1,33 \pm 0,41$. Une corrélation significative entre le type de naissance d'une part et d'autre part, le poids à la naissance ($-0,62$) et le poids de l'ensemble de la portée ($+0,87$) a été démontrée. Des facteurs de correction sont proposés en ce qui concerne les effets significatifs.

Introduction

Small ruminants have for so long taken the back seat in the livestock development programme of Nigeria. However, with current awareness and interest, it is necessary that basic information on production traits and factors that affect them should be documented. Fall et al (1982) reported that birthweight in Djallonke sheep of Senegal is significantly affected by year and season of birth, type of birth, sex and parity. There is paucity of such evaluation for the West African Dwarf (WAD) sheep in the humid tropics of Nigeria. This study was thus undertaken to evaluate the effects of these factors on lambing related parameters in WAD sheep.

Materials and Methods

The WAD sheep used in this study are adequately described by Adu and Ngere (1979). They were housed in barns measuring 22 m x 4 m on a cemented floor. The animals were grouped depending on their status: lactating, pregnant or growing. Each pen was provided with two receptacles for feeding concentrate and watering. A groove filled with water was made round each barn to prevent ant problem. The barns were cleaned daily.

The animals were put on pasture (Giant Stargrass in pure stand) at about 7.30 a.m. and returned to the barns in the afternoon. They were then fed *ad libitum* a supplementary diet consisting of 50% corn, 7.5% groundnut cake, 10% brewers' dry grain, 30% rice bran, 1.5% dicalcium phosphate, 0.5% Agricare and 0.5% salt.

Panicum maximum and *Gliricidia sepium* were also provided *ad libitum* in the pens. The sheep were treated for ectoparasites, drenched once every three months and given other veterinary attention when the need arose. The animals lambed all year round. Birthweights were recorded within 12 hours after birth. Stillbirth or deaths immediately after birth were disposed of after post-mortem examination. Such lambing records were discarded for this analysis. Lambs were examined for any defect at birth and to maturity.

Records of the birthweight, litter birthweight and litter size at birth were analysed for effects of year of birth, season of birth (dry season – November to March; rainy season – April to October) type of birth, litter composition and sex using the General Linear Model (SAS, 1982). Differences between means were tested by Duncan's New Multiple Range Test (Steel and Torrie, 1980). From least squares constants, weights of lamb were adjusted to the equivalent of a single, male lamb born in the wet season. Correlations between type of birth and birthweights were also computed.

Results and Discussion

The least squares means for birthweight, litter birthweight and litter size at birth are given in Table 1. The least squares constants and adjustment factors for birthweight and litter birthweight are presented in Table 2. Male:female ratio was equal while the ratio of single:twin:triplet was 68:31:1.

Significant ($P < 0.001$) correlation coefficients of -0.62 and 0.87 were obtained when type of birth was correlated with birthweight and litter birthweight, respectively.

The overall average birthweight of 2.15 ± 0.46 kg obtained in this present study was found to be higher than the 1.8 kg reported by ILCA (1979) for the same breed in Oyo town. Ngere and Aboagye (1981) reported a birthweight of 1.3 kg in Ghana while Ngere et al (1979) reported 1.5 kg in Ibadan. It appears that the location of the breed has an effect on the birthweight either as a result of differences in the management system practised or the feeding regime and feedstuffs offered. Nevertheless, the WAD sheep is the smallest of the Nigerian breeds of sheep. The WAD weighed lighter at birth than the Uda and Yankasa breeds (Buvanendran et al, 1981).

The estimated average litter size at birth of 1.33 ± 0.41 is higher than the estimates reported in the literature for indigenous Nigerian breeds (Buvanendran et al, 1981; Sackey et al, 1987). No case of quadruplets was observed in this study. Ngere and Aboagye (1981) observed a twinning rate of 55% in Ghana while Ademosun (1973) reported a 37% twinning rate which is slightly higher than the 31% obtained in this study for the WAD sheep. Sackey et al (1987), on the other hand, reported 22% twinning rate in Yankasa kept at institution farms.

Table 1. Least squares means for birthweight, litter birthweight and litter size at birth (kg).

Class	Birthweight		Litter birthweight		Litter size at birth	
	No	Mean	No	Mean	No	Mean
Least squares						
Overall mean	809	2.15	193	4.06	610	1.33
SD		0.46		0.77		0.41
Year: 1981	114	2.06 ^c	31	3.88 ^{cd}	86	1.39 ^a
1982	157	1.88 ^d	38	3.49 ^e	118	1.30 ^{abc}
1983	154	2.10 ^{bc}	40	4.23 ^{bc}	116	1.41 ^a
1984	127	2.31 ^{bc}	26	4.16 ^{bc}	96	1.24 ^{bc}
1985	122	2.35 ^b	33	4.42 ^b	92	1.37 ^{ab}
1986	69	2.46 ^a	13	4.82 ^a	52	1.28 ^{abc}
1987	66	2.11 ^c	12	3.70 ^{de}	50	1.20 ^c
SD		0.40		0.69		0.46
F. test		(P < 0.001)		(P < 0.001)		(P < 0.01)
Season: Wet	539	2.19 ^a	129	4.16 ^a	406	1.34 ^a
Dry	270	2.09 ^b	64	3.85 ^b	204	1.32 ^a
SD		0.43		0.76		0.21
F. test		(P < 0.001)		(P < 0.001)		ns
Type of birth: Single	417	2.30 ^a	—	—		
Twin	374	2.00 ^b	187	4.01 ^b		
Triplet	18	1.88 ^c	6	5.65 ^a		
SD		0.39		0.80		
F. test		(P < 0.001)		(P < 0.001)		
Sex: Male	405	2.21 ^a				
Female	404	2.10 ^b				
SD		0.46				
F. test		(P < 0.001)		(P < 0.001)		
Litter composition						
0 male, 2 females	94	1.92 ^b	47	3.84 ^b		
1 male, 1 female	196	2.00 ^a	98	4.01 ^b		
2 males, 0 female	80	2.06 ^a	40	4.12 ^b		
0 male, 2 females	—	—	—	—		
1 male, 2 females	15	1.86 ^b	5	5.58 ^a		
2 males, 1 female	—	—	—	—		
3 males, 0 female	3	2.00 ^a	1	6.0 ^a		
SD		0.36		0.89		
F. test		(P < 0.05)		(P < 0.01)		

SD = Standard deviation.

Means along the same column with different superscripts are significantly (P < 0.05) different from each other.

Table 2. *Least squares constants (LSC) and additive correction factors (ACF) for birthweight and litter birthweights (kg).*

Class		Birthweight		Litter birthweight	
		LSC	ACF	LSC	ACF
Sex:	Male	-0.55	0.00		
	Female	+0.055	0.11		
Type of birth:					
	Single	-0.24	0.00		
	Twin	+0.06	0.30	+0.82	0.00
	Triplet	+0.18	0.42	-0.82	-1.64
Season:	Wet	-0.05	0.00	-0.155	0.00
	Dry	+0.05	0.10	+0.155	0.31

There was a significant year effect for all the three traits under consideration, though with no clear-cut trend. Birthweight increased throughout the duration of the study except for 1982 and 1987. The year 1987 witnessed a decline in performance for the three traits which may be as a result of the absence of supplementary diet for that year. Litter size at birth began to decline in 1986. This could be attributed to the possible effect of inbreeding since the flocks are closed. In addition, there has never been any conscious genetic improvement of the flock for any trait.

The effect of season was significant ($P < 0.01$) for birthweight and litter birthweight but was not significant ($P > 0.05$) for litter size at birth. Lambs born in the wet season were heavier than those delivered in the dry season by 0.1 kg. Similar results were obtained by Buvanendran et al (1981) and Wilson and Murayi (1988). The seasonal effect could be nutritional due to the quality of forage available to the ewe during pregnancy. This view was held by Adu and Olaloku (1979) who stated that the birthweight of lambs is significantly affected by the nutritional status of the ewe during pregnancy. Osinowo et al (1989) also observed that season of birth significantly influenced litter size at birth. The insignificant effect obtained in this study may be due to the fact that the dry season in the southern part of Nigeria is not as pronounced as in the northern part to warrant a high foetal mortality and/or because season in the cited reference was defined differently from the definition in this paper.

Litter size was positively correlated (+0.87) with litter birthweight but negatively correlated (-0.62) with birthweight. Birthweight dropped significantly from 2.3 kg for singles to 2.0 kg for twins and 1.88 kg for triplets. Litter birthweight, however,

increased significantly from 4.01 kg for twins to 5.65 kg for triplets. Twins and triplets were thus 3.65 kg and 1.71 kg heavier than singles and thus the low birthweight for twins and triplets are offset by high litter weight. These differences are quite notable and are maintained to maturity (Buvanendran et al, 1981). Though the growth rate of the WAD sheep cannot match any of the northern breeds, the higher litter size could bridge the productivity gap to a certain extent.

Ngere and Aboagye (1981) reported that type of birth affected birthweight. This was further supported by the reports of Ademosun (1973) and Ngere et al (1979) although the birthweights reported (2.5 kg and 1.5 kg) were higher and lower, respectively, than the value obtained in this study. This goes to show the high variability that exists in the WAD sheep for birthweight. Birthweight recorded in this study ranged from 2.8 kg to 1.2 kg. This provides opportunity for selection to improve birthweight.

Male lambs were found to be heavier than female lambs at birth in this study. Buvanendran et al (1981), however, did not observe any sex effect on birthweight. In the present study there were no differences between the sexes within the different types of birth. However, the presence of a male in a litter or the preponderance of males in a litter led to an increase in the litter birthweight and birthweight.

From the foregoing, multiple birth is desirable in WAD sheep because of the higher litter weight and litter size and absence of congenital malformation. It should therefore be selected for, to improve reproductive efficiency (Turner, 1969). This will necessitate adequate selection criteria and adjustment factors. Taiwo et al (1982) suggested that age of dam, sex of lamb, type of birth and season of birth need to be adjusted for. The values obtained in this study are indicative, but more studies are still required.

Improvement in management practices and system, feeding (regime and feedstuffs) and disease control are, however, imperative for sustainable increase in productivity.

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Factors Influencing flock structure and production performance dynamics of breeding sheep and goat station flocks in Kenya

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Abstract

Population demographic analysis were carried out in four different breeding sheep and goat station flocks in Kenya using data collected over a four-year period from 1986 to 1989. Data collected included monthly flock inventory records for breeding adults, yearling and 0-1 year old within sex categories, lambings, disposals and mortalities and losses from the flock.

Results indicated that irrespective of the flock breed type composition, ecological lactation or breeding management schedule practised, the proportion of males to females remained at a ratio of 30-70 except for one flock with predominantly wool sheep breeds located in ecological zone II with a high proportion of 50% breeding adult females, the three station flocks had had breeding females comprising 40% of the total flock. It was observed that a hair sheep station breeding flock located in ecological zone IV and comprising of Dorper and red Maasai sheep breed types and practising frequent mating system recorded the lowest annual mortality rate (13%) and highest annual lambing rate per 100 breeding females (133%) in the flock, the highest annual disposal offtake (37%) and the highest annual flock population increase (17%) compared to the other three stations which practise once a year joining. A wool sheep station in a high potential ecological zone performed lowest in these parameters.

It is therefore concluded that management practise rather than flock structure plays a more critical role in production efficiency of sheep and goat flocks located in adaptive environments.

Facteurs agissant sur la structure et les performances de production des troupeaux d'ovins et de caprins reproducteurs élevés en station au Kenya

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Résumé

Une analyse démographique a été effectuée à partir de données collectées pendant quatre ans (1986-1989) sur quatre troupeaux d'ovins et de caprins reproducteurs élevés en station au Kenya. Ces données portaient sur le nombre mensuel d'adultes reproducteurs, de jeunes mâles et de jeunes femelles âgés de 1 an et de moins de 1 an, les agnelages, les ventes, la mortalité et les pertes enregistrés dans les troupeaux.

Il ressort des résultats obtenus que le sexe-ratien comptait toujours 30 mâles pour 70 femelles quelles que soient la composition par race des troupeaux, la zone écologique, le système de reproduction. A l'exception du troupeau de la zone écologique II constitué essentiellement de moutons à laine où il y a forte proportion (50%) de femelles reproductrices, les trois troupeaux élevés en station comptaient 40% de reproductrices adultes. Les meilleures performances ont été enregistrées pour un troupeau de Dorper et Red Masai élevé en station dans la zone écologique IV, et dont les animaux étaient fréquemment accouplés: ce troupeau a montré un taux de mortalité de 13%, un taux annuel d'agnelage de 133%, un taux d'exploitation de 37% et un taux de croissance démographique de 17%. Ces performances étaient meilleures que celles des trois troupeaux où l'accouplement est programmé une fois par an. Les chiffres les plus médiocres se rapportant à un troupeau de moutons à laine élevé en station dans une zone écologique à potentialités pourtant élevées.

Il apparaît, au vu de ces résultats, que le mode d'élevage est plus important que la composition du troupeau pour déterminer les performances de production de troupeaux d'ovins et de caprins élevés dans diverses zones écologiques.

Contrôle des béliers dans la gestion de la reproduction ovine

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Résumé

Le contrôle des béliers dans la gestion de la reproduction ovine au Maroc nécessite une uniformisation des techniques de l'examen, une programmation dans le temps des interventions et une coordination entre les différents acteurs. Un tel schéma de contrôle des géniteurs est présenté par les auteurs, suivi des résultats préliminaires de l'examen de 741 béliers en système d'élevage intensif et extensif.

Selection of rams in sheep-breeding management

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Abstract

The control of rams in sheep-breeding management in Morocco requires the standardisation of research techniques, scheduling of interventions and coordination among the people involved. The authors present preliminary results of a ram-testing programme that involved 741 rams in extensive and intensive production systems.

Introduction

Au Maroc, le cheptel ovin est estimé à 16 millions de têtes (MARA, 1990). Les taux de reproduction y restent généralement bas chez les races locales, malgré leur potentialité intrinsèque élevée de reproduction et des actions entreprises dans le sens de l'amélioration des conduites d'élevage des troupeaux aussi bien en élevage intensif qu'en élevage extensif.

La recherche des solutions à ce problème a abouti à toute une série d'investigations sur la reproduction des ovins. Mais les études entreprises au niveau de ces races ont beaucoup plus intéressé les femelles, et ce n'est qu'à partir de ces dernières années que des recherches ont été consacrées au mâle.

Les premières investigations ayant montré la présence d'un fort pourcentage d'infertilité chez les béliers, environ 30%, il s'est alors révélé nécessaire de procéder à un dépistage systématique de l'infertilité et au contrôle des béliers dans les élevages au Maroc.

Ce document présente une approche réaliste et adaptée aux conditions marocaines développée pour le dépistage de l'infertilité et le contrôle des géniteurs, tout en respectant les normes standards dans ce domaine, suivie de résultats préliminaires qui semblent prouver qu'une grande partie des géniteurs jusque-là utilisés dans les troupeaux marocains sont infertiles.

Schéma de contrôle des béliers au Maroc

Importance du contrôle des béliers

L'examen des mâles permet de détecter ceux qui sont impropres à la lutte ou à l'insémination artificielle et ceux à très haute fertilité. Des problèmes d'infertilité chez les béliers dominants du troupeau peuvent entraîner des pertes considérables en reproduction qui risquent de passer inaperçues pendant un certain temps, surtout si un bon niveau de libido est maintenu chez ces béliers.

Il permet d'éviter la propagation de certaines pathologies infectieuses ou héréditaires telles que des tares congénitales des agneaux (agénésies), la brucellose, les infections à *Actinobacillus seminis*, *Salmonella abortus ovis*, dont la transmission est assurée par le bélier.

Les grands traits de l'examen des béliers au Maroc

Le contrôle des béliers est réalisé au Maroc grâce à l'examen andrologique, qui a été standardisé dans le but de sa vulgarisation. L'historique individuel et collectif (âge, origine, gestion du troupeau, gestion de la reproduction en particulier, etc.) permet une meilleure interprétation des résultats de l'examen andrologique. Les objectifs des éleveurs, à court et à long terme, sont aussi à prendre en considération.

L'examen clinique des béliers comporte deux phases:

- un examen général pour apprécier les aptitudes physiologiques, l'état des réserves corporelles (par palpation lombaire), la conformation, avec une attention particulière à la posture du bélier et aux problèmes de l'appareil locomoteur postérieur, et l'aspect de la laine;

- un examen de l'appareil génital qui se limite à l'inspection et à la palpation des parties externes et facilement accessibles du tractus génital.

Une notation des testicules et épидидymes permet d'apprécier leur état sanitaire et fonctionnel. A la palpation, la fermeté et la souplesse des testicules sont chacune notées de 1 à 5 (de très fermes à très moux, et de très souples à très flasques). La taille, la fermeté et la souplesse des épидидymes sont notées de 1 à 3. Le prépuce et le pénis sont également examinés (état des muqueuses, mobilité etc.).

Pour s'assurer de la quantité et de la qualité de la semence produite par les béliers, l'examen du sperme des béliers, obtenu par électro-éjaculation, se limite à l'estimation des paramètres suivants:

- le volume et la consistance de l'éjaculat;
- la mobilité massale et individuelle, lue immédiatement après la récolte sous microscope à faible grossissement. La motilité en avant des gamètes est notée en termes de pourcentage. Une mobilité de 70% est exigée pour un sperme de bonne qualité;
- la concentration du sperme est déterminée par comptage à l'hématimètre;
- après coloration des frottis de sperme à l'éosine-nigrosine, la détermination des pourcentages de spermatozoïdes morts et des spermatozoïdes de formes anormales est réalisée sous microscope (Blom, 1950). Le microscope à contraste de phase est utilisé pour une meilleure visualisation de la morphologie des gamètes.

Organisation du contrôle des béliers

Formation et sensibilisation

Les directions provinciales de l'agriculture (DPA) constituent les organes de sensibilisation générale à travers la formation d'un personnel compétent et l'allocation des ressources nécessaires à la vulgarisation et à l'encadrement des éleveurs. Les instituts et les écoles supérieures, tels que l'Institut agronomique et vétérinaire Hassan II, sont chargés de la formation des cadres de l'élevage. Ces cadres supérieurs, en particulier les vétérinaires, doivent alors prendre en charge la formation continue de techniciens et de vulgarisateurs et tout l'encadrement technique et scientifique du contrôle des béliers dans le pays.

La sensibilisation des éleveurs pour le contrôle de leurs béliers doit être faite à travers les organisations d'éleveurs telles que l'Association nationale ovine et caprine (ANOC) ou les regroupements d'éleveurs tels que les coopératives, et par les médias.

Organisation du contrôle des béliers

Les éleveurs adressent des demandes d'examen des animaux en fonction de leurs besoins en géniteurs; ils font alors appel aux techniciens formés à cet effet pour la réalisation pratique de l'examen. Les vétérinaires sont responsables du contrôle du travail, de l'encadrement des opérations, de l'interprétation et de la communication des résultats aux éleveurs. Ils saisissent les laboratoires de l'Institut agronomique et vétérinaire (IAV) Hassan II pour la réalisation de tests complets ou spéciaux, et d'expertises en cas de besoin.

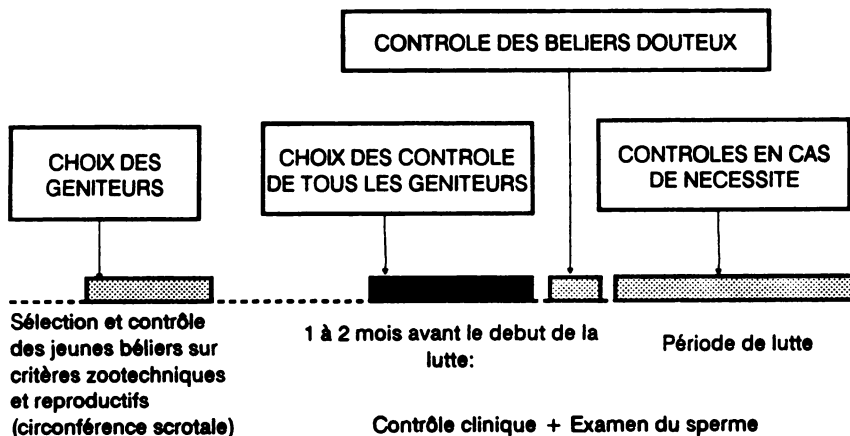
Le traitement de l'ensemble des données se fait à l'IAV qui soumet des rapports à la Direction de l'élevage au Ministère de l'agriculture et de la réforme agraire, chargée de la coordination de l'ensemble du système.

Programmes d'intervention sur le terrain

En général les schémas d'intervention seront centrés sur les périodes de lutte. Le schéma type est celui de la figure 1 correspondant au système extensif qui inclut la majorité des élevages ovins au Maroc. Il devrait être adapté au système intensif où la fréquence de lutte est différente.

En système extensif, le contrôle de tous les béliers se fera un à deux mois avant la lutte, avec appréciation de la conformation des animaux, examen de l'appareil génital, et spermologie. Les animaux douteux seront alors identifiés et réexaminés juste avant le début de la lutte. Au cours de la période de lutte, les éleveurs qui le désirent pourront demander des contrôles en cas de besoin.

Figure 1. Schéma d'un programme de contrôle des béliers dans les élevages extensifs



Matériel et méthodes

Nous rapportons ici l'examen de 633 béliers de race Timahdite effectué avant la période de lutte en élevage extensif dans le Moyen-Atlas de 1987 à 1989 (63, 66 et 504 têtes respectivement) (tableau 1). En 1988, 108 béliers de 6 races à viande (Ile-de-France et Causses du Lot principalement) en élevage intensif dans la région de Casablanca ont également été examinés.

Les élevages visités en système extensif en 1987 et 1988 sont tous encadrés par l'Association nationale ovine et caprine (ANOC) alors que tous ceux visités en 1989 appartiennent à des particuliers non membres de l'ANOC.

Tableau 1. Classement des béliers examinés en système extensif

Dentition	Elevages non encadrés par l'ANOC 1989 (%) N = 504		Elevages encadrés par l'ANOC				Effectif total examiné (%) N = 633	
			1987 (%) N = 63		1988 (%) N = 66			
0	106	(21,0)	11	(17,8)	3	(4,5)	120	(19,0)
2	74	(14,7)	3	(4,8)	8	(12,1)	85	(13,4)
4	91	(18,1)	5	(7,9)	10	(15,2)	106	(16,7)
6	76	(15,1)	30	(47,6)	19	(28,8)	125	(19,7)
8	157	(31,2)	14	(22,2)	26	(39,4)	197	(31,1)

Résultats

Conformation, état général et causes de réforme après examen général des animaux

A l'examen général les béliers ont été classés selon leur conformation, leur état général, la qualité de leur laine et leur âge. En système extensif, l'examen général révèle que 11,6% des animaux sont à réformer au niveau des élevages encadrés par l'ANOC contre 24,4% au niveau des élevages non encadrés (tableaux 2 et 3) et 20,4% en système intensif (tableau 4).

35,7% des béliers n'ayant pas encore de dents de remplacement (DR) présentent à ce niveau de l'examen de nombreux défauts dans les élevages encadrés par l'ANOC alors que ce taux est de 11,3% dans ceux non encadrés.

Tableau 2. *Classement des béliers après examen général dans les élevages encadrés par l'ANOC*

Dentition	Bon (%)	Acceptable (%)	Mauvais (%)	Nombre total
0	57,1	7,1	35,7	14
2	90,9	–	9,1	11
4	93,3	6,7	–	15
6	65,3	20,4	14,3	49
8	85	10	5	40
Total (%)	78	12,4	11,6	129

Tableau 3. *Classement des béliers après examen général dans les élevages non encadrés par l'ANOC*

Dentition	Bon (%)	Acceptable (%)	Mauvais (%)	Nombre total
0	80,2	8,5	11,3	106
2	55,4	23	21,6	74
4	46,1	20,9	33	91
6	51,3	22,4	26,3	76
8	50,3	21	28,7	157
Total (%)	56,7	18,9	24,4	504

N = 504,

Tableau 4. *Classement des béliers utilisés en élevage intensif après examen général*

Dentition	Bon (%)	Acceptable (%)	Mauvais (%)	Total
2	96,4	–	3,6	28
4	75	–	25	4
6	100	–	–	12
8	68,7	–	31,3	64
Total (%)	79,6	–	20,4	108

L'inverse est constaté pour les géniteurs ayant toutes leurs DR: 5% dans les élevages encadrés contre 28,7% dans les élevages non encadrés.

En système intensif nous constatons que 31,3% des béliers ayant 8 DR sont à réformer au niveau de l'examen général contre seulement 3,6% pour les animaux ayant 2 DR (tableau 4). Nous constatons globalement qu'après l'examen le

pourcentage de géniteurs impropres à la lutte reste plus élevé en système extensif (21,8%) qu'en système intensif (20,4%).

Les principales causes de réforme relevées au cours de l'examen général des géniteurs sont rapportées aux tableaux 5 et 6 respectivement pour les béliers utilisés en système extensif et en système intensif.

Tableau 5. *Causes de réforme des béliers utilisés en système extensif après examen général*

Causes de réforme	Elevages encadrés par l'ANOC N = 129 (%)	Elevages non encadrés par l'ANOC N = 504 (%)	Total (%) N = 633
Conformation	2,3	21,8	17,9
Laine	4,6	16,3	13,9
Age	3,9	5	4,7
Maladie	0,8	0,2	0,3

Tableau 6. *Causes de réforme des béliers utilisés en système intensif après examen général*

Causes de réforme	Nombre de cas relevés	Fréquence relative (N = 22)	Total (%) N = 108
Conformation	3	13,6	2,8
Boiterie	12	54,5	11,1
Appareil respiratoire	5	22,7	4,6
Autres pathologies	4	18,1	3,7

N.B. : Certains béliers présentent des pathologies associées et sont ici comptés à chaque fois au niveau des cas.

Dans le système extensif, les défauts de conformation sont la principale cause de réforme (17,9% des animaux examinés) suivis par la mauvaise qualité de la laine, notamment la présence de jarres (13,9%), alors qu'en système intensif la pathologie proprement dite est dominante (17,6% des animaux examinés). Nous relevons cependant que dans les élevages encadrés par l'ANOC, les fréquences de réformes dues à la mauvaise conformation et à la mauvaise qualité de la laine représentent respectivement 2,3% et 4,6%, contre 21,8% et 16,3% dans les élevages non encadrés.

Causes de réforme et leurs fréquences après examen spécial de l'appareil génital

Dans le système extensif (tableau 7), 10,1% des géniteurs utilisés sont à réformer pour taille testiculaire insuffisante (circonférence scrotale <28 cm), bien que les testicules soient sains. Cependant nous n'avons pas noté de circonférences scrotales (CS) inférieures à 28 cm au niveau des élevages encadrés par l'ANOC, alors que le pourcentage de géniteurs à éliminer pour CS <28 cm est de 12,7% dans les autres élevages.

Tableau 7. Causes de réforme des béliers utilisés en système extensif après examen de l'appareil génital

Causes de réforme	Elevages encadrés par l'ANOC N = 129 (%)	Elevages non encadrés par l'ANOC N = 504 (%)	Total (%) N = 633
Balanoposthite	5,4	3,6	3,9
Epididymite	6,9	5,2	5,5
Orchite	3,9	7,1	6,4
Monorchidie	0,8	1,2	1,1
Atroph./ Hypopl. testiculaires	9,3	5	5,8
Abcès/Tumeurs testiculaires	0,8	1,6	1,4
CS insuffisante	—	12,7	10,1
Toutes causes	27,1	36,3	34,2

Dans les élevages encadrés par l'ANOC, la pathologie "vraie" de l'appareil génital constitue la principale cause de réforme à l'examen spécial du tractus génital, avec une fréquence de 27,1% contre 23,6% dans les élevages non encadrés.

En système intensif (tableau 8), 40,7% des géniteurs en service ont présenté une pathologie au niveau du tractus génital. Les orchites, les balanoposthites et les épididymites avec respectivement des fréquences relatives de 40,9%, 34,1% et 40,9% représentent les trois pathologies les plus importantes chez les béliers examinés de races importées au Maroc. Elles constituent également pour l'ensemble des béliers examinés les dominantes pathologiques, avec des fréquences de 6,4%, 5,5%, et 3,9% en système extensif et de 16,6%, 13,6% et 16,6% en système intensif.

Tableau 8. Causes de réforme des béliers utilisés en système intensif après examen de l'appareil génital

Causes de réforme	Nombre de cas observés	Fréquence relative (N = 44)	Total (%) N = 108
Balanoposthite	18	40,9	16,6
Epididymite	15	34,1	13,9
Orchite	18	40,9	16,6
Monorchidie	2	4,5	1,9
Atroph./Hypopl. testiculaires	6	13,6	5,6
Abcès/Tumeurs testiculaires	1	2,2	0,9

N.B. : Certains béliers présentent des pathologies associées et sont ici comptés à chaque fois au niveau des cas.

Qualité du sperme

La spermologie réalisée chez tous les béliers utilisés en système intensif (N = 108) et chez 20% des béliers utilisés en système extensif (N = 125) montre que 20% des béliers sains cliniquement présentent des anomalies au niveau de leur spermogramme. En effet, 21% des éjaculats obtenus avaient un volume inférieur à 0,5 ml, 71,4% avaient une mobilité inférieure à 80%, 64,3% présentaient plus de 20% de spermatozoïdes de forme anormale et 35,7% avaient une concentration inférieure à 0,8 million par millimètre cube.

Discussion

Conformation et état général

En élevage extensif les causes majeures de réforme après examen général sont la mauvaise conformation et la mauvaise qualité de la laine, avec respectivement des fréquences de 17,9% et 13,9% contre 2,8% et 0% en élevage intensif. Ces chiffres montrent bien l'intensité de la sélection au niveau des béliers de races importées où la conformation bouchère des animaux est le critère zootechnique le plus important de choix de la race pour la production d'agneaux de boucherie.

Cette sélection se fait déjà sentir au niveau des élevages encadrés par l'ANOC. En effet, 2,3% seulement des béliers présentent une mauvaise conformation contre 21,8% dans les élevages non encadrés, et 4,6% présentent une mauvaise laine contre 16,3% dans les élevages non encadrés. Par ailleurs, les taux de réforme après examen général des géniteurs, qui sont de 11,6% et de 24,4%

respectivement pour l'ANOC et les élevages non encadrés, montrent bien l'importance de la conduite du troupeau. En effet, les élevages encadrés, suivant les conseils de l'ANOC, ont une meilleure gestion du troupeau en matière d'hygiène et d'alimentation.

Les taux de réforme élevés (17,6%) liés à la pathologie chez les animaux, après examen général en système intensif, pourraient s'expliquer par une moindre rusticité des races importées par rapport aux races locales d'une part, et d'autre part par leur utilisation très intensive pour la lutte.

Causes de réforme liées à l'état de l'appareil génital

Les géniteurs utilisés dans le système de l'ANOC ont tous une circonférence scrotale supérieure à 28 cm, alors que 12,7% de ceux utilisés dans les élevages non encadrés sont à réformer pour taille des testicules insuffisante. Ceci montre bien que de meilleures conditions d'élevage, notamment un meilleur apport alimentaire, ont un effet sur l'appareil génital. Les béliers ayant des testicules de taille insuffisante ne sont pas agréés par l'ANOC comme géniteurs. Cependant, la pathologie "vraie" de l'appareil constitue la principale cause de réforme des béliers (27,1%) dans les troupeaux encadrés par l'ANOC. Ceci démontre bien la nécessité d'intégrer au sein de toutes les commissions de sélection ovine des spécialistes en reproduction.

Au niveau des élevages en système intensif, 40,7% des béliers souffrent de pathologie au niveau de leur tractus génital contre 34,2% en système extensif. En effet, l'utilisation des béliers est plus intensive dans les élevages industriels que dans les élevages extensifs, et leur remplacement par des jeunes est très souvent tardif. Galloway (1982) affirme que les maladies générales et le surmenage se répercutent au niveau de l'appareil génital, notamment au niveau des testicules qui dégénèrent. C'est dans le lot des animaux âgés que l'on trouve une fréquence élevée de pathologie de l'appareil génital. En effet, ce taux peut atteindre 46,9% pour les géniteurs ayant leur 8 DR dans les élevages intensifs selon Toe (1989). Les béliers âgés (plus de 5 ans) doivent être réformés car avec l'âge et l'intensité d'utilisation la condition physique diminue et les pathologies de l'appareil génital apparaissent.

Nos résultats confirment, même si les fréquences trouvées ici restent relativement en dessous de celles déjà rapportées par Tibary *et al.* (1988) et Toe (1989), que les orchites, les épидидymites et les balanoposthites sont les dominantes pathologiques de l'appareil génital des béliers au Maroc. Nous trouvons des fréquences de 9,3%, 7,9% et 6,8% respectivement pour les orchites, les épидидymites et les balanoposthites contre 12,8%, 12,3% et 10,6% rapportés par Toe (1989).

La production et la qualité du sperme des béliers diminuent considérablement dans les épидидymites et les orchites, en particulier celles dues aux infections

(épididymite contagieuse du bélier). Nos résultats montrent que 20% des béliers présentent des anomalies au niveau du spermogramme; ceci pose le problème de la saisonnalité des béliers, notamment chez les races importées, et des pathologies infracliniques pouvant échapper à l'examen clinique.

Conclusion

S'il est vrai que la gestion de la reproduction chez le bélier doit tenir compte de toutes les variations de la fonction sexuelle mâle, le contrôle des géniteurs permet de garder pour la lutte ou pour l'insémination artificielle les plus performants et de les rentabiliser par l'utilisation d'un ratio mâles/femelles le plus faible possible, vu les prix sans cesse croissants des bons géniteurs. Il permet également d'obtenir de meilleurs taux de fécondité surtout lorsque parallèlement toutes les femelles infertiles sont écartées de la reproduction.

La pathologie de l'appareil génital, avec essentiellement les orchites, les épididymites et les balanoposthites, est l'une des principales causes de réforme des béliers au Maroc, à côté de l'aspect zootechnique (conformation et laine). Cependant, la recherche de toutes les causes de réforme, surtout à l'échelle de tout le pays, nécessite une standardisation de la technique de l'examen des béliers. La clinique et la spermologie constituent alors les deux éléments clés de cet examen. Mais un bélier jugé insatisfaisant au niveau de l'examen n'est pas nécessairement infertile (monorchidie).

Enfin, seuls des programmes d'intervention cohérents tenant compte des besoins des éleveurs dans les différents systèmes d'élevage, la sensibilisation des éleveurs aux problèmes de l'infertilité chez les mâles et la formation d'un personnel qualifié en nombre suffisant permettront de couvrir l'ensemble des élevages au Maroc.

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Puberté chez la race D'man, la race Sardi et leur produit de croisement

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Résumé

L'âge à la puberté est l'un des facteurs les plus importants qui déterminent la productivité des élevages ovins. Ainsi, une amélioration de celle-ci peut être achevée par la réduction de l'âge à la puberté chez les races dites tardives par sélection intrarace ou par croisement avec une race précocce. Ce dernier type d'action peut être réalisé au Maroc à travers des manipulations génétiques grâce à l'existence de la race ovine D'man connue par sa précocité sexuelle. Les auteurs présentent les résultats et la discussion d'une expérience de croisement de plusieurs années.

Puberty in the D'man and Sardi breeds and their crosses

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Abstract

Age at puberty is one of the most important factors of sheep productivity. Reducing age at puberty of so- called late maturing breeds through selection within the breed or crossbreeding with an early maturing breed leads to improved productivity. In Morocco, this was achieved through genetic engineering with the D'man breed which is known for its early maturity. This paper presents and discusses results of a crossbreeding operation that covers several years.

Introduction

En 1987, le nombre de moutons au Maroc était estimé à 16 millions de têtes (MARA, 1990) dont 50% de brebis adultes en âge de reproduire. La productivité ovine définie par le nombre d'agneaux élevés jusqu'à l'abattage reste encore faible. Elle est estimée en moyenne à 0,6–0,7 agneau par brebis et par an (Kabbal et Berger, 1990). Cela résulte d'un faible taux de fertilité (78–83%) et d'un taux élevé de mortalité des jeunes de 18 à 31% dans les conditions du terrain (Chaarani, 1987), contre 5 à 10% en stations expérimentales (Lahlou-Kassi, 1987).

L'étude des performances de reproduction des jeunes femelles ovines, réalisée à travers l'analyse des données recueillies sur le terrain ou en station expérimentale, met en évidence l'importance de la dispersion de l'âge à la première mise-bas et l'influence de la saison de naissance sur l'âge à la puberté.

Age au premier agnelage

L'ensemble des études menées aussi bien dans le berceau de race qu'ailleurs met en évidence la précocité sexuelle de l'agnelle de race D'man répandue dans le système des oasis et en zone présaharienne. Plusieurs cas d'agnelages ont été signalés à l'âge de 8 mois chez la D'man (Bouix *et al.*, 1974). Un intervalle d'âge de 9 à 22 mois a été observé dans les élevages D'man des vallées du Ziz (Barki, 1974) et du Drâa (El Fakir *et al.*, 1979). Par ailleurs, une étude menée en station pendant quelques années montre que l'âge au premier agnelage varie de 13 à 14 mois quand les agnelles sont respectivement nées en automne ou au printemps (Bouix *et al.*, 1974). En dehors de son berceau de race, l'âge moyen de la D'man au premier agnelage varie de 9 à 33 mois (Boutgayout, 1980), avec 87% des femelles mettant bas à un âge inférieur à 24 mois.

Contrairement à la précocité de la race D'man, la race Sardi est considérée comme une race tare. En effet, l'âge signalé au premier agnelage varie de 13 à 27 mois (Boutgayout, 1980) montrant une distribution bimodale (de 13 à 15 mois et de 22 à 25 mois). Dans le berceau de race, l'âge moyen observé est de 15,6 mois (Drissi, 1983).

Age et poids à la puberté

L'agnelle de race D'man élevée au niveau de la vallée du Drâa peut manifester le comportement de chaleurs aussi tôt qu'à l'âge moyen de 150 jours (130–170) (Harrouni, 1977) et au poids moyen de 15 kg (Bouix *et al.*, 1974). En dehors de son berceau de race, l'agnelle D'man devient pubère à un âge moyen de 6,3 à 6,5 mois et à un poids de $24 \pm 1,5$ kg (Lahlou-Kassi, 1982). Cette précocité sexuelle a été également signalée chez le mâle D'man (Glatzel, 1980). Par ailleurs, ce caractère peut être transmis à la descendance d'un croisement avec une race tare (Lahlou-Kassi, 1982). Cela suggère que la précocité sexuelle de la race D'man est un caractère racial génétiquement transmissible.

A l'inverse de la race D'man, il existe peu d'informations relatives à l'apparition de la puberté chez la race Sardi. Néanmoins, l'âge rapporté à la première saillie fécondante varie de 7 à 19 mois (Drissi, 1983).

Différents auteurs s'accordent maintenant pour dire que la puberté chez l'agnelle est déterminée par des facteurs génétiques (Dyrmundsson, 1973; Land, 1978) et par l'interaction de plusieurs paramètres environnementaux dont il n'a pas été possible de scinder les effets de façon satisfaisante. Ces derniers regroupent: le niveau alimentaire et la vitesse de croissance (Land, 1978; Quirke, 1979; Dyrmundsson, 1981; Foster *et al.*, 1985), la saison de naissance (Foster, 1981; Lahlou-Kassi *et al.*, 1989), la photopériode (Foster *et al.*, 1985) et enfin les traitements hormonaux exogènes (Foster *et al.*, 1985; Dyrmundsson, 1987).

L'objectif de cette étude est de déterminer avec précision l'âge et le poids à la puberté de la race D'man (précoce), de la race Sardi (tardive) et de leur produit de croisement dans des lots homogènes d'agnelles nées à différentes saisons de l'année.

Matériel et méthodes

Les observations ont été faites à la ferme d'application de l'Institut agronomique et vétérinaire Hassan II de Rabat (Maroc) dans la plaine du Tadla en périphérie de la zone irriguée.

Les brebis sont soumises à un rythme de reproduction intensif de trois agnelages en deux ans. Les jeunes sont sevrés à un âge allant de 55 à 100 jours et reçoivent une ration à base de luzerne (1 kg/tête) et d'orge (400 g/tête).

Dès l'âge de 3 mois, les femelles sont réparties en lots de 20 à 30 agnelles. Dans chaque lot, on procède à la détection biquotidienne des chaleurs à l'aide d'un bélier D'man x Sardi (DxS) à pénis dévié. La femelle est dite en chaleurs quand elle se laisse chevaucher par le bélier détecteur. Toutes les femelles sont systématiquement pesées une fois par mois et chaque femelle qui présente des signes de chaleurs est pesée séparément pour déterminer le poids au premier oestrus.

Le contrôle de l'activité ovarienne est réalisé par le dosage par la méthode radio-immunologique de la progestérone plasmatique dans des échantillons de sang prélevés une fois par semaine dès l'âge de 3 mois.

Un taux de progestérone supérieur ou égal à 1 ng/ml est considéré comme témoin de la présence d'un corps jaune actif faisant suite à une ovulation.

Au cours de la première semaine qui suit la manifestation du premier oestrus, le taux d'ovulation est établi par examen coelioscopique des ovaires *in situ* à l'aide d'un endoscope.

L'analyse de variance et l'ajustement des moindres carrés, pour étudier l'effet de la race, de la période de naissance et du type de naissance sur l'âge au premier oestrus et à la première ovulation, ont permis de faire des régressions entre:

- l'âge et le poids à la puberté;
- l'âge à la puberté et le taux d'ovulation;
- l'âge à la puberté et la saison de naissance.

La comparaison des distributions cumulées des âges au premier oestrus et à la première ovulation en tenant compte de la troncature des échantillons (observations non faites sur l'ensemble des échantillons de départ) a été faite à l'aide d'un test non paramétrique: le test de Smirnov.

Résultats

Le tableau 1 des moyennes observées de l'âge au premier oestrus, à la première ovulation, du poids et du taux d'ovulation à la puberté montre des différences aussi bien entre les génotypes qu'entre les périodes de naissance pour chaque génotype.

Age et poids à la puberté

Race D'man

Les âges moyens à la première ovulation et au premier oestrus sont respectivement de 212 et 229 jours, toutes périodes de naissance comprises. D'après le tableau 1, on constate que les agnelles nées en avril-mai montrent des signes de premières chaleurs à 194,46 jours contre 255,15 pour celles nées en novembre-décembre. Toutefois, 50% des agnelles du premier et du deuxième groupe ont leur premier oestrus respectivement au bout de 194 et 266 jours (figure 1). De même, l'ovulation survient à 196 et 224 jours chez la moitié des agnelles nées respectivement en avril-mai et en novembre-décembre (figure 2). Les agnelles nées au cours de cette dernière période sont plus lourdes (23,48 kg) que celles nées au cours de la première (17,81 kg) ($P < 0,01$). Notons ici que le poids à la puberté — toutes saisons comprises — ne varie pas en fonction du type de naissance et est de 21 kg.

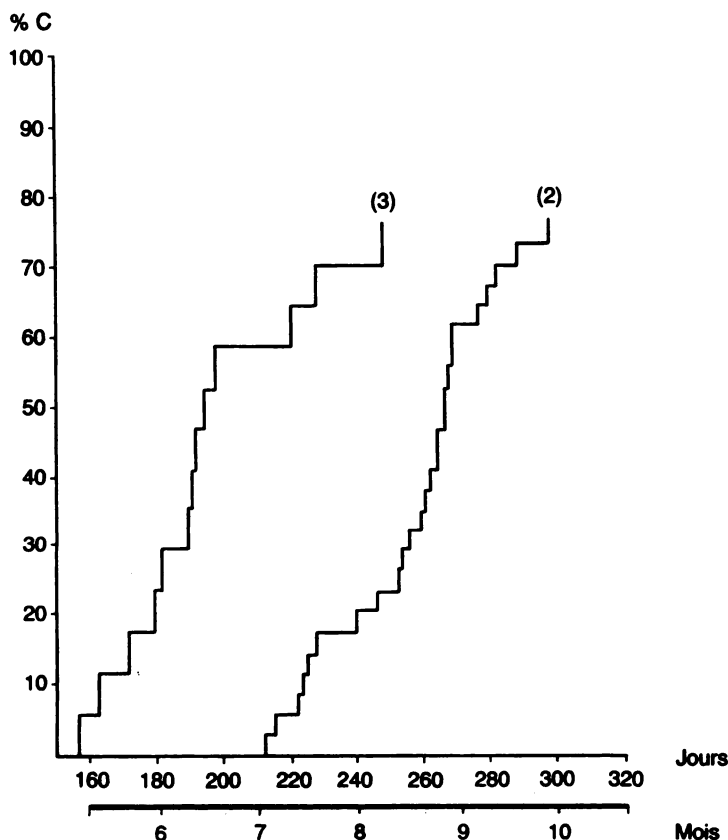
Race Sardi

La race Sardi semble atteindre la puberté à un âge plus tardif (11 mois environ) et à un poids plus élevé (30 kg) que la D'man. Ici, ces deux paramètres sont sous la dépendance de la saison de naissance. En effet, les moyennes ajustées des moindres carrés de l'âge au premier oestrus sont de 247,38; 273,73; et 459,20 jours respectivement pour les périodes de naissance de janvier-février,

Tableau 1. Valeurs moyennes observées de l'âge au premier oestrus et à la première ovulation (jours), du poids (kg) et du taux d'ovulation à la puberté chez des agnelles Sardi, D'man et croisées au cours de quatre périodes de naissance

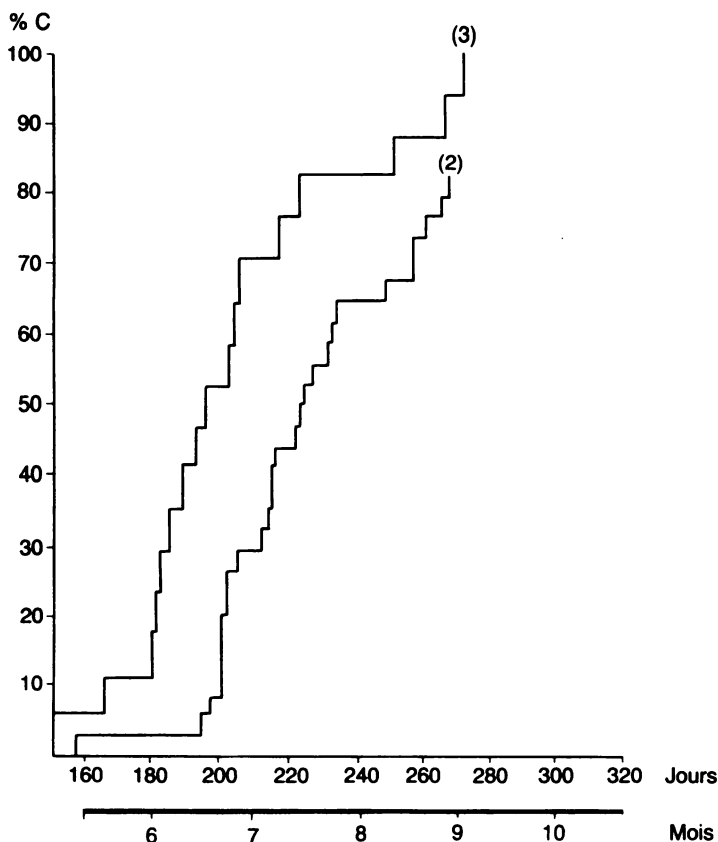
Période de naissance	Race	Nbre total		Age moy. au 1 ^{er} oestrus		Age moy. à la 1 ^{re} ov.		Pds moy. à la puberté		Taux moyen d'ovulation	
		n	x ± (s)	n	x ± (s)	n	x ± (s)	n	x ± (s)	n	x ± (s)
Janv.-févr. 1983	S	23	13	239,23 (37,05)	13	239,77 (18,23)	13	28,85 (4,71)	16	1,12 (0,57)	
	DxS	45	37	240,32 (20,38)	44	240,18 (19,45)	41	27,77 (3,64)	44	1,84 (0,17)	
	S	28	8	264,13 (26,57)	9	265,44 (13,11)	10	28,65 (3,94)	7	1,00 (0)	
Nov.-déc. 1983	DxS	74	46	261,15 (15,26)	58	249,17 (19,73)	62	27,01 (3,34)	51	1,35 (0,52)	
	D	34	26	255,15 (22,91)	28	220,61 (25,71)	26	23,48 (2,38)	21	1,76 (0,70)	
	S	26	20	454,40 (19,31)	-	-	21	33,00 (3,89)	21	1,14 (0,35)	
Avril-mai 1984	DxS	42	31	283,65 (83,63)	34	249,06 (68,65)	23	23,37 (6,24)	42	1,40 (0,58)	
	DxDS	19	14	235,14 (40,37)	17	221,00 (30,09)	14	19,00 (3,45)	16	2,13 (0,15)	
	D	17	13	194,46 (26,00)	17	203,94 (34,04)	13	17,81 (2,54)	17	2,12 (1,16)	
octobre 1984	DxS	18	13	308,92 (26,20)	-	-	13	29,54 (3,7)	11	1,73 (0,65)	

Figure 1. Pourcentages cumulés des âges au premier oestrus chez des agnelles D'man nées en avril-mai (3) et en novembre-décembre (2)



novembre-décembre et avril-mai (tableau 2). Cependant, l'âge observé à la première ovulation n'est pas significativement différent entre les naissances de janvier-février ($239,77 \pm 18,23$) et celles de novembre-décembre ($265,44 \pm 13,11$) (tableau 1). La comparaison des distributions cumulées des âges au premier oestrus montre — une fois de plus — que ce paramètre dépend de la saison de naissance. En effet, 50% des agnelles sont pubères à l'âge de 286 et de 464 jours pour des périodes de naissance respectives de janvier-février et avril-mai (figure 3). Quoique le poids au premier oestrus semble être différent, l'analyse de la variance ne révèle aucune différence significative.

Figure 2. *Pourcentages cumulés des âges à la première ovulation chez des agnelles D'man nées en avril-mai (3) et en novembre-décembre (2)*



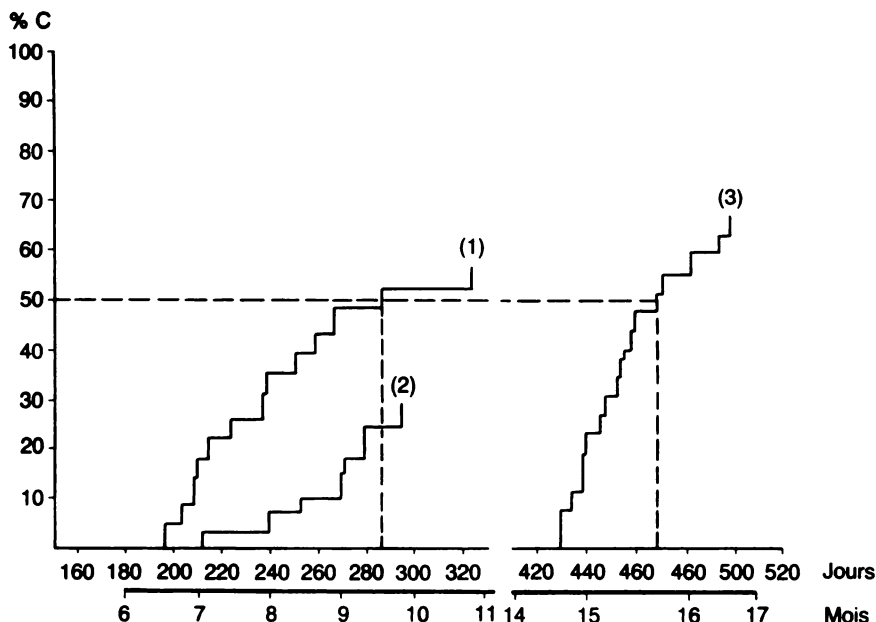
Produits de croisement DxS

Les agnelles de première génération DxS ont tendance à se placer en position intermédiaire par rapport aux races parentales (tableaux 1 et 2), avec un âge moyen au premier oestrus et à la première ovulation de 275 et de 244 jours respectivement. L'effet de la saison de naissance sur l'âge au premier oestrus est hautement significatif. Cependant, les variations de l'âge à la première ovulation ne sont pas significatives (tableau 2, figure 4). Le poids moyen à la

Tableau 2. *Age au premier oestrus, âge à la première ovulation, poids et taux d'ovulation à la puberté en fonction de la saison de naissance chez des agnelles D'man, Sardi et croisées (ajustement des moindres carrés avec terme constant)*

Race	Période de naiss.	Age au 1 ^{er} oestrus		Age à la 1 ^{re} ovulation		Poids au 1 ^{er} oestrus		Taux d'ovulation	
		n	jours	n	jours	n	kgs	n	x
D'man	Constante	39	229,34	45	211,99	39	20,91	38	1,86
	N-D 1983	26	+29,00	28	+8,63	26	+2,81	21	-0,15
	A-M 1984	13	-29,00	17	-8,63	13	-2,81	17	+0,15
**									
Sardi	Constante	41	326,76	22	259,33	44	29,68	40	1,11
	J-F 1983	13	-79,41	13	-5,85	13	-1,40	12	+0,06
	N-D 1983	8	-53,03	9	+5,85	10	-1,57	7	-0,10
	A-M 1984	20	+132,44	-	-	21	+2,97	21	+0,04
	**		**		**		**		**
DxS	Constante	127	274,82	136	244,41	139	26,56	148	1,57
	J-F 1983	37	-33,87	44	-2,78	41	+0,89	44	+0,26
	N-D 1983	46	-12,37	58	+7,02	62	+0,06	51	-0,23
	A-M 1984	31	+10,37	34	-4,24	23	-3,19	42	-0,17
	Oct 1984	13	+35,87	-	-	13	+2,24		+0,14
Fisher		**		ns		**		**	

Figure 3. Pourcentages cumulés des âges au premier oestrus chez des agnelles Sardi nées en janvier-février (1) en novembre-décembre (2) et en avril-mai (3)

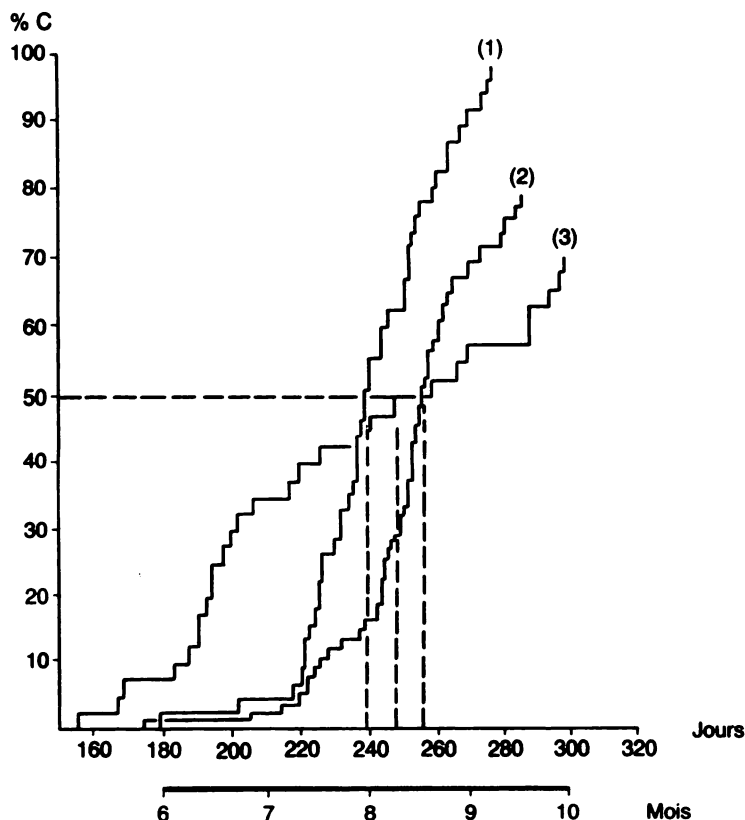


puberté est voisin de 26,5 kg chez les agnelles nées en novembre-février et enregistre une diminution (23,37 kg) chez celles nées en avril-mai et une augmentation (28,80 kg) quand la naissance a lieu en octobre. La comparaison des distributions cumulées des âges au premier oestrus, pris deux à deux, par le test de Smirnov montre que les agnelles nées en janvier-février sont plus précoces que celles nées en novembre-décembre, qui à leur tour sont plus précoces que celles nées en octobre (figure 5). Parallèlement à cela, on observe que pour une même saison de naissance, les agnelles sont d'autant plus précoces que leur génotype se rapproche du D'man (figures 6 et 7).

Taux d'ovulation à la puberté

Chez la race Sardi, le taux d'ovulation moyen est de 1,11. Le nombre d'ovulation varie de 1 à 3 avec une prédominance d'ovulations simples (88%). Chez la jeune D'man, ce taux est de 1,86. La période et le type de naissance ne semblent pas affecter significativement ce paramètre (tableau 2).

Figure 4. *Pourcentages cumulés des âges à la première ovulation chez des agnelles (DxS) nées en janvier-février (1), en novembre-décembre (2) et en avril-mai (3)*



Le taux d'ovulation moyen calculé et ajusté sur quatre périodes de naissance chez le génotype D'man x Sardi (DxS) est intermédiaire entre ceux des races parentales: 1,57. Un taux d'ovulation supérieur à celui de la race parentale la plus prolifique a été observé (2,12) chez les femelles du génotype Dx(DxS).

Figure 5. Pourcentages cumulés des âges au premier oestrus chez des agnelles D $\times$ S nées en janvier-février (1), en novembre-décembre (2), en avril-Mai (3) et en octobre (4)

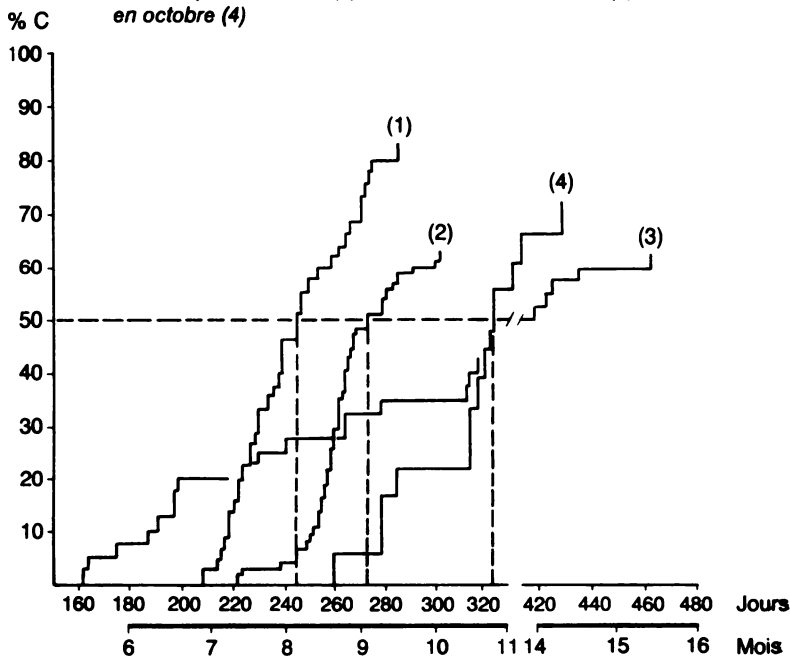


Figure 6. Pourcentages cumulés des âges au premier oestrus des agnelles D, S, D $\times$ S et D $\times$ (D $\times$ S) nées en avril-mai

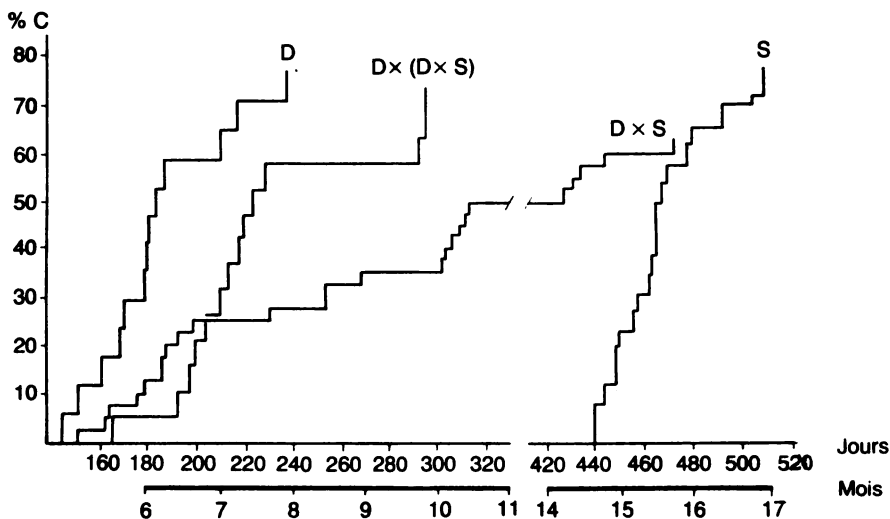
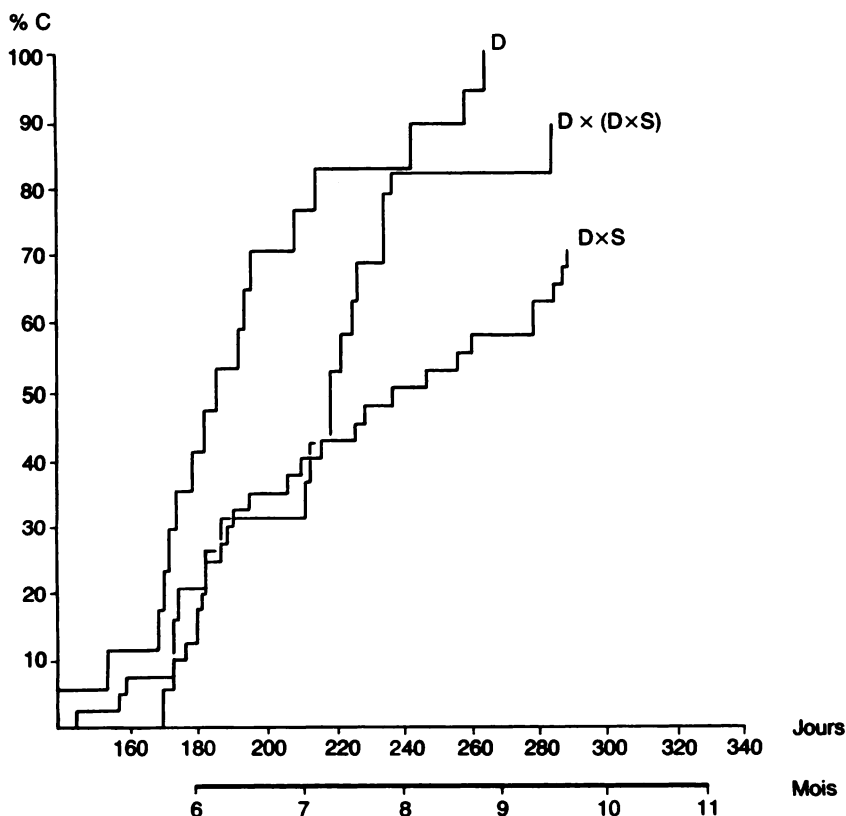


Figure 7. Pourcentages cumulés des âges à la première ovulation des agnelles D, DxS et Dx (DxS)



Discussion

Ces observations confirment la précocité sexuelle et la prolificité de la femelle D'man. L'âge à la puberté est influencé par la saison de naissance puisque les agnelles nées en avril-mai sont pubères à 200 jours alors que celles nées en novembre-décembre le sont deux mois plus tard. Le même effet a été observé chez des agnelles de même race nées en juillet-août (183 jours) comparées à celles nées en octobre-novembre (220 jours) (Lahlou-Kassi, 1982). Il semble résulter de l'interférence de la saison de naissance avec la période de baisse de l'activité sexuelle qui se manifeste par une baisse de l'incidence d'oestrus et d'ovulation spontanés chez la jeune D'man (Lahlou-Kassi, 1982) ou induits par l'effet mâle chez la jeune Barbarine (Khaldi, 1984; Khaldi et Lassoued, 1990). Le

poids à la puberté de cette race est positivement corrélé ($r=0,73$) avec son âge au premier oestrus. Quant aux agnelles Sardi, elles sont pubères à un âge plus tardif et à un poids supérieur comparées aux D'man. Les jeunes femelles nées tôt dans la saison d'agnelage (novembre-décembre) atteignent la puberté la même année alors que celles nées au début de la saison sexuelle de la race (mai-juin) n'ont pas le temps d'atteindre un développement corporel suffisant pour manifester leur premiers signes de chaleurs. Elles ne seront cyclées que la saison de l'année suivante (Foster, 1981). Les produits de croisement atteignent la puberté à un âge intermédiaire aussi bien en croisement D'man x Timahdite (Lahlou-Kassi, 1982) qu'en croisement D'man x Sardi. La diminution de l'âge à la puberté en parallèle à l'augmentation des gènes sexuels de la D'man est une caractéristique génétiquement transmissible de façon additive (Lahlou-Kassi *et al.*, 1989).

Le taux d'ovulation, qui constitue l'une des composantes principales de la prolificité, est élevé chez la jeune D'man indépendamment de la saison de naissance, tout en restant inférieur à celui observé chez l'adulte (2,85) par Lahlou-Kassi (1982). L'effet de la saison de naissance sur le taux d'ovulation est statistiquement significatif chez les produits de croisement. Il varie de 1,3 à 1,4 quand la puberté survient en période de journées croissantes ou longues (naissances de novembre-décembre ou d'avril-mai) à 1,7-1,8 quand elle survient en période de journées décroissantes. Chez la brebis adulte, le taux d'ovulation est élevé en début de saison sexuelle, puis diminue pour atteindre son minimum juste avant le début de la phase d'anoestrus saisonnier (Scaramuzzi et Radford 1983). Cela est probablement dû à l'effet de la photopériode sur le taux d'ovulation. Par ailleurs, l'évolution du taux de prolificité observé chez la D'man (Boutgayout, 1980) et la Sardi (Berger *et al.*, 1989) au cours des trois à quatre premiers agnelages résulte de l'augmentation progressive du taux d'ovulation et de la diminution du taux de mortalité embryonnaire (Boujenane, 1989; Bradford *et al.*, 1989).

Conclusion

La race D'man présente des caractéristiques de reproduction marquées par une précocité sexuelle, une prolificité élevée et une non-saisonnalité. Les produits issus du croisement D'man x Sardi présentent des caractéristiques pondérales et de reproduction intermédiaires. Cela témoigne de la transmission génétique de ces paramètres. Les efforts sont actuellement à concentrer sur la création d'une race synthétique à travers les croisements pour stabiliser ces paramètres le long des générations.

A nos jours, l'âge/poids optimum à la mise à la reproduction des jeunes antenaises n'est pas encore connu. Ce paramètre doit être déterminé et standardisé pour optimiser la reproduction ovine.

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Caractéristiques de reproduction des femelles ovines de race Barbarine

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Résumé

Les résultats de cette étude montrent que les brebis adultes de race Barbarine sont caractérisées par une longue saison sexuelle qui commence en juillet et se termine en février (242 jours). L'intensité de leur anoestrus saisonnier (printemps) est relativement faible: les pourcentages de brebis ovulant ou extériorisant un comportement d'oestrus au moins une fois par mois ne sont jamais inférieurs à 75 et 25% respectivement.

Les possibilités de reproduction des jeunes femelles nées à l'automne sont plus limitées. Atteignant leur puberté à l'âge de 10 mois, leur saison sexuelle ne dure qu'une centaine de jours (septembre-décembre).

Le rétablissement des activités ovarienne et oestrale post-partum des brebis allaitantes n'est pas immédiat. La précocité dépend essentiellement de la saison des agnelages. En effet, si l'intervalle parturition-première ovulation n'est que de 17 jours en moyenne chez les femelles agnelant au mois d'octobre, il est environ deux et trois fois plus long lorsque les mises-bas ont lieu aux mois de juin et de février respectivement. De même, la durée de l'anoestrus post-partum (intervalle parturition-premier oestrus) est de l'ordre de 60, 75 et 100 pour les mises-bas d'octobre, juin et février respectivement.

La stimulation de l'activité ovarienne des femelles en anoestrus saisonnier par effet bélier est très intense. L'ovulation est induite chez 98% des brebis et 75% des antenaises. Les pourcentages de femelles dont le premier cycle ovarien est de courte durée (6 jours) sont de 25 et 35 chez les deux catégories respectivement.

La sous-alimentation prolongée des brebis pendant la gestation et la lactation a des répercussions néfastes sur leurs caractéristiques de

reproduction, même quand elles sont suralimentées entre le tarissement et la lutte.

Characteristics of reproduction of the Barbary sheep females

G. Khaldi and N. Lassoued

Abstract

The results of this study show that the adult Barbary ewes are characterized by a long sexual season which begins in July and ends in February (242 days). The intensity of their seasonal anoestrus (spring) is relatively low: the percentages of ewes ovulating or displaying oestrus at least once a month are never lower than 75 and 25 %, respectively.

The possibilities of reproduction of the young females born during autumn are more limited. Reaching their puberty at the age of 10 months, their sexual season is not longer than 100 days (September–December).

The restoration of the post-partum ovarian and oestrous activities is not immediate. Its precocity depends essentially on the lambing season. In fact, if the first postpartum ovulation occurs approximately 17 days after parturition in the October lambing ewes, this interval is twice and three times longer for those lambing in June and February, respectively. On the other hand, the duration of the postpartum anoestrus (interval between parturition and the first oestrus) is about 60, 75 and 100 days when lambing occurs in October, June and February, respectively.

The stimulation of the ovarian activity of the seasonal anoestrous females in spring by the ram effect is very intensive. Ovulation is induced in 98 % of adult ewes and 75 % of yearlings. The first induced ovarian cycle is of a short duration (6 days) in 25 and 35 % of the two categories of females, respectively.

The prolonged undernutrition of ewes during pregnancy and lactation impairs some of their reproductive characteristics even when they are overfed between weaning and joining.

Introduction

Variations saisonnières de l'activité ovarienne et du comportement d'oestrus cyclique

L'étude est réalisée à la station expérimentale de Bou Rébiâa (36°38' nord et 10°07' est), située à 25 km au sud-est de la ville de Tunis, sur 25 brebis adultes âgées de 4 à 5 ans et 26 agnelles (nées en automne) âgées de 5 mois au début de l'expérience. Toutes les femelles sont de race Barbarine à tête rousse. En plus du pâturage, elles reçoivent une complémentation composée de foin ou d'ensilage et d'aliment concentré dont les quantités varient selon la saison. Elles subissent une détection biquotidienne de chaleurs à l'aide de béliers entiers et des endoscopies tous les 17 jours pendant 15 mois.

Résultats

Saison sexuelle

Le début de la saison sexuelle des agnelles nées en automne se situe pendant la première moitié du mois de septembre de l'année suivante (figure 1). Agées alors de 10 mois, ces agnelles ont un poids vif moyen de 34,7 kg. Leur saison sexuelle est courte puisque la date moyenne du dernier oestrus est le 3 décembre. Sa durée moyenne est de 104 jours.

La saison sexuelle des brebis adultes est significativement plus longue ($P < 0,01$), la date moyenne du premier oestrus se situant pendant la première quinzaine du mois de juillet et celle du dernier oestrus pendant la deuxième quinzaine du mois de février. Sa durée moyenne est de 242 jours.

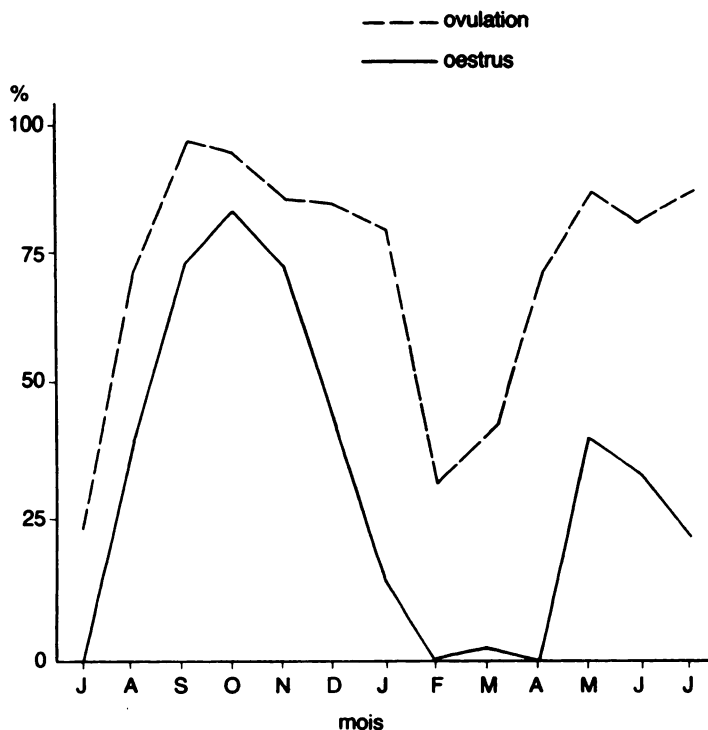
L'intensité de l'anoestrus saisonnier est également en rapport avec l'âge des femelles. En effet, 25 à 40% des brebis continuent à extérioriser un comportement d'oestrus au printemps alors que l'arrêt de l'activité oestrale est quasi total chez les agnelles pendant la même période.

Activité ovarienne

Quel que soit l'âge des femelles, il existe une dissociation oestrus-ovulation. Des ovulations silencieuses se produisent tout au long de l'année mais plus particulièrement avant le début de la saison sexuelle, après l'arrêt du comportement d'oestrus cyclique et en avril-mai.

Le taux d'ovulation reste faible (1,08) et relativement constant chez les agnelles. En revanche, il existe une variation saisonnière importante chez les brebis adultes. Chez celles-ci, le taux d'ovulation passe par un maximum en septembre-octobre (1,60) et un minimum en mars-avril (1,10).

Figure 1. Pourcentage de brebis ayant au moins un oestrus ou une ovulation par mois.



En considérant une période de un an (1^{er} juillet–30 juin), le taux moyen d'ovulation des brebis (1,32) est significativement plus élevé ($P < 0,05$) que celui des agnelles (1,08).

Le taux d'ovulation est plus faible lorsque l'ovulation est silencieuse. C'est ainsi que chez les brebis et les agnelles, il passe respectivement de 1,16 et 1,05 dans le cas des ovulations silencieuses à 1,38 et 1,12 lorsque les ovulations sont accompagnées de comportement d'oestrus.

Reprise de l'activité sexuelle post-partum

131 brebis de race Barbarine à tête rousse sont utilisées pour cette expérience à la station expérimentale de Bou Rébiâa. 53 agnèlent entre le 14 et le 30 octobre, 35 entre le 12 et le 26 février et 43 entre le 2 et le 28 juin. Pour chacune de ces périodes, la prolificité moyenne est de 120, 140 et 126% respectivement. Toutes les brebis sont adultes (3–5 ans) et leur poids vif moyen 48 heures après

parturition est proche de 50 kg. A chaque saison d'agnelage, le tarissement des brebis est effectué pour la moitié des femelles à 45 jours post-partum et pour l'autre à 90 jours, à l'exception de l'agnelage du mois d'octobre, où un troisième groupe est tari 48 heures après la mise-bas.

En plus des pâturages, les brebis reçoivent du foin de vesce-avoine à volonté et 300 g d'aliment concentré/tête/jour.

L'activité ovarienne des brebis est contrôlée par endoscopie tous les 17 jours et la détection des chaleurs est biquotidienne.

Résultats

Influence de la durée d'allaitement

Quelle que soit la saison d'agnelage, la durée de l'allaitement (45 ou 90 jours) n'a aucune influence significative sur la reprise de l'activité ovarienne post-partum des brebis. Par ailleurs, le tarissement des femelles 48 heures après la parturition n'entraîne pas une diminution significative de l'intervalle mise-bas-première ovulation (tableau 1).

Tableau 1. *Influence de la durée d'allaitement et de la saison de mise-bas sur l'intervalle parturition-1^{re} ovulation (j)*

Durée d'allaitement	Mois de mise-bas		
	Février	Juin	Octobre
2 jours	–	–	15,1 ± 5,5
45 jours	43,4 ± 19,8	30,3 ± 14,9	16,5 ± 9,1
90 jours	51,4 ± 14,8	33,3 ± 9,8	17,6 ± 8,1

Pour une saison donnée d'agnelage, la date du tarissement par rapport à la parturition (45 ou 90 jours) n'a aucune conséquence sur les proportions de femelles ayant présenté au moins un oestrus pendant les huit mois qui suivent la mise-bas et sur l'intervalle moyen parturition-premier oestrus de ces brebis pendant la même période (tableau 2). En revanche, le tarissement très précoce (48 heures après la mise-bas) au mois d'octobre réduit d'environ 25 jours la durée de l'anoestrus post-partum.

Influence de la saison d'agnelage

Que la durée d'allaitement soit de 45 ou de 90 jours, la saison d'agnelage a une influence considérable ($P < 0,01$) sur l'intervalle parturition-première ovulation. En effet, si cet intervalle n'est que de 17 jours en moyenne chez les brebis agnelant

au mois d'octobre, il est environ deux fois (32 jours) et trois fois (47 jours) plus long pour les femelles agnelant respectivement aux mois de juin et de février.

Tableau 2. Pourcentages de brebis présentant au moins un oestrus moins de 240 jours après parturition et durée de l'intervalle mise-bas-premier oestrus (j)

Durée de l'allaitement		Mois de mise-bas		
		Février	Juin	Octobre
2 jours	%	–	–	100
	Durée	–	–	32,1 ± 12,9
45 jours	%	82,3	100	100
	Durée	97,7 ± 12,4	73,5 ± 21,4	59,0 ± 24,9
90 jours	%	77,7	90,0	77,7
	Durée	103,9 ± 8,2	76,2 ± 30,3	60,0 ± 49,7

La première ovulation est silencieuse chez 95% des brebis et ceci quelle que soit la période de mise-bas.

La durée d'allaitement (45 ou 90 jours) ne modifiant pas la reprise du comportement d'oestrus cyclique pendant la période post-partum, l'influence de la saison de mise-bas a été étudiée en considérant l'ensemble des femelles de chaque groupe.

Les pourcentages de femelles présentant au moins un comportement d'oestrus pendant la période d'observation de huit mois sont respectivement de 90,3, 85,7 et 80,0 pour les agnelages d'octobre, de juin et de février ($P < 0,05$). Pour ces femelles, l'intervalle moyen parturition-premier oestrus est de l'ordre de 60, 75 et 100 jours respectivement.

Rupture de l'anoestrus saisonnier par effet bélier

Cette étude est réalisée à la station expérimentale d'Ousseltia (35°51' nord et 9°35' est), située à 160 km au sud-ouest de la ville de Tunis. Elle est menée sur 160 brebis adultes ($5,1 \pm 1,6$ ans) et 40 antenaises ($1,5 \pm 0,1$ an) de race Barbarine à tête rousse. Toutes les femelles sont sèches et complètement isolées des mâles. Ces derniers sont introduits dans le troupeau à la fin du mois d'avril à raison d'un bélier pour 10 femelles. Tous les animaux sont conduits sur des parcours naturels sans aucune complémentation.

Le contrôle d'oestrus est biquotidien et l'activité ovarienne est étudiée par coelioscopie des ovaires le jour de l'introduction des mâles et neuf jours plus tard.

Résultats

Activité ovarienne

L'âge des femelles a une influence hautement significative ($P < 0,01$) sur leur activité ovarienne spontanée avant l'introduction des mâles dans le troupeau (tableau 3). En effet, environ 50% des brebis contre 22,5% des antenaises ont des corps jaunes le jour de l'introduction des béliers.

Tableau 3. Pourcentages de femelles cycliques avant l'introduction des mâles

Catégorie	Nombre de femelles	Femelles cycliques	
		Nombre	%
Brebis	160	81	50,6
Antenaises	40	9	22,5

La stimulation de l'activité ovarienne des femelles non cycliques par effet mâle est très intense (tableau 4). L'ovulation est induite chez la quasi-totalité des brebis (97,5%) et les trois quarts des antenaises (74,2%). La différence entre les deux catégories de femelles est hautement significative ($P < 0,01$). L'ovulation induite apparaît au cours des trois premiers jours de lutte.

Tableau 4. Pourcentages de femelles non cycliques dont l'ovulation est induite par effet mâle

Catégorie	Femelles non cycliques	Femelles ovulant	
		Nombre	%
Brebis	79	77	97,5
Antenaises	31	23	74,2

Quel que soit l'âge des femelles, la durée du premier cycle ovarien n'est pas toujours normale. La proportion de femelles dont le premier cycle ovarien est de courte durée (6 jours) est de 23,4% pour les adultes et de 34,8% pour les antenaises (différence non significative).

Comportement d'oestrus

Parmi les femelles ayant ovulé à la suite de l'introduction des béliers, 87,0% des brebis et 73,9% des antenaises extériorisent un comportement d'oestrus au cours des 26 premiers jours de lutte. Quel que soit l'âge de ces femelles, le comportement d'oestrus apparaît vers le 17^e jour lorsque le premier cycle ovarien est normal et vers le 23^e jour lorsque ce dernier est de courte durée.

Influence du niveau alimentaire sur la réponse des brebis à l'effet mâle

110 brebis adultes de race Barbarine ayant un poids vif moyen de 51 kg sont réparties en 2 lots Haut (H) et Bas (B) pendant les 12 dernières semaines de gestation et en 4 sous-lots pendant les 18 semaines d'allaitement (HH, HB, BH et BB) selon leur niveau alimentaire:

- lot HH: haut avant et après mise-bas
- lot HB: haut avant mise-bas et bas après
- lot BH: bas avant mise-bas et haut après
- lot BB: bas avant et après mise-bas

Les agnelages ont lieu au mois d'octobre. Après le sevrage (28 février), le poids vif moyen des brebis des quatre lots est ramené à une valeur sensiblement identique (47 kg environ) à la date d'introduction des béliers (30 avril).

La détection des chaleurs est biquotidienne et l'activité ovarienne des brebis est contrôlée par une série d'endoscopies à J1, J4, J9 et 8 à 12 jours après la date d'apparition du premier oestrus.

Résultats

Les variations du poids vif des brebis sont représentées dans la figure 2.

Activité ovarienne

La sous-alimentation à long terme avant et/ou après la mise-bas réduit de moitié le pourcentage de femelles cycliques avant l'introduction des béliers (tableau 5).

Tableau 5. Pourcentages de brebis cycliques avant l'introduction des mâles

Lots	Nombre de femelles	Femelles cycliques	
		Nombre	%
HH	32	21	66
HB	26	8	31
BH	31	11	35
BB	21	7	33

L'ovulation est induite chez la totalité des femelles non cycliques des quatre lots dans les quatre jours qui suivent l'introduction des mâles (tableau 6). La sous-alimentation des brebis pendant la gestation et/ou la période d'allaitement ne semble donc pas affecter leur réponse à l'effet bélier à condition de les bien

Figure 2. *Evolution du poids vif du brebis*

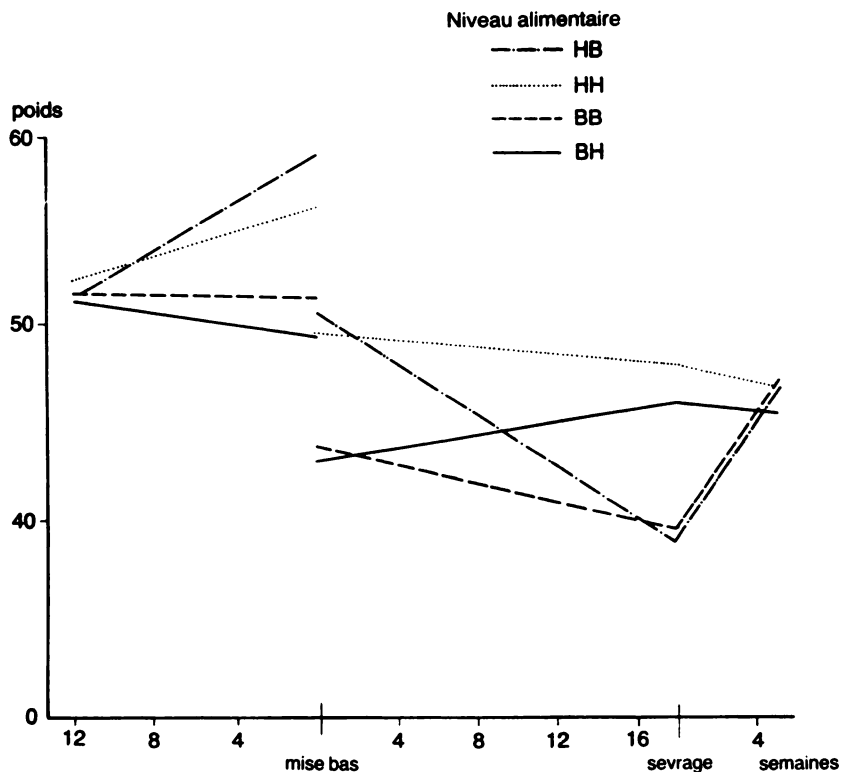


Tableau 6. *Réponse à l'effet mâle et pourcentages de cycles courts*

Lots	Nombre	Femelles ovulant		Cycles courts	
		N	%	N	%
HH	11	11	100	5	45
HB	18	18	100	12	67
BH	20	20	100	15	75
BB	14	14	100	11	79

nourrir entre le sevrage et la lutte. La sous-alimentation avant et/ou après la mise-bas augmente le pourcentage de cycles ovariens de courte durée qui est plus élevé dans les lots BH (75%), HB (67%) et BB (79%) que dans le lot HH (45%).

Performances de reproduction

Le taux d'ovulation induite varie entre 1,27 (HH) et 1,79 (BB). Au premier oestrus, ce taux varie entre 1,12 (HB) et 1,36 (HH).

Le tableau 7 montre que la sous-alimentation prolongée de part et d'autre de la mise-bas provoque une diminution sensible de la fertilité des brebis, même si elles sont suralimentées après le sevrage.

Tableau 7. Taux d'ovulation et fertilité des brebis (%)

Lots	Ovul. induite	1 ^{er} oestrus	Fertilité
HH	1,27	1,36	91
HB	1,35	1,12	94
BH	1,50	1,30	100
BB	1,79	1,31	77

The relative importance of tactile, visual, auditory and olfactory stimuli in oestrus detection in West African dwarf ewes

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Abstract

The response of ewes in oestrus to different stimuli was studied in five normocyclic West African dwarf ewes during five successive oestrous cycles. Sniffing around the perineum was significantly superior ($P < 0.05$) to other stimuli in evoking the characteristic "looking-over-the-shoulder" behaviour of ewes in oestrus and was not affected by masking the ram's odour with an odoriferous substance. Visual stimuli by a dummy ram evoked the response in 8% of the ewes but acted synergistically with the auditory stimuli, when accompanied by a pre-recorded ram's sexual vocalisation to increase the percentage response to 26. Olfactory stimuli with a linen, which was liberally rubbed on an intact ram, did not evoke the response.

It is concluded that oestrus detection in ewes may be possible using artificial stimuli in intensive sheep husbandry.

Importance relative des stimuli tactiles, visuels, auditifs et olfactifs dans la détection des chaleurs chez les brebis Djallonké

G.O. Oyediji, M.O. Akusu et G.N. Egbunike

Résumé

La réaction à différents stimuli a été étudiée au cours de cinq cycles successifs. Le reniflement du périnée s'est avéré significativement ($P < 0,05$) plus efficace que les autres stimuli à déclencher le comportement caractéristique de la brebis en chaleur, laquelle "jette

des regards par-dessus l'épaule". Cette faculté fut conservée lorsqu'on a fait disparaître l'odeur du bélier avec des substances odoriférantes. L'utilisation d'un faux bélier déclenchait des réponses positives dans 8% des cas, chiffre qui montait à 26% lorsque celle-ci était synchronisée avec un stimulus auditif, en l'occurrence l'enregistrement des appels d'un mâle à l'acte sexuel. En revanche, l'utilisation, comme stimulus olfactif, d'un morceau de tissu qu'on avait précédemment passé sur le corps d'un bélier entier laissait les brebis d'une superbe indifférence.

Ces résultats montrent qu'il est possible, notamment en élevage ovin intensif, de détecter les chaleurs des brebis par des stimuli artificiels.

Introduction

Oestrus behaviour is the most definite sign of oestrus in female animals and it has been reported for various species. The ewe does not exhibit oestrus behaviour in the absence of a ram (Terrill, 1975). It is therefore necessary to devise artificial teasers for oestrus detection in ewes under commercial or large flocks for the application of modern breeding techniques such as oestrus synchronisation and artificial insemination. This will involve identification of the stimuli involved in the "looking over the shoulder" which is characteristic of ewes in oestrus (Hafez et al 1969).

The objective of this study was to determine the characteristic behaviour of West African dwarf ewes and to identify the areas of the body of the ewe that evoke sexual arousal leading to the shoulder-looking behaviour of ewes in oestrus.

Materials and Methods

The experimental animals consisted of five normocyclic pluriparous WAD ewes aged 4–5 years and weighing 25–35 kg. Oestrus was synchronised with prostaglandin F₂-alpha (UpJohn Company, Kalamazoo, USA) as described previously in the WAD goat (Akusu and Egbunike, 1984). Following the second PGF₂-injection ewes were exposed to various stimuli as follows:

1. A dummy ram prepared with the skin of a 3-year old ram after slaughter (Stimulus A: Visual)
2. A dummy ram as in (1) but accompanied with a pre-recorded ram's characteristic sexual vocalisation (Stimulus B: Visual/Auditory)
3. An intact apronned ram (Stimulus C: Tactile)

4. An intact apronned ram liberally bathed with an odoriferous substance (Perfekthion Bayer A.G., Germany) to mask the ram's odour (Stimulus D: Olfactory)
5. A linen which has previously been rubbed generously on an intact ram (Stimulus E: Olfactory).

Results and discussion

The response of ewes to stimulus C was scored as described by Denenberg and Banks (1969) and Clayton et al (1981). The areas of the body investigated were the hindquarters, vulva, tail, abdomen and ears. A score of 1 was assigned to positive response (looking over the shoulder) while negative response was scored 0. For a comparison, stimuli responses were expressed as percentage of the observations.

Table 1. *Comparative scores for the different erogenic areas of the ewe ($\bar{x} \pm \text{Sem}$).*

Body area	$\bar{x} \pm \text{Sem}$
Hindquarters	2.8 ± 0.09^a
Vulva	2.6 ± 0.13^a
Tail	2.4 ± 0.16^b
Abdomen	1.1 ± 0.17^c
Ears	1.1 ± 0.17^c

Means with different superscripts are significantly ($P < 0.05$) different.

The relative positive response of the ewe to areas of the body investigated with stimulus C is summarised in Table 1. Responses to the ram's tactile stimulation of the hindquarters and the vulva were significantly superior to the stimulation of the tail ($P < 0.05$) which was in itself superior ($P < 0.05$) to stimulation of the abdomen and the ears.

The response of ewes to stimulus A was positive in 8% of observations. When accompanied with the ram's sexual vocalisation (Stimulus B), 26% of the ewes responded positively to the dummy. All ewes in oestrus elicited the response in the presence of an intact ram (Stimulus C) and this was not affected by masking the ram's odour with an odoriferous substance (Stimulus D). On the other hand, ewes in oestrus did not respond to the linen previously rubbed on an intact ram (Stimulus E).

The main sign of oestrus in the ewe observed in this study was "looking over the shoulder". This is in agreement with the report of Tomkins and Bryant (1974).

The hindquarters and the perineal region of the ewe may possess abundant tactile receptors in comparison to the abdomen and the ears. It is known that oestradiol-17^B is responsible for the psychic manifestation of behavioural oestrus in domestic animals (Scaramuzzi, 1975; McDonald, 1977). However, Glengross et al (1981) observed that the mechanism of uptake of oestradiol by the hypothalamus could affect oestrus behaviour. It is therefore probable that the ewe produces less oestradiol-17^B receptors during oestrus than other domestic animals such as the goat (Akusu, 1987) that displays behavioural oestrus characteristics in the absence of the buck.

Visual stimuli alone appeared to have a poor effect on the ewe in oestrus. However, response was improved by auditory stimuli and therefore both stimuli may be acting synergistically. The non-response to olfactory stimulus could not be explained. Pheromones of rams are located in the wool (Knight and Lynch, 1980). Hence, the non-response to the ram's odour may be due either to inadequate pheromones on the linen or the non-involvement of pheromones in the "looking-over-the-shoulder" response of ewes in oestrus. The latter suggestion is buttressed by the fact that response was unaffected by masking the ram's odour with an odoriferous substance. However, Baldwin and Meese (1977) and Alexander and Stevens (1982) reported that the scent of olfaction is very strong in the ewe. Therefore, it is possible that the ewe could discriminate the ram's pheromones from a variety of odoriferous substance.

Conclusion

This study has demonstrated that tactile, visual and auditory stimuli are important components in the characteristic "looking over the shoulder" behaviour of ewes in oestrus. It may be practicable to devise artificial oestrus detection stimuli consisting of blowing air around the perineum which simulate the ram's "nosing" around this area, a dummy ram and pre-recorded ram's sexual vocalisation.

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Peripheral plasma levels of progesterone and oestradiol-17^B of West African Dwarf goats during the oestrous cycle

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Abstract

Oestrus was synchronised with PGF₂-alpha in four pluriparous West African Dwarf (WAD) goats and blood collected through jugular venupuncture. The length of the oestrous cycle and oestrus duration were observed in three successive cycles while peripheral plasma progesterone and oestradiol-17^B levels were determined by the radioimmunoassay technique. The mean oestrous cycle lengths and oestrus duration were 19.4 ± 1.7 d and 33.3 ± 6.6 h, respectively. Progesterone levels were very low during the first four days of the cycle (day 1 = day of oestrous) with the lowest level of 0.3 ± 0.02 ng/ml being recorded on day 2 of the cycle. There was a steady rise in the levels during the cycle until day 15 when the highest level of 2.2 ± 0.05 ng/ml was recorded which was followed by a sharp decline on day 20 ($P < 0.05$). The profile of oestradiol-17^B was erratic during the cycle. Mean maximum and minimum concentrations were recorded on day 1 (152.6 ± 31.6 ng/ml) and day 2 (58.8 ± 22.6 ng/ml), respectively. These results showed that while progesterone and oestradiol profiles in the WAD goat followed the luteal and follicular phases of the oestrous cycle, progesterone profile is more reliable in assessing the phases of the oestrous cycle.

Teneur en progestérone et en oestradiol-17^B du sang périphérique chez la chèvre naine d'Afrique de l'Ouest au cours du cycle oestral

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Résumé

L'oestrus de quatre chèvres naines d'Afrique occidentale multipares a été synchronisé avec du PGF₂-alpha; des échantillons de sang ont été collectés à travers la veine jugulaire. Les durées du cycle oestral et de l'oestrus de trois cycles successifs ont été mesurées, et les taux de progestérone et d'oestradiol-17^B déterminés par radio-immunologie. La durée moyenne du cycle oestral était de $19,4 \pm 1,7$ jours et celle de l'oestrus de $33,3 \pm 6,6$ h. Très faible au cours des quatre premiers jours du cycle, la teneur en progestérone du sang périphérique atteignait son niveau minimum au deuxième jour du cycle, avec une valeur de $0,3 \pm 0,02$ ng/ml. Elle augmentait ensuite régulièrement jusqu'au 15^e jour du cycle où elle atteignait le pic de $2,2 \pm 0,05$ ng/ml, avant d'enregistrer une chute brutale au 20^e jour ($P < 0,05$). Le taux d'oestradiol-17^B a varié de manière erratique; les teneurs maximum ($152,6 \pm 31,6$ ng/ml) et minimum ($58,8 \pm 22,6$ ng/ml) ayant été enregistrées respectivement au premier et au deuxième jours du cycle oestral. Ces résultats montrent que, bien que les niveaux d'oestradiol et de progestérone suivent les phases lutéique et folliculaire, la progestérone est plus indiquée pour la détermination de la phase du cycle oestral à laquelle se trouve la chèvre naine d'Afrique de l'Ouest.

Introduction

Progesterone and oestradiol-17^B are ovarian hormones that have several practical biological applications in the management of reproduction in animals. They are involved in oestrus manifestations, the ovulatory process, cyclic regression of the corpus luteum, establishment of pregnancy and parturition. Progesterone levels have also been used in the determination of the onset of puberty in cattle (Diaz et al, 1986), pigs (Shille et al, 1979) and sheep (Oyedipe et al, 1986) and verification of the accuracy of oestrus detection (Sawyer et al, 1986). A knowledge of the levels of these hormones can be of benefit for diagnostic and therapeutic purposes in cases of endocrine dysfunction involving normal sexual activity of the female.

The levels of these hormones during the oestrous cycle and pregnancy have been determined in several species of domestic animals, especially in sheep and cattle (Scaramuzzi, 1976; Adeyemo and Health, 1980; Voh et al, 1987). Compared to the other species, fewer reports are available for the goat (Mori and Kano, 1984; Akusu et al, 1989).

The objective of this study was to generate basal data on the levels and profiles of progesterone and oestradiol-17^B during oestrous cycle of the West African Dwarf goat. This breed of goat is the most numerous of the ruminant species in the humid rainforest zone of southern Nigeria (FAO, 1966; Carew, 1982) and therefore represents the quickest means of increasing meat production for the populace through oestrous synchronisation and artificial insemination.

Materials and Methods

Four pluriparous WAD goats, aged 3–4 years and weighing between 15–20 kg were used for this study. They were managed intensively on concrete-floored pens in the small ruminant unit of the Department of Veterinary Surgery and Reproduction, University of Ibadan. Animals were fed on a corn-based ration (0.5 kg/d). Clean water and Giant Stargrass were constantly available.

Oestrus was synchronised with 10 mg PGF_{2-α} as described previously (Akusu and Egbunike, 1984; Akusu et al, 1989). Animals were teased for oestrus five times daily at intervals of 4 hours between 08.00 and 24.00 h with an aproned sexually mature buck.

Animals were bled through jugular venupuncture and plasma stored at -20°C until assayed for progesterone and oestradiol-17^B by radioimmunoassay techniques (Dada et al, 1984; Akusu et al, 1989). Hormone concentration was calculated from linearised logit-log plots of standard curves. Inter- and intra-assay variations for progesterone were 11.5% and 10.9%, the corresponding values for oestradiol-17^B were 10.3% and 11.5%, respectively.

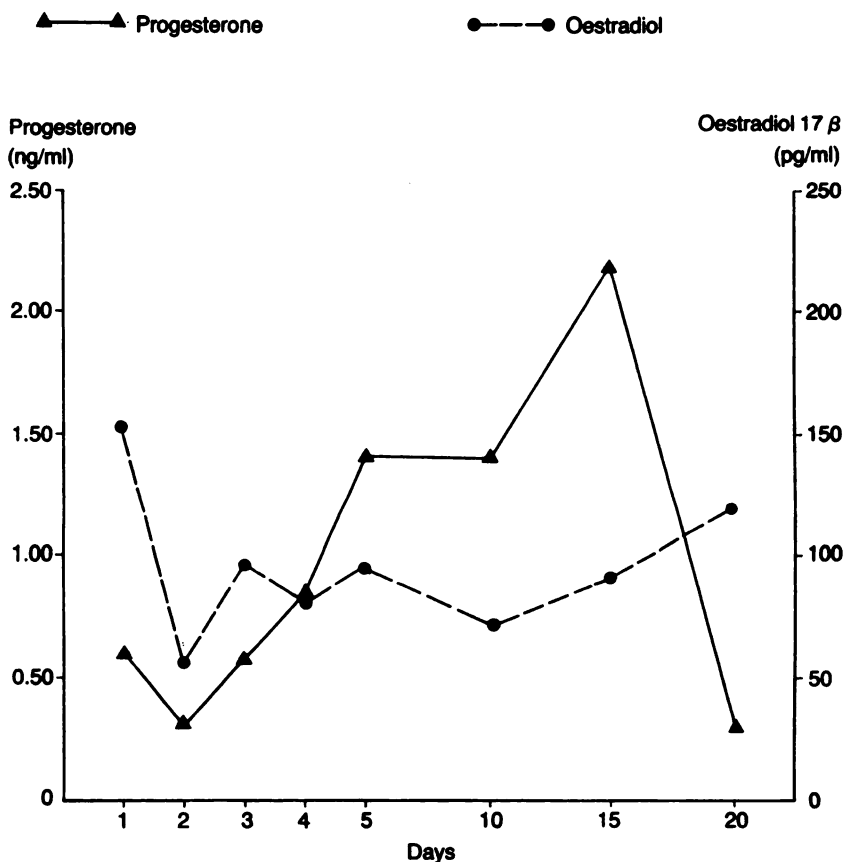
Blood was collected during the first five days of the oestrous cycle (day 1 = day of oestrus) and then on days 10, 15 and 20. The study was carried out during three successive oestrous cycles.

Results

Oestrus was synchronised in all goats treated with PGF_{2-α}. The mean oestrus duration was 33.3 ± 6.6 h while oestrous cycle occurred at 19.7 ± 1.7 d.

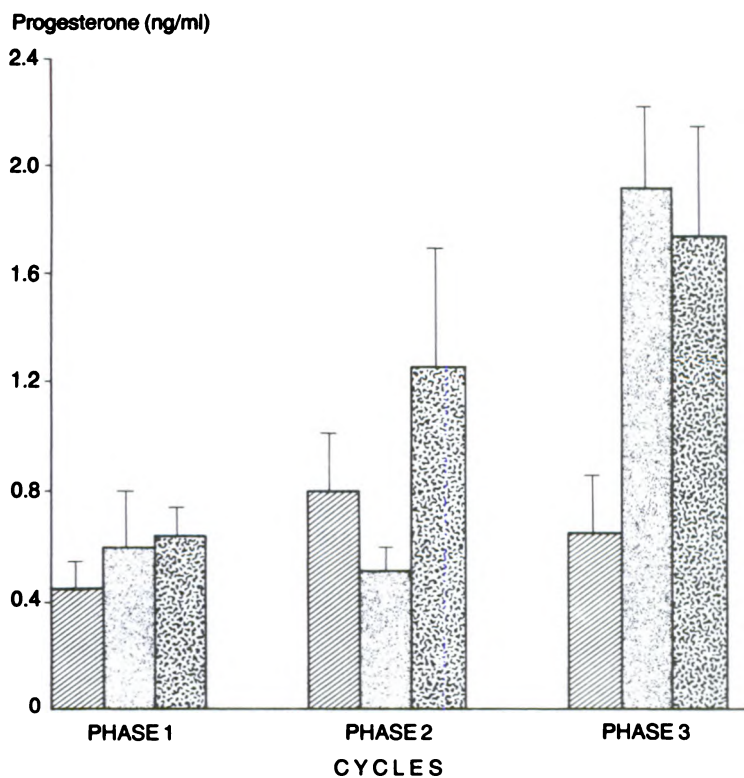
Peripheral plasma progesterone and oestradiol-17^B profiles are summarised in Figure 1. The levels of progesterone were generally lower than 1 ng/ml during oestrus and metoestrus (d 1–d 4). The lowest level of 0.3 ± 0.02 ng/ml was

Figure 1. *Peripheral plasma levels of progesterone and oestradiol-17 β of West African Dwarf goats during the oestrous cycle.*



determined on d 2 of the cycle. This was followed by a gradual rise in d 3 and d 4 (0.5 ± 0.03 ng/ml and 0.87 ± 0.02 ng/ml, respectively). D4 value was significantly higher than d 2 ($P < 0.05$). There was a sharp rise on d 5 and remained stable up to d 10 and a further rise in progesterone level to a peak value of 2.2 ± 0.05 on d 15 followed by a sharp decline ($P < 0.05$) by d 20. There were differences in the levels between the three cycles but the profiles were not affected (Figure 2).

Figure 2. *Peripheral plasma progesterone profiles during three successive oestrous cycles in WAD goats ($\bar{X} \pm \text{Sem}$).*



 CYCLE 1

 CYCLE 2

 CYCLE 3

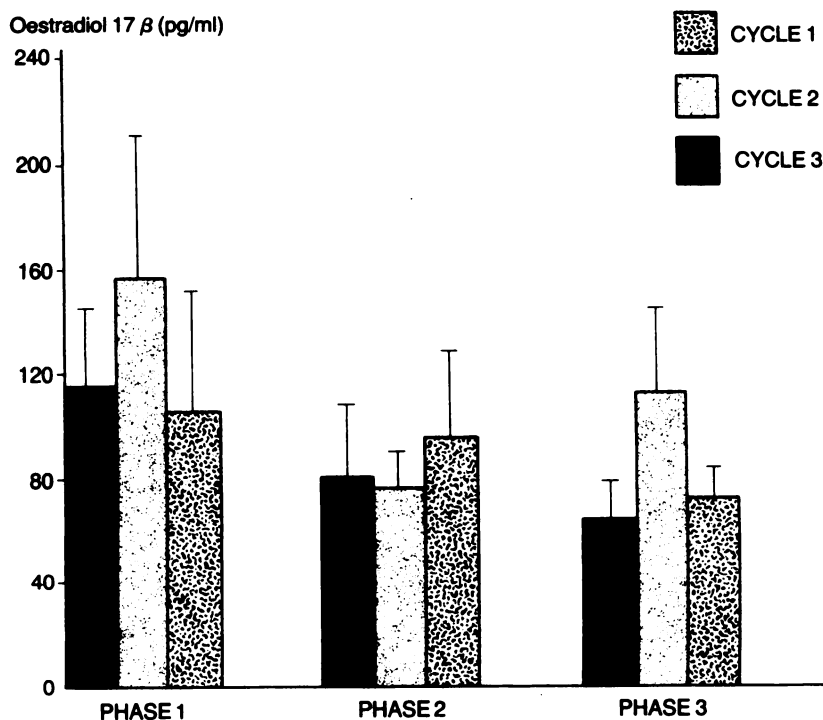
DAY 20 and DAY 1 (PHASE 1)

DAY 2 — DAY 4 (PHASE 2)

DAY 5 — DAY 15 (PHASE 3)

Peripheral plasma levels of oestradiol-17^B were highest on d 1 (152.6 ± 31.6). There was a rapid decline ($P < 0.05$) on d 2. Thereafter, there were fluctuations in the levels but a gradual rise was observed up to d 20 (131.7 ± 44.3 ng/ml). The profile of oestradiol was similar irrespective of the cycle (Figure 3).

Figure 3. *Peripheral plasma oestradiol-17^B profiles in WAD goats during three successive oestrous cycles.*



Discussion

The general profile of progesterone and oestradiol-17^B of the West African Dwarf goat was similar to reports in various species of domestic animals (Shearer et al, 1972; Sarda et al, 1973; Perera et al, 1978; Arora and Pandey, 1982; Oyedipe et al, 1986; Danell, 1987). The mean level of progesterone of the WAD goat was lower than the values reported for other breeds of goats (Heap and Linzell, 1966; Thornburn and Schneider, 1972). This may be a breed characteristic which has been reported in the ewe (Bindon et al, 1979).

The individual variations in the peak values of progesterone and oestradiol-17^B in the goats may be due to variations in individual traits that may be correlated with expression of overt heat signs and may serve as an index of selection (Perera, 1979). However, it was observed that all does had a common pattern

with relatively high levels of progesterone during the luteal phase, a decline between the 15th and 20th d of the cycle and values approximating zero at and around oestrus. Similarly, the peak values of oestradiol-17^B generally corresponded with the follicular and luteal phases of the oestrous cycle. It showed a fluctuating level of between 58 and 92 pg/ml until the day preceding the onset of behavioural oestrus when an increase was demonstrated. The peak value was for a day and there was no subsequent rise. This was consistent with the report of Shearer et al (1972) and therefore suggested that the psychic manifestation of behavioural oestrus in the goat is the result of oestradiol acting on the central nervous system (McDonald, 1977; Hansel and Convey, 1983).

Conclusion

These results showed that while progesterone and oestradiol profiles in the WAD goat followed the luteal and follicular phases of the oestrous cycle, progesterone profile is more reliable in assessing the phases of the oestrous cycle.

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Session 3

Small ruminant reproductive wastage and health

Pertes en reproduction et l'état sanitaire des petits ruminants

Quelles peuvent être les priorités de recherche dans le domaine de la pathologie des petits ruminants en Afrique?

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Résumé

Les auteurs présentent une synthèse des différentes maladies d'origine bactérienne, virale et parasitaire affectant les petits ruminants en Afrique, en les classant selon leur incidence économique et sanitaire, et propose des priorités de recherche et de développement. Pour illustrer l'exposé, deux exemples seront commentés (peste des petits ruminants et pneumopathies des petits ruminants) ainsi que les perspectives offertes par les nouveaux outils de diagnostic et de prophylaxie médicale.

Which research priorities in African small ruminant diseases?

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D. M. Antonio**

Abstract

This paper reviews different bacterial, viral and parasitic diseases affecting small ruminants in Africa. Diseases are classified on the basis of their economical and health impact and research and development priorities are also suggested. Two examples are discussed: (1) peste des petits ruminants and small ruminant lung diseases and (2) the future of new diagnostic and prophylactic tools.

Introduction

La pathologie constitue l'un des obstacles les plus importants à l'amélioration de la productivité des troupeaux de petits ruminants en Afrique. Aborder les problèmes de santé animale des caprins et ovins est cependant difficile pour des raisons liées à:

- notre connaissance de leur pathologie: les informations sont souvent disparates et limitées (surtout pour la pathologie caprine). La présence vétérinaire est souvent insuffisante pour assurer le contrôle et suivre l'évolution des maladies sur le terrain;
- la pathologie elle-même : il n'y a pas de pathologie dominante par zone ou par pays: existence de syndromes à étiologie multifactorielle plutôt que d'entités pathologiques bien définies;
- l'intervention de nombreux facteurs favorisant et déclenchant: la malnutrition et les carences alimentaires diminuent la résistance des animaux au parasitisme et aux infections. Le parasitisme potentialise à son tour les effets de la malnutrition et favorise ainsi les maladies infectieuses. Des facteurs physiques (climat), mécaniques (poussières), chimiques (baignades), biologiques (virus, bactéries) peuvent déclencher des pneumopathies;
- nos moyens d'action: souvent limités en Afrique, ils doivent être bien "ciblés" (CIPEA, 1983).

L'Afrique doit faire face à des impératifs économiques souvent contradictoires: sa population progresse à un rythme soutenu, les besoins en protéines animales croissent proportionnellement (ces protéines sont indispensables aux enfants en bas âge qui représentent une fraction importante de la population), mais dans le même temps, les ressources en devises affectées à l'amélioration sanitaire du cheptel stagnent, voire même régressent.

Cette pénurie de moyens financiers justifie des choix drastiques d'affectation des crédits qui doivent avoir des effets maximaux sur la productivité du cheptel dans un minimum de temps.

Ces éléments rendent complexe la proposition de priorités de recherche et de développement. Les thèmes prioritaires et les stratégies proposées devront bien sûr être rediscutés et éventuellement réorientés pour chaque pays en tenant compte des pathologies dominantes et des moyens d'intervention.

Importance économique et sanitaire des principales maladies des petits ruminants

Les tableaux 1, 2 et 3 présentent pour les principales maladies virales, bactériennes et parasitaires des petits ruminants en Afrique une estimation de

leur importance économique, de leur gravité pour la santé humaine, et de la priorité qu'elles constituent pour la recherche et le développement. Ces trois éléments seront successivement discutés.

Tableau 1. Synoptique des principales parasitoses des petits ruminants en Afrique.

	Importance économique	Zoonose	Priorité recherche	Priorité développement
Helminthes	+	+/–	–	+
dont <i>Fasciola</i>	+	+	–	+
dont <i>Echinococcus</i>	+	+	–	+
Gales	+	–	–	+
<i>Coccidia</i>	+	–	–	+
<i>Cryptosporidia</i>	?	?	+	?
<i>Toxoplasma</i>	?	+	+	–
<i>Trypanosoma</i>	?	–	+	–
<i>Theileria</i>	?	–	+	?

Tableau 2. Synoptique des principales maladies virales des petits ruminants en Afrique.

	Importance économique	Zoonose	Priorité recherche	Priorité développement
Peste des petits ruminants	+	–	+	+
Clavelée	+	–	+	+
Ecthyma	+	–	–	+
Fièvre aphteuse	+	–	+	+
Fièvre de la vallée du Rift	+	+	+	+
Maladie de Nairobi	+	–	+	+
Blue tongue	+	–	+	–
Akabane				
Wesselsbronn				
C.A.E.V.				
VISNA-MAEDI				
Border disease				
Rage				

Maladies mal connues en Afrique

Tableau 3. Synoptique des principales maladies bactériennes des petits ruminants en Afrique

	Importance économique	Zoonose	Priorité recherche	Priorité développement
<i>Mycoplasmes</i>	+++	-	++++	+
<i>Pasteurelles</i>	+++	-	+	++++
<i>Charbon</i>	+++	+	-	+++
<i>Corynébactéries</i>	+++	-	+++	+
<i>Brucella</i>	+	+	-	+++
<i>Clostridies</i>	?	-	+	+
<i>Salmonella</i>	?	+	+	+
<i>Chlamydia</i>	?	+	+	?
<i>Dermatophilus</i>	?	-	+	+
<i>Escherichia</i>	+	+/-	+	+
<i>Listeria</i>	?	+	+	-
<i>Campylobacter</i>	+	+	+	?
<i>Cowdria</i>	+	-	++?	++?

Importance économique

Cette notion est difficile à apprécier étant donné les conditions d'élevage en Afrique. Il semble pourtant que l'on puisse dégager quelques "certitudes".

- Les carences nutritionnelles sont certainement, à elles seules, responsables de plus de pertes que l'ensemble de la pathologie infectieuse. Ces pertes peuvent être directes ou indirectes, la malnutrition étant un facteur favorisant pour l'éclosion de syndromes infectieux. L'amélioration des performances du cheptel africain ne peut passer que par une alimentation correcte aussi bien du point de vue qualitatif que quantitatif. Pourtant cette amélioration peut se heurter à des contraintes culturelles qu'il est difficile d'ignorer, en particulier lorsque l'importance du cheptel représente plus un statut social qu'une valeur strictement économique, lorsqu'il existe des prix hautement spéculatifs (à la veille de l'Aid) qui font passer l'état d'embonpoint de l'animal au second plan.
- Les parasitoses sont elles aussi une dominante du point de vue économique. Elles peuvent avoir un effet néfaste direct mais surtout elles peuvent créer ou favoriser des carences nutritionnelles indirectes par spoliation, par perturbation de la flore intestinale normale. En outre, ces parasitoses favorisent aussi la pénétration de germes pathogènes ou pathogènes opportunistes lorsqu'elles occasionnent des brèches dans le système de défense naturelle de l'hôte.

- En dehors de toute carence il existe pourtant des maladies infectieuses majeures qui sont un frein à l'amélioration génétique du cheptel africain. Certaines d'entre elles touchent indistinctement l'ensemble de la population des petits ruminants, d'autres peuvent avoir une cible élective parmi les races exotiques importées pour obtenir une amélioration rapide du cheptel local. Enfin, il faut garder à l'esprit que ces mêmes animaux importés peuvent eux aussi être porteurs de maladies "d'avenir" pour l'Afrique.

Zoonoses

La gravité des zoonoses transmises par les petits ruminants est limitée face aux maladies spécifiquement humaines qui frappent encore l'Afrique et qui sont beaucoup plus meurtrières. Parmi celles dont l'impact est d'ores et déjà certain, nous citerons (IEMVT, 1980):

- *la brucellose*, due à *Brucella melitensis* principalement, qui peut occasionner une maladie humaine chez les éleveurs mais aussi chez les consommateurs si les produits laitiers sont appelés à une plus large utilisation (la pénurie de bois rend improbable le chauffage du lait avant consommation);
- *l'hydatidose*: dans ce cas, les petits ruminants ne sont pas à l'origine directe de la contamination humaine (ce sont les chiens principalement) mais ils sont un maillon essentiel du cycle de *Echinococcus granulosus*. Comme le traitement de la maladie humaine ne peut être que chirurgical et que la plupart des anthelminthiques utilisés chez les chiens sont inactifs sur ce cestode, l'effort principal doit porter sur l'éducation du public qui doit pouvoir reconnaître les lésions chez les petits ruminants et soustraire celles-ci de la consommation par les chiens;
- *la fièvre de la vallée du Rift*: les épidémies les plus récentes ont montré (Egypte, Sénégal) que cette maladie pouvait avoir une répartition panafricaine et ne se cantonne plus dans son aire d'origine. Son importance en tant que zoonose n'est plus à démontrer aussi bien que son impact économique lorsqu'elle se déclenche dans une population entièrement réceptive. Néanmoins, son apparition erratique rend difficile toute prophylaxie suivie et demande surtout une bonne information des services vétérinaires pour raccourcir les délais d'intervention en cas d'apparition de la maladie;
- *le charbon*: les petits ruminants sont des animaux très sensibles à *Bacillus anthracis* au même titre que les bovins; il faut donc les inclure dans les plans de prophylaxie contre cette maladie;
- *la fasciolose*, très répandue chez les ovins, peut aussi avoir une certaine importance chez les humains. Le nombre de cas de fasciolose zoonose en Afrique est assez mal connu et mériterait d'être précisé. De toute façon, l'impact économique sur les productions ovines justifie à lui seul des plans de prophylaxie.

Orientation de la recherche sur la pathologie ovine et caprine

Priorités de recherche et priorités de développement

Afin d'évaluer les niveaux de priorité indiqués dans les tableaux 1, 2 et 3, nous avons considéré dans le champ de la recherche les études pouvant, à plus ou moins long terme, aider à combattre les maladies des petits ruminants.

Les études épidémiologiques

Elles indiquent l'importance (prévalence) des maladies à un moment donné, et permettent de déterminer des ordres de priorité d'action. Les études épidémiologiques dynamiques peuvent, elles, aider à élaborer d'autres moyens de lutte qui viseront plutôt à freiner la dissémination des maladies. La mise en place de telles mesures ne pourra toutefois se faire que dans des structures d'élevage bien organisées, ce qui est encore loin d'être le cas dans de nombreux pays.

L'amélioration des moyens de lutte

Cela concerne la création ou l'amélioration de matériel de diagnostic, des antibiotiques, des vaccins, des antiparasitaires, etc.

La sélection génétique d'animaux plus résistants aux différents pathogènes et en particulier aux parasites

Cette voie a pu être explorée pour les bovins (trypanotolérance) et pourrait l'être aussi pour les petits ruminants (hémonchose). Si nous n'avons pas considéré cette approche comme une priorité, c'est pour deux raisons. D'une part, il a été montré qu'il est pratiquement impossible de sélectionner des animaux sur de multiples caractères; les races "laitières" perdent leurs qualités "bouchères" (et inversement). L'amélioration des qualités zootechniques se fait souvent au détriment des qualités de résistance aux infections; il est probable que l'inverse soit aussi vrai. D'autre part, il est possible que nous n'ayons pas utilisé tous les moyens à notre disposition pour éviter l'apparition de parasites résistants aux anthelminthiques.

Les actions de développement sont celles ayant un effet direct sur l'évolution de la maladie considérée. Elles vont au-delà des seules mesures d'ordre vétérinaire. Il peut s'agir par exemple d'actions favorisant la plus grande disponibilité d'antiparasitaires et d'antibiotiques à moindre coût: fabrication sur place ou importation de molécules encore actives dont la licence est tombée dans le domaine public, ou encore de la fabrication de vaccins éprouvés, mais surtout

de leur diffusion à une échelle la plus large possible. Dans certains cas, l'information du public est capitale lorsqu'il n'existe pas beaucoup d'autres moyens de lutte (exemple du kyste hydatique).

Dans le domaine du parasitisme, il doit être possible de proposer des schémas de prophylaxie avec des molécules déjà existantes mais qui soient mieux ciblés. Cela peut concerner: la date d'intervention en fonction stricte des cycles parasitaires, le nombre de ces interventions car leur multiplication peut rapidement entraîner une chute du rapport bénéfice/coût. Enfin, il est peut-être possible de limiter l'apparition de parasites résistants par un emploi plus raisonné des molécules actives: limitation du nombre d'interventions, respect des doses à prescrire, permutation régulière des classes de molécules utilisées, etc.

Synthèse des thèmes de recherche prioritaires: une approche par syndrome

Sur le terrain on se trouve malheureusement souvent en présence de syndromes à étiologie multiple et non de maladies bien identifiées du point de vue clinique et nécropsique (CTA, 1986; IEMVT, 1980). Très schématiquement, deux syndromes dont l'incidence économique est extrêmement importante représentent actuellement les thèmes majeurs de recherche.

Un syndrome pneumopathies

- des parasitoses pulmonaires;
- la pneumonie "enzootique" d'étiologie complexe: facteurs favorisant (climat, alimentation, parasitoses pulmonaires et/ou digestives). Virus pathogènes les plus fréquents (PPR, parainfluenza III, clavelée, ecthyma, variole caprine). Infections bactériennes et/ou mycoplasmaïques (pasteurelles, staphylocoques, streptocoques, corynébactéries, *Haemophilus*, mycoplasmes d'infections associées),
- pleuropneumonie contagieuse caprine (F 38).

L'étude des pneumopathies des petits ruminants doit être différenciée selon les espèces ovine et caprine.

Chez les ovins

L'étiologie des pneumopathies est assez complexe, mais les pasteurelles jouent sans doute un rôle prédominant. Malheureusement, ces pasteurelles appartiennent non seulement à des espèces différentes (*haemolytica* et *multocida*) mais en plus, au sein de chaque espèce, il existe de nombreux sous-types sérologiques qui ne confèrent pas de protection croisée entre eux. La fabrication d'un vaccin efficace bute sur cette difficulté et c'est pourquoi les

efforts nous semblent devoir porter sur des actions de développement: amélioration des conditions d'élevage, respect des mesures sanitaires de base que sont la mise en quarantaine avant l'introduction de nouveaux animaux dans un troupeau, la disponibilité d'antibiotiques actifs, etc.

Chez les caprins

Il serait tentant de reprendre ici le parallèle fait avec les bovins. En effet, chez ces derniers il existe une espèce de mycoplasme particulièrement pathogène (*M. mycoides mycoides*) responsable de la péripneumonie. Les problèmes posés par cette maladie ont reçu une réponse satisfaisante par la vaccination, puisque dans les pays où celle-ci est effectuée à grande échelle les foyers de péripneumonie ont disparu.

Il existe chez les caprins une souche de mycoplasme particulièrement pathogène, dénommée F 38, responsable d'un syndrome voisin de la péripneumonie : la pleuropneumonie contagieuse caprine (OIE, 1989). Là encore, cette maladie est largement répandue en Afrique (Tchad, Tunisie, Soudan, Somalie, Kenya) et il est probable que son "absence" dans certains pays soit plutôt due à un manque de puissance des moyens de diagnostic. Il est donc urgent de trouver une parade à cette maladie et, pourquoi pas, de fabriquer un vaccin efficace. Malheureusement, le parallèle avec les bovins s'arrête peut-être là, car il a été montré que chez les caprins il existe de nombreuses espèces de mycoplasmes qui peuvent être pathogènes. Pour ne citer que les plus importants: F 38, *mycoides mycoides* LC, *capricolum*, *agalactiae*, *ovipneumoniae*. Si le tropisme électif de ces souches est assez variable: mamelle, articulations, yeux, il n'est pas rare de les isoler à partir de lésions pulmonaires et même de reproduire un syndrome respiratoire par inoculation endobronchique et passage à des animaux intacts.

C'est pourquoi les mycoplasmoses de la chèvre nous semblent une priorité de recherche; en effet, les antibiotiques, s'ils sont efficaces (macrolides, tétracyclines), n'empêchent pas la pérennité de l'infection. Enfin, avant la mise au point d'un vaccin efficace, il reste à déterminer si la souche F 38 est bien la cause principale des pneumopathies caprines; si d'autres mycoplasmes jouaient un rôle non négligeable, comme cela semble être le cas, il faudrait alors envisager la possibilité de vaccins multivalents en fonction des souches isolées dans chaque pays. La faisabilité de tels vaccins reste encore à étudier.

Un syndrome digestif (diarrhée-amaigrissement)

Il comprend essentiellement des parasitoses digestives (strongylose, fasciolose, cysticercose, echinococcose, coccidiose) les entérotoxémies et les colibacillooses- salmonellose, (surtout chez les jeunes de moins de 1 an).

La peste des petits ruminants semble jouer maintenant, pour les petits ruminants, un rôle tout à fait comparable à la peste bovine en Afrique. Auparavant plus connue dans l'ouest du continent, elle s'est étendue progressivement vers l'est pour atteindre le Proche-Orient. A l'heure actuelle, aucun pays africain ne peut s'estimer à l'abri de cette maladie.

Or il a été montré que, grâce à une communauté antigénique poussée, le vaccin peste bovine pouvait être utilisé chez les petits ruminants et leur conférerait une bonne protection. Des vaccins homologues sont d'ailleurs en cours d'essai (Nigéria, IEMVT) et devraient être disponibles dans un proche avenir. C'est pourquoi cette maladie, malgré son impact énorme, n'est pas considérée comme une priorité de recherche mais au contraire, le maximum de ressources disponibles devrait être consacré à son contrôle, à l'instar de ce qui est fait pour la peste bovine.

Deux autres thèmes de recherche importants doivent d'autre part être pris en considération:

- avortements mammites (brucellose, fièvre Q, chlamydiose, campylobactériose), mammites bactériennes diverses;
- affections de la peau et des pieds (ecthyma, varioles ovine et caprine, fièvre aphteuse, corynébactéries, streptotrichose, teignes, gales, tiques, myases, piétin)

Nouveaux outils

Il convient de ne pas passer sous silence les progrès de la recherche fondamentale qui vont peut-être révolutionner à la fois les techniques de diagnostic aussi bien que les méthodes de lutte.

Diagnostic

De plus en plus, la recherche fondamentale s'est préoccupée d'élaborer des outils de diagnostic rapide. Les techniques immunoenzymatiques ont été une première voie d'approche (immunofluorescence, méthodes ELISA, techniques d'immunoblotting, mais elles se heurtent à des contraintes techniques pour une plus grande diffusion et à un certain manque de sensibilité.

Une autre technique, dérivée, elle, de la biologie moléculaire, pourrait ne pas avoir les mêmes défauts: il s'agit de la PCR (Polymerase Chain Reaction) ou encore "amplification de gène". Cette technique permet d'amplifier sélectivement une séquence d'ADN (ici spécifique d'un germe pathogène) si elle est présente dans un produit pathologique. Si l'on dispose ensuite de sondes ADN marquées, il est possible de mettre en évidence la présence d'un agent pathogène même si celui-ci n'est présent qu'à quelques exemplaires. Bien entendu, les sondes

utilisées devront absolument être "froides", c'est-à-dire non radioactives, pour pouvoir être utilisables largement sur le terrain.

Vaccins

En ce qui les concerne, de nombreuses perspectives sont ouvertes. De nouveaux immunostimulants ont déjà vu le jour (ISCOM, par exemple) qui peuvent permettre la création de nouveaux vaccins inactivés. Le génie génétique ainsi que la biochimie peuvent permettre l'apparition de vaccins à sous-unités. Enfin, il y a la possibilité de créer des vaccins chimères, par recombinaison génétique, le plus souvent avec une souche virale dérivant d'un vaccin "pox".

Ces nouveaux vaccins peuvent offrir un autre avantage par rapport aux vaccins classiques, qui est de pouvoir différencier les réponses sérologiques ou bien les séquences génomiques d'avec celles produites par des agents pathogènes. Cette possibilité pourrait alors réconcilier deux méthodes de lutte qui sont pour le moment souvent antinomiques: les prophylaxies sanitaires et médicales.

Enfin, il faut insister sur le fait que ces techniques ne sont pas encore passées dans l'usage courant et que la lutte contre les maladies infectieuses passe avant tout par des infrastructures d'élevage bien construites.

Conclusion

Cette présentation est forcément schématique et nous souhaitons qu'elle ouvre une large discussion. En particulier, nous n'avons pas insisté sur les "maladies d'avenir" que pourraient être les maladies introduites par les reproducteurs importés pour l'amélioration des races locales; ce sera sans doute un chapitre à développer ultérieurement.

Pour finir nous voudrions insister sur les trois questions fondamentales auxquelles il faut répondre avant d'engager toute enquête.

- 1) La question vaut-elle vraiment la peine d'être posée ?
- 2) La question n'a-t-elle pas déjà reçu une réponse ailleurs ?
- 3) Avons-nous vraiment les moyens nécessaires de répondre correctement à la question posée ?

Des réunions comme celle à laquelle nous participons doivent permettre de confronter des expériences diverses et répondre au moins partiellement aux deux premières interrogations. En ce qui concerne la troisième, chaque institution doit pouvoir apprécier le rapport coût/résultat; en effet, l'affectation de trop peu de moyens pourrait aboutir à l'obtention de résultats biaisés, peu fiables, qui dans une certaine mesure pourraient être pires que l'absence de résultat.

Ainsi, dans tous les cas où un moyen de lutte efficace et peu cher est disponible, nous pensons qu'il faut affecter le maximum de ressources aux actions de développement et réserver la recherche aux problèmes qui n'ont pas encore trouvé de réponse satisfaisante.

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Effet des parasites gastro-intestinaux sur la durée de l'anoestrus post-partum chez la brebis Djallonké

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Résumé

Deux tests (un en saison pluvieuse et l'autre en saison sèche) ont été menés pour déterminer l'influence du taux des strongles gastro-intestinaux et des coccidies sur la durée de l'anoestrus post-partum. Les brebis étaient infestées naturellement. Au cours des deux saisons, le retour de l'oestrus a été détecté par un bélier et la lecture des frottis vaginaux.

D'une façon générale, l'anoestrus post-partum est plus long en saison humide qu'en saison sèche. L'anoestrus physiologique vrai (déterminé par la cytologie vaginale) est nettement plus court que la durée d'anoestrus à partir de la détection des chaleurs par un bélier.

L'étude coprologique révèle que le parasitisme gastro-intestinal influence beaucoup plus le comportement sexuel après la mise-bas que la physiologie sexuelle. Le taux d'infestation des brebis à la mise-bas est le principal facteur du retour tardif des signes extérieurs de chaleurs. Dans plus de 90% des cas, le parasitisme gastro-intestinal retarde la réapparition des signes de chaleurs en saison pluvieuse. En saison sèche l'influence est moins sensible, le taux de parasites étant beaucoup plus faible en cette saison.

Effect of gastro-intestinal parasites on “anoestrus post-partum” duration of Djallonke ewes

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Abstract

Two tests (one during the rainy season and the other during the dry season) were carried out to determine the influence of the level of gastro-intestinal strongyles and coccidies on the “anoestrous post-partum” duration. Ewes were naturally infested. For both tests, return of oestrous was detected by a ram and the reading of vaginal smears.

Generally “anoestrous post-partum” duration is longer in the rainy season than in the dry season. Duration of the real physiological anoestrous (determined by vaginal cytology) is significantly shorter than anoestrous duration calculated by using the detection of rut by a ram.

Analysis of the level of parasite eggs in ewe faeces showed that gastro-intestinal parasitism influences more sexual behaviour after dropping than sexual physiology. The level of infestation of ewes at dropping is the main factor of the belated return of external sign of oestrous. In more than 90 % of the cases, gastro-intestinal parasitism delayed the reappearance of oestrous signs during the rainy season. During the dry season, the influence is less sensitive, the level of parasites being lower.

Introduction

L'anoestrus post-partum chez la brebis est défini comme l'intervalle de temps qui sépare l'agnelage des premiers signes de chaleurs visibles. Cette durée a souvent été déterminée à partir de l'intervalle de temps entre deux mises-bas successives (Berger et Ginisty, 1980). Mais la brebis n'étant pas systématiquement en gestation après la reprise des activités ovariennes, l'intervalle entre deux mises-bas peut ne pas toujours être la somme de la durée d'une gestation et de celle de l'anoestrus post-partum. Compte tenu de l'importance de ce paramètre de reproduction dans la maîtrise du rythme des mises-bas en vue de l'amélioration de l'élevage ovin, il a paru intéressant et même indispensable de connaître avec précision la durée de l'anoestrus post-partum.

Parmi les facteurs influençant le rétablissement normal de l'activité ovarienne après la mise-bas, nous citerons la lactation, l'alimentation qui détermine le poids vif de l'animal, et la pathologie, particulièrement les parasitoses gastro-intestinales.

L'objectif de notre travail est d'étudier la durée précise de l'anoestrus post-partum par la détection des chaleurs et les frottis vaginaux chez des brebis soumises à l'influence de coccidies et des strongles gastro-intestinaux.

Matériel et méthode

Le troupeau ovin qui fait l'objet de cette étude se trouve dans une ferme de l'Université nationale du Bénin à Abomey-Calavi situé à environ 20 km de Cotonou (République du Bénin). La pluviométrie y est de type bimodale.

Les animaux sont de race Djallonké et correspondent à la sous-race décrite par Rombaut et van Vlaenderen (1976) au sud de la Côte d'Ivoire. Pour l'étude de l'activité ovarienne post-partum nous avons disposé de 9 brebis multipares âgées de 25 à 36 mois pesant 17 à 23 kilos, et de 4 brebis primipares âgées de 16 à 22 mois pesant 15 à 20 kilos.

Pendant ou après la gestation, les animaux ont été vaccinés contre la peste bovine et contre le tétanos. Certains sont déparasités contre les helminthes et contre les coccidies. Toutes les brebis allaitantes reçoivent en plus du pâturage naturel dont elles disposent, des compléments alimentaires composés de sous-produits agro-alimentaires.

Après la mise-bas et une fois par semaine, toutes les mères ont été pesées; des prélèvements vaginaux et coprologiques ont été pratiqués. Des observations journalières (matin, midi, soir) du comportement sexuel des brebis en présence d'un bélier muni d'un tablier ont été faites. Les frottis vaginaux sont colorés par la technique de Papanicolaou (1942) et les prélèvements coprologiques sont analysés par la méthode de Mac Master modifiée par Mishra (1978). Ce suivi a été réalisé en saison sèche et en saison humide de la même année.

Résultats

Détermination de la durée de l'anoestrus post-partum par la détection des chaleurs (D1)

La durée moyenne de l'anoestrus post-partum dans le troupeau étudié est de $76,36 \pm 16,44$ jours, les extrêmes étant de 40 et de 154 jours.

La brebis Djallonké n'est pas saisonnée. Les mises-bas ont lieu pendant toute l'année indépendamment des saisons climatiques. On remarque cependant que

la durée de l'anoestrus varie d'une saison à l'autre: les mises-bas à la fin de la saison sèche ou au début de la saison humide sont suivies d'un anoestrus post-partum plus long ($85,37 \pm 27,37$ jours) que celui ($64,33 \pm 13,34$ jours) qui suit les mises-bas en saison sèche ($P < 0,05$).

Les durées les plus courtes (40–60 jours) s'observent chez les jeunes brebis primipares ou chez les multipares qui n'allaitent qu'un agneau. En saison des pluies, la durée moyenne de l'anoestrus post-partum est nettement plus courte chez les primipares que chez les multipares ($P < 0,02$). De même, la fluctuation des valeurs autour de la moyenne est plus faible chez les primipares que chez les multipares ($P < 0,001$).

Détermination de la durée de l'anoestrus post-partum par les frottis vaginaux (D2)

La lecture des frottis vaginaux et les courbes de variation des cellules vaginales (figure 1) au cours de l'anoestrus révèlent:

- un taux de cellules superficielles inférieur ou égal à 40% durant les quatre premières semaines après la mise-bas. Durant cette période, les cellules intermédiaires basophiles sont dominantes associées à une abondance simultanée des polynucléaires;
- un pic d'environ 70% de cellules superficielles se produit quinze jours avant les manifestations des signes de chaleurs. Ce pic suivi d'une chute est caractérisé par une abondance des cellules superficielles éosinophiles et par la disparition des polynucléaires;
- un autre pic de cellules superficielles autour du jour du premier oestrus. Ce nouveau pic est moins grand que celui observé quinze jours plus tôt;
- l'indice karyopycnotique révèle quelquefois un pic dès la troisième semaine après la mise-bas. Si parfois il y a un décalage entre ce pic et celui des cellules superficielles, on note souvent la coïncidence entre ces deux pics.

Ces résultats permettent de recalculer la durée de l'anoestrus déterminée par la cytologie vaginale ($D2 = 54,85 \pm 9,71$ jours) qui est nettement plus courte ($P < 0,02$) que celle révélée par la détection des chaleurs ($D1 = 76,88 \pm 16,44$ jours). La cytologie vaginale révèle aussi une reprise tardive de l'activité ovarienne après la mise-bas en saison pluvieuse (tableau 1).

Influence du parasitisme gastro-intestinal sur la durée de l'anoestrus post-partum

Influence de la coccidiose

Le nombre moyen de coccidies au moment de la mise-bas (1039 ± 261 oeufs par gramme) est légèrement inférieur à celui à la fin de l'anoestrus (1807 ± 959).

Tableau 1. *Durée de l'anoestrus post-partum déterminée par la détection des chaleurs (D1) et la cytologie vaginale (D2)*

Saisons	Brebis	Type de brebis	Durée de l'anoestrus (D1)	Durée de l'anoestrus (D2)
Saison humide	0022	Multipare	154	84
	0026	Multipare	80	77
	0035	Multipare	115	77
	0039	Multipare	75	49
	0041	Multipare	82	70
	0043	Multipare	66	56
	0055	Primipare	57	42
	5005	Primipare	54	35
Saison sèche	0023	Multipare	91	63
	0031	Multipare	55	28
	0048	Multipare	64	48
	5017	Primipare	61	42
	0074	Primipare	71	42

Néanmoins, il existe une corrélation positive étroite entre la durée de l'anoestrus et le taux de coccidies au moment de la mise-bas. Cette corrélation est encore plus étroite pendant la saison pluvieuse ($r=0,98$).

Aussi les brebis dont la durée de l'anoestrus post-partum est inférieure à 60 jours sont les moins parasitées. Leur OPG de coccidies est inférieur à 400. Le rapport du taux de coccidies par poids de l'animal est de l'ordre de 20 dans ce groupe d'animaux. Chez les brebis dont la durée de l'anoestrus est comprise entre 60 et 90 jours, l'OPG moyen de coccidies est de l'ordre de 700. Le rapport OPG par poids est égal à 43,87.

Il existe une étroite corrélation ($r=0,87$; $P<0,01$) positive entre le taux de coccidies et la cytologie vaginale (taux de squames et de l'indice karyopycnotique) (tableau 2).

Figure 1 Cytologie vaginale de cinq brebis Djallonké

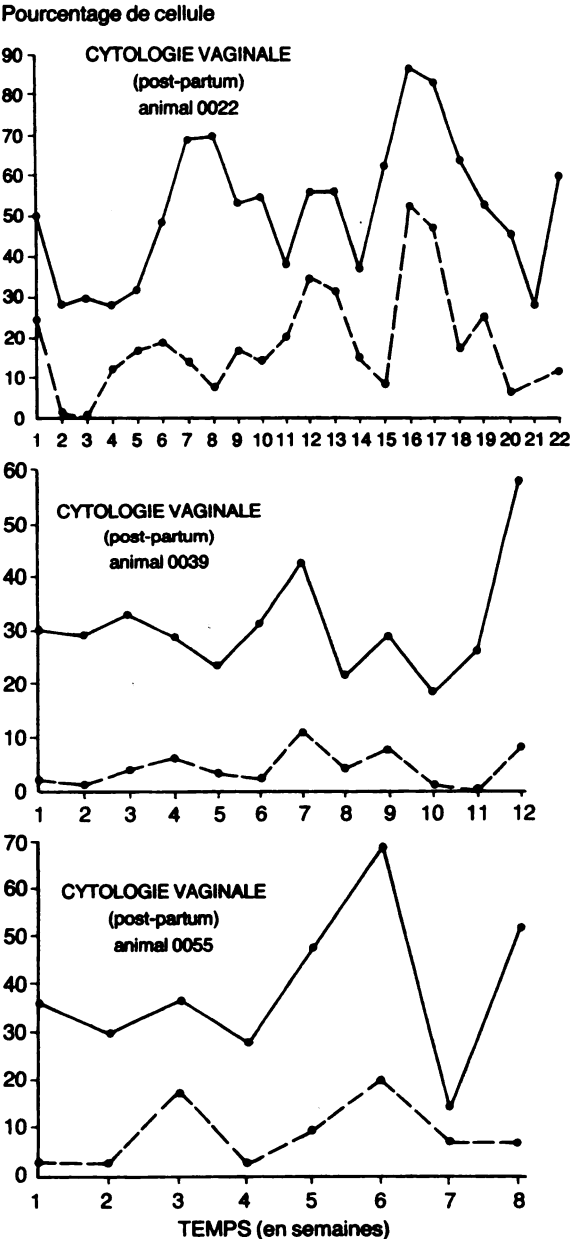
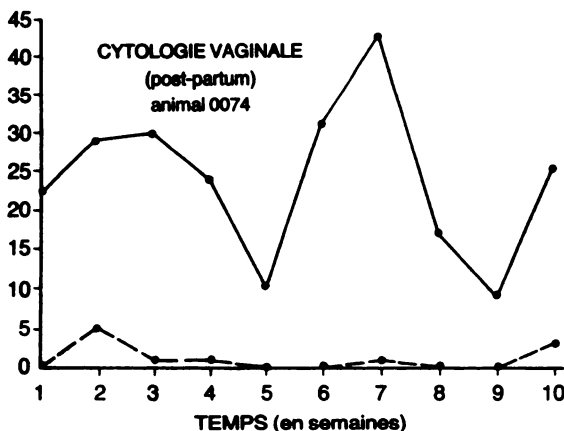
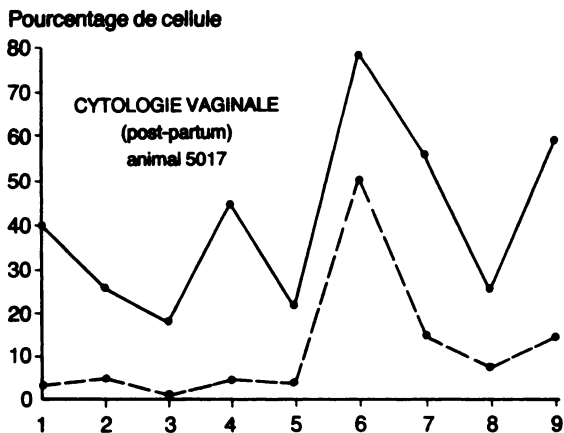


Figure 1. (Suite)



Influence de la strongylose

L'infestation strongylienne (575 OPG) est moins importante que l'infestation coccidienne (7000 OPG). Les valeurs d'OPG les plus élevées s'observent généralement après la mise-bas ($P < 0,01$).

Tableau 2. *Influence de l'infestation coccidienne sur la durée de l'anoestrus post-partum*

Brebis	Poids (kg)	Coccidies (OPG)	OPG/kg vif	Durée (j)	Saison
0022	17,4 ± 3,79	3905	224,43	154	
0026	18,4 ± 0,89	714	38,81	81	
0035	14 ± 0,69	2052	146,57	115	
0039	16,5 ± 0,8	428	25,89	75	
0041	14,5 ± 0,47	1015	64,79	82	Humide
0043	17,7 ± 0,83	942	53,11	66	
0055	16 ± 0,85	404	25,28	57	
5005	14,5 ± 0,22	321	22,13	54	
0023	18,1 ± 0,78	11926	658,90	91	
0031	16,5 ± 1,06	119	7,21	55	
0048	14 ± 0,69	160	11,47	64	Sèche
0074	14,25 ± 0,68	720	50,95	71	
5017	16 ± 0,98	172	10,81	61	

Pour les brebis dont l'anoestrus post-partum dure moins de 60 jours, l'OPG moyen est inférieur à 250. Le rapport taux de strongles par le poids de l'animal est de l'ordre de 12. Chez les brebis dont l'anoestrus dure 60 à 90 jours, l'OPG moyen atteint 350. Le rapport taux de strongles par poids est de l'ordre de 15. Chez les brebis dont la durée de l'anoestrus est supérieure à 100, l'OPG moyen est égal à 485,75. Le rapport strongles-poids est de 30,87 (tableau 3).

Il existe une étroite corrélation positive ($r=0,78$; $P<0,01$) entre l'infestation strongylienne et l'âge. La corrélation existe, mais elle est plus faible entre le taux de strongles et le poids de l'animal ($r=0,58$; $P<0,01$).

Tableau 3. *Influence de l'infestation strongylienne sur la durée de l'anoestrus post-partum*

Brebis	Poids (kg)	Strongles (OPG)	OPG/kg vif	Durée (j)	Saison
0022	17,4 ± 3,79	442	25,45	154	Humide
0026	18,4 ± 0,89	285	15,52	81	
0035	14 ± 0,69	532	38,03	115	
0039	16,5 ± 0,47	825	49,86	75	
0041	14,5 ± 0,47	364	25,16	82	
0043	17,7 ± 0,83	20	1,16	66	
0055	16 ± 0,85	142	8,9	57	
5005	14,5 ± 0,22	102	7,16	54	Sèche
0023	18,1 ± 0,78	196	10,91	91	
0031	16,5 ± 1,06	23	1,44	55	
0048	14 ± 0,69	128	9,18	64	
0074	14,25 ± 0,68	3432	240,89	71	
5017	16 ± 0,98	1311	81,98	61	

Discussion

La durée de l'anoestrus post-partum chez la brebis Djallonké calculée à partir des détections de chaleurs, paraît longue au regard des valeurs données par la littérature: 42,4 jours (Berger, 1979) et 60 jours (Amégée, 1984). L'anoestrus physiologique vrai est généralement plus court que la durée d'anoestrus observée dans les conditions ordinaires d'observation. Selon certains auteurs,

les ovulations se produisent dès le 18^e jour après la mise-bas, mais les signes extérieurs d'oestrus ne sont observables que plus tard. Dans ces conditions pratiques, il est difficile de distinguer l'anoestrus physiologique vrai et le faux anoestrus. Le faux anoestrus serait dû à une détection incorrecte des oestrus.

La difficulté de distinguer le vrai anoestrus du faux anoestrus résulte surtout d'une dissociation oestrus-ovulation: la première ovulation est fréquemment silencieuse; dans certains cas, le premier oestrus n'est pas toujours accompagné d'une ovulation.

Pour déterminer l'anoestrus physiologique vrai, il faut maîtriser les problèmes posés par la brièveté des oestrus et par la fréquence des chaleurs silencieuses. Cela peut se faire par l'emploi de méthodes plus efficaces de détection des chaleurs, comme la multiplication des observations chaque jour, ou l'emploi de méthodes plus efficaces de détection des ovulations telles que la cytologie vaginale.

L'abondance des cellules superficielles sur les frottis vaginaux réalisés traduit une élévation du taux d'oestrogène (après l'ovulation), confirmant la théorie selon laquelle il y a décalage entre la première ovulation et le premier oestrus. Le premier pic de cellules superficielles correspondrait à la première chaleur silencieuse.

La différence entre le premier pic et celui du premier oestrus traduirait une sécrétion plus importante de FSH après la mise-bas. La teneur en FSH est plus élevée pendant le premier cycle après la reprise des activités ovariennes que pendant les cycles ultérieurs. La sécrétion de FSH semble par ailleurs inhibée par la prolactine liée à la lactation.

La libération de FSH favorise comme on le sait la folliculogénèse, qui se traduit par une forte sécrétion d'oestrogène à laquelle sont sensibles les cellules superficielles de l'épithélium vaginal. Si la pycnocytose traduit la présence d'oestrogène, nous pouvons penser à la reprise assez rapide des activités ovariennes avec des productions d'oestrogènes puisqu'on a observé un pic d'indice karyopycnotique dès la troisième semaine après la mise-bas.

Dans le troupeau étudié, l'infestation coccidienne semble constante et régulière. Elle a une influence sensible sur la durée de l'anoestrus post-partum. L'augmentation de l'infestation parasitaire après la mise-bas s'explique par une diminution de la résistance physiologique de la mère liée entre autres à l'allaitement. La diminution de l'absorption intestinale des aliments due aux coccidies se traduit par une perte de poids sensible. Il existe donc une corrélation linéaire entre la durée de l'anoestrus et le rapport OPG par poids.

La mise-bas peut donc constituer un facteur de déséquilibre biologique provoquant des troubles de l'état général de l'animal qui devient sensible à l'infestation parasitaire.

Conclusion

L'activité ovarienne post-partum chez la brebis Djallonké a été étudiée par la détection de chaleurs et par les frottis vaginaux colorés au Papanicolaou. L'examen coprologique a permis d'évaluer l'influence de la coccidiose gastro-intestinale sur la durée de l'anoestrus post-partum.

La durée moyenne de l'anoestrus post-partum déterminée à partir de la détection des chaleurs est plus grande que celle donnée par Berger et Ginnisty (1980). Le retour des chaleurs est plus tardif pendant la saison pluvieuse. L'étude de la cytologie vaginale au cours de l'anoestrus post-partum permet de déterminer la durée moyenne de l'anoestrus physiologique vrai qui est nettement plus court que la durée d'anoestrus observée dans les conditions ordinaires d'observation.

Le taux de coccidies à la mise-bas est le facteur qui influence le plus la durée de l'anoestrus post-partum. Cette corrélation positive est encore plus étroite pendant la saison pluvieuse. La strongylose influence plus faiblement la reprise des activités ovariennes après la mise-bas. Ces travaux nous permettent de recommander un déparasitage (anticoccidien et anthelminthique) systématique à la fin de la gestation.

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The effects of endoparasites on the productivity of Ethiopian highland sheep

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Abstract

*During 1988 and 1989 the effect of endoparasites on the productivity of Ethiopian highland sheep was studied using eggs per gram (EPG) counts, worm counts and packed cell volume (PCV) at Debre Berhan, Dejen, Deneba, Tulu Meko and Wereilu. Nematode and trematode EPG counts were low except at Tulu Meko with significant ($P < 0.05$) differences in age, season and year effects in most sites. Mean monthly mature worm counts in necropsied sheep were also low to moderate and ranged from 0–4 375 and 0–1 825 in the abomasum and intestines, respectively. The predominant worms in the counts were mainly *Trichostrongylus colubriformis* with a few *Haemonchus contortus* and others, irrespective of season. This was attributed to possible resistance and/or "self cure" to haemonchosis and/or environmental factors. Mean PCV values were almost similar for all the locations and were significantly ($P < 0.05$) affected by the degree of nematode and trematode infections in all sites.*

Low PCV and high EPG levels were significantly ($P < 0.05$) associated with poor body-condition scores and low bodyweights. Monthly repeatabilities of PCV, bodyweight and body-condition score were 0.44 ± 0.01 , 0.71 ± 0.01 and 0.35 ± 0.01 , respectively, while the values for nematode (0.09 ± 0.01) and trematode EPG (0.20 ± 0.20) were much lower. The higher repeatability for PCV in contrast to EPG would indicate that it was less affected by the variable factors influencing egg output. It is, therefore, suggested that it should be used in conjunction with nematode and trematode EPG levels in endoparasite monitoring.

Effets des endoparasites sur la productivité du mouton des hauts plateaux éthiopiens

Tekelye Bekele et O.B. Kasali

Résumé

*L'effet des endoparasites sur la productivité du mouton des hauts plateaux éthiopiens a été étudié en 1988 et 1989 à Debre Berhan, Dejen, Deneba, Tulu Meko et Wereilu. Les paramètres considérés étaient le nombre d'œufs de parasites par gramme de fécès, le nombre de vers dans diverses parties du tube digestif et l'hématocrite. Exception faite de la localité Tulu Meko, le nombre d'œufs de nématodes et de trématodes par gramme de fécès était faible et, dans la plupart des régions variait significativement ($P < 0,05$) en fonction de l'âge des animaux, de la saison et de l'année. Le nombre de vers adultes chez les moutons autopsiés était faible ou moyennement élevé, variant de 0 à 4 375 dans la caillotte et de 0 à 1 825 dans les intestins. Quelle que soit la saison considérée, les vers les plus nombreux étaient les *Trichostrongylus colubriformis*. On a également dénombré quelques *Haemonchus contortus* ainsi que des représentants d'autres espèces. La rareté relative des *Haemonchus* était peut-être due à une résistance à l'hémomonchose et/ou à un "auto-traitement" de cette maladie à moins que cela ne soit dû à l'action du milieu.*

Avec des valeurs moyennes de $33,40 \pm 0,70$, $32,70 \pm 0,78$, $33,92 \pm 0,76$, $28,63 \pm 0,79$ et $35,79 \pm 0,68$ respectivement à Debre Berhan, Dejen, Deneba, Tulu Meko et Wereilu, l'hématocrite variait significativement ($P < 0,05$) en fonction du degré d'infestation par les nématodes et les trématodes quelle que soit la localité considérée.

Une association significative ($P < 0,05$) entre les faibles niveaux d'hématocrite et les nombres élevés d'œufs par gramme de fécès d'une part et d'autre part, les notes médiocres d'état corporel des animaux et leurs faibles poids vifs a été montrée. Les coefficients de répétabilité de l'hématocrite, du poids vif et de la note d'état corporel furent respectivement de $0,44 \pm 0,01$, $0,71 \pm 0,01$ et $0,35 \pm 0,01$. En comparaison, les coefficients relatifs au nombre de parasites par gramme de fécès étaient beaucoup plus faibles, s'établissant respectivement à $0,09 \pm 0,01$ pour les nématodes et à $0,20 \pm 0,20$ pour les trématodes. Compte tenu de la valeur élevée du coefficient de répétabilité relatif à l'hématocrite, il est probable que les divers facteurs dont dépend le nombre d'œufs influencent moins ce

paramètre que les autres. En conséquence, il est proposé d'utiliser l'hématocrite, conjointement avec le nombre d'œufs de nématodes et de trématodes par gramme de fécès pour évaluer le niveau d'endoparasitisme de ces animaux.

Introduction

Most sheep in Ethiopia are owned by smallholders in the highlands where there is mixed crop–livestock production. These sheep are an integral part of the livestock sector of the economy. Sheep supply meat, wool (hair) and skin and generate about 89% of farmers' cash income (Gryseels et al, 1989).

The productivity of Ethiopian sheep is affected by nutritional and endoparasitic stress although they are all year-round breeders. Nutritional stress occurs whenever there are dry spells and often before grass grows during the rainy seasons. The major endoparasitic diseases of importance include fascioliasis, gastrointestinal nematodiasis, cestodiasis and lung worm (Graber, 1975; Scott and Goll, 1977; Bekele Mamo et al, 1981; Lemma et al, 1985). Their effects range from a reduced performance to mortality (Sykes, 1978; Armour and Gettinby, 1983). These effects are also exacerbated by the level of nutrition.

There are limited field studies on the effects of endoparasites on productivity. Most attempts have been on experimental infections of either a single or few parasites which do not simulate the dynamics in field conditions. Hence this study was performed to determine the impact of endoparasites on productivity of the highland sheep in Ethiopia. This report focuses on the relationship of some of the indicators of endoparasites on productivity and the estimates of repeatability of associated parameters.

Materials and Methods

The study was carried out on-farm at Debre Berhan, Dejen, Deneba, Tulu Meko and Wereilu in the Ethiopian highlands from June 1988 to December 1989. These places are located in the central, northern and north-western part of the country where the altitude ranges from 2500–3000 m above sea level and the production system is mainly mixed farming. They have bimodal rainfall pattern with long rains from June to September and short rains from March to May. A total of 2594 sheep were involved in the study. These included the Menz, Horro, Wollo and Dejen breed types from 30–50 farmers with 350–400 sheep each at the beginning of the study. There was also periodic replacement of exits. All animals were raised under traditional management with minimum health interventions.

Each site was visited monthly for sampling and data collection which included faeces for eggs-per-gram (EPG) counts and faecal culture, blood for packed cell

volume (PCV) and screening haemoparasites, bodyweight, body-condition score (MAFF, 1984; Hossamo et al, 1986) and pregnancy and lambing status. In addition, 122 (six-month-old or more) sheep were sacrificed at each site at the rate of four per month in the first year and then periodically in the second year for post-mortem examination, worm count and identification; Skerman and Hillard, 1966) at Debre Berhan and Tulu Meko. The age of each sheep was estimated from teeth-eruption changes (Williamson and Payne, 1959) on each visit.

Data were analysed by least squares (SAS, 1987) using the general linear model for the effect of endoparasites on productivity for each site separately but were pooled for repeatability estimates. Dependent variables were bodyweight, body-condition score and lambing interval. The independent variables were nematode and trematode EPG levels determined by classifying infection levels as either low (≤ 50) or high (> 50), and PCV which was also classified as below normal (≤ 27) and above normal (> 27). The EPG and PCV classifications for each animal were based on the means of the repeated monthly determinants over the study period. Repeatability was estimated using a mixed model (Harvey, 1987) with random animal effect and other relevant fixed effects. The estimates of repeatability for log value of positive EPG and PCV were obtained by treating these as dependent variables and adjusting for the fixed effects.

Results

Peak nematode EPG counts were observed during the long and short rainy seasons especially at Tulu Meko (Figures 1 and 2). In addition, trematode EPG counts were also high for most parts of 1989 at Tulu Meko but not on other sites. Log values of monthly EPG counts were significantly ($P < 0.05$) affected by age of sheep, season and year. The mean monthly mature worm counts in necropsied sheep ranged from 0–4375 and 0–1825 in the abomasum and intestines, respectively. Immature worms were less frequently encountered. Worm counts at Tulu Meko were higher than at Debre Berhan. The log transformed mature worm counts from the abomasum did not show significant ($P > 0.05$) seasonal differences in both sites while year-effect was significantly ($P < 0.05$) different at Tulu Meko but not at Debre Berhan ($P > 0.05$). The commonest mature and immature worms found during worm counting were *Trichostrongylus colubriformis* with only few *H. contortus*, *T. axei*, *Oesophagostomum columbianum*, *Bunostomum trigoncephalum* and *Trichuris skrjabini*. These gastrointestinal parasites were also found in faecal cultures. The mean monthly counts of *Fasciola hepatica* in the liver ranged from 0–78 for both Debre Berhan and Tulu Meko. Seasonal frequencies of *D. filaria* and *T. colubriformis* were 66.7–100% and 64.0–100% in necropsied sheep but they were low for others.

The correlation and regression coefficients of both nematode and trematode EPG counts on PCV were significantly ($P < 0.01$) different from zero. Least squares means for PCV at different sites were 33.40 ± 0.70 , 32.70 ± 0.78 , 33.92 ± 0.76 , 28.63 ± 0.79 and 35.79 ± 0.69 at Debre Berhan, Dejen, Deneba, Tulu Meko and Wereilu, respectively. Levels of nematode and trematode EPG caused

Figure 1. Correlation of mean monthly rainfall with mean monthly nematode egg counts by site (1988–1989).

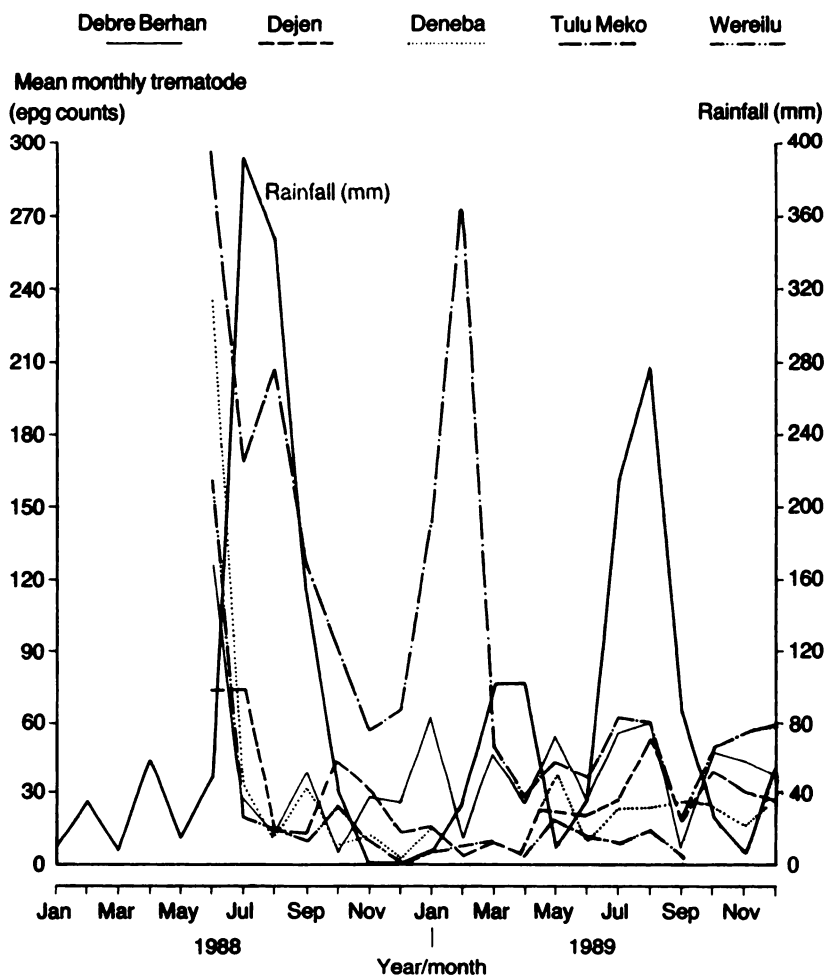
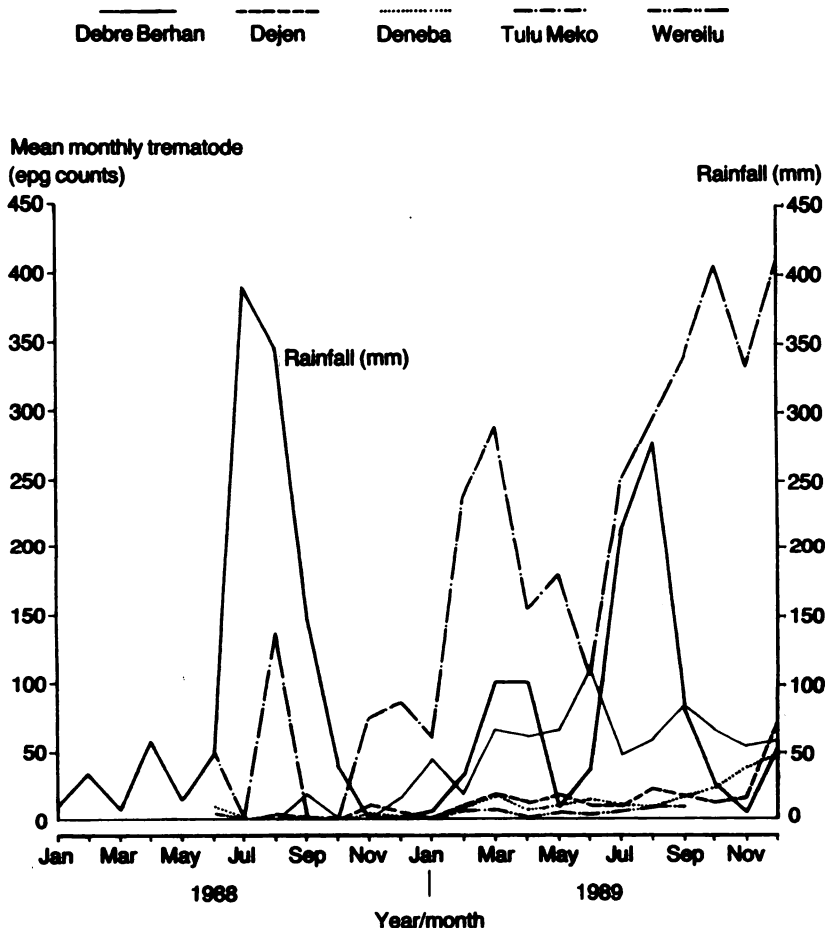


Figure 2. Correlation of mean monthly rainfall with mean monthly trematode egg counts by site (1988–1989).



significant ($P < 0.05$) differences in PCV which decreased with increasing parasitic load in each site. Mixed nematode and trematode infections were few and insignificant ($P > 0.05$). PCVs were also significantly ($P < 0.03$) different in different age groups of sheep, different seasons and different years but not in different sexes.

Figure 3 shows the frequency of average PCV (average above and below normal), nematode (average low and high EPG levels) and trematode (average low and high EPG levels) EPG levels of all sheep in different sites. These frequencies indicate that endoparasitism was highest at Tulu Meko with low PCV, high nematode EPG and high trematode EPG levels of 37.4, 31.8 and 38.4%, respectively. The least-squares means for body-condition scores, bodyweights of male sheep and lambing interval are, respectively, presented in Tables 1, 2 and 3. The means for body scores were 1.69 ± 0.76 , 1.85 ± 0.71 , 1.75 ± 0.79 , 1.60 ± 0.82 and 1.85 ± 0.74 at Debre Berhan, Dejen, Deneba, Tulu Meko and

Figure 3. Frequency of average PCV, nematode and trematode EPG levels of all sheep in different sites.

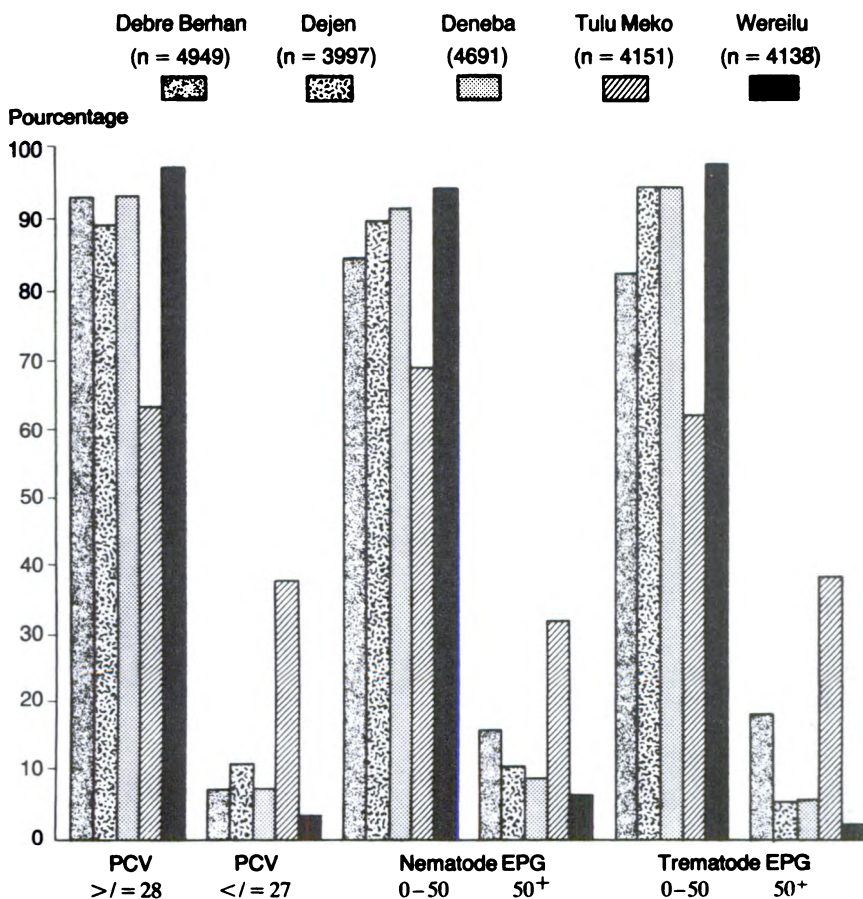


Table 1. Least-squares means ($\pm$ SE) for body-condition score of all sheep in different sites.

	Debre Berhan			Dejen			Deneba			Tulu Meko			Wereilu		
	No	Mean ($\pm$ SE)	No	Mean ($\pm$ SE)	No	Mean ($\pm$ SE)	No	Mean ($\pm$ SE)	No	Mean ($\pm$ SE)	No	Mean ($\pm$ SE)	No	Mean ($\pm$ SE)	
Overall mean	4949	1.69 $\pm$ 0.76	3997	1.85 $\pm$ 0.77	4691	1.75 $\pm$ 0.79	4151	1.60 $\pm$ 0.82	4138	1.85 $\pm$ 0.74					
Packed cell volume															
$\geq$ 28	4594	1.74 $\pm$ 0.02a	3545	1.85 $\pm$ 0.04a	4369	1.77 $\pm$ 0.04a	2600	1.75 $\pm$ 0.02a	4009	1.70 $\pm$ 0.06a					
$\leq$ 27	355	1.16 $\pm$ 0.05b	452	1.03 $\pm$ 0.06b	322	1.03 $\pm$ 0.07b	1551	1.23 $\pm$ 0.03b	129	1.13 $\pm$ 0.10b					
Nematode EPG levels															
0 - 50	4172	1.52 $\pm$ 0.03a	3581	1.67 $\pm$ 0.04a	4280	1.53 $\pm$ 0.04a	2832	1.65 $\pm$ 0.02a	3894	1.61 $\pm$ 0.07a					
50 +	777	1.39 $\pm$ 0.04b	416	1.21 $\pm$ 0.06b	411	1.27 $\pm$ 0.06b	1319	1.33 $\pm$ 0.03b	244	1.23 $\pm$ 0.09b					
Trematode EPG levels															
0 - 50	4064	1.37 $\pm$ 0.03b	3781	1.34 $\pm$ 0.03b	4433	1.32 $\pm$ 0.04b	2555	1.41 $\pm$ 0.02b	4051	1.42 $\pm$ 0.05a					
50 +	885	1.54 $\pm$ 0.04a	216	1.55 $\pm$ 0.08a	258	1.49 $\pm$ 0.07a	1596	1.57 $\pm$ 0.03a	87	1.41 $\pm$ 0.12a					

Within variable groups means followed with the same letter are not significantly ($P > 0.05$) different.

Within variable groups means followed with the same letter are not significantly ($P > 0.05$) different.

Table 2. Least-squares means ($\pm$ SE) for liveweight of all male sheep.

	Debre Berhan		Dejen		Tulu Meko	
	No	Mean ($\pm$ SE)	No	Mean ($\pm$ SE)	No	Mean ($\pm$ SE)
Overall mean	904	22.2 $\pm$ 1.7	521	26.0 $\pm$ 2.3	219	26.8 $\pm$ 1.6
Packed cell volume						
$\geq$ 28	887	27.2 $\pm$ 0.5a	506	36.1 $\pm$ 1.6a	171	29.8 $\pm$ 0.8a
$\leq$ 27	17	21.2 $\pm$ 1.9b	15	30.5 $\pm$ 3.3a	48	31.8 $\pm$ 1.3a
Nematode EPG levels						
0 - 50	800	22.5 $\pm$ 1.0b	489	32.3 $\pm$ 2.0a	104	30.8 $\pm$ 1.0a
50 +	104	26.0 $\pm$ 1.2a	32	34.3 $\pm$ 2.6a	115	30.8 $\pm$ 1.0a
Trematode EPG levels						
0 - 50	776	19.3 $\pm$ 1.1b	497	23.3 $\pm$ 1.6b	166	24.1 $\pm$ 0.8b
50 +	128	29.1 $\pm$ 1.1a	24	43.3 $\pm$ 2.9a	53	37.4 $\pm$ 1.2a

Within variable groups means followed with the same letter are not significantly ($P > 0.05$) different.

Within variable groups means followed with the same letter are not significantly ($P > 0.05$) different.

Wereilu, respectively, and were significantly ($P < 0.05$) affected by PCV, nematode and trematode EPG levels. Liveweights had mean squares of 22.2 ± 1.7 , 26.0 ± 2.3 and 26.8 ± 1.6 kg at Debre Berhan, Dejen and Tulu Meko, respectively, with the subclass means showing significant ($P < 0.05$) differences due to PCV and nematode EPG levels at Debre Berhan and trematode EPG levels in all. The least-squares means for lambing interval was 263.2 ± 4.0 days at Tulu Meko with no significant ($P > 0.05$) effect by the different variables.

The repeatability values for PCV, bodyweight, body-condition score, lambing interval, nematode EPG and trematode EPG were 0.44 ± 0.01 , 0.71 ± 0.01 , 0.35 ± 0.01 , 0.43 ± 0.14 , 0.09 ± 0.01 and 0.20 ± 0.02 , respectively (Table 4). Correlation coefficients between bodyweight and body-condition score were low ($r = 0.3\text{--}0.5$, $P < 0.01$) for different sites.

Table 3. *Least-squares means ($\pm$ SE) for lambing interval at Tulu Meko.*

Variable	No	Mean ($\pm$ SE)
Overall mean	97	263.2 ± 4.0
Packed cell volume		
≥ 28	74	$262.5 \pm 7.7a$
≤ 27	23	$259.9 \pm 15.5a$
Nematode EPG levels		
0 – 50	37	$253.1 \pm 15.5a$
50 +	60	$266.3 \pm 9.4a$
Trematode EPG levels		
0 – 50	39	$257.3 \pm 12.8a$
50 +	58	$262.1 \pm 9.3a$

Table 4. *The repeatability ($\pm$ SE) of eggs-per-gram (EPG) counts, packed cell volume (PCV), bodyweight, body-condition score and lambing interval for all sites.*

Parameter	Number of observations	Repeatability
Nematode EPG (log value)	5 750	0.09 0.01
Trematode EPG (log value)	4 331	0.20 0.02
Packed cell volume (PCV)	22 464	0.44 0.01
Bodyweight	22 669	0.71 0.01
Body-condition score	22 671	0.35 0.01
Lambing interval	475	0.43 0.14

Discussion

Monthly nematode EPG counts were low with very little variation with rainfall for most sites except at Tulu Meko compared to previous findings (Tekelye Bekele et al, 1987). This agreed with the low to moderate worm counts (Skerman and Hillard, 1966) of necropsied sheep at Debre Berhan and Tulu Meko. The EPG of the necropsied sheep was also low. The moderately high nematode EPG counts at Tulu Meko was associated with the high intensity of worm load. The commonest species found during worm counting, *T. colubriformis*, has low prolificacy and pathogenicity (Holmes, 1985). Highly prolific worms like *H. contortus* had low counts specially at Debre Berhan although they were available in necropsied sheep and faecal cultures. This may be due to genetic factors where *H. contortus* was not established and/or was removed after infection due to self cure (Preston and Allonby, 1979; Kasali et al, 1988) and/or other environmental factors.

Trematode EPG counts were highest in 1989 than in 1988 in all sites which probably happened due to the heavy rainfall in 1988, which also increased the transmission of fascioliasis by increasing the abundance of the intermediate host, the snail, *Lymnae truncatula* (Goll and Scott, 1978). Fascioliasis, especially when complicated by *Clostridium novyi* infection, is the major cause of ovine mortality in the Ethiopian highlands (Njau et al, 1988). The presence of *D. filaria* in most necropsied sheep agreed with previous findings (Bekele Mamo et al, 1981). Its high frequency is suggestive of its importance since it is commonly complicated by pasteurellosis, inclement weather and inadequate nutrition.

The overall mean and subclass mean PCV were lowest at Tulu Meko which could be due to high intensity of endoparasitism as observed in the EPG and worm counts. This could also be due to differences in breed parasite tolerance and/or management. PCV variation with age, year and EPG load effects was common to most sites. PCV variation with age could be physiological, while year effect could be due to differences in the rainfall leading to differences in the degree of endoparasitism. The effect of season was variable depending on the degree of endoparasites and level of nutrition.

Repeated measurements of endoparasites indicated high frequencies of sheep with subnormal PCV, and high nematode and trematode EPG levels at Tulu Meko. This further confirmed the high intensity of endoparasitism in this site. Productivity traits like body-condition scores and bodyweights were directly correlated with the level of PCV, being low when PCV were low and high when PCV were high. High nematode EPG lowered body-condition scores and bodyweights. But high trematode EPG resulted in high body-condition scores and high bodyweights which could be due to repeated exposures to fascioliasis while at the same time growing and increasing in body mass. Endoparasitism did not have any effect on lambing interval which may be due to its periodic occurrence and/or it may not influence this parameter.

Monthly repeatability estimates for nematode and trematode EPG were low showing that egg output was variable being affected by different factors like age of the host, species and age of parasite, nutritional status of the host, season, physiological factors like pregnancy and degree of repeated infections. But although PCV could also be affected by multiple factors, its monthly within-animal variation was moderately high and hence it should be used in conjunction with EPG for monitoring the level of endoparasites. Although there are reports of high correlation between bodyweight and body-condition scores (Hossamo et al, 1986), this was not the case in this study. The repeatability of body-condition score was low which could be probably due to the effect of either within-animal and/or between-scorer variation. The repeatability estimates for lambing interval across parities is higher than the range reported (Wilson et al, 1989).

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Lamb and kid wastage through slaughtering of pregnant ewes and goats at Enugu and Nsukka abattoirs in Anambra State, Nigeria

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Abstract

A study was made of abattoir records in Enugu and Nsukka over a five-year period (1985–1989). A total of 266 060 goats and 91 289 sheep were slaughtered at Enugu and 27 185 goats and 6669 sheep in Nsukka. 50.11% of these goats and 62.03% of these sheep were females; of these females, respectively, 11.00% and 11.40% were pregnant. Avoidable pregnancy wastage (12–20 weeks old) was 31.04% and 33.90%, respectively, for each species. The study calls for attention to the magnitude of slaughter of pregnant females and the percentage of pregnancy wastage at a time of increasing shortage of meat supply to the population. It is suggested that pregnancy diagnosis be done at abattoirs prior to slaughter of small ruminant females, and that farmers be trained on simple methods of pregnancy detection.

Pertes de foetus enregistrées aux abattoirs d'Enugu et Nsukka au Nigéria par suite de l'abattage de brebis et de chèvres gestantes

L.O. Wosu et E.C. Dibua

Résumé

Les données rassemblées aux abattoirs d'Enugu et de Nsukka de 1985 à 1989, ont été analysées. Au cours de cette période, 266 060 caprins et 91 289 ovins à Enugu contre 27 185 caprins et 6 669 ovins à Nsukka, soit un total de 391 203 petits ruminants ont été abattus dans ces deux abattoirs. 11,00% et 11,40% étaient gestantes. Les pertes de foetus par suite de l'abattage des femelles en gestation

peuvent être évitées chez les petits ruminants dès lors que le fœtus atteint l'âge de 12 à 20 semaines dans la mesure où il devient alors décelable et palpable. Celles-ci concernaient 31,04% et 33,90% des femelles gestantes abattues. Cette étude attire l'attention sur les problèmes liés à l'abattage des femelles des ruminants et notamment sur les pertes de fœtus au moment même où les pénuries de viande ne cessent de s'aggraver. Il est recommandé de détecter les femelles gestantes aux abattoirs et de former les éleveurs à des techniques simples de diagnostic de gestation.

La mortalité des jeunes dans les élevages extensifs traditionnels de la zone sud-soudanienne du Sénégal (site de Kolda)

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Résumé

A l'issue de trois années d'observation et de prophylaxie à l'aide de vaccins contre la peste des petits ruminants et la pasteurellose chez les caprins et contre la pasteurellose chez les ovins, et à l'aide du tartrate de morantel chez les deux espèces, l'on a fait les constats suivants.

- les 0–3 mois sont la classe d'âge la plus vulnérable;*
- ils sont affectés en priorité par le syndrome "chétivité";*
- ils ont une hiérarchie des syndromes mortels relativement stable d'une stratégie prophylactique à l'autre;*
- ceci quelle que soit l'espèce.*

Ces constats laissent croire que la mortalité des jeunes de 0 à 3 mois répond à un déterminisme autre que celui contrôlé par les prophylaxies testées.

Mortality rate in 0–3 month old animals in extensive traditional livestock production systems of the southern Sudanian zone of Senegal

M. Ndiaye

Abstract

This paper reports observations over three years on flocks that received the following prophylaxis: vaccination against peste des petits ruminants and pasteurellosis in goats, vaccination against pasteurellosis in sheep, and treatment with Morantel tartrate in both species.

Mortality was greatest in the 0–3 month age class, which was primarily affected by unthriftiness. The ranking of the main causes of death were similar for all treatment groups and both species.

These observations indicate that mortality among 0–3 month old animals was caused by factors other than the diseases against which prophylaxis had been given.

The author proposes an aetiology for deaths due to unthriftiness, based on the characteristics of the farming system, biopathological data obtained from the literature and the clinical symptoms of unthriftiness.

Introduction

Les enregistrements épidémiologiques obtenus par le programme Pathologie et productivité des petits ruminants en milieu traditionnel (PPR) de 1985 à 1987 permettent de décrire l'importance absolue et relative de la mortalité des petits ruminants dans la région de Kolda. Ce qui nous donne l'occasion de poser un regard critique sur le paramètre constitué par les taux de mortalité très usités en épidémiologie.

Les résultats rapportés ici ont été obtenus dans l'une des zones d'intervention du PPR, la région de Kolda, au sud du fleuve Casamance. Les précipitations y sont plus abondantes (950 mm par an), plus régulières et réparties sur une plus longue période que dans le reste du Sénégal.

Les petits ruminants exploités dans cette zone, sont des animaux de petite taille: ovins Djallonké et chèvres guinéennes.

L'on serait tenté, devant l'importance de la mortalité chez les ovins et les caprins de moins de 3 mois, de mettre en route des prophylaxies plus complètes ou tout au moins de rechercher les étiologies précises de la mortalité ainsi notée. Cependant, il nous paraît prudent avant pareille décision de procéder à l'évaluation de l'effet des prophylaxies sur la mortalité.

Matériel et méthode

Pour chaque espèce, les troupeaux de cinq villages ont constitué le lot témoin, ceux de cinq villages ont été vermifugés par le tartrate de pyrimidine (lot vermifugé), ceux de cinq autres villages vaccinés contre la pasteurellose à *P. multocida* types 1 et D et contre la peste des petits ruminants (lot vacciné), et ceux de cinq autres villages vaccinés et vermifugés.

Le taux brut de mortalité est défini comme le nombre total de décès enregistrés au sein d'une population, divisé par le nombre d'individus dans cette population, mesure au cours de la période considérée (Putt *et al.*, 1987). Il donne au pathologiste un paramètre chiffré à l'échelle de la population pour apprécier la gravité du phénomène mortalité. Par analogie à un taux de positivité à un test de diagnostic, il se calcule par rapport à une population exposée.

Lors d'études épidémiologiques ponctuelles sur de courtes périodes n'autorisant pas une refonte profonde de l'effectif présent en début d'observation, l'usage du taux se révèle très commode, surtout lorsque l'étude porte sur une population dont les individus ne sont pas identifiés ou lorsque l'on veut évaluer à postériori l'impact d'un épisode mortel.

La population ciblée est cependant sujette à des changements de taille et d'individus, fonctions du contexte de gestion démographique et des facteurs de productivité numérique propres à la population. Ces deux derniers éléments ont une influence d'autant plus marquée que la période d'observation est longue.

Lors d'études de longue durée portant sur la mortalité d'une enzootie ou lorsque l'on veut évaluer l'impact sur la démographie ou sur les productivités numériques d'une enzootie, le taux n'est plus approprié car il est influencé par la dynamique démographique de la population. La méthode des quotients de mortalité sur des cohortes d'animaux se révèle alors plus performante. Le suivi individuel du programme PPR permet de connaître précisément la composition des cohortes.

Le taux de mortalité annuel est calculé comme le rapport M , nombre de sujets morts dans une population donnée pendant une période de n mois, et P la somme des nombres de sujets recensés dans cette population à chaque passage mensuel durant ces mêmes mois, multiplié par 12. La mortalité relative peut ensuite être établie par classe d'âge ou en fonction des causes de mortalité.

Le taux de mortalité est donc simplement une donnée énumérative (le nombre de morts) rapportée à une autre donnée énumérative qu'est l'effectif moyen de la population, et peut à ce titre être considéré comme une mesure caractéristique de la population et être statistiquement traité comme telle.

L'effet des prophylaxies sur la mortalité sera étudié en comparant les différentes mortalités annuelles des quatre lots par une analyse de variance sur le taux de mortalité (assimilé à une mesure). C'est à partir de ces valeurs que nous évaluons l'effet de la vaccination et de la vermifugation.

L'ensemble des causes de mort considérées dans cette analyse et relevées par le suivi sanitaire du PPR s'établit comme suit:

- trouble de croissance ou chétivité (TRC): mort d'un jeune faible sans signe clinique;
- pneumopathie (PNE): jetage, toux, dyspnée non associés à une diarrhée;
- diarrhée (DIA): non associée à des troubles respiratoires;
- peste (PES): association de pneumopathie et de diarrhée sans précision sur la contagiosité, sans confirmation virologique. C'est le syndrome et non la maladie;
- maladies cutanées (CUT): tout ectoparasitisme;
- autres (AUT): symptômes avérés ne se rapprochant pas des rubriques précédentes (boiterie, conjonctivite, etc.).

La rubrique divers (DIV) regroupe les causes de morts inconnues, non identifiées et celles dont la venue nous paraît être liée à des facteurs extrinsèques occasionnels.

Pour étudier l'effet des prophylaxies sur l'ordre d'importance des causes de mort, on comparera un à un les rangs de chaque cause de mort dans les deux groupes de lots respectivement pour la vaccination puis la vermifugation dans chaque espèce sans tenir compte du sexe. Pour ce faire, nous appliquerons la formule de Spearman entre les groupes vermifugés et non vermifugés, puis entre les vaccinés et les non vaccinés, pour avoir un élément d'appréciation: le coefficient de corrélation d'ordre (Murray, 1975):

$$r_{\text{rang}} = 1 - \frac{d^2}{n(n^2 - 1)}$$

ou d = différences entre les rangs des x et y correspondants

n = nombre de paires de valeurs (x , y) dans les données.

Résultats et discussion

Mortalité

Chez les ovins et les caprins, en taux de mortalité par sous-classe d'âge, la sous-classe d'âge la plus affectée et quel que soit le lot prophylactique, reste la sous-classe 0-3 mois, sauf chez les caprins vaccinés où les 4-6 mois sont légèrement plus affectés (tableaux 1 et 2).

Tableau 1. *Taux annuel de mortalité des ovins par classe d'âge en pourcentage (Kolda, 1985-1987), et mortalité relative par classe d'âge*

Lot	Classe d'âge (en mois)	Nombre de morts de 1985 à 1987	Cumul des présents/mois	Taux de mortalité
Témoin	0 - 3	37 (49%)	904	49
	4 - 6	23 (31%)	806	34
	7 - 9	11 (15%)	662	20
	10 - 12	4 (5%)	553	9
Vacciné	0 - 3	73 (47%)	1 275	69
	4 - 6	41 (26%)	1 115	44
	7 - 9	22 (14%)	971	27
	10 - 12	20 (13%)	780	31
Vermifugé	0 - 3	59 (55%)	1 736	41
	4 - 6	28 (26%)	1 505	22
	7 - 9	12 (11%)	1 254	11
	10 - 12	9 (8%)	870	12
Vacciné	0 - 3	30 (43%)	1 495	24
et	4 - 6	19 (27%)	1 301	18
vermifugé	7 - 9	15 (21,1%)	1 109	16
	10 - 12	7 (10%)	875	10

En mortalité relative par sous-classe d'âge, ce constat se trouve conforté par le fait que plus de 40% des morts de 0 à 12 mois intéressent les moins de 3 mois et ceci dans chaque lot chez les espèces étudiées. Nous notons enfin que les troubles de croissance viennent en tête des causes de mort quel que soit le lot prophylactique (tableau 3).

La vaccination n'induit pas chez les béliers de différence significative, alors que la vermifugation engendre une baisse significative de la mortalité ($P < 0,05$). Aucune différence n'est induite chez les brebis, les chèvres et les boucs, par aucun traitement (tableaux 4, 5, 6, 7).

Tableau 2. Taux annuel de mortalité des caprins par classe d'âge en pourcentage, et mortalité relative par classe d'âge (Kolda 1985-1987)

Lot	Sous-classe d'âge (en mois)	Nombre de morts de 1985 à 1987	Cumul des présents/mois	Taux de mortalité
Témoin	0 - 3	52 (44%)	1 154	54
	4 - 6	36 (31%)	1 018	42
	7 - 9	20 (17%)	720	33
	10 - 12	9 (5%)	556	19
Vacciné	0 - 3	69 (43%)	1 609	51
	4 - 6	60 (37%)	1 352	53
	7 - 9	24 (15%)	974	30
	10 - 12	9 (5%)	574	19
Vermifugé	0 - 3	84 (55%)	1 777	57
	4 - 6	42 (27%)	1 463	34
	7 - 9	17 (11%)	993	21
	10 - 12	10 (7%)	659	18
Vacciné	0 - 3	56 (75%)	1 476	46
et	4 - 6	12 (16%)	1 252	12
vermifugé	7 - 9	2 (3%)	970	2
	10 - 12	5 (6%)	654	9

Tableau 3. Mortalité relative par cause chez les caprins (C) et les ovins (O) de moins de 3 mois (en pourcentage), Kolda 1985– 1987

Cause de mort(1)	Témoins		Vacciné		Vermifugé		Vacciné et Vermifugé	
	O	C	O	C	O	C	O	C
DIV	38	32	26	31	42	36	37	39
TRC	40	56	37	31	52	43	37	54
PES	0	0	0	1	0	13	0	0
PNE	3	4	11	10	0	1	10	2
DIA	14	2	22	26	0	6	13	0
AUT	0	4	1	1	3	0	0	5
CUT	5	2	3	0	3	1	3	0
TOTAL	100	100	100	100	100	100	100	100

(1) Voir texte pour la signification des symboles

Tableau 4. Effet de la vaccination chez les ovins.

Cause	Groupe vacciné		Groupe non vacciné		Différence de rang
	Nombre de morts	Rang	Nombre de morts	Rang	
DIV	30	2	39	2	0
TRC	38	1	46	1	0
PES	0	7	0	7	0
PNE	11	4	1	6	2
DIA	20	3	5	3	0
AUT	1	6	2	5	1
CUT	3	5	4	4	1

$r = 0,99$

Tableau 5. Effet de la vermifugation chez les ovins.

Cause	Groupe vermifugé		Groupe non vermifugé		Différence de rang
	Nombre de morts	Rang	Nombre de morts	Rang	
DIV	36	2	33	2	0
TRC	42	1	42	1	0
PES	0	7	0	7	0
PNE	3	4,5	9	4	0,5
DIA	4	3	21	3	0
AUT	2	6	1	6	0
CUT	3	4,5	4	5	0,5

$r = 0,99$

Tableau 6. Effet de la vaccination chez les caprins

Cause	Groupe vacciné		Groupe non vacciné		Différence de rang
	Nombre de morts	Rang	Nombre de morts	Rang	
DIV	44	2	47	2	0
TRC	52	1	65	1	0
PES	1	6	11	3	3
PNE	8	4	3	5	1
DIA	16	3	6	4	1
AUT	4	5	2	6,7	1,5
CUT	0	7	2	6,7	0,5

$r = 0,95$

Tableau 7. Effet de la vermifugation chez les caprins

Cause	Groupe vermifugé		Groupe non vermifugé		Différence de rang
	Nombre de morts	Rang	Nombre de morts	Rang	
DIV	52	2	39	2	0
TRC	66	1	51	1	0
PES	11	3	1	6	3
PNE	2	6	9	4	2
DIA	5	4	17	3	1
AUT	3	5	3	5	0
CUT	1	7	1	6	1

$r = 0,95$

Analyse des causes de la mortalité

Les coefficients de corrélation d'ordre déterminés ci-dessus sont tous positifs et proches de 1. L'on en déduit que les rangs de chaque cause de mort sont très semblables à travers les groupes comparés dans chaque espèce, ce qui permet de conclure à un manque d'effet des diverses prophylaxies mises en œuvre sur la hiérarchie des causes de mort.

Conclusion

Le PPR a mis à l'essai dès son démarrage différents scénarios prophylactiques pour éprouver en milieu réel l'efficacité des vaccinations antipestiques et antipasteurelliques et des vermifugations. Ces actions prophylactiques ont l'avantage d'être de vrais programmes minimaux d'intervention vétérinaire en élevage traditionnel extensifs qui ciblent des agents pathogènes réputés très limitant pour la productivité globale des troupeaux. Elles ont aussi l'avantage, du fait de leurs effets relativement spécifiques, de constituer pour l'épidémiologiste ce qu'un diagnostic thérapeutique représente pour un clinicien. L'étude du PPR rapporte les mortalités à des causes qui recouvrent la forme de syndrome et non d'agents ou de facteur causal, démarche conforme à la pratique de l'épidémiologie clinique.

En résumé, la mortalité chez les 0–3 mois est abaissée par le déparasitage significativement chez les ovins mâles seuls.

Par contre, les vaccinations sont sans effet sur les taux de mortalité globale aussi bien chez les ovins que chez les caprins de moins de 3 mois. Ce qui peut s'expliquer par la protection immunitaire passive (non spécifique) dont ces jeunes bénéficient dans tous les cas.

Ces résultats sont conformes à ceux du PPR obtenus par la méthode des quotients sur des cohortes d'animaux de même classe d'âge (PPR, 1988).

Enfin, il importe de retenir que la hiérarchie des causes de mort dans la sous-classe d'âge des 0–3 mois est relativement stable à travers les groupes de lots prophylactiques.

Ces constatations portent à croire que la mortalité des jeunes de 0 à 3 mois d'âge constitue une entité épidémiologique répondant à un déterminisme faisant intervenir en sus des facteurs et des agents parasitaires ou infectieux autres que ceux ciblés par les essais prophylactiques.

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Annexe 1. Taux de mortalité annuel de 0 à 3 mois

		Lot			
	Année	Témoin	Vermifugé	Vacciné	Vermifugé et vacciné
Ovins	1985	61	56	49	5
mâles	1986	56	45	69	37
	1987	52	35	58	23
Ovins	1985	53	31	43	30
fémmelles	1986	16	36	54	15
	1987	53	40	157	29
Caprins	1985	76	66	73	53
mâles	1986	54	85	24	25
	1987	48	27	71	36
Caprins	1985	35	56	45	76
fémmelles	1986	53	70	32	28
	1987	48	23	79	60

Optimal time for vaccination against peste des petits ruminants (PPR) disease in goats in the humid tropical zone in southern Nigeria

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Abstract

Investigation of the incidence of peste des petits ruminants (PPR) disease in goats revealed seasonality in its natural occurrence in the environment. Tissue culture rinderpest vaccine was effective in protecting goats against the disease. The optimal time for vaccinating goats against PPR was when the least number of animals were incubating the disease. In the tropical humid zone of West Africa this would be in late November.

Moment optimum de vaccination des caprins contre la peste des petits ruminants (PPR) dans la zone tropicale humide du sud du Nigéria

L.O. Wosu, J.E. Okiri et P.A. Enwezor

Résumé

Il est montré que l'incidence de la peste des petits ruminants (PPR) chez les caprins dans la zone tropicale humide du Nigéria a un caractère saisonnier. Le vaccin sur culture tissulaire contre la peste bovine s'est avéré apte à les protéger efficacement contre cette maladie. Cette étude montre que le meilleur moment pour vacciner les chèvres contre la PPR correspond à la période d'incidence minimum, au cours de laquelle le nombre d'animaux couvant la maladie est particulièrement réduit, soit de fin novembre à la mi-décembre dans la zone tropicale humide d'Afrique occidentale.

Introduction

Peste des petits ruminants (PPR) disease is an acute or subacute viral disease of goats and sheep characterised by fever, stomatitis, gastro-enteritis and pneumonia. It is an endemic disease in West Africa especially in the humid zone. The disease is caused by a paramyxovirus, close to the rinderpest virus.

PPR disease is of great economic importance. It was described as the most destructive viral disease against small ruminant flocks (Bourdin, 1983) and as number one constraint to intensive small ruminant farming. Mortality in susceptible flocks varies from 10% to 100% and morbidity from 50% to 100%.

Tissue culture rinderpest vaccine (TCRV) is widely used in West Africa in the control of PPR disease. However, to date, there are conflicting reports both documented and mostly undocumented by field veterinarians as to the effectiveness of TCRV in controlling this disease.

This study was therefore carried out in the tropical humid zone in southern Nigeria to determine whether this disease shows clear seasonality of occurrence and whether this accounts for the conflicting reports on the effectiveness of TCRV in controlling PPR.

Materials and Methods

Locality

Nsukka is a small university town in a rural agricultural environment. It is located in the tropical humid zone in southern Nigeria. It lies approximately on latitude 06°52'N and longitude 07°24'E.

Climatic data

Rainfall and mean daily temperature data on monthly basis over a five-year period (1982–1986) in Nsukka environs were obtained from the university farm meteorological unit where the records were maintained on daily basis.

Prevalence of PPR

Two veterinary clinics in the town, the University veterinary teaching hospital and the town veterinary clinic were patronised by small ruminant owners from Nsukka and the surrounding villages within 15–20 km radius of the town. From daily treatment records in both clinics over the period of study, data were collected on monthly basis of the first-time reports of cases characteristic of PPR. Cases of pneumonia only or parasitic gastro-enteritis shown in the records were excluded from the data. Data from the two clinics were pooled on monthly basis

Source of Tissue Culture Rinderpest Vaccine (TCRV)

The TCRV was obtained from the National Veterinary Research Institute (NVRI), Oji River depot.

Method of vaccination with TCRV in each location

One-hundred dose vial of freeze-dried TCRV was reconstituted in 100 ml of sterile refrigerated normal saline. 1 ml of the reconstituted vaccine was injected into a goat subcutaneously in the neck region, with a sterile needle. Animals less than three months old were excluded from the experiment.

With the co-operation of the owners, the number of goats in each household was split into two equal groups taking into consideration age, sex and body condition. One group was vaccinated and the other was not (control). Only clinically healthy goats with no history of previous vaccination were used in the project. The ages ranged from six months to four years. Animals were individually identified.

Goats were vaccinated either at the end of November or end of January.

a) Vaccination in November

On 24th November 1988, 100 goats were vaccinated and 101 goats left as controls in various households as described above at Obukpa on the outskirts of Nsukka town. Twenty households were involved.

On 28th November 1988, 100 goats were vaccinated and 103 goats left as controls in various households as described above at Afikpo about 120 km south of Nsukka. Thirty households were involved.

b) Vaccination in January

On 25th January 1989, 200 goats from 45 households in Nkpirimkpi, a village in another part of the Nsukka outskirts, were vaccinated and 200 goats left as control.

All the locations were in the tropical humid zone in southern Nigeria.

Observation period

All animals in the project at the various locations were monitored for 12 weeks post-vaccination both by regular weekly visits and with the aid of the local veterinarian for evidence of PPR or any other illness in any of the experimental animals.

Table 1. PPR incidence and climatic data, Nsukka environs, Nigeria.

		1982	1983	1984	1985	1986	Cum monthly PPR* Av monthly RF Av monthly RH T
January	PPR	10	11	9	10	11	51
	RF	17.3	Nil	Nil	6.9	8.9	6.6
	RH	61	20	52	71	59	53
	T	27	24	24.5	24.5	26.5	26.0
February	PPR	11	14	12	13	12	61
	RF	55.7	Nil	Nil	Nil	Nil	11.1
	RH	59	54	64	68	74	63.6
	T	27.5	26.5	26.5	24.5	28	27
March	PPR	15	15	13	16	15	72
	RF	56.4	Nil	47.8	153.9	83.0	68.3
	RH	69	51.7	69	70	73	16.5
	T	27	26.5	26	25.5	27	26
April	PPR	19	16	17	15	16	83
	RF	113.4	46.7	138.1	120.3	179.8	120
	RH	76	68	83	74	76	75.4
	T	27	28	25	24.5	27.5	26
May	PPR	10	24	21	20	12	87
	RF	217.2	114.4	129.3	264.5	172.1	180
	RH	81	78	87	77	72	80
	T	25.5	25	24	23.5	26	25
June	PPR	13	15	13	12	11	64
	RF	255.4	198.5	232.8	139.2	195.1	204
	RH	86	86	88	83	82	84.8
	T	23.5	23.5	23	22.5	25	24
July	PPR	5	7	6	4	6	28
	RF	312.9	158.7	379.1	276.2	217.5	269
	RH	90	89	85	90	87	88.2
	T	23	23	22.5	21.5	24	23
August	PPR	Nil	3	2	3	5	13
	RF	108.9	102.4	294.4	191.1	141.9	178
	RH	90	92	88	87	86	88.6
	T	22.5	22	22	24.5	23.5	23

Table 1 (continued)

		1982	1983	1984	1985	1986	Cum monthly PPR* Av monthly RF Av monthly RH Av daily T
Sept.	PPR	2	Nil	3	5	Nil	10
	RF	228.5	241.2	253.6	234.3	248.4	241
	RH	83	87	90	84	13	86.4
	T	23	23	22	14.5	24.5	23
October	PPR	2	2	Nil	3	4	11
	RF	302.1	55.8	126.2	192.9	116.0	159
	RH	85	79	89	77	80	82
	T	23.5	2.3	23	25.5	25	14
November	PPR	7	6	11	5	7	36
	RF	19.0	33.1	14.4	17.3	19.3	23
	RH	64	75	82	76	74	74.2
	T	25	24.5	23	25.5	24.5	25
December	PPR	6	7	3	6	4	26
	RF	Nil	11.2	Nil	Nil	Nil	2.3
	RH	66	67	48	48	41	54
	T	25	24.5	23	25.5	24.5	25

* PPR = Peste des petits ruminants; RF = Rainfall (mm); T = Temperature (C); RH = Relative humidity (%).

Results

Table 1 shows the monthly occurrence of PPR, rainfall, mean daily relative humidity and temperature for each year of the five-year period of the study undertaken in Nsukka environs. The cumulative monthly PPR incidence and rainfall over the period are shown in Figure 1.

Table 1 and Figure 1 show that PPR occurs throughout the year. PPR incidence starts to build up from end of December and rises rapidly during harmattan season to a peak in the early rainy season in April. There was a sharp fall in the incidence over the latter part of the rainy season (May to September) in each year of study.

Daily records showed no reports of new PPR cases within 40 hours of rainfall.

The effects of vaccinating goats with TCRV against PPR are shown in Table 2 for the November vaccinations and Table 3 for the January vaccination.

Figure 1. 1982–1986 mean monthly rainfall and PPR incidence rate in Nsukka, N

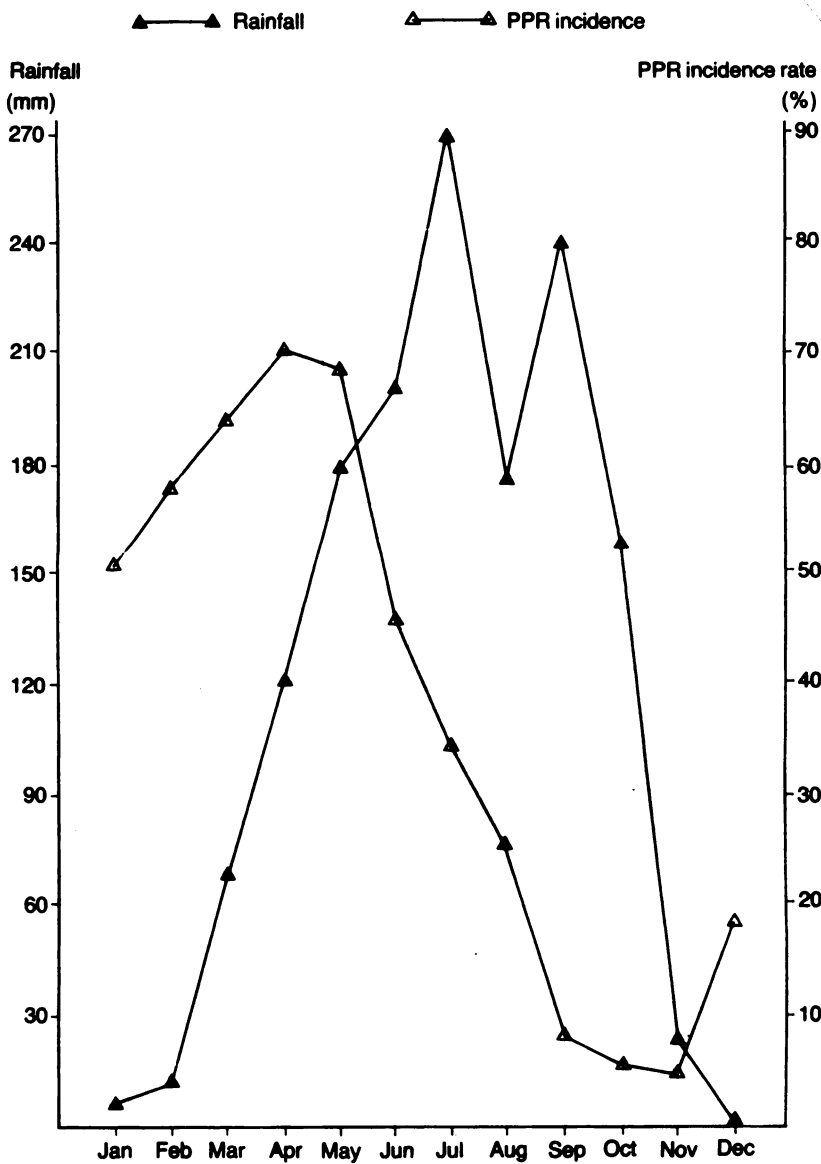


Table 2. *Effect of November vaccination.*

Location	Obukpa		Afikpo	
	Vaccinated N = 100	Non-vaccinated N = 101	Vaccinated N = 100	Non-vaccinated N = 103
No of PPR cases	0	9	0	8

Table 3. *Effect of January vaccination at Nkpirimki location.*

	Vaccinated N = 200	Non-vaccinated N = 200
Total PPR cases	16	83
Mortality from PPR	3	22

Discussion

Though PPR seems to occur throughout the year, there is a definite indication of seasonality in its natural occurrence in the Nduka environs (Figure 1). The incidences were higher during the dry harmattan season than during the rainy season. It appears that the inclement dry, cold and dusty harmattan weather (December–February) and the poor nutrition by this time combine to spread PPR. The incidence seems to rise rapidly from December to a peak in April. Obi (1983a) and Durojaiye (1983) in western Nigeria also associated most outbreaks with this season of the year. In Oyo State (western Nigeria), Opasina (1983) observed two out of four outbreaks in the early dry season and an other two in the last third of the dry season (January). These observations were in a climatic zone similar to that in Nsukka. Bourdin (1983) on the other hand stated that in the Sahelian climate of Senegal, outbreaks of PPR occur mostly during the rainy season. Reported occurrence of new outbreaks within 48 hours of rainfall as in Ondo State in Nigeria (Ojo, 1983) could not be confirmed in this study. January to April appeared to be the period of greatest risk of small ruminants to PPR each year (Table 1). This raises the question of how long a naturally acquired immunity after a field outbreak lasts. The 3–5 year cycle of occurrence reported by Obi (1983) was not observed in this study.

There have been conflicting reports on the effectiveness of Tissue Culture Rinderpest Vaccine (TCRV) to control PPR in goats and sheep. Effective vaccination against PPR is a major advance in the control of the disease. According to Gibbs et al (1977) TCRV confers complete immunity to goats without transferring the disease to other animals. Adu and Nawathe (1981) reported that even pregnant animals tolerated TCRV well. On the contrary, Abegunde (1983) suggested that if animals are not screened for sub-clinical infection prior to vaccination, they may come down with the disease and that

abortions may occur in pregnant animals. There are more undocumented similar conflicting reports by field veterinarians.

The results of various times of vaccination with TCRV to protect the goats against PPR in this study seem to confirm the observations made by Abegunde (1983). When the goats were vaccinated with TCRV in November, a period of sub-clinical infection, none of them came down with PPR infection while about 8.5% of the control came down with PPR. However, when the vaccination was done in January, a period of peak infection, about 8% of PPR cases including 1.5% mortality were recorded among the vaccinated animals. About 41.5% of PPR cases including about 11.0% mortality were recorded among the control.

Conclusion

Our work thus confirms that TCRV is very effective in protecting goats against the PPR disease, but that this efficacy only holds if the vaccination is done when the animals are at a subclinical level of infection (Abegunde, 1983). In the Nsukka environment in Nigeria, the end of November seems to be the right period for TCRV vaccination.

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Prophylaxie chez les petits ruminants au Sénégal: régionalisation d'une politique nationale de protection sanitaire

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Résumé

Les pneumopathies et les strongyloses gastro-intestinales sont les dominantes pathologiques des petits ruminants au Sénégal. Cette communication présente les résultats d'une évaluation technico-économique des actions de prophylaxie anti-infectieuse et antiparasitaire qui peuvent être proposées aux éleveurs de petits ruminants au Sénégal.

L'évaluation biologique a été réalisée sur 6 500 ovins et caprins en milieu paysan dans le cadre du programme ISRA-IEMVT "productivité et pathologie des petits ruminants". L'évaluation économique a utilisé le progiciel de simulation LIVMOD.

Prophylactic measures for small ruminants in Senegal: Regionalisation of a national health protection policy

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Abstract

The main small ruminant diseases in Senegal are lung diseases and gastro-intestinal strongyle infections.

This paper presents the results of the technical and economic assessment of a series of parasitic and infectious disease-control measures intended for small ruminant owners in Senegal.

The biological performances of 6500 sheep and goats have been evaluated on-farm. This assessment is part of the ISRA-IEMVT "Diseases and productivity in small ruminants" programme. The LIVMOD Software was used for the economic calculations.

Introduction

Les dominantes pathologiques des petits ruminants au Sénégal sont les pneumopathies et les strongyloses gastro-intestinales. Cette communication présente les résultats d'une évaluation technico-économique des actions de prophylaxie anti-infectieuse et antiparasitaire qui peuvent être proposées aux éleveurs de petits ruminants du Sénégal.

Cette évaluation a été réalisée dans le cadre du programme "Pathologie et productivité des petits ruminants" de l'ISRA (Institut sénégalais de recherches agricoles) et de l'IEMVT (Institut d'élevage et de médecine vétérinaire des pays tropicaux).

Dispositif expérimental

Zone d'étude

L'étude a été menée dans trois sites correspondant à des zones écologiques et des systèmes d'élevage différents:

- le site de Ndiagne, dans la partie nord du pays, avec 3 500 petits ruminants en expérimentation. Ce site sahélien reçoit de 250 à 400 mm de précipitations et est peuplé de paysans Wolof essentiellement cultivateurs, entretenant un petit troupeau d'une quinzaine d'ovins de type Peul-Peul, et de paysans peuls essentiellement éleveurs et possédant des troupeaux d'une trentaine d'ovins (Peul-Peul) et caprins (sahéliens),
- le site de Kaymor, dans la partie centre du pays, avec 1 500 petits ruminants en expérimentation. Ce site soudanien reçoit 650 mm de précipitations et est peuplé de paysans Wolof, essentiellement cultivateurs, entretenant un petit troupeau de 10 à 15 têtes d'ovins et de caprins issus d'un métissage ancien entre grandes races sahéliennes et races naines du Sud;
- le site de Kolda, dans la partie sud du pays, avec 1 500 petits ruminants en expérimentation. Ce site soudano-guinéen reçoit 950 mm de précipitations et est peuplé de paysans peuls cultivateurs et éleveurs, entretenant dans chaque concession un petit troupeau de 10 à 15 têtes d'ovins Djallonké et de caprins guinéens.

Contraintes pathologiques

Il a été décidé de tester parallèlement, en traitant tous les animaux de 3 mois et plus, l'efficacité en termes de "production ajoutée" de:

- la vermifugation contre les strongles (Panacur), par deux administrations en début et en fin de saison des pluies;
- la vaccination antipasteurellique (vaccin PasteurelladND du LNERV-Dakar), par deux injections à six mois d'intervalle (avant la saison sèche fraîche et relance de l'immunité au cours de la saison sèche chaude);
- la vaccination antipestique hétérologue (vaccin TissupestND du LNERV-Dakar), par une injection au cours de la saison des pluies.

Echantillonnage

Le dispositif expérimental comprend un lot témoin, un lot vermifugé, un lot vacciné, un lot vacciné et vermifugé. L'échantillonnage a été réalisé en grappes, tous les animaux d'un village faisant partie du même lot prophylactique.

Les résultats zootechniques sont évalués à partir des performances de reproduction, de croissance et de viabilité. Une synthèse des résultats peut être faite en utilisant deux paramètres :

- l'indice de productivité pondérale annuelle: le nombre de kilogrammes d'agneau (de chevreau) de 3 mois produits par brebis (chèvre) et par an, qui rend compte de la reproduction de la mère, de la viabilité et de la croissance des produits avant 3 mois d'âge;

IPP = taux de mise-bas

X (taux de productivité numérique à la naissance)

X (1 - quotient de mortalité 0-3 mois)

X (poids moyen à 3 mois (mâle-femelle) des produits)

- le poids des femelles à 18 mois qui rend compte de la croissance des agnelles ou chevrettes (PAT).

L'analyse économique a été réalisée à l'aide du progiciel LIVMOD développé par la Banque internationale pour la reconstruction et le développement, la FAO et l'EMVT, en comparant sur cinq années l'évolution démographique de deux populations animales identiques en année 1, l'une bénéficiant des actions prophylactiques, l'autre n'en bénéficiant pas.

Les différentes variables qui caractérisent chaque situation sont d'abord introduites dans le modèle:

- paramètres zootechniques (structure de la population, mortalité, reproduction, croissance);
- paramètres d'exploitation (immigration, émigration);
- prix au producteur et coûts d'intervention.

Trois types d'approche sont ensuite développés:

- a) Le calcul du coût de la maladie, en rapportant la différence de bénéfices (bénéfices d'exploitation + capital animal induit) entre la situation "avec action" (B_1) et la situation "sans action" (B_0), au nombre total d'animaux en première année :

$$\text{coût de la maladie} = \frac{B_1 - B_0}{N}$$

- b) Le calcul de l'amélioration relative des bénéfices, en rapportant le bénéfice supplémentaire (actualisé) au bénéfice de la situation "sans action":

$$\text{amélioration relative des bénéfices} = \frac{B_1 - B_0}{B_0}$$

- c) Le taux de rémunération des dépenses prophylactiques, en rapportant le bénéfice supplémentaire (actualisé) au coût des interventions:

$$\text{taux de rémunération des dépenses} = \frac{B_1 - B_0}{C}$$

Résultats

Techniques

Le tableau 1 montre:

- que la vermifugation permet d'améliorer au moins une catégorie de performances animales dans chacune des zones et pour chacune des deux espèces. Elle est toutefois plus efficace pour les ovins dans le sud du pays;
- que la vaccination antipasteurellique pratiquée seule n'est efficace chez les ovins (non testée chez les caprins), que dans la partie nord du pays;
- que la vaccination antipestique (associée à la vaccination antipasteurellique) est efficace au nord comme au sud du pays tout au moins pour les ovins.

Ces constatations amènent à proposer une régionalisation des interventions, qui concernerait les deux espèces:

- vermifugation sur toute l'étendue du territoire et plus particulièrement dans la partie sud;
- vaccination antipestique sur toute l'étendue du territoire;

Tableau 1. Amélioration des performances par les actions prophylactiques (en %) chez les ovins et les caprins.

	Ovins					
	Vermifugation			Vaccination		
	IPP 3 m	PAT 18 m		Antipeste + Antipasteurellique	Antipesteurellique seule	
				IPP 3 m	PAT 18 m	IPP 3 m PAT 18 m
Nord	5			2		2
Centre	27			?	?	?
Sud	33	22		10		
Caprins						
Nord	13	16		11		
Centre	2	14				
Sud	14	17				

- vaccination antipasteurellique dans la partie nord du pays.

Ces recommandations doivent être évaluées sur le plan économique avant d'être retenues.

Economiques

Le coût des interventions a été calculé:

- en considérant que les structures des services de l'élevage se chargeraient de l'organisation des campagnes de vaccination, tandis que des structures privées se chargeraient de promouvoir et de distribuer les vermifuges;
- en répercutant l'intégralité des coûts d'intervention (prix du produit + promotion + distribution + conservation + salaires des agents pendant les campagnes) sur le prix du traitement au niveau de l'éleveur qui s'établit ainsi:

- vaccination antipestique	33 F CFA/animal/an
- vaccination antipestique/antipasteurellique	93 F CFA/animal/an
- vermifugation	320 F CFA/animal/an.

Ces trois approches ont permis de montrer que les actions régionalisées proposées étaient toutes économiquement rentables. A titre d'exemple, nous présentons dans le tableau 2 les résultats de ces calculs pour la zone nord que l'on peut brièvement commenter:

- 1- En termes zootechniques le parasitisme digestif et le complexe pneumopathie sont des contraintes plus nettes chez les caprins que chez les ovins, nous l'avons vu. En revanche, en termes monétaires ils entraînent un manque à gagner (coût de la maladie) plus important chez les ovins. Ceci en raison du prix au producteur beaucoup plus élevé pour les ovins (350 à 450 F CFA/kg pour les femelles, 700 à 850 F CFA/kg pour les mâles) que pour les caprins (350 F CFA/kg pour les deux sexes).
- 2- La prophylaxie anti-infectieuse génère une amélioration relative des bénéfices plus importante (14,5% pour les ovins) que la prophylaxie antiparasitaire (6,5%). Ceci du fait du coût plus élevé des actions de vermifugation (320 F CFA/animal/an contre 93 F CFA pour la vaccination associée).
- 3- Pour une prophylaxie donnée, l'amélioration relative des bénéfices est identique pour les deux espèces. Cependant, la rentabilité des investissements est plus importante pour les ovins (2 à 3 fois supérieure), ce qui traduit encore le fait que la valeur commerciale des ovins est supérieure à celle des caprins. Un franc investi chez les ovins rapporte deux fois plus que chez les caprins, alors que l'amélioration des performances est plus importante chez ces derniers.

Tableau 2. Analyse économique des actions prophylactiques dans la zone nord

Ovins						
Maladie	Action prophylactique	Amélioration I.P.P.	Coût intervention	Coût maladie	Amélioration relative des bénéfices	Taux de rémunération
Helminthes	Vermifugation	5%	320 F	1 020 F	7%	100%
Pneumopathie	Vaccination Antipestique et Antipasteurellique	2%	93 F	1 230 F	15%	800%
Caprins						
Helminthes	Vermifugation	13%	320 F	510 F	7%	100%
Pneumopathie	Vaccination Antipestique et Antipasteurellique	11%	93 F	540 F	16%	300%

On peut considérer que, pour être incitatrice au niveau du producteur, la rémunération des investissements doit être d'au moins 200% (2 francs de bénéfice pour un franc investi). Dans ces conditions, il apparaît que la vermifugation n'est pas suffisamment rentable pour être adoptée par les éleveurs de cette zone sans subvention de l'intervention. Au contraire, la prophylaxie anti-infectieuse est apparemment suffisamment rentable pour que les éleveurs adoptent cette action. Le problème de leur capacité effective à mobiliser des liquidités pour ce type d'action reste néanmoins posé.

Conclusion

L'originalité de cette étude réside dans son exécution:

- en grandeur réelle ayant impliqué 6 500 petits ruminants dans le dispositif expérimental;
- en milieu villageois sur cinq années, ce qui permet de tenir compte à la fois des conditions de production traditionnelle et de leur variation annuelle;
- étendue du nord au sud du pays, ce qui amène à établir des recommandations régionalisées en matière de prophylaxie.

Elle est aussi originale dans son exploitation qui, premièrement, prend autant, sinon plus, en compte les pertes qualifiées d'indirectes, intéressant les performances de reproduction et de croissance, que les pertes directes par mort des individus, et qui, deuxièmement, fournit des éléments techniques mais également économiques pour raisonner la régionalisation d'une politique nationale de protection sanitaire du cheptel.

Cette communication montre l'intérêt des études multilocales coût-bénéfice des actions d'amélioration. Elles permettent d'une part d'établir une régionalisation de la politique nationale de protection sanitaire, raisonnée sur le plan technique et économique, et d'autre part d'identifier les actions suffisamment rentables du point de vue national pour être justifiées, mais qui nécessitent une subvention pour être adoptées par les éleveurs car elles ne déterminent pas un gain suffisamment attractif à leur niveau.

Annexe:

PROPHYLAXIE ANTIPARASITAIRE PANACUR - KOLDA OVINS

Situation SANS et AVEC projet

Classe	Effectif	Mortalité	Exploit.	Immigrat.	Fertilité	Prolificité	Poids	Age*(m)	Prix/kg.				
Femelle													
0-1 an	203	36,9	25,1	36,7	18,4	10,7	17,9	1,11	1,05	15,2	17,1	8,0	350
1-2 ans	126	13,8	13,4	43,2	16,3	120,2	137,9	1,05	1,06	18,7	22,8	18,0	350
2-3 ans	87	18,2	6,1	38,1	8,0	130,5	145,7	1,14	1,20	20,6	23,5	30,0	350
3-4 ans	60	14,1	6,8	35,7	7,3	145,8	159,5	1,21	1,34	20,6	23,5		350
4-5 ans	37	14,1	6,8	35,7	7,3	140,6	155,8	1,24	1,36	20,6	23,5		350
5-6 ans	19	14,1	6,8	35,7	7,3	140,6	155,8	1,24	1,36	20,6	23,5		350
6-7 ans	13	14,1	6,8	35,7	7,3	140,6	155,8	1,24	1,36	20,6	23,5		350
7-8 ans	7	14,1	6,8	35,7	7,3	140,6	155,8	1,24	1,36	20,6	23,5		350
> 8 ans	0	14,1	6,8	100	7,3	140,6	155,8	1,24	1,36	20,6	23,5		350
Total	552												
Mâle													
0-1 an	176	36,9	25,1	60,0	8,3					16,8	19,7	8,3	500
1-2 ans	33	0	11,3	80,4	5,5					23,0	27,4	16,0	500
2-3 ans	6	0	0	94,7	0					28,0	32,3	28,0	500
> 3 ans	0	0	0	100	0					28,0	32,3		500
Total	215												

Programme PPR (LNERV-ISRA/IEMT-CIRAD)

* Age moyen à la vente (en mois)

Gastro-intestinal parasites in small ruminants in Mali: Geographical distribution epidemiology and chemotherapy

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Abstract

An investigation of helminth parasites in sheep and goats was carried out in several abattoirs in various regions of Mali between 1983 and 1985.

Faecal and visceral examinations from 284 sheep and 318 goats indicated a marked variation in the level of parasitism in livestock raised in different geographic areas. Both sheep and goats were found to be infested with identical nematode species, however, with different levels of infestation. The more common nematodes in sheep were, in order of predominance: Trichostrongylus colubriformis, Haemonchus contortus, Strongyloides papillosus, Oesophagostomum columbianum, Gaigeria pectinata, C. punctata, C. curticei, and Trichuris ovis. Four trematodes (Fasciola gigantica, Dicrocoelium nospes, Paramphistomum spp and Carmyerius spp), one larval (Cysticercus tenuicollis) and three adult cestodes (Monezia, Stilesia, and Avitellina) were identified.

The following nematodes were found in goats in order of predominance: T. colubriformis, S. ovis, H. contortus, G. pachyscelis, S. papillosus, O. colombianum, T. axei, C. pectinata, and C. punctata. Trematodes and cestodes identified were the same as those in sheep.

Variation in geographic distribution and prevalence were noted in relation to the season and management practices.

Since 1987 efforts are being made in two ecological zones to assess the impact of mass anthelmintic treatment on production parameters such as weight and mortality.

Parasitisme gastro-intestinal des petits ruminants au Mali. Epidémiologie et contrôle

**S. Tembely, T.J. Galvin, B. Kouyaté, S.B.Ba, K. Bengaly
et W. Berckmoes**

Résumé

De 1983 à 1985, le parasitisme à helminthes des petits ruminants a été étudié dans les abattoirs de plusieurs régions du Mali. L'examen des fécès et des viscères de 284 moutons et 318 chèvres a montré la variation du niveau d'infestation parasitaire des animaux élevés dans les différentes régions du pays. Les deux espèces sont infestées par les mêmes parasites, mais à des degrés différents. Les nématodes des ovins prédominants sont dans l'ordre d'importance: Trichostrongylus colubriformis, Haemonchus contortus, Strongyloides papillosus, Oesophagostomum columbianum, Gaigeria pectinata, C. punctata, C. curticei, and Trichuris ovis. 4 trématodes (Fasciola gigantica, Dicrocoelium nospes, Paramphistomum spp et Carmyerius spp); un cestode larvaire (Cysticercus tenuicollis) et trois cestodes adultes (Monezia, Stilesia et Avitellina).

Les nématodes des caprins sont dans l'ordre d'importance: T. colubriformis, S. ovis, H. contortus, G. pachyscelis, S. papillosus, O. colombianum, T. axeï, C. pectinata et C. punctata.

Les caprins sont parasités par les mêmes trématodes et cestodes que les ovins.

Des variations de répartition géographique et de prévalence furent notées en liaison avec la saison et les pratiques de gestion.

Depuis 1987, l'impact de traitements anthelminthiques à grande échelle sur le poids et la mortalité a été évalué dans deux zones écologiques.

Introduction

Sheep and goats, although representing an important source of animal protein in semi-arid countries such as Mali, seem to have benefited little from veterinary care and production improvement. Goats are often the main supply of daily meat in rural areas. Sheep, on the other hand, are used in ceremonial festivities throughout the country, providing important trade (mainly male sheep) between rural and urban areas. Together, sheep and goats provide a large portion of the meat consumed and produce a considerable amount of manure, which is of special importance in those areas where cattle are of lesser importance. Different breeds have been adapted to different environments. Long-legged sheep and goats are found in the Sahelian regions, and the dwarf breed are found in the Sudanese region of Mali. Although adapted to local climatic and nutritional conditions, economic production of small ruminants is hampered by infectious and parasitic diseases coupled with inadequate management as mentioned by Nawathe et al (1985).

Epidemiology

Materials and methods

Sites of collection

In order to obtain adequate numbers of samples from the animals, all collections were made at abattoirs. To obtain data on seasonal variations in parasite populations and biology, attempts were made to make a minimum of four collections at most sites. Points of collection are shown in Figure 1.

Selection of the abattoirs was based on the number of individual animals slaughtered daily and the probability of obtaining native animals from the various ecological regions of Mali.

Climatic data

Monthly temperature and rainfall data were obtained from the National Agroclimatological Office at Bamako.

Parasitological Findings

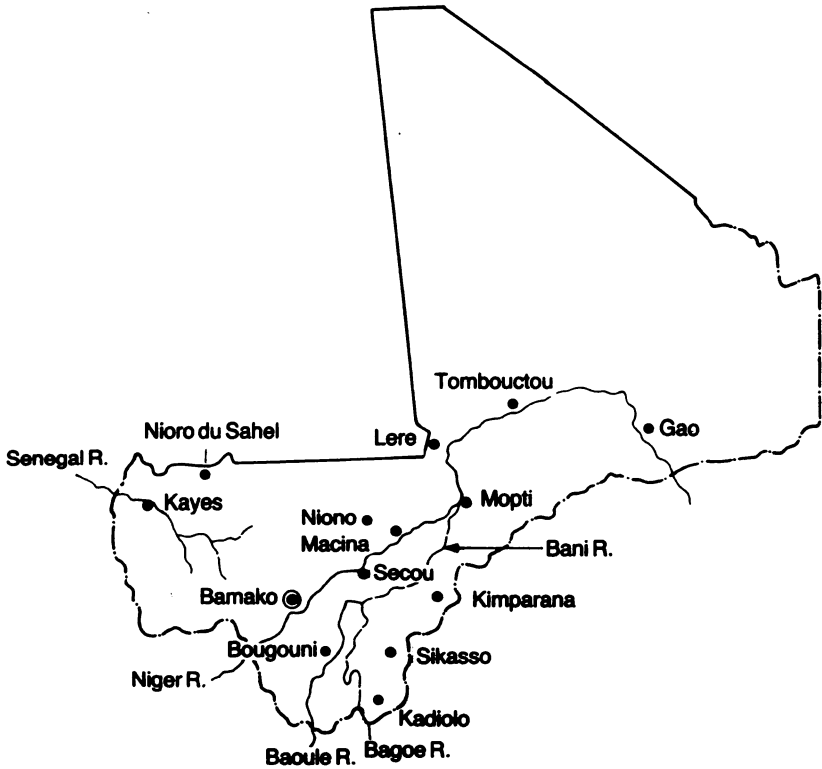
Nematodes

Sahelian sheep

The following parasites species were recorded from Sahelian sheep in order of predominance: *Trichostrongylus colubriformis*, *Haemonchus contortus*,

Strongyloides papillosus, *Cooperia curticei*, *Oesophagostomum columbianum*, *Skrjabinema ovis* and *Trichuris ovis*.

Figure 1. Map of Mali showing major rivers and collection sites.



Sudanese dwarf sheep

The results obtained from this survey may not reflect the overall field situation due to a limited sample size from the abattoirs visited.

Sahelian goats

Based on post-mortem examination, the following nematodes were identified in long-legged Sahelian goats in order of predominance: *Skrjabinema ovis*, *S. papillosus*, *H. contortus*, *T. colubriformis*, *O. columbianum* and *Cooperia curticei*.

Sudanese dwarf goats

Only two nematode species were found in significant numbers. These were *T. colubriformis* and *H. contortus*. Prevalence figures are given in Table 1. There was a relatively high prevalence of *G. pachyscelis* infection (27 %) observed in these goats.

Table 1. Prevalence of trematode parasites of sheep and goats in Mali (%).

	Sheep		Goats	
	Sahelian	Sudanese	Sahelian	Sudanese
<i>Fasciola gigantica</i>	20	0	7	0
<i>Dicrocoelium hospes</i>	0	18	0	44
<i>Paramphistomes</i>	35	18	34	0
<i>Schistosoma</i> sp	1	0	3	0
<i>Cysticercus tenuicollis</i>	19	42	42	46

Trematodes

Sahelian sheep

Fasciola gigantica and paramphistomidae infections occurred with a prevalence of 20% and 35%, respectively. Only one sheep was found to be infected with *Schistosoma* spp. No *Dicrocoelium* was found during the course of the investigation.

Sudanese dwarf sheep

Not a single *F. gigantica* was found to infect the local dwarf sheep in the southern part of the country. However, 18% of the animals were infected with both *D. hospes* and paramphistomes. Due to a limited sample size, the results of this investigation concerning the dwarf sheep may not reflect the overall field situation.

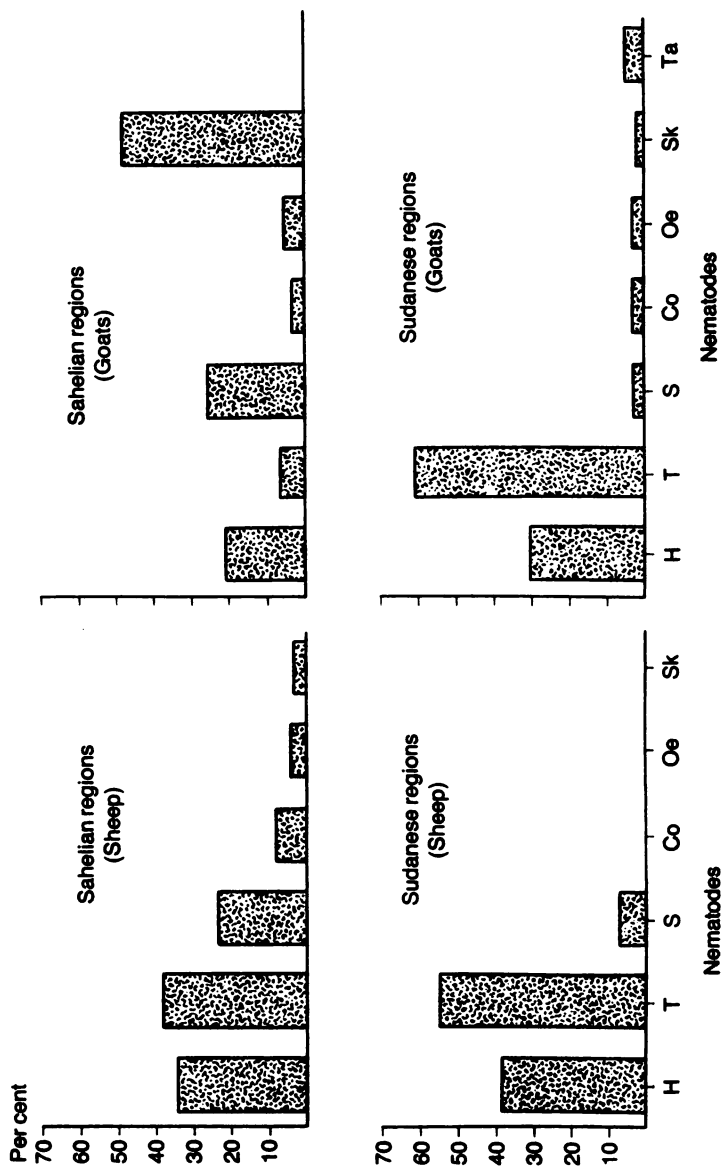
Sahelian goats

Trematodes were found with the following frequency: *Paramphistomum* spp (34%), *F. gigantica* (7%) and *Schistosoma* spp (3%).

Sudanese dwarf goats

No *Fasciola* was recovered in these goats in the course of this investigation. On the other hand, 44% of the animals examined were infected with *Dicrocoelium hospes*.

Figure 2. Parasite profiles of sheep and goats from different geographic areas of Mali. Percentage of parasite species or genera is based on total number of nematodes recovered (100%). H = *Haemonchus*; T = *Trichostrongylus*; S = *Strongyloides papillosus*; Co = *Cooperia*; Oe = *Oesophagostomum*; Sk = *Skrjabinema*; Ta = *Trichostrongylus axei*.



Cestodes

The only larval cestode reported in this study is *Cysticercus tenuicollis*. Post-mortem examination showed the following prevalence: Sahelian sheep (19%), Sahelian goats (42%) and Sudanese dwarf sheep (42%) and Sudanese dwarf goats (46%).

Discussion

In the traditional management of animals in Mali, sheep and goats are grazed together. This parasitological survey has shown that they also share the same parasite species but with different levels of infection. Studies conducted in Australia also showed that sheep and goats were infected with the same species of worms when grazed together (Malins, 1971). However, conflicting results have been reported elsewhere in Africa (McCulloch et al, 1968) and in Europe (Le Riche et al, 1973) with different types of management. One explanation for the difference in worm burdens and composition in sheep and goats is that the latter they are browsers as well as grazers and, if feeding on scrub high enough, they could avoid most of the infective trichostrongyle larvae.

Nematodes

Haemonchus contortus

Heavy infections coincided with the rainy season, then progressively declined during the dry season. Immature stages (most of which were at an early stage of development) were recorded during the dry season and, thus, probably contributed to the increase of the adult populations during the rainy season. These findings suggest that most of the larvae had undergone inhibition of development during the drier period of the year. The phenomenon, as described in cattle, is commonly known to occur in sheep in temperate regions (Donald et al, 1964; Dinneen et al, 1965; Michel, 1974) and recently recognised in tropical Africa. Studies done in Senegal (Vercruysse, 1985, have shown that larvae ingested between October and December were inhibition-prone, the adult populations resulting from the burden acquired during the previous August. Furthermore, the study showed that from January onwards, as the hypobiotic larvae started to mature, these new adults gradually replaced the older population and seeded the pasture with eggs. Therefore, the author concluded that starting in June–July–August, a new population of adult worms developed.

In Mali, the peak of immature *Haemonchus* was observed in March among the Sahelian sheep and represented 91% of the rainy season. This decrease coincided with a sharp increase of the adult population suggesting the maturation of the immature worms. Additional data are required from the dwarf sheep in the Sudanese region to ascertain the survival mechanisms of the parasite.

Trichostrongylus colubriformis

Although the genus *Trichostrongylus* is considered to occur primarily in temperate regions and not thought to thrive during the warm rainy season (Grant, 1981), results from this study indicate that this species may be of economic importance in sheep in Mali because it is one of the most prevalent species both in the Sudanese and in the Sahelian regions. In the Sahelian sheep, *T. colubriformis* was found to be the most abundant nematode species with the highest mean intensity.

Gaigeria pachyscelis

Since the first report on the occurrence of the hookworm *Gaigeria pachyscelis* in sheep and goats in South Africa (Orlepp, 1935), a wide distribution of the parasite has been reported in tropical Africa. Graber (1965) recognised this parasite among native sheep of Senegal. Assoku (1981) in Ghana found only 1 % of the sheep infected with this hookworm. The present survey indicates a higher prevalence in the southern regions with 27 % and 15 % of sheep and goats being infected, respectively. On the other hand, the Sahelian counterparts had a much lower prevalence (7% for sheep and 2% for goats). These findings suggest that the parasite thrives in a region with higher rainfall. However, research is needed to ascertain the importance of the epidemiology of this parasite in Mali.

Oesophagostomum columbianum

Results from earlier workers indicated that up to 66% in sheep of Chad were infected with *O. columbianum* and there was a wide distribution among the Senegalese sheep (Vassiliades, 1981). In Mali, it appears from this study that nodular form of the infection is of greater economic importance with a prevalence rate of 25 to 40%. The presence of nodules on viscera is of prime importance for the rural population because the infected intestines are subject to condemnation during meat inspection and are therefore lost for use as sausage casings.

***Cooperia* spp**

These species occurred more commonly in cattle than in sheep and goats (less than 5% of the small ruminants were infected with the genus). The following species were identified: *Cooperia pectinata*, *Cooperia punctata* and *C. curticei*.

Trematodes

As indicated by gross liver and microscopic examinations for the presence of adult worms and eggs, 20% of the Sahelian sheep were infected with *Fasciola gigantica*, where as only 7 % of the goats in the Sahelian regions were infected with the same parasites. The difference in the level of infection and prevalence is probably due to difference in resistance to infection and grazing habits of the host species.

Only 3 % of the sheep examined were found to be infected with *Schistosoma bovis* in the Sahelian region. Further investigation is needed to assess the pathology of schistosomes in small ruminants because of increasing reports of damage that the parasite might cause in sheep (Vercruysse, 1985).

Cestodes

Cysticercus tenuicollis was widely distributed among small ruminants in Mali. However, this parasite is known to be of low pathogenicity (Dunn, 1978). Other species, such as *Moniezia*, *Avitellina* and *Stilesia* were also commonly associated with sheep and goats.

Control Strategy in the Semi-arid Zone

Materials and methods

The experiment was carried out in the Djoni village located in the Bamako country, 150 km north-east of Bamako with an average annual rainfall ranging from 500 – 600 mm.

One hundred and fifty goats and 70 sheep aged from birth to 24 months were grouped at random into different age categories prior to anthelmintic treatment. Animals comprised exclusively Djallonke sheep and dwarf goats.

Both animal breeds were owned by small individual households. They are kept around the villages during the rainy season and allowed to graze freely away from the villages without herding during the dry season.

Prior to anthelmintic treatment, animals were divided into five different treatment groups and all were immunised against pasteurellosis, anthrax, black leg and peste des petits ruminants (PPR). The anthelmintic treatments were as follows:

No treatment (control group)

T1 – received TBZ 66 mg/kg of liveweight

T2 – fenbendazole 5 mg/kg

T3 – morantel tartrate 7.5 mg/kg

T4 – levamisole 12 mg/kg

Treatment was done in July and September 1988.

Each month, faeces were obtained from the rectum and submitted to a quantitative parasitological examination using the McMaster modified method.

Liveweights were recorded every two months and the average daily weight gain was determined.

The effects of treatment on weight gain were analysed using the General Linear Model (SAS).

Results and discussion

The following strongyle eggs reduction rates were observed following the prime anthelmintic treatment.

Fenbendazole: 100% in sheep; 93 to 100% in goats;

Morantel tartrate: 98 to 99% in sheep; 90 to 99% in goats;

Levamisole: 98 to 100% in sheep and 85 to 87% in goats;

TBZ : 89% in sheep and 78% in goats.

Fifty sheep out of 70 from the starting of the experiment were analysed for live weight changes. There was no significant difference ($P > 0.05$) between the treated and the control group. One hundred and fourteen goats out of the 150 at the beginning of the experiment were analysed for the same purpose.

When the two animal species were combined for statistical analysis a difference of 6 to 7 kg appeared. Since the standard deviations were very high the differences may not be conclusive (Table 2).

Table 2. *Weight-change analysis on sheep and goats combined.*

	General Linear Models Procedure		
	N	Mean	SD
Bolumisol	27	5.1109393	11.6966865
Exhelm	36	12.1871206	26.81456227
Panacur	38	11.8638104	17.9935661
Pas de traitem	31	5.1871548	22.9355640
Thybenzol	38	10.8740727	29.4437642

Control Strategy in the Humid Zone

Material and methods

The experiment was carried out at Fonsebougou, 56 km north of Sikasso in the southern part of Mali.

Eight flocks of sheep owned by villagers were identified by ear tags and randomly divided into three groups of treatment according to their weight:

Group 1 – Fenbendazole 10 mg/kg liveweight

Group 2 – Morantel tartrate 7.5 mg/kg liveweight

Group 3 – Control

Treatments were given in May, July, September and November 1989.

These groups were subdivided into three age categories: 6–12 months old; 12–18 month old and over 18 months.

Parasitological examination: A quantitative evaluation of strongyle eggs was performed using the modified McMaster method.

Liveweight changes: to determine any change that has occurred in liveweight, sheep were individually weighted every two months.

No mortality was recorded.

Results and discussion

Our findings demonstrated that lambs were more heavily infected by trichostrongyles because they were more susceptible. The maximum egg count was observed between August and October with a peak in September. However, ewes remained infected all year-round thus serving as the source of contamination for the lambs.

No significant change was noted on liveweight between the treated groups and the control in adult sheep (ewes and rams). No statistical analysis could be done of weight data lambs because of the low number of observations by the end of the experiment.

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Session 4

Small ruminant feeds and feeding systems

Ressources alimentaires et systèmes d'alimentation des petits ruminants

Strategies for matching feed resources to small ruminant needs: A review

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Abstract

This paper reviews strategies for matching feed resources to small ruminant production. Climatic, ecological and socio-economic conditions prevailing determine the types of strategy to adopt. Strategy options proposed include limiting small ruminant numbers to suit available feed resources, efficient use of natural browse resources, increased use of legumes in cropping and pastoral systems, integration of small ruminant production with tree crop plantations, more effective utilisation of crop residues and agro-industrial by-products, conservation of forages as silage or hay for use during periods of scarcity, strategic animal feeding schemes and use of fertiliser to improve forage yield where and when feasible.

Evaluation des stratégies visant à faire correspondre les ressources fourragères aux besoins des petits ruminants

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Résumé

Cette étude passe en revue les stratégies à suivre pour que les ressources fourragères puissent couvrir les besoins de l'élevage des petits ruminants. Le choix du type de stratégies à adopter s'effectue en tenant compte des conditions climatiques, écologiques et socio-économiques prévalantes. Diverses stratégies sont

proposées, notamment: diminuer les effectifs de manière à équilibrer le nombre d'animaux avec les ressources fourragères disponibles; tirer parti des espèces ligneuses spontanées; intensifier l'exploitation des légumineuses dans les systèmes agricoles ou pastoraux; associer l'élevage des petits ruminants à la pratique des cultures arboricoles; améliorer l'utilisation des résidus de récolte et des sous-produits agro-industriels; recourir à l'ensilage et au fanage afin de conserver les fourrages pour les périodes de pénurie; mettre en place des plans raisonnés d'alimentation; et, lorsque c'est faisable, utiliser des engrais pour augmenter les rendements fourragers.

Introduction

Africa, excluding South Africa, has about 22% of the world's population of sheep and goats, and produces 14% of the total sheep and goat meat. Goat and sheep milk production in Africa also accounts for approximately 14% of the world production (FAO, 1981).

Small ruminants represent 24% of the total livestock units in Western Africa and 17% in eastern Africa (Peacock, 1985). Their distribution tends to favour the arid and semi-arid zones of tropical Africa where 58% of sheep and 68% of goats are found. Dwarf goats and sheep are more abundant in the humid zone of West and central Africa particularly as they have the advantage of being trypanotolerant.

Small ruminant production is typically a small-scale farmer activity attracting minimum investment in housing, feed and health care and is largely sustained by the potential of the individual breeds themselves. Three distinct management systems can be distinguished: free roaming (extensive) or herding, tethering and confinement of animals. Tethering and confinement are associated with areas characterised by high population densities, more intensive cropping, land scarcity and high labour requirements. In most of Africa, an extensive management system of production seems most popular for both sheep and goats. Among the numerous constraints to production under these systems, those related to nutrition are of primary concern.

The nutritional problem

Gatenby (1982) has indicated that the major factors limiting the productivity of small ruminants in Africa are poor nutrition in the semi-arid areas and diseases in more humid areas. Water can be a problem in some dry areas. Contrary to popular belief, the genotypes of breeds in Africa are not the primary limiting factors especially where nutrition, disease and marketing problems have been adequately handled.

The nutrient content in the form of metabolisable energy, digestible protein and minerals may be poor in arid and semi-arid regions, even when vegetation appears to be adequate. The dry season poses serious feed problems in semi-arid areas. There are three aspects of the feed problem, namely, the issue of increasing the efficiency with which the available feed is utilised (e.g. forages, crop residues, agro-industrial by-products and nonconventional feeds), the inability to make maximum use of the limited total feed resources and the inadequate supplies of feed (Devendra, 1987) and water.

Strategies for ensuring adequate nutrition of small ruminants must be based on optimising overall agricultural and livestock productivity from available resources, improving existing technologies and integrating technology that employs multipurpose crops and animals and recycling of crop residues and by-products as nutrients for both animals and plants.

Components of such strategies may include matching livestock production systems to available resources, selection of crops and cropping systems that will maximise biomass production and nitrogen fixation and thus minimise use of inputs external to the system, developing simple processing techniques to optimise the use of different components of crops for different end purpose, recycling of livestock wastes, making more efficient and widespread use of agricultural and industrial by-products as sources of ruminant feed and incorporation into the production system of non-ruminant species that are well adapted to use of farm resources, by-products and wastes. An in-depth analysis of each strategy is worthwhile.

Increased offtake

De Boer (1982) reported that traditional producers, because of their small-scale operations, market few animals on *ad hoc* basis, if at all. Small-scale intermediaries handle the transport and assembly functions needed to make up economic numbers of animals for transportation to larger markets.

Experience shows that the scope for increasing offtake lies neither in attempts to regulate and control the market participants nor in the control prices, nor creation of parastatals but rather in facilitating the operations of the market participants and instituting measures which reduce marketing costs. These include, improving the infrastructure of livestock marketing, the provision of market information through the mass media (i.e. prices and volume of livestock traded in various markets), regulating the standards of products and services and negotiating favourable trade agreements in export markets (Solomon Bekure and McDonald, 1985).

The strategy options

Increased use of legumes in cropping and pastoral systems

Use of forage legumes in crop mixture

Intercropping forage legumes with cereals tends to increase the overall crude protein level of the total fodder available after grain harvest of the primary crop. Usually this involves undersowing a cereal crop with legume. The time of undersowing is critical to optimum production of grain and fodder. Mohamed Saleem (1985) indicated that planting *Stylosanthes guianensis* cv Cook or *S. hamata* cv Verano on the same day with sorghum reduced grain yield by more than 70%, but the loss of grain yield was minimised if they were sown 6 and 3 weeks, respectively, after planting the sorghum. Similarly, reduction in grain yields was observed in a trial in which sorghum was sown with *Centrosema pascuorum*, *Alysicarpus vaginalis* or *Macroptilium lathyroides* on the same day, but the reductions were not as significant as with *S. guianensis*.

Use of forage legumes to supplement natural grazing

Fodder banks have been suggested as a strategy to improve nutritional status of livestock in the dry season. Fodder banks are concentrated units of legumes established by pastoralists adjacent to their homesteads to serve as supplements to dry-season grazing. In Nigeria this has been developed into a low-input technology package for pastoralists by ILCA (Mohamed Saleem, 1985). Preliminary results on use of fodder banks appear to be quite promising despite some problems associated with establishment, utilisation and regeneration.

Use of forage legumes in crop rotations

Association of forage legumes in crop rotation has been demonstrated to improve the nitrogen content of soil thereby benefiting crop production when such plots are cropped. This also offers appropriate opportunity to integrate crop and livestock production. Mohamed Saleem (1985) reported that maize growth and grain yield was much higher when a portion of fodder banks of different ages was cropped as compared to yields immediately outside the fodder banks, which were previously either cropped or under natural sub-climax vegetation.

Better use of forage of tree legumes

Production systems using tree legumes usually consist of either a dense population of trees in a small area, a row of trees planted as "hedgerow" on bunds, as edges of crop areas or interplanted with crops (alley cropping).

The leaves of trees can be used as a high quality supplement to crop residues and grass. The level of incorporation may range from 20–75%. High responses in terms of weight gain have been registered with small ruminants (Horne et al, 1986). Leaf production seems relatively unaffected by frequency of cutting although wood production is increased with decreasing cutting frequency.

Preston and Leng (1987) have indicated that tree legumes such as *Gliricidia*, *Erythrina* and *Leucaena* have a great potential as sources of legume fodder particularly as they are high-yielding perennials and possess deep-rooted systems that may have access to ground water and nutrients that may not be available to smaller leguminous plants. Rajaguru (1987) estimated that a hectare of tree fodder such as *Gliricidia sepium* and *Leucaena leucocephala* could yield up to 6–8 tons of dry matter per year which could support 12 goats or sheep. Meanwhile, Horne et al (1986) estimated forage yield of *G. sepium* and *L. leucocephala* at 12.1 tons/hectare/year.

Small ruminant production in an alley-cropping perspective has been analysed by Sumberg (1985). Alley-cropping is a system in which crops are grown in alleys between rows of frequently pruned trees. The large input of nitrogen and organic matter from tree foliage can potentially support continuous cropping at intermediate yield levels (Kang et al, 1981). Small ruminants can be integrated into an alley cropping by cut-and-carry feeding of portions of the tree foliage or by grazing natural fallow regrowth and trees during periodic fallow years. The cut-and-carry feeding applies to goats and sheep while the grazing system is limited to sheep because goats tend to de-bark the trees. Fast growing leguminous trees like *G. sepium* and *L. leucocephala* are essential for the system of feeding. In order to give sufficient benefit to the crop and avoid the possibility of soil mining, it is recommended that approximately 75% of the available tree foliage be applied to the soil as mulch while the rest is given as feed to animals. An annual tree foliage yield of four tons dry matter/hectare would yield about one ton dry matter which is sufficient to support approximately 14 adult animals per hectare as a year-round supplement or four animals/ha as sole feed. Van Eys (1987) cautioned that structural carbohydrates are usually high in forage supplements. When their levels are high, this tends to interfere with the utilisation of roughage as well as supplement. In addition, there are some antiquality components in forage supplements (tannins, cyanogenic glucosides, nitrates, soluble oxalates) that can reduce palatability, voluntary intake and productivity if forage supplements are fed continuously to small ruminants, and particularly if they are fed in the fresh form or grazed by the animals. Some of these compounds can be partially destroyed by drying or storage. However, ruminants tend to be suited to utilising some forage legume supplements that contain antiquality substances since these can be detoxified in the rumen (for example, mimosine DHP in *L. leucocephala*).

Effective exploitation of natural browse for the nutrition of small ruminants

In Africa, it has been estimated that over 250 million head of domestic animals live in arid, semi-arid and mountain zones where browse is an important qualitative component of the livestock diet (Le Houérou, 1978). The widespread traditional use of browse as an available source of quality feed during the dry season is vitally important to maintain seasonal and yearly stability of livestock production. Lamprey et al (1980) have reported a browse productivity rate of 5000 kg dry matter/ha/annum for riverine *Acacia xanthophloea* which is about double that of most savannah grasslands. However, there is a large variability in productivity within populations of browse species depending on the ecological conditions. Established browse plantations of *Medicago arborea* have been able to produce 3500 kg dry matter/ha/year under annual rainfall of 350–450 mm (Le Houérou, 1975).

Otsyina and McKell (1984) indicate that browse, especially in the savannah vegetation types, contributes a large amount of available forage as a complementary source of feed for livestock, particularly during the dry season when herbaceous forage is in short supply. The major problems appear to be inadequate management systems that fail to make optimum use of shrubs and find ways to increase the number and quality of valuable browse species available for livestock production. Le Houérou (1980) reported that compared with tropical grasses, browse is richer in protein and some minerals in the dry season. At this time, browse plants are the most valuable feed used by livestock. Browse could therefore supplement the low protein content of grass forage if used effectively during dry periods. The crude fibre content of browse also tends to be lower than that of grasses and usually ranges from 20–40% and is even lower for shoots and leaves (Pellew, 1980). Given the low content of crude fibre in browse compared with dry grass, the energy content of browse appears to be higher than that of dry grass (Le Houérou, 1978).

Browse plants can satisfy the needs of small ruminants on provided that the animals can gain easy access to them and a sufficient quantity is available to them directly or with the aid of man. From dry to humid tropical Africa the contribution of browse towards intake by an animal implies considerable effort on the part of herdsman in activities such as planting of browse trees, maintaining the necessary balance of the species present by selective bush-clearing and making browse available to animals by either beating down fruits as in the Sahel, by trimming or cutting back (Boudet and Toutain, 1980).

Carew et al (1980) reported studies on the potential of browse plants in the nutrition of small ruminants in the humid forest and derived savannah zones of Nigeria. Savannah goats and sheep browsed and grazed longer and spent less time scavenging than their counterparts in the humid forest. The biting ratios of

browse to grass in the forest zone were 77:1 for the goats and 13:1 for the sheep. This shows that browse plants were selected more often by goats and sheep in the forest zone than the savannah region though browse plant height or accessibility tended to affect selection pattern. Common species studied were *Ficus exersperata*, *Newboulotia leavis*, *Asphilia africana*, *Spondias mombin* and *Cyclicodiscus gabunensis*.

Recommendations (Otsyina and McKell, 1984) for research on browse plants include the identification of superior browse species with regard to available productivity, nutritive value and persistence under grazing by livestock; the development of methods for establishing desirable browse species in ecologically favourable areas along with grasses in mixed plantings; the improvement of management practices of established and native pastures containing both browse and grass species to maintain effective species composition; and the documentation of characteristics useful for improving shrublands for small ruminants in different seasons.

Integration of small ruminants in plantation crop production

Tree crops may contribute to livestock feed resources through use of their by-products. If these by-products could be collected properly and processed, they could offer alternatives to costly concentrates. Common by-products obtained from plantation crops include coconut cake, palm-kernel cake, rubberseed cake, citrus wastes (pulp, seed meal) and cocoa pods and residues. Cover crops grown in plantations also offer feed that can be used for small ruminants. Natural herbage growing under plantation trees may be collected and conserved in the form of hay. Where possible, controlled grazing underneath tree canopies may be practised on a rotational basis. Fodder cultivation under plantation crops can also be practised.

Wan Mohamed (1987) has indicated that cultivation of cover crops in plantations in Malaysia offers a lot of potential for production of small ruminants. The age of rubber trees or oil-palm trees tends to influence the botanical composition of the ground cover. Cultivated legume cover crops tend to decline as the trees mature due to their shading effect which reduces photosynthesis. In terms of compatibility, sheep production is more compatible with oil palm cultivation than goats. However, both species are complementing in reducing the need to use herbicides and thus reducing the cost of weeding and increase returns per unit area of land.

Parawan and Ovalo (1987) reported that integration of livestock production with coconuts has a high potential in the Philippines. Moog et al (1977) indicated that coconut plantation pasture is available throughout the year and provides of farmers with nutritious feed for livestock. When feeds are scarce, farmers use

coconut fronds in addition to bamboo leaves, banana leaves and *Gliricidia sepium*.

The low technology inputs, the versatility in the feeding habits, and the relatively low acquisition cost of goats and sheep can fit appropriately into the majority of smallholder coconut farms. The added value of goat meat and milk, mutton and animal manure as fertiliser produced from the use of crop products, crop by-products and forage under coconut can raise the average income of the coconut smallholder (Parawan and Ovalo, 1987).

The constraints of integrating small ruminant production in rubber and oil-palm plantations include damages to young plants especially at establishment time, the potential toxic effect of herbicide sprayed on tree crop planted in rows and rat-baiting in oil-palm plantations which could contaminate by-products of oil-palm processing which could lead to copper toxicity problems in livestock (Pillai and Tan, 1977).

In countries where there is large-scale cultivation of citrus, their by-products offer useful feed resources for livestock. When grapefruit (*Citrus paradisi*) and sweet orange (*Citrus sinensis*) are industrially processed on a large-scale to produce juice or sections, by-products such as peels, rag, and depending on method of processing, other by-products like citrus molasses and citrus seed meal may be available. In most cases, the harvest of citrus usually coincides with the dry season when grass is scarce. When quantities of peel and rag (the string axis and white fibrous membrane) are large, they are conserved by drying. The dried citrus pulp can easily be mixed with other ingredients and is palatable, rich in nutrients and exerts a mild laxative effect. It can be stored for all-year feeding and deteriorates less in storage than many other feeds (Gohl, 1978). The pulp is better used as pellets where possibilities for pelleting exist.

Banana plantations also offer important feed resources for feeding small ruminants. It has been estimated that, for every ton of banana picked and exported to the fruit market, about 750 kg are rejected as being either unsuitable or in excess of requirements. This discarded fruit represents 10–20% of the crop depending on the degree of culling and the amount of fruit that is rendered unusable by storms (Le Dividich et al, 1978). Most of this can be used as animal feed. Chenost et al (1976) reported that in *ad libitum* feeding of goats, when forage and bananas were offered separately in a trough, the two feeds were ingested in such proportions that bananas constituted 20–40% of total ingested dry matter. When bananas were blended with forages, the intake of both dry matter and digestible organic matter rose sharply from 0–20% with increasing dietary content of bananas; at the 20% level, dry-matter intake was higher for ensiled than for fresh green bananas with a peak of 1.8 to 2.2 kg/100 kg liveweight. Beyond this level, dry-matter intake remained relatively constant as bananas replaced green forage on a weight-for-weight basis, while digestible organic matter rose slowly. Banana leaves may also be used as forage for animals.

More effective use of crop residues and agro-industrial by-products

With increases in population pressure and the demand for more food and farmland, the use of crop residues and by-products is increasing. Straw, for example, is a valuable feed resource especially during the dry season. However, Preston and Leng (1987) believe that the feeding of straws, like most roughages, to ruminants is constrained by their slow rate of degradation and therefore low total digestibility, their low propionate fermentation pattern in the rumen and their negligible levels of both fermentable N and by-pass protein which is usually associated with their low intake.

The digestibility of straws can, however, be improved by either alkali treatment, ammoniation, treatment with poultry manure or feeding with green forage legumes.

Alkali treatment of by-products to improve intake and digestibility

Kategile (1983) described a simple method of treating roughages with NaOH that could significantly improve their intake and digestibility in small ruminants. However, the cost and availability of NaOH may pose an important constraint under rural conditions. It is hazardous if not well handled and is a pollutant to environment.

Urea supplementation (ammoniation)

Naga and El-Shazly (1982) reported that supplementation with urea can improve the digestibility of nutrients contained in supplemented material provided the level of urea is maintained at 0.5 to 2%. There are risks involved when urea nitrogen in the diet exceeds 30%. This may lead to potassium losses in urine resulting in the depletion of the animal's body supplies (Juhaz et al, 1976). Eventually, this can lead to depressed bacterial growth, decreased synthesis of the B-vitamins in the rumen, loss of appetite and cerebrocortical necrosis (Naga et al, 1978).

Ammonium hydroxide from urea appears to be safer to use than direct liquid ammonia or gaseous ammonia. When mixed with an equal weight of water, the mixture contains about 5% urea equivalent of dry matter on dry-weight basis. The solution can be kept in water and feed containers covered with plastic sheet to prevent exposure to air for 3–4 weeks. After this period the plastic sheet is opened to release ammonia that has been produced, and the material can be fed to animals.

Using animal wastes to improve intake and digestibility of roughages

Excreta from poultry are rich in N, mostly as uric acid which is hydrolysed to ammonia by rumen micro-organism.

Sha and Muller (1982) reported that poultry wastes used at the 25–40% level can meet most of the protein and mineral requirements in ruminant livestock. However, the use of poultry wastes in ruminant feeds tend to result in reduced microbial count, low dietary energy content, exposure to pathogens and high intake of antibiotics and chemotherapeutics that may be present in the waste. Incorporation of high energy feed ingredients such as molasses, root crops and grains can balance energy requirements and maximise utilisation of the non-protein nitrogen (NPN) fraction of the wastes; mixing molasses with ration containing poultry wastes may improve palatability and intake and prevent eye and respiratory problems associated with the dusty nature of poultry waste. Pathogens could be eliminated by ensiling, stacking, formaldehyde in treatment or dehydration. Feeding of wastes that contain high levels of antibiotics and chemotherapeutics should be avoided.

Increased exploitation of lignocellulose as animal feed

Large quantities of lignocellulose from sugar-cane, timber and cereal processing usually go to waste. Feeding materials that are high in lignocellulose tend to have a low digestibility, low nitrogen content and low animal production potential. Simple inexpensive treatments which increase lignocellulose breakdown in the rumen and supplements of non-protein nitrogen could significantly increase animal production. However, when subjected to 3–6% sodium hydroxide solution and/or steam treatment, irradiation, grinding and ammoniation, lignocellulose breakdown in the rumen is increased, and with the addition of non-protein nitrogen its utilisation increases and thus improves animal production. Wong et al (1974) reported that treating bagasse with high pressure (14 kg/cm²) steam for five minutes raised dry-matter digestibility from 28 to 60%.

Conservation of forage as silage for feeding small ruminants during the dry season

Conservation of forage as silage under proper conditions can result in the preservation of 90% harvested energy and protein and the concentration of energy within the silage (McCullough, 1978).

In tropical Africa the use of silage is not common. It, however, offers a good opportunity to preserve abundant forage produced during the wet season for use in the dry season. Under rural conditions, silage can be made in pit silos which are relatively easy to construct and are also affordable by farmers. Recently, there have been improvements of silage-making using discarded fertiliser plastic bags.

The chopped grass is compacted in the bag and sealed. All the bags are then packed and compacted in the silo after which the silo is sealed. This system enables farmers to ration the daily require silage by simply removing one or more bags as required. Empty fertiliser bags cost about 0.3 US dollars in local markets.

Silage-making is most convenient in high population areas where pastures are scarce and grasses like *Tripsacum laxum* and *Pennisetum purpureum* are readily available. Where sugar-cane tops are abundant these could also be ensiled. Under rural conditions, labour may be a serious constraint if large amounts of silage are to be made without mechanisation.

Increased conservation of feed as cut or standing hay and supplements for use in the dry season

Where animals are prevented from migration during the dry season, feeding strategies must be evolved that will prevent the animals from losing weight. Quite often some of the pasture is ungrazed during the wet season and retained for use during the dry season. This is called standing hay. This would require suitable supplements in order to maximise its efficiency of utilisation. Diets based on molasses/urea mixture may be employed to supplement dried standing hay (Gulbrassen, 1985). Whole cotton seed is occasionally used (Ngo Tama et al, 1987) in sheep rations in the semi-arid regions in North Cameroon. Similarly, cotton seed and groundnut cakes may be fed with straws, cut fodder or hay (Njwe, 1978; Fall et al, 1989).

The use of non-protein nitrogen (NPN) with standing hay has also proved most effective in dry-season feeding. Urea is most commonly used. The primary concern in feeding urea is providing sufficient amounts to be of value to the animal but minimising the risk of mortality from toxicity. NPN may be fed to animals by spraying on pasture in the field. The spray usually consists of 39% molasses, 6.25% urea and 54.75% water. This method is wasteful. Alternatively, the urea/molasses mixture may be fed separately as liquid in troughs placed in pastures, but the risk of poisoning, as each animal has free choice, is high. Block licks (40% urea, 10% molasses, 2.5% trisodium phosphate and 47.5% salt) have been used (Alexander et al, 1970). Molasses blocks of relatively low urea content can be used during droughts as high energy feed (Preston and Leng, 1987). The hardness of the blocks restricts and slows rate of intake.

Alexander (1978) has recommended incorporation of biuret in dry licks that contain salt. First, a 1:1 biuret to grain mixture is made. This is then mixed with salt in a ratio varying from 1:1 to 1:3. This mixture has been used to arrest decreases in body weight of sheep grazing dry poor quality pasture in Australia.

Use of fertiliser to improve pasture yields

On soils with low fertility, fertiliser application can increase dry-matter production per unit area. Superphosphate and nitrogen fertilisers like urea and ammonium sulphate are most widely used. Usually, fertiliser application is adopted in intensively managed systems in which high value products can justify the economic cost. The smallholder in most cases cannot afford the cost of using fertiliser, but farmyard manure from goat and sheep pens may be used in promoting higher pasture yields for a cut-and-carry intensive system of small ruminant production. Common fodder grasses that may be exploited in such a system include *Tripsacum laxum*, *Pennisetum purpureum* and *Panicum maximum*.

Conclusion

Unimproved pasture will continue to play an important role in small ruminant production in Africa. Overgrazing must be avoided to prevent degradation of these pastures. However, since these pastures become markedly deficient in quality, they are better utilised in the dry season with supplements such as urea-molasses, tree-forage legumes, leguminous browse, conserved legume hays and crop residues like groundnut and cotton haulms. Dehydrated poultry excreta from caged layers can also be exploited in supplementing poor quality forages during the dry season. It seems to be an economical protein supplement for ruminants especially as the cost of dehydration is low when compared to the cost of conventional feeds. A destruction of possible pathogens in poultry wastes needs to be done before it is used.

Quite often there may be competition for the use of some crop residues and agro-industrial products between livestock producers and industry. The production of paper from rice straw and alcohol from molasses, and the use of bagasse as fuel are common examples. This could easily render these feeds unavailable for livestock. Alternatives have to be identified and exploited to sustain livestock during a period of scarcity.

Conservation of herbage and surplus by-products by ensiling, drying or other means ensures a continuous supply of fresh and conserved feed over prolonged periods. Preservation of by-products of citrus industry either by ensiling or drying can make important contributions to the amount of locally available feed resources for small ruminants.

The cultivation of legumes in cropping systems may be hindered by the limited quantities and unaffordable prices of seeds. Commercial seed production which is a specialised activity, needs every encouragement by African governments. Several indigenous and introduced legumes and grasses need investigation in

order to recommend suitable species for cropping systems and pasture improvement.

Grazing sheep can help control weeds on rubber estates and provide income to smallholders (in smallholder schemes) during pretapping years. Optimum carrying capacities for different aged plantations need to be determined. Sheep seem to be more compatible than goats when reared on a semi-intensive basis in rubber and oil-palm plantations. Both species are suitable for coconut plantations.

Siivipasture offer potential feed resources for small ruminant production in densely populated areas with forest reserves. Goats tend to adapt better to siivipasture than sheep.

The feeding strategy to adopt will depend on factors such as climate, ecological conditions, topography, farming systems and prevailing socio-economic conditions.

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Some experiences in adapting previously free-ranging traditionally managed Matabele goats of Zimbabwe to individual stall-feeding

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Summary

One hundred multiparous indigenous does were purchased from communal farmers for on-station trials. At the research site, the goats were confined and zero-grazed. During adaptation, six goats died, 28 aborted, 56 kidded and 10 had no reproduction records. The does lost weight and were afflicted by diseases not previously experienced under the traditional management system. After nine months of adaptation to the station regime, the goats were synchronised for oestrous and mated. Only 74% of the flock conceived and kidded while 19% did not conceive and 7% aborted. Factors considered to be associated with the poor adaptability to stall-feeding of previously free-ranging goats are discussed.

Essai d'adaptation à l'alimentation individuelle à l'étable de caprins Matabele du Zimbabwe précédemment élevés en plein air suivant le système traditionnel

L.M. Sibanda, L.R. Ndlovu et M.J. Bryant

Résumé

100 chèvres multipares ont été achetées auprès d'éleveurs communaux pour cette étude. Une fois arrivées sur la station

expérimentale, elles ont été confinées et alimentées sans pouvoir avoir accès au pâturage. Au cours des cinq mois qu'a duré la période d'adaptation, elles ont perdu énormément de poids; six d'entre elles sont mortes, 28 ont avorté, 56 ont mis-bas tandis qu'aucun événement important sur le plan de la reproduction n'a été enregistré pour les 10 restantes. Au sixième mois, l'oestrus a été synchronisé chez les 94 chèvres encore vivantes, qui ont ensuite été mises à la lutte (1 bouc pour 10 chèvres). Seules 56% d'entre elles ont conçu et mis-bas. Les chèvres précédemment élevées en plein air — c'est connu — supportent mal la claustration et l'alimentation à l'étable, mais rien de concret n'a encore été fait pour remédier à ce problème. Il est recommandé que les chercheurs fassent connaître leur expérience en la matière pour permettre de mieux cerner le phénomène et d'y remédier.

Introduction

Extensive goat production under the traditional communal grazing system is widely practised in the semi-arid and arid regions of Africa which sustain 66.7% of the African goat population (FAO, 1984). This system, characterised by shortage of land, poor range management and seasonal fluctuation of feed supply favours mere survival rather than optimum production. Productivity of the goats in these areas can be improved by making more efficient use of the feed resources presently or potentially available to the farmer. To do this will require information on the nutrient quality of the feed as a function of season, the suitable physical form of the feed, the refusal rate and the physiological state and energy balance of the goats to be fed. Studies to generate such information often necessitate stall-feeding of the animals with no access to grazing. Unfortunately, when previously free-ranging goats are confined and stall-fed, they are stressed and may either eat less, lose weight, abort (Wentzel, 1987) or even die (Kasowanjete et al, 1986). Many feeding trials are usually prematurely abandoned when goats fail to adapt to stall-feeding and unfortunately most of these futile efforts but nonetheless useful experiences are never reported.

This paper discusses some of the problems experienced during the adaptation to stall-feeding of 100 previously free-ranging indigenous Matabele does.

Materials and Methods

Location

The reported work was carried out at the former Thuli Breeding Station which is situated in Matabeleland Province in the south-western part of Zimbabwe. The

region is semi-arid. The vegetation is mainly acacia shrub and mopane woodland with several species of annual grasses appearing during the rainy months of November to March. Droughts are frequent, consequently herbage quality and quantity fluctuate within and between years. The total amount of rainfall during the study year (1989) was 162 mm. The mean maximum and minimum temperatures were 28°C and 13°C, respectively.

Animals

In May 1989, one hundred multiparous indigenous Matabele goats were bought from communal farmers living within a 20-kilometre radius of the research station. The animals were driven on hoof to the research site. They were ear-tagged, weighed and their age was determined by counting the number of permanent incisors.

Management of the does during adaptation

On arrival the does were dewormed, dipped and vaccinated against pulpy kidney disease. Thereafter deworming and dipping were repeated on a regular basis.

The animals were housed in groups in a large animal house with concrete floors and partial roofing that allowed adequate ventilation. A forage mixture (two-thirds veld hay and one-third lucerne hay) with a mean crude protein content of 12% and neutral detergent fibre content of 60% was offered *ad libitum* in raised feeding troughs. Water and a salt mineral blocks were freely available to the animals. As from September 1989 (fourth month of adaptation), all the does were individually offered 100 g maize grain daily so as to increase energy intake in preparation for breeding on-station. At the end of the fifth month of adaptation (October 1989), the goats were synchronised for oestrous using progesterone-impregnated intravaginal sheep sponges (Veramix 60 mg medroxyprogesterone, Upjohn, UK). The sponges were withdrawn after 14 days and 2 days thereafter, 10 large Matabele bucks, with a mean liveweight of 65 kg, brought in from Matopos Research Station, were introduced to the flock. The bucks continuously ran with the does during the day but were confined separately overnight so that mating records could be kept.

In order to determine pregnancy, blood was collected through the jugular vein 21 days after mating and twice weekly thereafter. The blood was kept at 2°C overnight and allowed to clot. After 24 hours, serum was decanted and stored at -20°C until assayed for progesterone levels using a radio-immunoassay technique developed for goat serum.

All goats were weighed weekly and kept under close observation during the adaptation period. All incidences of diseases and reproduction were recorded.

Results and Discussion

The adaptation period was intended to take three weeks but had to be extended to six months due to problems associated with feeding, disease incidences and reproduction.

Feeding

In the first four weeks of adaptation, feed refusals were approximately 60% of the feed offered as goats selected mainly lucerne hay which constituted only 24% of the total dry matter offered. When the forages were ground in an effort to reduce selection, feed refusal rates doubled because the feed was dusty. Low dry-matter intake (below 40% of the expected intake) during the first few months of adaptation is not uncommon in stall-feeding trials involving goats fed forage-based diets (Ademosun et al, 1985). The low feed intake has largely been attributed to the ability of goats to select and ingest the higher quality of diets on offer (Owen and Aboud, 1988). Owen and Aboud (1988) have shown that intake will improve when goats are permitted to reject at least 50% of the feed offered rather than the conventional 10 to 20%.

The reduced feed intake experienced in the first few weeks of adaptation may be the root cause of the observed liveweight losses, diseases and abortions.

Diseases

The most prevalent diseases during adaptation were orf (contagious *ecthyma*), gaseous lymphadenitis, kerato-conjunctivitis (pink eye) and swollen knee joints. In cases of orf, daily swabbing of the lesions with salt solution and gentian violet led to rapid recovery.

In the second month of adaptation (July 1989) there was an outbreak of pink eye disease which spread rapidly amongst the whole herd; treatment with oxytetracycline led to quick recovery. Swollen knee joints were observed in 20 does and all 100 breeding bucks in the second month of adaptation. These swellings were diagnosed as non-pathogenic (no antibodies to caprine *Arthritis encephalitis* virus) and were attributed to lack of exercise due to confinement. The affected goats spontaneously recovered within four weeks.

Diseases encountered during adaptation may have led to the liveweight losses, abortions and acyclicity. In our study, incidences of orf and gaseous lymphadenitis were a lot higher than in normally experienced under the traditional system.

Six does died during the first month on station. Autopsies carried out were test negative for bacteriological and virological pathogens.

Doe liveweight changes

There were (P) differences in mean doe liveweights at buying between the different age groups (Table 1). Mature 8-tooth does were 18% and 35% heavier than the 6- and 4-tooth age groups, respectively. In the first 6 weeks on station all does lost an average 56 g/day. After six months adaptation (November 1989) when the does were mated, doe liveweight differences were smaller although the younger 4-tooth does were still significantly (P) lighter than the 6- and 8-tooth groups which were about equal in weight. As from November (sixth month of adaptation) all does gained weight. The highest gains were in the 4-tooth age group (90 g/day) compared to 53 g/d and 80 g/day for the 6- and 8-tooth groups. These weight gains could be attributed to replenishment of lost body tissue and genuine growth in the immature 4- and 6- teeth groups.

Table 1. Doe liveweights during adaptation to on-station conditions.

Date	Variable record	Age	Number of teeth		Total/Mean
		4	6	8	
May 1989	No. of goats	18	46	30	94
May 1989	Mean weight at buying (SD)	29.4a (3.97)	33.7b (4.83)	39.8b (5.22)	34.8
Nov. 1989	Mean weight at mating (SD)	(2.97)	(5.64)	(4.19)	

All row values with different superscripts are significantly ($P < 0.05$) different.

(SD) = standard deviation.

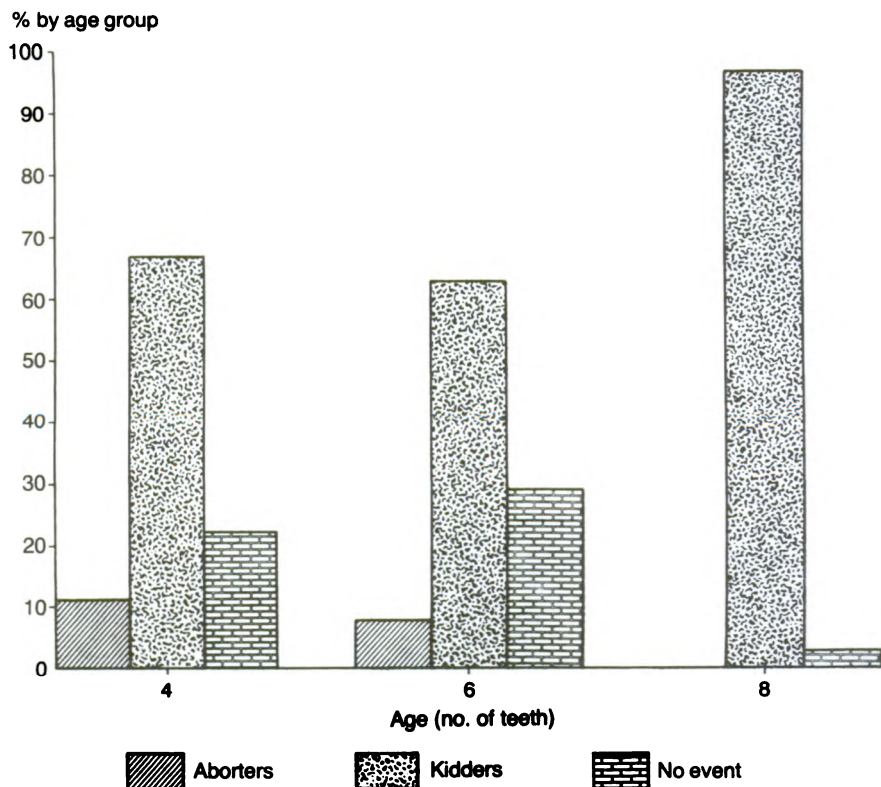
Reproduction

Notwithstanding the concerted efforts to avoid buying pregnant females, about 90% of the goats purchased turned out to be pregnant (Figure 1), mostly in the second month of gestation. None of these goats had shown overt pregnancy symptoms when purchased.

During the first three months of adaptation, 30% of the does aborted. The highest number of aborters was in the young 4-tooth age group where almost 1.5 and 8 times more does aborted than in the 6- and 8-tooth age groups, respectively (Figure 1). Specimens from the aborted fetuses and placentae were tested for leptospirosis, contagious abortion, Rift Valley fever and blue tongue. All test results were negative and it was postulated that stress factors (such as a sudden change of environment, rather than disease could have caused the abortions. Based on information available in other ruminants and observations made in goat flocks, Morand-Fehr (1987) has concluded that pregnant goats are very

sensitive to various kinds of stress such as rapid variations of environmental conditions, excessive animal density in the goat house, struggles between animals, psychic shock etc.

Figure 1. *Reproductive response to breeding on station (April–July 1990).*



Hypersensitivity to stress of pregnant goats has been explained by the theory that, unlike other domestic ruminants where both the corpus luteum and the placenta secrete progesterone, pregnancy in goats is sustained by progesterone secretion from the corpus luteum only (Sheldrick et al, 1980).

Intravaginal sponges that were used for oestrus synchronisation could not be withdrawn from 10 does. The sponges were eventually pulled out after surgical manipulation of the vagina. Five of the does resumed normal oestrus after three months but the others remained acyclic.

Mating was expected to commence two days after sponge withdrawal but was delayed by 20 days. Reasons for this delay cannot be readily explained. It is possible that the sheep intravaginal sponges used were unsuitable for goats, though other workers have reported successes with progesterone impregnated sheep sponges used on goats (Cameron et al, 1988). Environmental effects such as ambient temperatures could have contributed to the delay of oestrus onset or lack of libido after sponge withdrawal. It has often been stated that goats in the tropics will kid all year round (Wilson et al, 1984; Hale, 1986). However, there are indications of definite peak kidding periods, usually two per year, availability as influenced by rainfall patterns (Hale, 1986). It is possible that the rains also have a cooling effect on cyclic goats which enhances libido. In sheep, it has been shown that a high proportion of mating occurs in the early morning and activity subsides to a low point at midday and increases again in the evening (Blockey and Cummings, 1970). In this study the mean daily temperature was above average (34°C) when the goats were exposed to the bucks and mating only commenced a day after the first rains of the season.

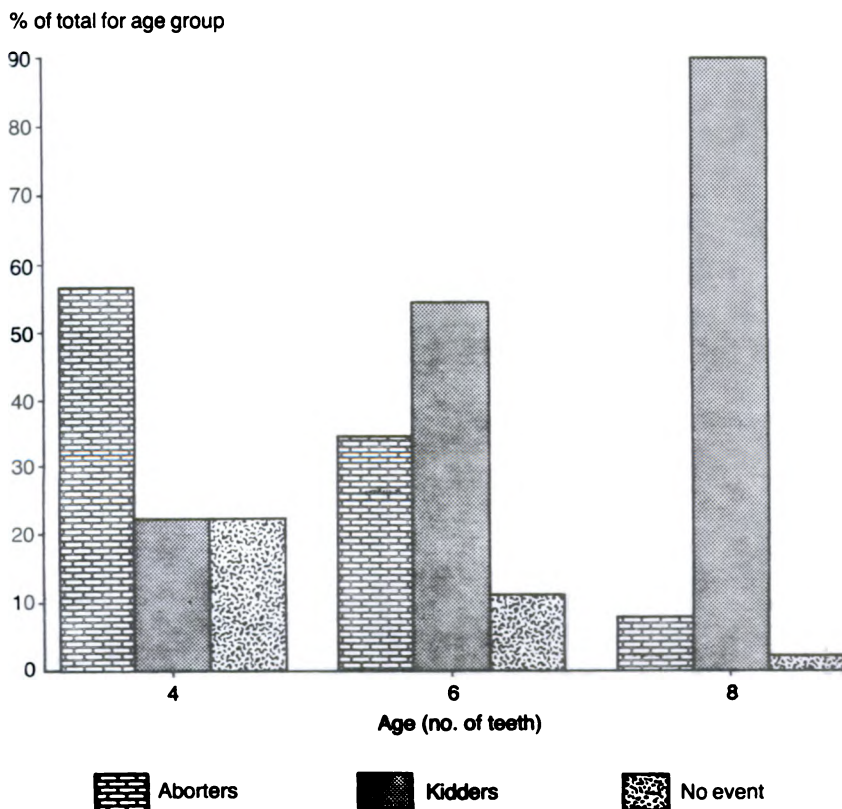
Mating (November 1989) lasted about four weeks and only 50% (48 goats) of the flock conceived as confirmed by consistently high blood progesterone levels (1 ng/ml). The rest of the flock which did not conceive in November continued to run with the bucks. Twenty eight of the remaining 46 goats were mated in February after which there were no further matings (Figure 2).

Combining the reproductive outcome for matings in November and February (after 6-9 months adaptation to on-station regime), 74% of the original flock purchased managed to conceive and kid, 7% aborted while 19% remained acyclic recording basal blood progesterone levels (<0.3 ng/ml). The number of goats that aborted was far less after nine months (7%) on-station (Figure 2), as compared to 28% (Figure 1) in the second month on-station. Mature 8-teeth does had the best performance with the highest number of goats kidding (96%), the least number of does remaining empty (4%) and no aborters (Figure 2). The abortion rate was higher in the younger 4-tooth does (11%) than in the 6-tooth does (8%) which were 7.6 and 4.2 kg, respectively, does lighter than the mature 8-tooth does at mating. The presence of habitual aborters (does with a long standing poor reproductive history) in the flock cannot be ruled out. It is quite likely some farmers took advantage of the sale to rid themselves of their non-productive stock. This could also explain barrenness of 10 goats at buying and the failure of the same goats to conceive at mating in November and in February.

The fact that more does conceived when mated in February (increasing the total kidding rate in response to breeding on-station from 46% to 74%) means that given time to adjust a larger proportion of the goats will conceive and kid. Unfortunately this prolonged adaptation greatly inflates the cost of goat research projects as compared to cattle and sheep which usually adapt to stall-feeding in 3 weeks. Unlike cattle and sheep, goats seem to have a lower stress threshold

demonstrated by being very sensitive and reacting adversely in an exaggerated manner to stress caused by change of routine.

Figure 2. Reproductive response during adaptation (May–July 1989).



Poor adaptability to stall-feeding of goats previously managed under the traditional system presents serious problems to researchers wishing to carry out feeding trials and to entrepreneurs wishing to rear goats under an intensive feeding system. Kasowanjete et al (1986) lost 428 breeding does within the first 3 years of setting up a goat breeding station in Malawi and attributed the deaths to general adaptation problems. Peters (1989) has reported on-station performance below levels measured on-farm and attributed this poor on-station performance of goats to differences in management systems, reduced feed selection possibilities and higher disease risks.

Conclusion

In our experience, adaptation to on-station regime by indigenous Matabele goats previously managed under the traditional extensive system took more than 6 months. In the first few months, the goats ate very little forage and consequently lost weight. Diseases not previously experienced in the traditional system became a problem on station. Reproductive performance was poor, especially among the younger groups of females, suggesting that adult females have a better chance of adapting to complete confinement.

It seems that numerous environmental factors acting either individually or collectively will impose some degree of stress but our knowledge of the ability of these previously free-ranging goats to adapt or adjust to stall-feeding needs to be improved by further long-term research.

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Fattening mature indigenous (Matabele) goats: Effects on animal performance, body and carcass composition

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Abstract

Complete cereal-based diets, containing either 50, 33, 22, or 10 veld hay (9.7, 10.3, 11.6, and 12.1 MJ ME/kg DM, respectively) were fed to 40 wethers, to achieve a target body mass gain of 10 kg by 230 days. Ten animals were slaughtered at the start of the experiment to determine initial carcass mass and the body and carcass composition.

For animals which attained the target, slaughter mass growth rate and feed intake were similar between diets. Animals fed the 22 per cent hay diet out-performed the others in terms of mean body mass gain feed conversion ratio. Means of performance traits had high coefficients of variation and it is suggested that the heterogeneity of the sample population may have masked treatment effects.

Compared to the preliminary slaughter group, carcass mass and yield was significantly ($P < 0.05$) increased by feeding as was fat deposition in both visceral and carcass depots. The quantity of fat deposited appeared to be positively related to dietary energy concentration.

Embouche de caprins adultes de race locale matabele : effets sur les performances et la composition de la carcasse

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Résumé

Des rations équilibrées à base de céréales contenant 50, 33, 22 ou 10% de foin (9,7; 10,3; 11,6 et 12,1 MJ d'EM/kg de MS respectivement), ont été distribuées à 40 boucs castrés, l'objectif étant de réaliser un gain total de poids vif de 10 kg. Au début de l'expérience, 10 autres boucs ont été abattus afin de déterminer le poids et la composition initiaux de la carcasse. Pour les animaux qui ont atteint l'objectif de gain pondéral visé, le taux de croissance et la quantité d'aliment ingérée n'ont pas été significativement différents ($P>0,05$) selon les rations. Les meilleures performances ont été enregistrées pour la ration à 22% de foin, avec un gain pondéral de 92 g/jour et un taux de conversion de 9,5 kg de matière sèche par kg de poids vif. Les coefficients de variation des moyennes des paramètres étudiés étaient élevés, ce qui suggère que l'effet des traitements avait peut-être été masqué par l'hétérogénéité de l'échantillon.

Par rapport aux abattages témoins, le poids et le rendement de la carcasse ont augmenté significativement ($P<0,05$) de même que les quantités de matière grasse déposées aussi bien dans les viscères que dans la carcasse. Enfin, il y a une corrélation positive entre la quantité de graisse déposée et la teneur en énergie de la ration.

Introduction

Peasant farmers in Zimbabwe own over two million goats (CSO, 1989). These goats, predominantly of the 'indigenous' type, are a heterogeneous population unselected for productive traits. Goats in Zimbabwe are reared primarily as meat animals (Hale, 1986), with little information on carcass attributes. Research in an extensive production system with the 'Matabele' goat of southern Zimbabwe, has suggested that a slaughter mass of about 38 kg will yield carcasses with desirable meat characteristics (Tawonezvi and Ward, n.d.).

The effects of fattening goats on complete cereal-based diets differing in energy content, on animal performance, body and carcass composition were investigated.

Materials and Methods

Fifty wethers (castrated goats) from the Matopos Research Station flock, aged either 18 or 24 months were used in the experiment. The goats were allocated into five groups of 10 animals each, balanced for body mass and age. One group (PS), was slaughtered at the beginning of the experiment to estimate the initial carcass mass and body and carcass composition.

The remaining groups were randomly allocated to one of four diets containing either 50 (H50), 33 (H33), 22 (H22) or 10 (H10) per cent coarsely milled (<1.5 cm lengths) range hay. Chemical composition and digestibility of the diets (Table 1) were as reported by Hatendi et al (1990). Animals were individually penned and offered feed in two equal meals at 07.00 and 14.00h daily. The amount of feed offered daily was adjusted each morning to allow refusals of between 100 and 200 g. Water was available at all times. Animals were slaughtered after gaining 10 kg body mass. The experiment ended after 230 days due to lack of feed.

Table 1. *Composition and apparent digestibility of diets offered to goats.*

	Hay level			
	50%	33%	22%	10%
Veld hay	500	330	220	100
Cottonseed meal	100	100	100	100
Maize meal	320	495	608	731
Molasses	50	50	50	50
Urea	12	7	4	1
Salt	7	7	7	7
Limestone flour	5	5	5	5
Gypsum	5	5	5	5
Vit/min premix ¹	1	1	1	1
Dry matter (DM) (g/kg)	910	910	910	900
Ash (g/kg DM)	80	70	60	60
Crude fibre (g/kg DM)	190	160	90	90
Crude protein (g/kg DM)	200	190	150	160
Ether extract (g/kg DM)	30	30	40	40
Dry-matter digestibility ²	0.69	0.73	0.74	0.83
Estimated metabolisable energy ² MJ/KG DM	9.67	10.33	11.60	12.09

1. 1 kg = 3×10^6 i.u. retinol, 35 g manganese, 35 g zinc, 0.6 g selenium and 0.12 g iodine.

2. Hatendi et al (1990).

Animals were weighed before and after a 24 to 30-hour fast to determine final body mass (FBM) and mass at slaughter (SM), respectively. The head, feet, pelt, full gut, omentum mesentery, liver and heart were removed and weighed. The mass of the empty gut was determined after washing-out the gut contents whose mass was estimated by difference (full gut–empty gut).

Hot carcass mass was recorded within 30 minutes of slaughter and cold carcass mass after chilling at approximately 7°C for 48 hours. Chilled carcasses were visually scored for fat cover as described by Colomer-Rocher (1987).

Carcasses were cut into three sections. The fore section was removed from the carcass by cutting between the 6th and 7th ribs, and the rib section separated from the hind section at the penultimate rib. Eye-muscle depth, eye-muscle width and backfat depth were measured with callipers on the cut surface of the penultimate rib.

The carcass sections were split along the mid-line and the right sides sealed in plastic bags and frozen pending chemical analysis. Prior to analysis the frozen sections were ground twice through a cutter-grinder fitted with a 9-mm screen (Jeffco Food and Fodder Cutter-grinder Model 262B). Ground carcasses were thoroughly mixed by hand and a representative sample analysed to determine dry matter, crude protein, ether extract and ash content (O'Donovan and Elliot, 1971).

Initially data from both the PS and fed treatment groups were analysed for treatment differences by ANOVA using age and initial body mass (IBM) as covariates. Where significant treatment effects were found orthogonal comparisons were made between the PS and the fed-treatment means. Subsequently, data from the fed treatments only were reanalysed by ANOVA using age and IBM as covariates and differences between diets evaluated using paired orthogonal contrasts. Differences ($P < 0.05$) between means of fed animals are indicated in tables by use of superscripts.

Results

Three animals died during the trial of unspecified causes (Table 2). These, in addition to the six animals which did not attain the targeted body mass, and had daily body mass gains of less than 35 g/d were excluded from the analysis.

Diet offered did not affect ($P > 0.05$) animal performance traits (Table 3) though performance generally tended to improve with decrease in dietary hay.

Slaughter mass and the carcass characteristics of all groups are shown in Table 4. Among the fed treatments, though gut fill at slaughter and the proportion of SM represented by gut fill were significantly higher ($P < 0.05$) for the H50 than either the H33 or H22 groups, diet had no effect on empty body mass. Carcass

Table 2. *Fate of fed goats offered diets containing different roughage levels.*

	Hay level			
	50%	33%	22%	10%
Body mass gain ≥ 10 kg	10	8	7	4
Body mass gain < 10 kg	-	2	2	2
Fatalities	-	-	1	2
Total	10	10	10	10

Table 3. *Performance characteristics of fed goats which gained 10 kg body mass.*

	Hay level				se
	50%	33%	22%	10%	
Initial mass kg	25.5	26	23.9	27.4	0.51
Final mass kg	35.6	36.3	34.3	37.5	0.53
Daily gain g	68	75	92	74	4.3
Total gain kg	10.1	10.3	10.4	10.1	0.10
Total dry-matter intake kg	130.5	118.3	97.8	113.9	4.76
Feed-conversion ratio (kg food/kg gain)	12.9	11.4	9.5	11.3	0.60

masses of animals offered diet H50 were lower ($P < 0.05$) than for those offered H33 and H22.

Carcass fat score was lower ($P < 0.001$) for the PS than the fed animals (Table 4). Among fed groups, though diet had no effect on fat score, it was highest for animals offered H10.

Body parts of fed animals were heavier than those of PS animals. In terms of proportion of EBM, however, they were lower, except for the omental and mesenteric (O+M) fat (Table 5). Amongst the fed treatments the weight of the O+M fat depots and their proportion of EBM were lowest ($P > 0.05$) for animals offered H50 (Table 5).

As proportions of the cold carcass the fore and hind sections were lower ($P < 0.001$) and the rib section higher ($P < 0.001$) for the fed groups as compared the the PS group (Table 6). There were no differences ($P > 0.05$) among the fed groups in carcass proportions.

Eye-muscle width and depth tended to be greater (though not significantly as for the fed animals) than the PS group (Table 7). Among the fed groups, there were no differences in eye-muscle dimensions and back fat. Weight and proportion in the carcass of the kidney knob and channel fat (KKCF) was lower ($P < 0.001$) for

Table 4. Carcass characteristics of preliminary slaughter and of fed goats.

	Hay level					PS vs	
	PS	50%	33%	22%	10%	SE	FED
Slaughter							
mass (SM) kg	26.1	34.1	33.6	33.2	36.5	0.53	***
Gut fill kg	6.0	4.9 ^a	3.5 ^b	3.6 ^b	4.4 ^{ab}	0.14	***
GF/SM kg/kg	0.23	0.15 ^a	0.10 ^b	0.11 ^b	0.12 ^{ab}	5.1	***
Empty body							
mass (EBM) kg	20.1	29.2	30.1	29.6	32.1	0.49	***
Carcass mass							
Hot kg	11.1	16.9 ^a	18.5 ^b	17.1 ^b	18.9 ^{ab}	0.27	***
Cold (CCM) kg	10.6	16.4 ^a	18.1 ^b	16.6 ^b	18.3 ^{ab}	0.27	***
Killing-out ratios							
(CCM/SM)	0.40	0.48 ^a	0.54 ^b	0.50 ^{ab}	0.50 ^{ab}	0.005	***
Carcass fat							
cover ¹	1.5	2.5	2.8	2.7	3.3	0.09	***

¹where 1 = low cover, 2 = slight cover, 3 = average cover, 4 = high cover, 5 = very high cover (Colomer-Rocher et al, 1987).

Values in the same row with the same superscript are not significantly ($P > 0.05$) different.

Table 5. Proportions (g/kg) of body parts in empty body of goats preliminary slaughtered (PS) and fed.

	Hay level					SE	PS vs FED
	PS	50%	33%	22%	10%		
Head	82	66	65	64	61	1.1	***
Feet	38	30	28	27	28	0.6	***
Pelt	110	70	70	69	66	1.7	***
Heart	6	5	5	5	5	0.6	*
Liver	27	18	18	22	20	1.7	***
Empty gut	162	121	120	117	99	0.2	***
Omentum + mesentery	15	29 ^a	42 ^b	38 ^b	50 ^b	2.7	***

the PS than the fed groups. Among the fed groups KKCF weight and its proportion of carcass mass tended to increase as the roughage level of the diet decreased and were significantly ($P < 0.05$) lower for the H50 group as compared to the other fed groups (Table 7).

Table 6. Proportions of carcass sections of preliminary slaughtered and fed goats.

	Hay level					SE	PS vs FED
	PS	50%	33%	22%	10%		
Fore section	0.47	0.45	0.45	0.46	0.46	0.002	***
Rib section	0.09	0.13	0.13	0.13	0.12	0.003	***
Hind section	0.45	0.42	0.42	0.42	0.43	0.002	***

Table 7. Eye muscle (Em) back fat and kidney measurements of the cold carcass of preliminary slaughtered and fed animals.

	Hay level					SE	PS vs FED
	PS	50%	33%	22%	10%		
em width mm	45	49	49	42	50	8	ns
em depth mm	18	23	25	22	23	5	***
Back fat depth mm	0	0.9	0.9	0.6	1.3	0.1	***
KKCF kg	0.14	0.55 ^a	0.99 ^b	0.84 ^b	1.01 ^b	0.03	***
KKCF/CCM g/kg	13	34 ^a	55 ^b	50 ^b	54 ^b	1.4	***

Values in a row with the same superscript are not significantly ($P < 0.05$) different.

KKCM = kidney knob and channel fat.

ns = not significant.

SE = standard error.

CCM = cold carcass mass.

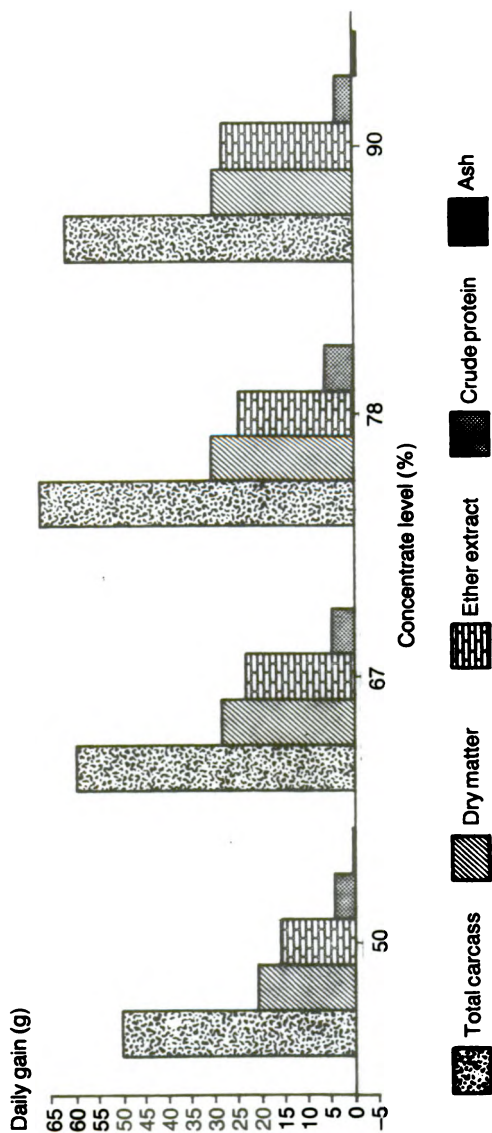
Table 8 shows the chemical composition of the right carcass side (less kidneys and KKCF). Compared to PS group, feeding decreased carcass water ($P < 0.001$), crude protein and ash content ($P < 0.001$) and increased ($P < 0.001$), carcass fat content. Among the fed groups carcass water, crude protein (CP) and ash were higher for the H50 group but differences were not significant. Carcass fat content was highest for the H10 group.

Table 8. Water content (g/kg) and chemical composition of the dry matter of the right carcass side of preliminary slaughtered and fed animals.

	Hay level					SE	PS vs FED
	PS	50%	33%	22%	10%		
	n = 8	n = 10	n = 8	n = 7	n = 4		
Water (g/kg)	588	536	516	488	511	6.9	*
Crude protein (%)	438	347	314	325	265	11.2	***
Ether extract (%)	384	542	590	579	654	14.4	***
Ash (%)	178	111	96	96	81	3.6	***

Daily carcass gain (less kidneys and KKCF) tended to have more fat as the concentrate proportion in the diet offered increased (Figure 1).

Figure 1. Mean chemical composition of carcass gain (less kidneys and KKCF).



Calculated by difference between means of preliminary slaughter and fed treatments.

Discussion

Dry-matter intakes of the fed animals ranged from 2.4–2.9 per cent of their body weight and falls within the 1.9 to 3.8 per cent range suggested by Devendra and Burns (1983) for meat goats fed *ad libitum*. The observed inverse relationship between intake, diet energy content and DM digestibility is in agreement with work elsewhere (ARC, 1980; Forbes, 1986). Mean daily intakes of energy and protein (estimated by difference between the composition of feed offered and refused), were 8.8, 9.6, 9.8, and 10.4 MJ ME and 200, 190, 130, and 140G CP for diets H50 to H10, respectively. In this experiment, growth rates at these intake levels were lower than those suggested (> 100 g/d) for growing goats by NRC (1981), Devendra and Burns (1983) or Wilkinson and Stark (1987). Animal performance was comparable to that reported for African breeds of goats reared intensively (Adebowale and Ademonsun, 1981; El Hag et al, 1984; El Hag et al, 1985). Growth rates in this trial were greater than the mean post-weaning gain between 5 and 18 months of 36 g/d reported at Matopos Research Station for extensively reared goats (Baffour-Awuah, 1987).

Means of performance traits in this study had high coefficients of variation. This suggests a lack of uniformity of the indigenous goat population and may have masked treatment effects.

Gut fill as a proportion of mass at slaughter was greater than the six to eight per cent reported for finished Sudan Desert goats (Gaali et al, 1972).

Carcass mass and yield of the fed animals in this study were greater than those previously reported at Matopos Research Station for animals of similar origin reared extensively (38 kg body mass yielding 16 kg hot carcass mass; Tawonezwi and Ward, n.d.), and are comparable to those reported elsewhere for finished goats of similar slaughter mass (Naude and Hofmeyr, 1981; Devendra and Burns, 1983).

Carcass fat cover increased appreciably in the fed groups. The observed large deposits of fat in the omentum + mesentery, and the kidney knob and channel fat depots, support reports which indicate minimal fat deposition in the subcutaneous fat depot of goats (Kirton, 1970; Gaali et al, 1972). The omental and mesenteric fat depots increased in weight by 3 to 5 times in the fed animals, representing between three and five per cent of the empty body weight. A large amount of fat was deposited in the carcass tissues of the fed animals.

Whilst some of the differences in carcass chemical composition between treatment groups can be explained by the relationship with carcass mass (Kirton, 1970; Naude and Hofmeyr, 1981), there was a tendency for the fat component of carcass gain to increase with dietary energy content and intake. The large amount of fat deposited in non-carcass and carcass fat depots may be indicative of the final body mass of animals in this study approaching their mature mass

and thus a tendency towards 'fattening' rather than 'growing'. The increased fat deposition with dietary energy level may in part be attributable to the effects of reduced protein: energy ratio of the diets as the roughage content decreased (Beede et al, 1985; Mtenga and Kitaly, 1990).

Goats exhibit a centripetal growth pattern (Colomer-Rocher, 1987), with the proportion of the carcass represented by the forequarter and joints along the mid-line increasing with age and carcass mass (Kirtan, 1970; Owen and Norman, 1977). The resultant improved carcass conformation of the fed groups becomes evident if the carcass mass to length ratio is used as an objective indicator of conformation (Colomer-Rocher, 1987). Calculated from the means of cold carcass weight and body length, with the ratio of the PS group used as a baseline, ratios for the fed treatment groups were 1.3, 1.6, 1.4, and 1.5 for treatments H50 to H10, respectively.

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The utilisation of sorghum stover fed to sheep as influenced by urea or graded levels of lablab supplementation

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Summary

The effect of urea and graded levels of Lablab purpureus cv Rongai on the voluntary intake and utilisation of sorghum stover was determined with 30 Yankasa sheep. The physical and chemical composition of the sorghum stover and lablab as well as their stem and leaf fractions were described.

The intake of sorghum stover was depressed when supplemented with Lablab but overall feed intake improved with increasing levels of Lablab supplementation.

The addition of urea increased stover intake and the digestibility of the dry matter, neutral detergent fibre (NDF) and nitrogen. Supplementing sorghum stover with either Lablab or urea generally improved liveweight gains of the sheep. It is concluded that supplementing sorghum stover with Lablab improved its intake and utilisation. However at high levels of supplementation, Lablab tends to have a substitution effect on sorghum intake.

Effet d'une complementation d'uree ou de dolique sur l'utilisation de la paille de sorgho chez les ovins

I.F. Adu, B.A. Fajemisin et A.M. Adamu

Résumé

L'effet de l'urée et de niveaux croissants de dolique (Lablab purpureus) cv. Rongai (blanc) sur l'ingestion volontaire et l'utilisation

de la paille de sorgho a été étudié chez 30 moutons Yankassa. La composition physique (proportion de tiges, de feuilles) et chimique de la paille et du dolique est présentée.

La complémentation de dolique a déprimé l'ingestion de la paille de sorgho: (de 9 et 7% pour 90 et 180 g de dolique). Cette baisse est devenue significative ($P < 0,05$) avec une complémentation de 270 g.

L'addition d'urée a augmenté l'ingestion de paille et la digestibilité de la matière sèche et des parois cellulaires, respectivement de 6,5, 14,6 et 11,8% et a entraîné un accroissement significatif ($P < 0,05$) de la digestibilité de l'azote. La complémentation s'est globalement traduit par une amélioration du gain de poids des moutons. Au vu de ces résultats, il apparaît que la complémentation de la paille de sorgho par le dolique en améliore la consommation et l'utilisation. Toutefois, à niveau élevé (au-delà de 20%), le dolique tend à avoir un effet de substitution.

Introduction

Quantitatively, sorghum is the most important cereal crop grown in Nigeria (Table 1). About 46% of the estimated 21795000 hectares of land under cultivation is devoted to sorghum production with an annual total grain yield of about 5.53 million tonnes (Central Bank of Nigeria, 1988). Alongside this grain production is an estimated 22.14 million tonnes of stover which is available for ruminant livestock feeding. And since cereal crop growing areas are also the home of most of Nigeria's livestock population, cereal crop residues constitute an important feed resource during the dry season. Also, because Nigeria cannot as yet develop intensive livestock feeding systems based on expensive and scarce feed resources like grains, oilseed cakes, high-quality pastures, crop residues will continue to be important in Nigeria's livestock feed resources.

However, crop residues are known to have low content of available protein, energy and minerals. It is recognised that rumen fermentation is impaired and animal performance lowered when the nitrogen content of the diet is less than 1.2% (Conrad and Hibbs, 1968). The feeding of energy and protein supplements is known to enhance the utilisation of poor-quality feeds like crop residues by maximising roughage degradation and optimising rumen microbial protein synthesis (Anderson, 1978; O'Donovan, 1983). Because of high cost, scarcity and other logistic problems, the use of concentrates and non-protein nitrogen as supplements is not justified.

The current interest in a more intensive use of crop residues in Nigeria justifies the search for cheaper and readily available supplements. *Lablab purpureus* is a dual-purpose legume crop that is rapidly gaining acceptance by agropastoral

farmers in northern Nigeria (Tanko et al, 1990). *Lablab* has high seed and forage yield as well as good hay-curing ability compared with other commonly grown legume crops in Nigeria.

The objective of this study was to compare the effect of urea and three levels of *Lablab* supplementation on the utilisation of a basal diet of sorghum stover by Yankasa sheep.

Table 1. Annual grain, stover/haulm yield and nutritive value of some common crops in Nigeria ('000 tonnes).

Crop	Seed or grain ¹	Stover or haulm/vines ²	Crude protein content of stover/haulm(%)
Sorghum	5534	22136	1.6–7.5
Maize	1370	5480	2.6–4.9
Millet	4170	25020	4.0–5.4
Rice	307	2456	3.0–4.6
Cowpea	698	3490	5.9–10.4
Groundnut	709	2188	11.4–16.7
Benniseed	36	324	2.0–5.1
Soyabean	121	363	4.3–6.8

1. Central Bank of Nigeria (1988).

2. The extraction rates (seed:stover/haulm) developed by Alhassan and Kallah (1984) in NAPRI (unpublished) were used.

Materials and methods

Sorghum (SK-5912) was planted at a seed rate of 10 kg ha⁻¹. At planting, fertiliser was applied at the rate of 37.5 kg N ha⁻¹ followed at 6 weeks by a side-dressing of 22 kg N ha⁻¹. The sorghum was harvested for grains 123 days after sowing. After grain harvest, the whole plant was removed at ground-level and packed. Thereafter, a random sample was taken, weighed and subdivided into leaf and stalk portions. This paper reports the trials with ground sorghum stover (3–4 cm).

Lablab purpureus cv. Rongai (white) was planted from seed at the rate of 15 kg ha⁻¹. At 90 days the forage was cut and field-dried. A random sample was taken, weighed and separated into leaf and stem fractions. The *Lablab* was chopped into 1–2 cm pieces and used as the supplement in a series of experiments.

Samples of the whole sorghum and *Lablab* as well as their leaf and stem fractions were analysed for dry matter, nitrogen, NDF, lignin and ash (AOAC, 1975; Goering and Van Soest, 1970).

The nylon bag method (Orskov et al, 1980) was used to estimate ruminal degradation of the whole stover, *Lablab* and their respective leaf and stem fractions. About 3 g of each sample was placed in nylon bags (size 100 x 170 mm with 12 mm pore size) and were incubated in the rumen of 2 Bunaji cows in replicates. The bags were anchored by a 50-cm nylon string to the cap of the rumen cannulae and withdrawn at 12, 18, 24, 48 and 72 hours. They were then washed and dried at 60°C for 48 hours (Mehrez and Orskov, 1977) for the estimation of dry-matter and nitrogen disappearance. Thirty yearling Yankasa sheep with an average weight of 22.8 ± 0.7 kg were treated for endo- and ectoparasites and used for the 78-day feeding trial. The treatments were:

A — Sorghum stover *ad libitum*

B — Sorghum stover + 90 g *Lablab*

C — Sorghum stover + 180g *Lablab*

D — Sorghum stover + 270g *Lablab*

E — Sorghum stover + 9 g urea + sulphur to achieve N:S ratio of 10:1

The *Lablab* supplements were intended to provide 10, 20 and 30% of total intake while the urea represented 1.5% total intake. The urea was dissolved in about 5 cc of water and mixed with the sulphur. The resulting solution was mixed with a grab-sample of the stover and fed to the animals first before offering the basal diets. This was to ensure a complete consumption of the urea. The stover was fed *ad lib*. Animals were weighed fortnightly. A 7-day total faecal collection was done at the end of the feeding trial.

All data were subjected to analysis of variance and differences among treatment means were determined (Snedecor and Cochran, 1980).

Results and discussion

The sorghum stover is made up of 17.3% leaf, 26% upper softer stem and 56.7% lower woody stem while the corresponding figures for the *Lablab* are 38.7, 13.5 and 47.7%, respectively. In terms of physical composition the leaf and upper softer stem, which generally contain a higher concentration of most nutrients, constituted approximately 43 and 53% of the stover and *Lablab*, respectively.

The apparently higher ash content (Table 2) of the leaf fraction may be partly due to soil contamination while being dried in the field. As expected, the NDF and lignin in the stem fractions were generally higher than in the leaf fractions. The grinding of the stover reduced selection of leaf fraction which are generally more nutritious and more relished by animals (Martin and Wedin, 1974; Powell, 1985) and enhanced a better utilisation of the whole plant.

Table 2. *Chemical composition of whole, leaf and stem fractions of sorghum stover and Lablab.*

	Sorghum stover			Lablab			Sorghum stover + urea
	Whole	Leaf	Stem	Whole	Leaf	Stem	
Dry matter	96.6	95.9	96.5	94.6	93.1	95.1	94.8
Nitrogen	0.84	1.1	0.74	1.6	2.1	1.2	2.2
NDF	76.0	78.6	89.4	38.9	39.7	62.4	69.3
Lignin	11.8	10.7	13.6	4.2	6.8	10.9	14.3
Cellulose	43.0	21.9	47.3	10.5	21.9	40.4	39.3
Ash	7.8	7.7	3.6	7.4	11.1	6.5	8.6

The 48-hour dry-matter disappearance rate (Table 3) increased with incubation time. *Lablab* was degraded more rapidly than stover. In both cases, the leaf fractions was degraded more rapidly than the stem fractions. Supplementation of sorghum stover with either *Lablab* or urea improved its degradability (Table 3) and digestibility (Table 4).

Table 3. *Dry-matter disappearance (g/100 g) of whole leaf and stem fractions from nylon bag incubated in the rumen of Bunaji cows.*

Hours of incubation	Sorghum stover			Lablab			Sorghum stover + Lablab (4:1)	Sorghum stover + urea
	Whole	Leaf	Stem	Whole	Leaf	Stem		
12	8.9	13.8	7.6	10.9	14.7	9.7	12.7	10.3
18	13.1	21.5	11.8	15.1	19.1	12.5	17.2	14.2
24	25.4	31.8	21.1	29.2	32.4	22.2	30.7	27.6
48	33.8	42.4	29.6	35.5	43.5	28.4	37.4	38.1
72	41.2	50.6	37.0	48.6	53.6	35.9	44.3	44.2

Table 4. *Digestibility (g/kg) of the different feed combinations used.*

	Sorghum stover	Stover + 90g	Stover + 180g Lablab	Stover + 270g Lablab	Stover + urea Lablab
Dry matter	457	476	537	541	524
Organic matter	475	507	526	572	502
Crude protein	613 ^a	693 ^b	761 ^b	789 ^b	768 ^b
NDF	551	559	577	596	616

Means with different superscripts within each row are significantly different ($P < 0.05$).

Total feed intake increased significantly ($P < 0.05$) when the stover was supplemented with 180 g *Lablab*. The 85, 170 and 255 g actual *Lablab* intake accounted for 18.8, 31.4 and 53.3% of the total dry matter intake, respectively. Total feed intake and utilisation were generally better in sheep given stover plus either urea or *Lablab*, a confirmation that nitrogen is deficient in the stover (Table 5). Stover intake was depressed by 9 and 7% at the 10 and 20% levels of *Lablab* supplementation, while the depression (44%) was significant ($P < 0.05$) at the 30% level of supplementation. This result tends to support the contention that supplements have beneficial effects on the utilisation of fibrous feeds if the level of supplementation does not exceed 20% of the diet dry matter (Preston and Leng, 1984; Wegad and NDumbe, 1987). It would appear that *Lablab* had a substitution effect beyond the 20% level of supplementation.

Table 5. *Performance of sheep fed sorghum stover supplemented with urea or Lablab.*

	Stover alone	Stover + 90 g Lablab (10%)	Stover + 180 g Lablab (20%)	Stover + 270 g Lablab (30%)	Stover + urea
Stover intake (g/day)	401.3 ^a	367.1 ^a	372.3 ^a	223.5 ^b	427 ^a
Total DM intake (g/day)	401.3 ^a	452.2 ^a	542.2 ^b	478.8 ^a	427 ^a
Total DM intake (g/kgW ^{0.75} /day)	41.3	45.4	57.2	47.7	43.6
Liveweight gain (g/day)	-20.9	15.9 ^a	36.1 ^b	47.7 ^b	9.3 ^a
Feed efficiency		28.4	15.0	10.0	45.9

Means with different superscripts within each row are significantly different ($P < 0.05$).

Though not significant ($P > 0.05$) the digestion of dry matter, organic matter and NDF generally increased with increasing levels of *Lablab* supplementation.

Crude-protein digestibility was, however, significantly ($P < 0.05$) improved by the supplements. The supplements generally improved rumen fermentation of the test diets and the range of improvement falls within that reported by Sharma et al (1972).

The improved liveweight gains of sheep fed *Lablab* supplement justify its use in preventing liveweight loss during the critical dry season period.

It is concluded that the use of sorghum stover as a feed resource is greatly enhanced by supplementing with *Lablab*. The planting of *Lablab* with sorghum or maize has been accepted as a cropping practice by farmers in the subhumid zone of Nigeria. The settled farmers who feed crop residues to animals in their rugas can be encouraged to further reduce particle size (or grind) to enhance better utilisation. Already some well-to-do farmers have installed grinders on their farms.

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Lablab (*Dolichos lablab*) meal as protein supplement for weaned fattening lambs

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Summary

A study was conducted to investigate the effect of inclusion of Lablab meal on growth rate, feed intake and carcass composition of Black Head Persian (BHP) lambs. Twenty-four BHP castrate sheep with average weight of 14.1 ± 2.7 kg were allotted randomly to four dietary treatments. Lambs were individually maintained in metabolic crates. All animals were offered hay ad libitum. Lambs on control treatment (A) were given in addition 380 g of maize bran per day. Animals on treatments B, C, and D were given daily 380 g of concentrate based on maize bran with 25, 50 and 75% lablab meal, respectively.

Growth rate, dry-matter intake and feed conversion ratio were 34, 66, 68, 71 g/day; 58.7, 69.5, 74.0 g/kgW^{0.75}/day and 15.2, 11.3, 9.3, 9.1 g/DMI/g gain, respectively, of treatments A, B, C and D. The level of inclusion of lablab meal had no significant ($P > 0.05$) effect on killing-out characteristics. Hot carcass weight as percentages of slaughter weight and empty body weight were 41.3, 41.0, 40.5, 42.5 and 52.0, 52.3, 53.5, respectively, for animals on treatments A, B, C and D. Carcass composition expressed as percentage of carcass weight showed no significant treatment effects and value of 60.91, 61.29, 61.11 and 62.97% for carcass lean, 19.06, 20.24, 18.42 and 17.54% carcass fat and 17.86, 16.70, 17.91 and 16.67% for carcass bone were obtained for treatments A, B, C and D. It is concluded that inclusion of lablab meal in maize bran above 25% has no beneficial effect in terms of growth rate and carcass composition.

Utilisation de la farine de dolique (*Dolichos lablab*) comme complément protéique dans l'embouche d'agneaux sevrés

W.D. Mafwere et L.A. Mtenga

Résumé

Une étude a été effectuée en vue de mettre en évidence l'effet d'une complémentation alimentaire de dolique sur la croissance, la consommation et la composition de la carcasse d'agneaux de race Somali à tête noire (BHP). Vingt-quatre moutons BHP castrés, pesant en moyenne $14,1 \pm 2,7$ kg et gardés individuellement dans des cages métaboliques, ont été répartis au hasard en quatre groupes (A, B, C et D) de traitement recevant chacun une ration déterminée. Du foin leur était servi ad libitum.

Les animaux du groupe témoin (A) ont en outre reçu chacun 380 g de son de maïs par jour tandis que ceux des groupes B, C et D ont eu en remplacement la même quantité d'un concentré à base de son de maïs et contenant 25, 50 et 75% de farine de dolique.

Pour les groupes A, B, C et D, le gain de poids, la consommation de matière sèche et le taux de conversion des aliments furent de 34, 66, 68 et 71 g/jour; 58,7, 64,7, 69,5, 74,0 g/kg de poids vif^{0,75} et 15,2, 11,3, 9,3, 9,1 g MS/g de poids vif.

La teneur du concentré en dolique n'a pas eu d'effet significatif ($P > 0,05$) sur les caractéristiques à l'abattage. Le poids de la carcasse chaude exprimé en proportion du poids à l'abattage et en outre, le traitement n'avaient pas d'effet significatif sur la composition de la carcasse exprimée en proportion du poids de celle-ci: pour les animaux des groupes A, B, C et D respectivement, les chiffres obtenus étaient de 60,91, 61,29, 61,11 et 62,97% pour la carcasse maigre, de 19,06, 20,24, 18,42 et 17,54% pour la matière grasse de la carcasse et de 17,86, 16,70, 17,91 et 16,67% pour les os de la carcasse. Au vu de ces résultats, il apparaît qu'en ce qui concerne la croissance et la composition de la carcasse, il n'y a aucun avantage à donner à des agneaux un concentré à base de son de maïs contenant plus de 25% de dolique.

Introduction

Most of the four million sheep found in Tanzania are kept under extensive management systems and depend almost exclusively on natural pastures for their nutrient requirements. The availability of these feeds is mainly determined by the amount of rainfall and length of the dry season. Sheep find adequate quantities of a fair- to good-quality herbage during the initial months of the wet season and consequently gain weight. However, they start losing weight as soon as the grasses approach maturity and their condition deteriorates progressively through the dry season.

Several experiments with sheep and goats have shown that performance can be improved by protein supplementation (Mtenga and Nyaky, 1985; Mtenga and Kitaly, 1990). However, most of the supplements used such as soyabean, cottonseed cake and cashewnut cake are expensive and are not readily available in sheep-rearing areas. Leguminous multipurpose trees and forages such as lablab niger offer the best alternative cheap source of protein supplement. Lablab can be easily cultivated and is drought resistant. It can be successfully grown in dry areas with rainfall as low as 400 mm (Luck, 1965). It can also be intercropped with maize or sorghum. The beans as meal and the forage as hay or silage, can form a good source of supplement to ruminants.

A detailed study is underway at Mpwapwa in Tanzania to evaluate the yield and effect of supplementing low-quality maize and sorghum stover with lablab to provide further information on the effect of supplementing low-quality Rhodes grass hay with different levels of lablab bean meal on performance of lambs.

Materials and Methods

Animals and dietary treatments

A completely randomised design was undertaken with 24 castrated Black Head Persian (BHP) lambs. The age of the lambs was between 4 and 7 months and initial weight was 14.1 ± 2.7 kg. Animals were randomly allocated to four dietary treatments. *Chloris gayana* hay was harvested from the University farm and was offered *ad libitum* to animals in all treatments. In addition to hay, animals in treatments A, B, C and D were offered 380 g of supplements containing maize bran, lablab seed meal and mineral mixture in ratios of 95:0:5, 70:25:5, 45:50:5 and 20:75:5, respectively. The supplements were formulated to contain 100.7, 141.7, 182.7 and 223.7 g CP/kg DM for treatments A, B, C and D, respectively. The mineral mixture contained Ca 186, P 35, Na 130, Cl 200, Co 0.3, Cu 1.2, Fe 3.1, Mg 4.4 and SD 1.8 g/kg.

Lambs were penned in 150 x 90 cm wooden pens and fed individually. Hay was chopped into 4–6 cm length and was offered twice a day at 09.00 and 14.30 hrs

while supplements were given once a day at 08.00 hr. Water was available at all times. Animals were weighed weekly. Samples of hay and supplement offered and refusals were collected for chemical analysis.

Slaughter and carcass evaluation

At the end of the feeding period which lasted for 100 days, four animals per treatment were slaughtered, skinned and eviscerated. The head was removed at the OS occipitate-first cervical junction, while the hind and forefeet were separated at the tarso-metatarsal and carpo-metacarpal junctions. Carcass was weighed after the kidney and pelvic fat was removed. The carcass was split into two halves and the left side was dissected into lean, fat and bone (Cuthbertson et al, 1972).

Chemical analysis

All dried feeds were ground to pass through a 1-mm screen in a Christy and Norris 20-cm laboratory hammer mill. Chemical components of the feeds and meal samples (Table 1) were determined by standard methods (AOAC, 1975).

Table 1. *Composition of hay, feed ingredients and supplements.*

	Hay	Hay refusal	Maize bran	lablab meal	Supplements			
					A	B	C	D
No. of samples	8	8	6	6	6	6	6	6
DM (g/kg ADW)	850	860	898	876	894	892	885	882
Composition of DM (g/kg)								
Crude protein	52	24	134	254	132	169	206	227
Crude fibre	380	437	57	921	56	67	78	86
Ether extract	7	9	49	6	49	32	24	14
Ash	60	126	46	47	46	46	48	47
Organic matter	940	874	954	953	954	954	952	953

DM = Dry matter;

Statistical analysis

Data were analysed by standard analysis of variance procedure for a completely randomised design (Steel and Torrie, 1980). If the treatment mean square was significantly greater than error mean square, treatment means were compared

by the New Multiple Range Test of Duncan, using standard error of difference (s.e.d.) at $P < 0.05$.

Results

Chemical composition of *Chloris gayana* hay, individual feed ingredients and the supplement are shown in Table 1. The supplements in B, C and D had crude protein content of 169, 206 and 227 g/kg DM. These values are higher than the initially intended values of 141, 183 and 224 g/kg DM, respectively, derived from published figures. Hay refusals were lower in crude protein than hay offered.

Total dry-matter intake (g/day and g/kgW^{0.75}) increased with increasing level of dietary lablab meal in the supplements as a result of increased intake of hay (Table 2). Lambs on treatments B, C and D consumed 18, 43 and 50% more hay than lambs on treatment A (without lablab supplement). A similar trend was also observed in protein intake and animals on treatments B, C and D consumed 27, 58, 86% and 28, 56, 90% more protein per day and per kgW^{0.75} than animals on treatment A. The estimated concentrations of protein of diets consumed were 7.8, 8.8, 10.9 and 12.2 g digestible crude protein per MJ ME.

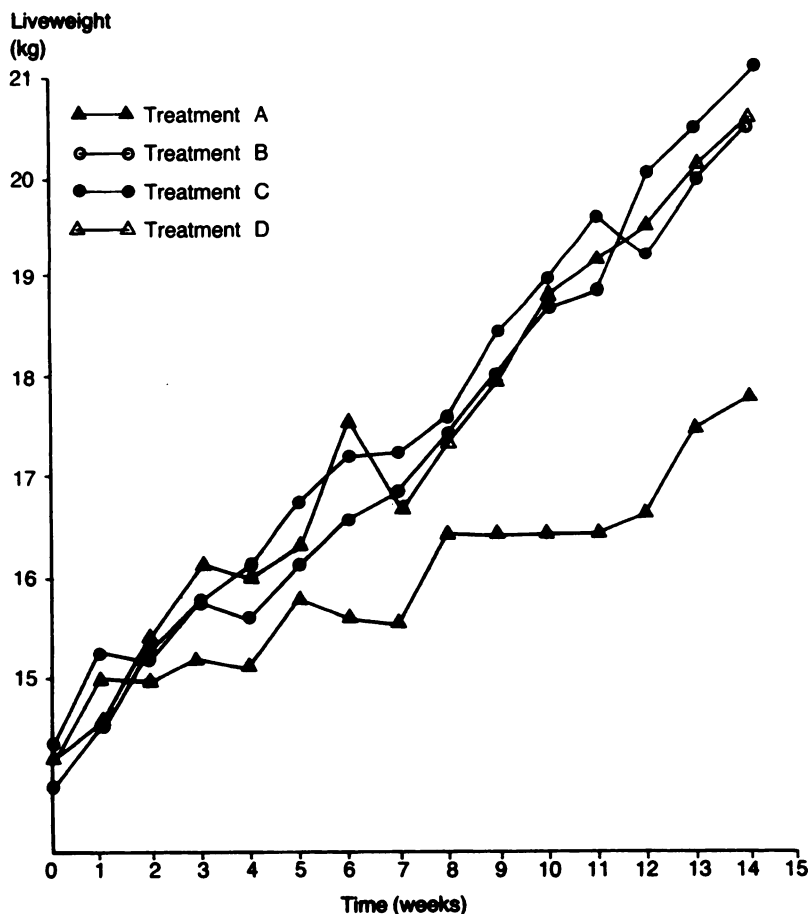
Table 2. Effect of level of lablab meal in supplements on feed intake and growth rate.

	Treatments				SED and significance
	A	B	C	D	
Initial weight (kg)	14.88	13.97	14.97	13.14	1.253 NS
Final weight (kg)	17.76 ^a	20.47 ^b	21.10 ^b	20.62 ^b	8.971***
Growth rate (g/day)	34 ^a	66 ^a	68 ^b	71 ^b	9.7***
Intake (g/day)					
Hay	194 ^a	228 ^{ab}	276 ^b	291 ^b	4.3**
Total DM	498 ^a	547 ^{ab}	596 ^b	630 ^b	5.35**
Crude protein	56.6 ^a	72.4 ^b	89.5 ^c	105.4 ^d	1.08***
Intake (g/kgW ^{0.75})					
DM	58.7 ^a	64.8 ^b	69.5 ^c	72.0 ^c	1.71***
Crude protein	6.7 ^a	8.6 ^b	10.5 ^c	12.8 ^d	0.49***
gDMI/g gain	7.8	8.8	10.9	12.2	-
gDMI/g gain	15.2a	11.3b	9.3b	9.2b	1.13***

DM = dry matter; DMI = dry-matter intake; SED = standard error of difference; NS = not significant.

Mean weekly liveweight changes as influenced by treatment are shown in Figure 1. Animals without lablab meal supplement (treatment A) were inferior in growth rate throughout the period of study. However, treatment differences in growth trends of animals with lablab supplements (treatments B, C, and D) were not apparent. Table 2 shows that animals on treatment A had significantly ($P < 0.05$) slower growth rate than animals on treatment B, C, and D. However, the difference in food conversion ratio among animals offered different levels of lablab supplement were small and insignificant (Table 2), but animals that received 25% lablab did not gain as fast as those fed which had higher levels of lablab ($P < 0.05$).

Figure 1. Mean weekly liveweight as influenced by level of lablab supplementation.



The level of inclusion of lablab in the ration had no significant effect on killing-out characteristics (Table 3). Dressing percentage showed no defined pattern. Animals on treatments A and B had significantly higher proportion of kidney fat than animals on treatment D. The weights of lean, fat and bone as percentages of carcass weight and tissue ratios were also not affected by treatment.

Table 3. *Effect of levels of lablab meal in supplements on slaughter.*

Characteristics and carcass composition					SED and significance
	Treatments				
	A	B	C	D	
Carcass weight					
% SW	41.3	41.0	40.3	42.5	0.83 NS
% EBW	52.5	52.0	52.3	53.5	1.11 NS
Components (% EBW)					
Gut fat	2.7	2.3	1.7	1.3	0.38 NS
Head	8.5	8.0	8.0	7.4	0.29 NS
Skin	9.6	9.5	10.2	9.0	0.40 NS
Alimentary tract	8.4	8.6	7.8	7.9	0.31 NS
Liver	1.7	1.8	1.8	1.7	0.09 NS
Kidney and pelvic fat	1.4 ^a	1.49 ^a	0.9 ^b	0.7 ^b	0.14*
Heart	0.8	0.8	0.8	0.7	0.334 NS
Tissue in carcass (%)					
Lean	60.9	61.3	61.1	63.0	1.19 NS
Fat	19.1	20.2	18.4	17.5	0.86 NS
Bone	17.9	16.7	17.9	16.7	0.47
Tissue ratios in carcass					
Lean:fat	3.2	3.1	3.3	3.6	0.20 NS
Lean:bone	3.4	3.7	3.4	3.8	0.14 NS
Lean + fat:bone	4.1	3.9	4.3	4.5	0.23 NS

SW = slaughter weight; EBW = empty body weight;

NS = not significant; SED = ?????

No correction was made for losses during dissection which ranged from 1.8 to 2.7%.

Discussion

Crude protein content of 59 g/kg DM of *Chloris gayana* hay used in this study is lower than that of 86 g/kg DM reported by Mtenga and Nyaky (1985) and of 143 h/kg DM reported by Mtenga and Shoo (1990) but higher than the value of 44 to 54 g/kg DM found by Mtenga and Massae (1988) from hay harvested in the same University farm. This variability is mainly associated with season of cutting and stage of growth at the time of harvest. The protein content of lablab bean meal of 254 g CP/kg DM found in the present study compares well with values reported elsewhere. Gohl (1981) found values of 242 and 280 g CP/kg DM for seeds from Uganda and Zimbabwe, respectively, while Santos (1976) reported a value of 270 g/kg DM for seeds from Mozambique.

Protein supplementation may affect DM intake through its effect on digestion in the rumen (Adeneye and Oyenuga, 1976; Egan, 1977) and this may be the case in the present study. In our earlier studies on protein supplementation, voluntary intake of dry matter was reduced by protein supplementation containing high energy in diets and this was due to the animals receiving sufficient energy from the supplement to satisfy its requirements. Thus total DMI and hay intake will depend on the hay quality, amount of concentrate offered and the energy:protein ratio of the supplements.

Response to nitrogen supplementation on growth rate has been reported by several workers. A crude-protein content of 11% in DM is considered ideal for normal liveweight gains in sheep and goats (Kay et al, 1968; Kay and MacDermid, 1973). A similar trend in growth rate (34.14, 65.65, 68.01 and 70.5 g/day for treatments A, B, C and D, respectively) was also observed in the present study as the protein content of the diet consumed increased in the order of 11.36%, 13.22%, 15% and 16.73% CP, DM. The growth rate observed in lambs on a low level of protein intake in this study (treatment A) was lower than that 50.0 g/day reported by Mtenga and Nyaky (1985) for similar sheep under grazing conditions. Similarly Mtenga and Nyaky (1985) reported higher values of growth rate ranging from 73.4 to 94.6 g/day in BHP sheep under grazing conditions. The higher growth rates in these studies were perhaps due to ability of the lambs under grazing condition to select the more nutritious parts of browse during grazing. The findings are, however, in agreement with that 25.19 g/day reported by Shoo (1986) and that 33.9 g/day reported by Mtenga and Massae (1988) in BHP lambs under confinement which was the case in this study. Growth rate for lambs under high levels of protein intake (16.73% CP) were also lower than that of the 98.5 g/day reported by Mtenga and Massae (1988) and that of 120.27 g/day reported by Mtenga and Nyaky (1985) for similar type of sheep under grazing plus concentrate supplementation.

The tendency for lower growth rate at each level of protein supplementation observed in the present study could partly be due to the low intake of energy

(Balch, 1976). The level of energy supplied to sheep has been considered to be of importance as the level of protein intake increases (ARC, 1980). In the present study increasing the level of lablab meal in the diet increased the protein: energy ratio, whose values were 26.59, 29.08, 36.84 and 43.44 g/DP/Mcal DE for treatments A, B, C and D, respectively. The importance of the protein : calorie ratio of diets has been reported by Preston et al (1965) who found that daily intake of 22 g DCP per Mcal of DE resulted in the maximum body gain of 251 g/day with wether lambs. Similarly, Adeneye and Oyenuga, (1976) recorded best performance (302 g/day) for sheep with high energy intake (7.68 MJ ME/day) and medium but adequate protein (82.8 g/CP/day). In another experiment where energy was held constant and protein level was varied, highest daily gain (176 g/day) was attained by sheep on a crude-protein intake of 147.7 g/day and digestible energy intake of 9.9 MJ/day (Adeneye and Oyenuga, 1976). The lowest and highest protein intakes (100.4 g and 151.4 g CP/day) produced the lowest daily gains (24 g and 54 g/day, respectively).

The dressing percentages of 41.3 to 42.5% on liveweight basis observed in this study compare well with the result (40–50%) reported by Devendra and McLeroy (1982). Increasing level of protein in the diet had little and insignificant influence on dressing percentage. These results are in agreement with the results reported by Kemp et al (1976) with lambs given diets varying in protein level from 10 to 16% CP. The findings are, however, at variance with those of Robinson and Forbes (1970) and Levy et al (1980) who observed an increase in the dressing percentage with increasing level of dietary protein in the supplement concentrate. Dressing percentage of 52.5% based on EBW observed in the present study compares well with the value of 52% reported by Owen and Norman (1977) for indigenous Botswana sheep. The importance of dressing percentage in the tropics, however, remains to be questionable since practically all of the by- products are consumed as food. Other components of the body even sell at higher prices than carcass meat (Mtenga, 1979; Devendra and McLeroy, 1982).

The small and insignificant effect of protein level on the proportion of non-carcass components observed in this study is in agreement with past findings at Sokoine University. This was expected because these organs are early-maturing (Palsoon and Verges, 1952; Mtenga, 1979). Gut fat, however, showed a tendency to decrease from 2.7% at low-protein level in treatment A to 1.3% at high-protein level in treatment D. Similar trend has been reported elsewhere by Mtenga (1979).

The overall mean percentage carcass composition data obtained in the present study are in line with few published data on sheep in Tanzania (Mtenga and Nyaky, 1985). French (1938), however, reported relatively lower values for lean and bone tissues and higher values for fat tissues for Black Head Persian lambs in Tanzania ranging from 49.9–57.5% and 8.9–11.1%, respectively, but the

composition (as percentage lean, bone and fat) observed in the present study is in agreement with the findings reported elsewhere (Owen, 1976). Contradictory results were, however, reported by other workers (Andrew and Orskov, 1970; Fattet et al, 1984; Vipond et al, 1989). In their studies, they reported increase in percentage carcass nitrogen and decrease in ether extract in lambs as the level of dietary protein increased. Factors such as age and weight at slaughter, sex and breed singly or in combination may cause disparity of results between workers.

The profit margin per animal for raising animals under treatment B diet was greater (30 TSh per animal) than that of control treatment (maize bran plus hay). The lowest margin of profit was, however, obtained for animals on treatment D (Table 4). At higher levels of energy intake, high level of lablab inclusion may be more profitable. The difference in marginal profit between animals given maize bran alone (treatment A) and those supplemented with lablab bean meal is too small to justify the practice of rearing lambs on lablab bean meal supplementation. The marginal profit, however, may vary from one place to another depending on the price of lablab bean.

Table 4. *Effect of level of lablab supplementation on economic returns from sheep.*

Input data:	Treatments			+
	A	B	C	D
Total concentrate consumed (kg/animal)	30.15	31.68	33.26	33.44
Cost of concentrate (TSh/kg) ¹	10.00	12.80	15.55	18.30
Total cost of concentrate (TSh/animal)	301.50	405.50	517.20	614.15
Marginal cost	-	104.50	215.7	312.65
Output data:				
Carcass weight (kg)	8.03	8.80	9.23	9.68
Non-carcass component (kg)	1.92	2.23	2.28	2.16
Revenues from sales of carcass (TSh) ²	1204.50	1320.00	1384.50	1452.00
Revenues from sales of edible non-carcass ³	115.20	133.80	136.80	129.60
Total revenues (TSh/animal)	1319.70	1453.80	1521.30	1581.60
Margin profit (TSh/animal)	1018.21	1048.30	1004.10	967.45
Marginal returns	-	30.09	-14.11	-50.76

1. Price of lablab seed meal was 21.10 TSh/kg while price of maize bran was 10.00 TSh/kg.

2. Price of 1 kg of meat was 150 TSh.

3. Price of 1 kg of edible non-carcass was 60 TSh.

TSh = Tanzanian shilling.

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Experiences in protein supplementary feeding of weaned lambs and goat kids in Tanzania: The issue of dietary energy

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Summary

The prevailing idea, implied in previous studies on supplementary feeding of small ruminants in the tropics, has been that protein is the major limiting factor for growth. However, the low response to protein supplementation found in several studies at Sokoine University of Agriculture (SUA) cast some doubt on the validity of this idea.

This paper reviews past research work at SUA on supplementary feeding of lambs and goat kids. Intake of metabolisable energy and digestible crude protein were calculated from the original data. Growth rate was highly correlated to intake of metabolisable energy ($r = 0.85$) while the correlation to protein intake was poor ($r = 0.67$). It is concluded that the energy intake is the major limiting factor for growth of small ruminants under SUA conditions (tropical semi-arid region). It is also concluded that best effects on growth of weaned lambs and kids can be expected from supplements with high energy and moderate protein contents.

Etudes sur la complémentation protéique de la ration d'agneaux et de chevreaux sevrés en Tanzanie: le problème de l'énergie de la ration

L.A. Mtenga et A. Madsen

Résumé

L'hypothèse dominante, sous-jacente aux études effectuées jusqu'à présent sur la complémentation alimentaire des petits ruminants dans les régions tropicales, veut que les protéines constituent le principal

facteur limitant pour la croissance des ovins et des caprins. Cependant, compte tenu de la faible réponse à la complémentation protéique enregistrée dans des essais effectués à la Sokoine University of Agriculture (SUA), on est en droit de s'interroger sur le bien-fondé de cette assertion.

Cette étude fait le point des travaux effectués jusqu'ici à la SUA sur la complémentation alimentaire des agneaux et des chevreaux. Les quantités ingérées d'énergie métabolisable et de protéines brutes digestibles ont été calculées à partir des données initiales. Les analyses effectuées ont révélé qu'il existait une forte corrélation ($r = 0,85$) entre le rythme de croissance et la quantité d'énergie métabolisable ingérée, mais une faible corrélation ($r = 0,67$) entre celui-ci et la consommation de protéines. Ces résultats amènent à conclure que la quantité d'énergie consommée constitue le principal facteur limitant de la croissance des petits ruminants dans les conditions de la SUA (région tropicale semi-aride). Il est également conclu que les meilleures performances de croissance des agneaux et des chevreaux sevrés peuvent être obtenues avec des aliments complémentaires très riches en énergie mais seulement moyennement riches en protéines.

Introduction

The major part of cattle as well as small ruminants in Tanzania are fed on arid or semi-arid grasslands. That the nutritive value of the pasture drops drastically during the dry season is well documented. The content of crude protein decreases while the content of crude fibre increases resulting in a decreased digestibility of all nutrients and hence a decreased energy content of the grass (Butterworth, 1967; Osbourn, 1976; Gohl, 1981; Butterworth, 1985). The low digestibility of grasses means that the amount taken up by the animal will be reduced due to the decreased rate of passage through the rumen. All together, it means that uptake of both protein and energy from pasture the animal decrease considerably during the dry season.

Therefore, supplementary feeding of livestock has been advocated and much research work has been devoted to trials using different compositions and amounts of supplements. The major idea has been that protein is the major limiting factor in the diet, and most trials have used supplements with protein-rich feeds. However, in many cases the response in terms of growth rate has been poor.

The present paper reviews the results of a total of eight research projects performed at Sokoine University of Agriculture, Tanzania as MSc thesis or

special projects during the years 1981–1989 in search of an answer to the following questions:

Is intake of protein or energy the major limiting factor for ruminant growth on tropical grassland? and

What types of supplementary feeds are more likely to improve the performance of grazing small ruminants?

Methods

None of the reviewed papers estimated the animals' intake of energy. For most of the works the animals were kept in metabolic cages and the intakes of dry matter as well as of the individual nutrients were measured. Moreover, the digestibilities of the individual nutrients were determined in the same experiments.

The available data therefore allowed us to calculate the intake of total digestible nutrients (TDN) or the intake of digestible organic matter (DOM) from which the intake of digestible energy (DE) or metabolisable energy (ME) was estimated using the following equations given by Devendra and McLeroy (1982):

$$\text{DE (MJ)} = 18.4 \times \text{TDN (kg)}$$

$$\text{DE (MJ)} = 19.2 \times \text{DOM (kg)}$$

$$\text{ME (MJ)} = 0.82 \times \text{DE (MJ)}$$

Hence the metabolisable energies stated in this paper were calculated as follows:

$$1) \text{ ME (MJ)} = 0.82 \times 18.4 \times \text{TDN} = 15.1 \times \text{TDN (kg)}$$

or

$$2) \text{ ME (MJ)} = 0.82 \times 19.2 \times \text{DOM} = 15.7 \times \text{DOM (kg)}$$

Results obtained from using equation (1) or (2) were not significantly different.

For some of the works reviewed the animals were grazed, so that the uptake of only the supplemented feed could be measured. For these cases we assumed that the uptake of dry matter from grazing was 0.45 kg/day for animals of 15-kg liveweight, and that the grass contained 9 MJ ME and 40 g digestible crude protein (DCP) per kg dry matter (DM). These assumptions are in accordance with the findings of Shoo (1986) and Muhikambe (1990) using grass hay (Table 2). An uptake of 0.45 kg/day for a 15-kg animal corresponds to 3% of its liveweight. This agrees with a low-level uptake as stated by Devendra and McLeroy (1982).

The estimated intake of metabolisable energy and digestible crude protein (DCP) as well as the growth rates observed in the reviewed works are shown in Tables 1, 2 and 3. Kitanyi (1982) is a typical example of an experiment using

Table 1. Effect of supplement feeding on growth rate of hay-fed lambs and goat kids confined in metabolic cages.

Animal (sex species, breed age, LW)	N	Supplementary feed		Total intake per day			Protein-energy ratio (g DCP/MJME)	Growth rate (g/d)	Sym- bol Fig. 1	Ref.
		Composition	Amount (g/d)	DM (kg)	ME ¹ MJ	DCP (g)				
Male goat kids	6	-	0	0.40	3.1	10	3.2	23±11	(X)	
Local Tanz., 1-18 month	5	MB-CSC-Moll-Min (78:10:10:2)	200	0.53	5.0	25	5.0	45±3	(X)	
	6	MB-CSC-Moll-Min (68:20:11:2)	200	0.55	5.0	34	6.8	53±13	(X)	Kitalyi (1982)
	6	MB-CSC-SFC -Moll-Min (45:20:23:10:2)	200	0.54	5.1	41	8.0	63±17	(X)	
Male lamb, BM and BHP	12	MB-CSC-Min (71:27:1)	75	0.56	5.1	27	5.3	34±66	(X)	
10-17 month 10-19 kg LW	12	"	400	0.77	7.9	67	8.5	99±10	X	Massae (1984)
Castrate male lamb, BHP	5	MB-Min, (95:5)	380	0.50	4.6	36	7.8	34±7	X	
4-7 month	6	MB-LB-Min (45:25:5)	380	0.55	4.9	43	8.8	66±7	(X)	10-19 kg LW
	5	MB-LB-Min (20:75:5)	380	0.63	6.3	77	12.2	70±14	X	

1. Metabolisable energy (ME) calculated from intake of digestible organic matter (DOM), or from total digestible nutrients (TDN) as explained in the text.

Abbreviations and symbols:

RM - Red Maasai	Moll - Molasses	DM - Dry matter
BHP - Black Head Persian	Min - Mineral mixture	ME - Metabolisable energy
MB - Maize bran	SFC - Sunflower cake	DCP - Digestible crude protein
CSC - Cottonseed cake	LB - Lablab bean meal	N - Number of animals in experiment

Table 2. Effect of supplementary feeding on growth rate of grazing lambs and goat kids.

Animals (species, sex, breed, age, LW)	N	Suppl. feed		Total intake per day ¹			Protein-energy ratio (g DCP/MJ ME)	Growth rate	Symbol Fig. 1	Ref.
		Compo- sition	Amount (g/d)	DM (kg)	MEMJ	DCP (g)				
Goat kids	6	*	0	0.45	4.1	19	4.6	20±4	(X)	
Males and females	6	LL*	100	0.50	4.7	34	7.2	23±7	X	
Local Tanz., 6-7 month	6	LL*	200	0.57	5.4	46	8.5	29±4	X	Shoo (1986)
11-15 kg LW	6	LL*	<i>ad lib</i>	0.55	5.2	45	8.7	30±6	X	
Goat kids, 9	-	0	0.47	4.2	19	4.5	31±9	(X)		
Males and females										
Local Tanz. and Tanz.-Norw. crosses 13-16 kg LW	9	CSC	100	0.57	5.1	45	8.8	27±19	X	Muhi- kambele (1990)

Abbreviations:

LL = *Leucaena leucocephala*, see also notes for Table 1.

1. Intakes of nutrients assumed to be as determined in digestibility trials conducted with the same experimental animal.

* Indoor, hay was also supplemented *ad libitum*.

Table 3. Effect of supplementary feeding on growth rate of grazing lambs and goat kids.

Animal (species, sex, breed, age, LW)	N	Supplementary feed*		Total intake per day ¹			Protein-energy ratio (g/DCP/MJME)	Growth rate (g/d)	Fig. 1 Symbol	Ref.
		Composition	Amount (g/d)	DG(kg)	ME(MJ)	DCP(g)				
Male lamb	10		0	0.45	4.1	18	4.4	38	(X)	
RM and BHP	10	MB-CSC (67:33)	100	0.54	5.1	29	5.7	63	(X)	
4 month, 11-15 kg	10	MB-CSC (93:7)	500	0.90	9.2	51	5.5	108	(X)	Nyaki (1981)
Male goat kids	3	MB-CSC-Min (69:30:1)	300	0.72	7.2	51	7.1	57±11	X	
Tanz.-Norw. crosses, 5-6 month, 10-17 kg	4	Cass-CSC-Min (49:50:1)	300	0.72	7.4	55	7.4	99±31	(X)	Hai (1988)
Female goat kids	6	MB-CSC-(70:30)	300	0.72	7.2	51	7.1	63±32	X	
Tanz.-Norw. crosses 4-8 months, 9-14 kg	5	Cass-CSC (55:45)	300	0.72	7.4	51	6.9	94±43	(X)	Susuma (1989)

Abbreviation:

Cass = Cassava, dried tubes, see also notes for table 1.

1. Intake from grasses assumed to be 0.45 kg DM per day with a content of 9 MJ ME and 40 g DCP per kg of

DM (Ref. Shoo, 1986 and Muhikambe, 1990 in Table 2).

* Indoor Nyaki also supplemented Rhodes grass, while Hai and Susuma supplemented Guatemala grass *ad libitum*. For other abbreviations, see Table 1 footnote.

supplements with increasing contents of protein. The results clearly demonstrate that supplementation of 200 g concentrate with only 10% oil cake (11% CP) improved growth rate by two times. No further improvement was obtained by increasing the protein content of the mixture.

Nyaki (1981) and Massae (1984) observed about three-fold increase in growth rates by using 400 or 500 g of supplement with moderate protein content.

The effect of high-protein allowance to low-energy diets was especially demonstrated by the works of Shoo (1986) and Muhikambe (1990) using supplements of *Leucaena leucocephala* or cottonseed cake, respectively (Table 2). In both cases, the supplement had no effect on the growth rate.

The relationship between growth and intake of energy or protein for all eight studies is illustrated in Figure 1a and 1b, respectively. The data show that growth rates are highly correlated with energy intake ($r = 0.85$), while the correlation to protein intake (all points) is poor ($r = 0.67$). Figure 2 illustrates growth rates in relation to the amount of supplemented concentrate. The correlation is fairly high ($r = 0.77$).

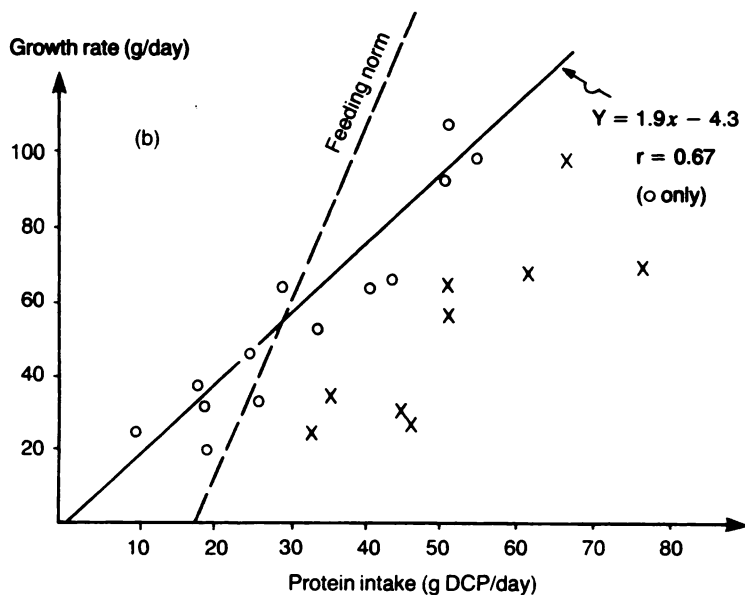
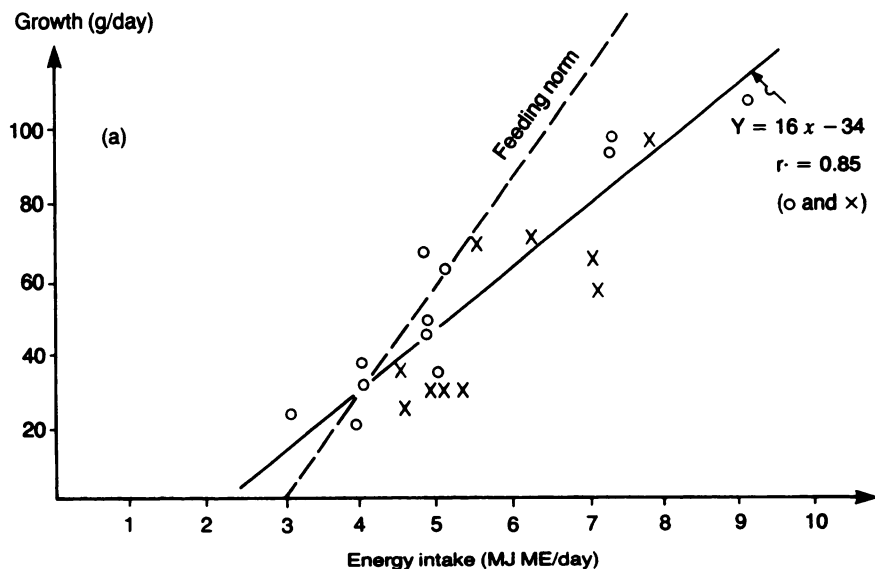
Results and Discussion

The relationship between growth rates and intakes of protein and energy was already illustrated by ARC (Agricultural Research Council) in 1980 (Figure 3). The data presented in Figure 1b are in good agreement with the ARC illustration. Increase of protein intake on a low level of energy intake gives no improved growth. With increasing intakes of energy, growth rate increased and the requirement for protein increased. The encircled points in Figure 1b show protein intake vs the growth when energy is non-limiting. Under these conditions growth rate is highly correlated to protein intake ($r = 0.94$).

The stippled lines in Figure 1a and 1b show feeding norms for a 15-kg goat kid according to Devendra and McLeary (1982). These feeding norms assume that protein and energy are fed in a ratio of 6 g DCP per MJ ME. Other feeding norms also give similar ratio for protein/energy, e.g. NRC (1976) stated 6.5 g DCP/MJ ME. The protein/energy ratios of the supplemented diets referred to in the present review (Tables 1, 2 and 3) in most cases exceed that of feeding norms.

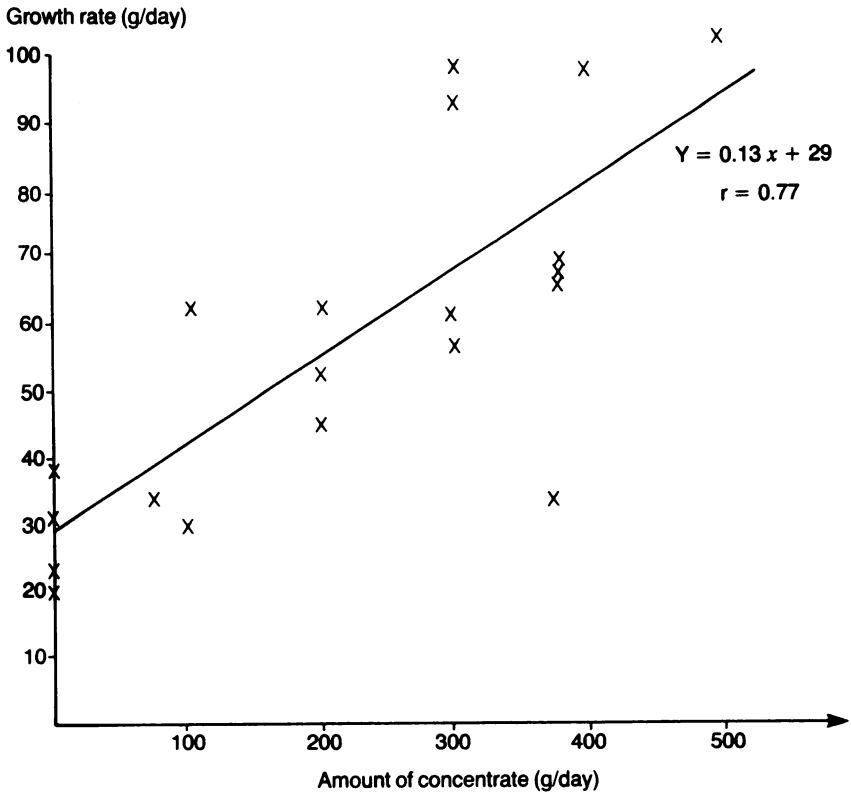
Table 4 summarises the data in Tables 1, 2 and 3, showing average values of intake, protein/energy ratio and growth rates for unsupplemented groups and for groups given concentrates with "moderate" or "high" protein content. The data show that unsupplemented diets have low intakes, low protein/energy ratio and low growth rate. Supplementation increased energy intakes by 50% in average (from 4 to 6 MJ) and increased intakes of digestible protein by 100 or 200 %. The average effect on growth rates was about 100%, independent of the

Figure 1. Growth rate of lambs and goat kids versus intakes of energy and protein.



† Encircled points selected from graph b, as least-protein intake for same growth, i.e. protein limiting for growth. Stippled lines show feeding norms (Devendra and McLeroy, 1982).

Figure 2. Growth rate of lambs and goat kids versus daily allowance of concentrate feed.



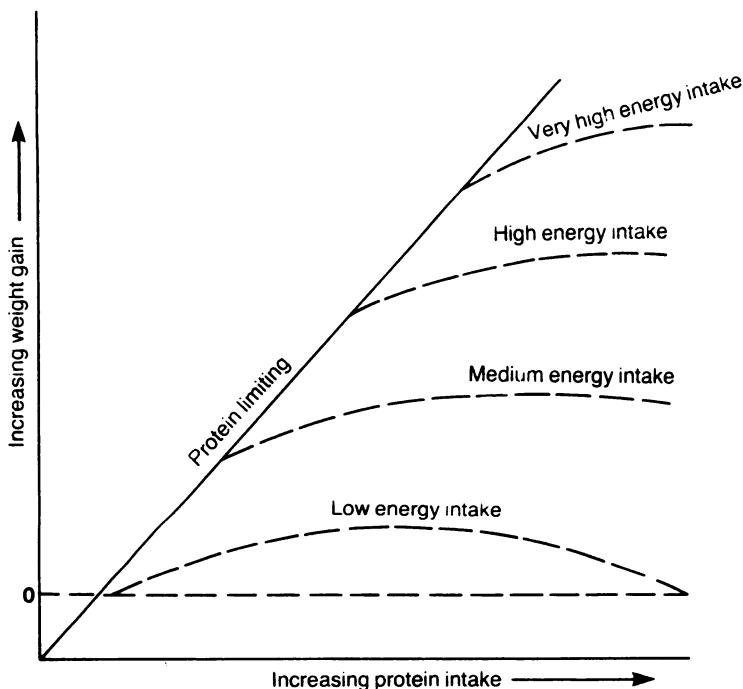
Data from Tables 1, 2 and 3.

protein level. The data strongly point to the energy intake as the major limiting factor for growth under the conditions of the studies reviewed.

The importance of energy supplementation is emphasised by the findings of Hai (1988) and Susuma (1989) both using cassava chips to increase the energy content of the supplement without changing the protein content (Table 3). The minor increase in energy intake from the supplement can not explain the observed increase of growth rate (about 50%). However, it is most likely that the groups on the cassava based concentrates had a higher uptake of grasses, resulting from a positive effect of cassava starch on the digestibility of the grass.

The effect of energy on utilisation of protein is mainly due to the fact that protein synthesis is a very energy demanding process. The synthesis of microbial protein in the rumen requires the presents of digestible carbohydrate to provide

Figure 3. *The response of growing ruminants to the combined effects of energy and protein (after ARC, 1980).*



energy. The synthesis of proteins in the animal body, for example muscle protein, require the supply of energy from combustion of nutrients like acetate and glucose. If the supply of energy rich nutrients is deficient, then an increased intake of protein will result in an increased transamination and deamination of amino acid. Increased amounts of ammonia are released, converted into urea in the liver and further excrete in the urine (Riis, 1983).

This explains that increased protein intake on low energy allowance results in increased excretion of urinary nitrogen (Shoo, 1986; Muhikambe, 1990). Such diets result in increased nitrogen intake and increased nitrogen excretion, but no significant improvement in nitrogen balance or growth.

Furthermore, the addition of high protein to low energy diets may have a negative effect as illustrated in Figure 3, lower curve. This is likely due to the energy expense of urea synthesis.

Table 4. *Effects of supplementary feeding on growth rate of lambs and goat kids (average $\pm$ SD of values from Tables 1, 2 and 3).*

Supplement	N ¹	Total intake per day		Protein-energy ratio (gDCP/MJ ME), (g/d)	Growth rate	
		DM (kg)	ME(MJ)			
None	4	0.44 ±0.03	3.9 ±0.5	17 ±4	4.2 ±0.7	28 ±8.1
"Moderate" protein content (protein limiting ²)	9	0.62 ±0.13	6.0 ±1.6	40 ±11	6.6 ±1.3	69 ±25
"High" protein content (protein in excess ³)	10	0.61 ±0.09	5.9 ±1.2	51 ±14	8.7 ±1.7	50 ±25

1. N = Number of experiments.

2. The supplement groups symbolized with (X) in Figure 1 and in the Tables 1, 2 and 3.

3. The groups are symbolised with X in Figure 1 and in the Tables 1, 2 and 3.

For abbreviations, see Table 1 footnote.

Conclusion

The present review allows us to conclude the following:

1. Energy intake is the major limiting factor for growth of ruminants on semi arid grasslands of Tanzania.
2. Protein supplement alone to low energy diet has no effect on growth rate.
3. Concentrate supplements should contain high energy and moderate amounts of protein to allow a content of about 6 g DCP per MJ ME in the whole ration (concentrate + roughage).
4. The summarised data of this review (Table 4) indicate that the growth rates of grazing lambs or kids can be improved from 30 to 60 g/day by use of a daily supplement of 200 g concentrate containing 12 MJ ME/kg DM and 12–13% of DCP. This corresponds to a mixture of maize bran with 30% cotton seed cake (CSC). A growth rate of 100 g/d requires total intake of 8.5 MJ ME and 55 g DC (Fig. 1). Considering the supply from the basic diet (Table 4) the required content of the supplement is 4.6 MJ ME and 37 g DCP. If 400 g concentrate is given it must contain 11.5 MJ ME/kg DM and 9% DCP. This corresponds to maize bran mixed with only 15% CSC.
5. Improved suggestions for best supplements require growth studies using different amounts of concentrate mixture with different protein–energy ratios. Such trails would allow us to calculate the economical optimal composition and amount of mixture.
6. Future research on feeding must consider the intakes of both energy and protein, during the experimental design as well as in the conclusion of the work. Otherwise we shall continue to judge all beneficial effects as due to protein and all lacks of effect as due to experimental error!

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Effects of plane of nutrition on growth performance and carcass composition on lambs in Tanzania

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Abstract

A study was undertaken to investigate the effect of plane of nutrition on growth performance and carcass composition of lambs. Some animals were on low (L) and high (H) planes of nutrition throughout the experimental period of 112 days. One other group started on a low plane of nutrition for 56 days (LH) and changed to a high plane of nutrition for 56 days (LH) while another group started on a high plane of nutrition for 56 days and changed over to a low plane of nutrition for the remaining 56 days (HL).

During the first 56 days, lambs on H regime grew faster and consumed less feed per unit gain than those on L regime. In the last 56 days lambs on LH regime showed compensatory growth by growing faster than those on the HH regime. In the same period lambs on the LL regime grew faster than those on the HL regime. When the whole 112 days were considered, the lambs on LH regime were almost as efficient as those on the HH regime in growth rate and feed utilisation.

Carcass weight as a percentage of empty body weight was lowest for lambs on L and LL regimes. Carcass quality was, in terms of lean, fat, lean-to-fat and lean-to-bone ratios best for LL followed by HL, LH and HH regimes.

Effets du niveau alimentaire sur les performances de croissance et la composition de la carcasse des agneaux en Tanzanie

E.E. Massae et L.A. Mtenga

Resumé

Dans le cadre d'une étude entreprise pour examiner les effets du niveau alimentaire sur les performances de croissance des agneaux et sur la composition de leur carcasse, des rations hautement (H) et faiblement (L) nutritives ont été servies à un certain nombre d'animaux pendant une période expérimentale de 112 jours. Un autre lot d'animaux avait été soumis à un régime alimentaire faiblement nutritif pendant les 56 premiers jours de l'expérience et à un régime alimentaire hautement nutritif pendant les 56 derniers jours de l'expérience (LH), alors qu'un dernier lot avait d'abord été soumis au régime hautement nutritif, puis au régime faiblement nutritif (HL).

Au cours des 56 premiers jours de l'expérience, les agneaux bénéficiant du régime H affichaient une croissance plus rapide que celle enregistrée pour les animaux soumis au régime L, et consommaient moins d'aliments par unité de gain de poids. Au cours des 56 derniers jours, les agneaux soumis au régime LH manifestaient une croissance compensatrice et augmentaient plus rapidement de poids que les animaux bénéficiant du régime HH. Au cours de la même période, la croissance des agneaux soumis au régime LL était supérieure à celle des animaux bénéficiant du régime HL. Sur l'ensemble de la période des 112 jours, les performances des agneaux soumis au régime LH étaient presque aussi bonnes que celles des agneaux bénéficiant du régime HH pour ce qui est du taux de croissance et de l'utilisation digestive.

Le poids de la carcasse exprimé en pourcentage du poids mort était le plus faible chez les agneaux soumis aux régimes L et LL. Exprimée en fonction de critères d'engraissement (maigre, gras, rapports maigre-gras et maigre-os), la qualité de la carcasse la meilleure s'observait chez les agneaux soumis au régime LL, suivis de ceux soumis aux régimes HL, puis LH et enfin HH.

Introduction

The aim of the sheep producer is to get his lambs to slaughter weight in a short time with maximum amount of lean meat, minimum bone and an amount of fat which is desired by the market. Among the many factors which contribute to variation in growth performance and carcass composition in sheep, plane of nutrition plays the major role. A high plane of nutrition improves performance and carcass composition of lambs (Owen, 1976; Andrew and Speedy, 1980; Mtenga and Nyaky, 1985). This is associated with increased intake of dietary energy and protein.

It has also been observed that undernutrition disturbs the normal relationship between chronological and physiological ages in such a way that in case of animals on a low plane of nutrition, physiological ageing proceeds at a slower rate. When such retarded animals are given liberal amount of feed, they tend to grow at a rate appropriate to their physiological age rather than their chronological age. Osborne and Mendel (1915) noted this biological phenomenon which was characterised by faster than average growth rate and it was later termed "compensatory growth" by Bohman (1955).

The phenomenon of compensatory growth has been a subject of great interest to researchers as reviewed by Allden (1968), Keenan and MacManus (1969) and Goodchild and Mtenga (1982). This is because proper utilisation of compensatory growth can result into economic benefits as producers are interested to keep their animals alive at the lowest cost possible in the dry season. Strategic supplementation of expensive concentrates can be beneficially used in feeding underfed animals at the end of the dry season in feedlot operations. Carcass composition of the underfed-refed sheep have also been observed to vary from those of continuously growing animals (Goodchild and Mtenga, 1982).

Sheep which are mostly found in Tanzania include Red Maasai and Black Head Persian (BHP). BHP is considered superior in growth rate and carcass composition (French, 1944; Mtenga and Nyaky, 1985) and has been used to upgrade local sheep. There has been little research work carried out on the ability of these animals to survive during periods of less feed supply and compensate sufficiently during periods of liberal feed supply taking into account the existence of interbreed difference in the magnitude of response (Goodchild and Mtenga, 1982). The aim of this study was therefore to investigate the effect of plane of nutrition on growth rate and carcass composition of lambs.

Materials and methods

Twenty-eight male Black Head Persian (BHP) and Red Maasai lambs were used. The lambs had a mean initial liveweight of 14.6 $\pm$ 2.3 kg and ranged between 10–14 months of age. Four animals were randomly selected and slaughtered to form a

base line. The remaining 24 animals were randomly allocated to two treatments (H and L), each treatment having 12 lambs. Lambs on treatment L were fed the hay *ad libitum* plus 100 g of concentrate (basal diet), and was referred to as low plane of nutrition. Animals on treatment H were fed high plane of nutrition which consisted of hay *ad libitum* plus 400 g concentrate.

After eight weeks, four animals were randomly selected from each treatment and were slaughtered. The remaining eight sheep on treatment L were randomly allocated to two groups. One group of animals continued with the low plane of nutrition (LL) while the other was put on high plane of nutrition (LH). Similarly the eight lambs on treatment H were randomly allocated to the two dietary treatments (HL and HH). Animals in the four treatments were slaughtered at the end of the 6th week to determine slaughter characteristics and carcass composition. Daily feed intake and weekly liveweights of animals were recorded.

Chloris gayana hay was obtained from the university farm from two cuttings done in October, 1982 and January, 1983. The concentrate consisted of 71% maize bran, 27% cottonseed cake and 2% mineral mixture (Maclik). The mineral mixture consisted in percentage of Ca (18.61), P (3.5), Na (13.0), Cl (20.0), Cu (0.12), Co (0.03), Fe (0.31), I (0.01), Mg (0.44) and S (0.18).

At the stated slaughter points animals were slaughtered and weight of warm carcass was taken excluding kidney and kidney fat. Non-carcass components were also obtained. The left half carcass was dissected into lean, fat and bone. Losses during dissection were assumed to come mainly from the lean meat and therefore lost weight was added to lean weight. The dissected components were thoroughly mixed together, frozen and then minced through a 2.5- mm sieve.

Samples of feeds and carcasses were analysed according to the AOAC (1975) method. Analysis of variance was used for most of the parameters studied and treatment means were compared using least significant differences (Steel and Torrie, 1980).

Results

Health of animals

Diarrhoea was the only disease problem noted in four cases which occurred in the 9th week of the study. This problem was observed in lambs which were changed from low to high plane of nutrition and was probably due to initial high concentrate intake.

Chemical composition of feeds

Table 1 shows the chemical composition of Rhodes grass at two cuttings. There was an increase in crude fibre and a decrease in crude protein with the second cutting as a result of maturity and high lignification. The chemical composition of the other ingredients is also shown in Table 1 and the concentrate had about 18.0% crude protein. The concentration of energy in these diets, derived from a digestibility study was 9, 8, 9.7, 10.8, 10.3 MJ/kg DM digestible energy and 7.9, 7.8, 8.7, 8.4 MJ/kg DM metabolisable energy for treatments LL, HL, LH and HH, respectively.

Table 1. *Chemical composition of Rhodes grass hay and concentrate feeds (means and standard deviation in g/kg DM).¹*

	Hay (Rhodes grass)		Maize bran	Cottonseed cake	Concentrate
	1 st cutting	2 nd cutting			
Dry matter (DM)	920.7±19.8	929.5±12.7	925.6± 6.1	945.6±11.5	944.0±26.0
Crude protein (CP)	54.0±8.3	44.2±8.5	104.6±2.9	411.1± 1.5	182.7±15.9
Crude fibre (CF)	365.0±34.4	378.0±17.6	121.0±3.5	133.4±3.6	65.3±4.2
Ether extract (EE)	15.2±2.3	12.3±3.3	108.4±1.8	48.3±32.4	86.2±4.8
Ash	90.1±8.8	89.2±35.1	28.1±6.3	74.1±1.9	44.2±4.1
Nitrogen-free extract (NFE)	395.8±30.6	476.9±47.5	636.9±22.3	332.1±30.7	621.7±22.2

¹Concentrate contained 12.3 MJ DE and 133 CP g/kg DM.

Growth rate and feed intake

Lambs on treatment H grow faster ($P<0.001$) than those on treatment L during the first eight weeks of the experiment (Table 2). Between weeks 9 and 16, there was also a highly significant ($P<0.001$) difference between treatments in daily gains. Lambs on treatment LH grew the fastest, gaining 41, 71 and 84 g/day more than those on treatments HH, LL and HL, respectively. Changing from a high to a low plane of nutrition adversely affected growth rate of lambs (LL vs HL). Considering the whole experimental period, lambs on HH treatment had the highest gain followed by those on treatments LH, HL, and LL in decreasing order. Differences between HH and LH were, however, not significant ($P<0.001$).

Liveweight of lambs as influenced by treatment with time is shown in Figure 1. It is clear that lambs on LH are compensating and compensation is more pronounced in the first few weeks following change from low to high plane of nutrition. No covariance analysis was undertaken to correct for differences in liveweight gain brought about by the initial liveweight of the animals as there were little and insignificant differences in initial weights between treatments.

Table 2. *Effect of feeding regime on growth performance.*

Period	Liveweight (kg)		Gain (kg/day)	Intake (g DM/day)			FCR
	Initial	Final		Hay	Total	g/kg W ^{0.75}	
Start–8th week (12)							
L	14.4	16.3 ^a	34 ^a	498	558 ^a	66 ^a	17.7 ^a
H	14.9	20.5 ^b	98 ^b	503	765 ^b	87 ^b	7.8 ^b
F-value	0.13 NS	19.3 ^{***}	436 ^{***}	5.1 NS	43 ^{***}	11.8 ^{**}	15.3 ^{***}
9th–16th week (4)							
LL	13.8	17.3 ^a	33 ^a	534 ^a	612 ^a	56 ^a	19.6 ^{ac}
HL	14.9	21.2 ^{ab}	20 ^a	451 ^b	514 ^a	53 ^b	26.3 ^a
LH	15.3	23.4 ^b	104 ^b	477 ^b	837 ^b	90 ^c	8.3 ^b
HH	14.8	24.2 ^b	63 ^c	428 ^b	788 ^b	76 ^a	13.7 ^{bc}
F-value	0.3 NS	5.0 [*]	13 ^{***}	15 ^{***}	52 ^{***}	17 ^{***}	11.4 ^{***}
Start–16 th week							
LL	13.7	17.3	33 ^a	496 ^a	564 ^a	74	17.4 ^a
HL	14.9	21.2 ^{ab}	56 ^b	446 ^b	660 ^b	76	11.8 ^b
LH	15.3	23.4 ^b	73 ^c	491 ^a	705 ^b	77	9.9 ^c
HH	14.8	24.2 ^b	83 ^c	407 ^c	767 ^c	83	9.4 ^c
F-value	0.3 NS	5.0 [*]	27 ^{***}	5 [*]	5 [*]	3 NS	24.8 ^{***}

¹In this and subsequent tables:

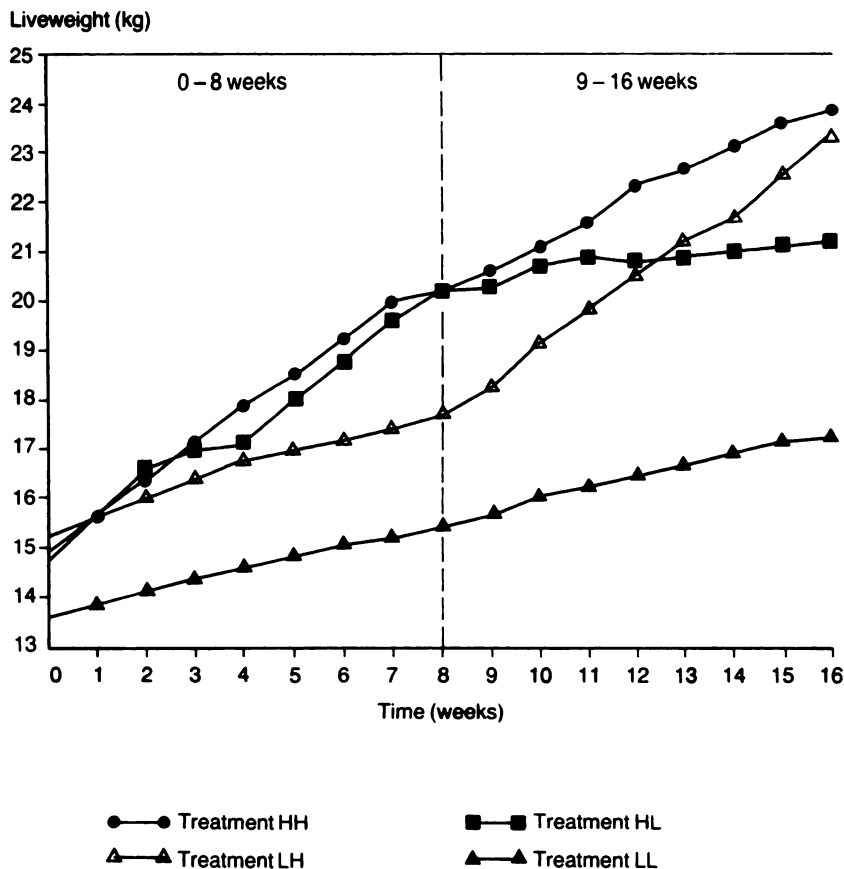
(a) means within the same column/row bearing different superscripts are significantly different at $P < 0.05$

(b) NS = not significant ($P > 0.05$)

(c) *, **, *** = significant at $P < 0.05$, $P < 0.01$ and $P < 0.001$ respectively.

Compared to lambs on treatment L, lambs on treatment H ate significantly more food in total (765 vs 558 g/day; $P < 0.001$) and per unit metabolised weight (87 vs 66 g/kg W^{0.75}; $P < 0.01$) during the first eight weeks of the study (Table 2). This

Figure 1. *Liveweight-time relationship as affected by plane of nutrition.*



was expected as lambs on H were given more concentrates. During the last eight weeks of the experiment, there was also a highly significant difference ($P < 0.001$) between treatments in hay and total dry-matter consumption. Hay consumption was highest in animals on LL, followed by animals on LH, HL and HH in a decreasing order. DM intake expressed as total g/day and kg metabolic body weight was highest for LH animals, followed by HH, LL and HL in decreasing order (Table 2) and differences between treatments were significant ($P < 0.001$). Feed conversion ratio (DM intake/g liveweight gain) was lowest in animals on treatment LH and highest in animals on treatment HL.

When the whole experimental period is considered, animals on treatment HH consumed more dry matter (767 g/day and 83 g/kg $W^{0.75}$) followed by LH (705 g/day and 77 g/kg $W^{0.75}$), HL (600 g/day and 76 g/kg $W^{0.75}$) and LL (564 g/day and 74 g/kg $W^{0.75}$). However, differences in feed intake per metabolic body size were small and insignificant ($P > 0.05$). On average, animals on LH and HH were superior in feed utilisation (9.7 vs 14.6 FRC) compared to animals on LL and HL. Feed utilisation efficiency (reciprocal of FRC) was highest in animals on HH and lowest on animals on LL but the difference in FRC between LH and HH animals was insignificant ($P > 0.05$).

Slaughter characteristics

Table 3 shows the effect of dietary treatment on slaughter characteristics. Animals on treatment H slaughtered at the end of the first eight weeks weighed and dressed higher ($P < 0.05$) than the animals on treatment L. Percentage gut fill, kidney and kidney fat were about equal for animals on both dietary treatments. Gut fat was, however, significantly ($P < 0.01$) higher in lambs on the high plane of nutrition.

Table 3. Effect of feeding regime on killing-out characteristics.

	Liveweight at slaughter (kg)	Per cent of empty body weight			
		Carcass wt	Gut fat	Gut fill	Kidney and kidney fat
End of 8th week					
L	15.55 ^a	45.21 ^a	0.55 ^a	35.19	0.36
H	20.68 ^b	51.49 ^b	4.34 ^b	28.38	0.38
F-value	6.18 [*]	7.49 [*]	54.10 ^{**}	2.62 NS	0.65 NS
End of 16th week					
LL	17.33 ^a	44.98 ^a	1.74 ^a	36.24 ^b	0.68 ^a
HL	21.18 ^{ab}	50.03 ^b	4.28 ^c	32.94 ^a	0.60 ^a
LH	23.40 ^b	51.60 ^b	13.68 ^b	29.15 ^a	0.76 ^a
HH	24.25	53.16 ^b	N/A	N/A	N/A
F-value	5.03 [*]	7.85 ^{**}	8.03 ^{**}	9.80 ^{**}	4.00 [*]

At the last slaughter weight (16 weeks; Table 3), animals in treatment HH weighed more ($P < 0.01$) at slaughter than the others with the differences between these lambs and those on treatments LH, HL and LL being 0.85, 3.07 and 6.92 kg

respectively. The differences in dressing percentage between lambs on treatment LH and those on HL and HH of 1.57 and 1.56 were not significant whereas the difference between lambs on LH and LL of 6.62% was significant ($P < 0.01$). Animals on LL treatment had the lowest proportions of gut fat ($P < 0.01$) and kidney plus kidney fat ($P < 0.05$) and the highest ($P < 0.01$) proportion of gut fill.

Carcass composition (physical and chemical)

There were significant ($P < 0.001$) differences in carcass weight between treatments (Table 4) and these mainly reflected differences in slaughter weight of these animals. These differences were also reflected in absolute weights of carcass components. Weights of carcass tissues in Table 4 are therefore expressed as percentage of carcass weights to partly correct for carcass weight effects.

Table 4. *Effect of feeding regime on carcass composition.*

Treatment	Carcass wt (kg)	Per cent carcass wt			Ratios	
		Lean	Fat	Bone	Lean to fat	Lean to bone
End of 8th week						
L	5.14 ^a	67.8	5.0 ^a	25.6 ^a	15.4 ^a	2.7 ^a
H	8.12 ^b	64.0	18.1 ^b	17.9 ^b	3.6 ^b	3.6 ^b
F-value	18.65 ^{***}	3.2 NS	79.4 ^{***}	51.8 ^{***}	28.2 ^{**}	18.1 [*]
End of 18th week						
LL	5.49 ^a	62.2 ^a	14.0 ^a	23.8 ^a	5.3	2.9
HL	7.78 ^b	65.5 ^b	13.6 ^b	20.9 ^b	4.9	3.1
LH	9.00 ^b	60.7 ^c	19.2 ^b	20.1 ^b	3.4	3.1
HH	9.65 ^b	57.0 ^d	26.0 ^c	17.0 ^c	2.0	3.4
F-value	14.59 ^{***}	13.5 [*]	15.5 ^{**}	56.6 ^{***}	2.7 NS	0.7 NS

By the eighth week, animals on treatment H had significantly ($P < 0.001$) higher proportions of fat and lower proportions of bone but the superiority of 3.8% of lean in animals on L was not significant ($P > 0.05$). Lambs on treatment L had 11.8% more lean to fat ratio but 0.9% less lean-to-bone ratio than lambs on treatment H. Chemical composition data in Table 5 show that carcasses of animals on H were superior to those of animals on L in dry matter and ether extract but inferior in crude protein and ash.

Table 5. *Effect of feeding regime on chemical composition of the carcass of lambs.*

	Chemical composition (% , fresh weight)			
	DM	CP	EE	ASH
End of 8th week				
L	31.1 ^a	18.6 ^a	4.2 ^a	13.4
H	40.4 ^b	16.8 ^b	9.3 ^b	12.1
F-value	140.1 ^{***}	27.8 ^{***}	48.1 ^{***}	3.8 NS
End of 16th week				
LL	36.4 ^a	16.3	15.8 ^a	10.4
HL	39.8 ^a	17.8	18.1 ^b	11.0
LH	41.5 ^a	16.1	19.5 ^b	13.4
HH	45.8 ^b	14.4	27.1 ^c	11.2
F-value	9.4 ^{**}	1.86 NS	17.3 ^{**}	1.02 NS

At the end of the 16th week, lambs on treatment HL had the highest percentage of lean meat followed by lambs on LL, LH, and HH ($P < 0.05$) in descending order. Percentage carcass fat in lambs on HH treatment was higher ($P < 0.01$) than that in lambs on LH, LL and HL by 6.8, 12.0 and 12.4 units, respectively, while proportions of bone was highest ($P < 0.001$) in lambs on treatment LL followed by those on treatments HL, LH and HH in decreasing order (Table 4). Treatment effects on lean:fat and lean:bone ratio were small and insignificant ($P > 0.05$). Table 5 shows that the plane of nutrition significantly ($P < 0.01$) influenced the dry matter and ether extract composition of the carcasses, with the highest value being observed in animals on HH treatment.

Changes in carcass lean and fat

Table 6 shows that both the increases in carcass lean and fat were highest in lambs on treatment H during the first 8 weeks. Increase in lean from the 9th to the 16th weeks in lambs on LH was 3.8 times that of animals on HH (31.1 vs 8.3 g/day), but lambs on HH were slightly superior in the rate of fat deposition. When the whole experimental period is considered, increase in lean in LH and HH lambs were very similar but fat increase rate was 1.5 times more in lambs on HH. Fat and lean increase rates were also higher in HL compared to LL lambs during this period.

Table 6. *Effect of feeding regime on change in carcass lean and fat (g/day).*

	L	H	LL	HL	LH	HH
Lean						
Start-8th week	4.1	32.6	-	-	-	-
9th week-16th week	-	-	0.2	7.5	31.1	8.3
Start-16th week	-	-	2.1	17.6	20.0	20.4
Fat						
Start-8th week	0.8	9.8	-	-	-	-
9th week-16th week	-	-	9.8	5.3	14.9	18.3
Start-16th week	-	-	5.3	9.6	13.6	20.3

Efficiency and economic returns

High efficiency of lean meat production is always desirable. Efficiency is sometimes defined as the ratio of total lean tissue to total food consumed during the period under evaluation but under practical situations carcass rather than lean weight is used. In this study, efficiency of carcass deposition was 0.02, 0.4, 0.6 and 0.06 kg of carcass per kg of food (hay and concentrate combined) for the LL, HL

Table 7 shows the economics of treatments imposed in this study. The highest profit margin per carcass sold was obtained from animals on LH, followed by those on HH, HL and LL.

Table 7. *Effect of feeding regimes on profitability of lamb production.*

	LL	HL	LH	HH
Concentrate consumed (kg/animal)	8.4	26.6	26.6	44.8
Cost of concentrate consumed (T.shs./animal)	58.8	186.2	186.2	313.6
Gain in carcass weight (kg/animal)	0.94	3.23	4.45	5.10
Revenue from carcass gain/animal (T.shs. 150/kg)	141.0	484.5	667.5	765.0
	(823.5)	(1167.0)	(1350.0)	(1147.5)
Marginal profit (T.shs./carcass)	82.2	298.3	483.3	451.4

Discussion

Performance response of animals to low and high plane of nutrition during the first eight weeks of the experiment was as expected and was mainly due to higher concentrate intake, which resulted in increased growth rate, higher slaughter weight, dressing percentage and proportion of carcass fat, and lower proportion of lean, (Owen, 1976).

During the growth period between the 9th and 16th week, lambs on treatment LH were superior in growth rate (104 g/day) to those on treatment HH (63 g/day) despite the fact that they were on the same plane of nutrition. This is likely due to the phenomenon of compensatory growth (Osbourn and Wilson, 1960; Keenan and MacManus, 1969; Keenan, et al, 1970; Goodchild and Mtenga, 1982). In this period, animals on treatment LH consumed more feed per unit metabolic body weight and utilised it more efficiently than their counterparts on treatment HH. This partly accounts for their superiority in growth rate. In a concurrent study, digestibility coefficients for dry matter, crude protein and crude fibre were 59.1, 59.3, 67.0, 65.0, 71.2, 70.2, 77.6, 76.5%, and 63.5, 60.3, 65.3 and 85.3%, respectively, for animals on treatments LL, HL, LH and HH. Similar observations have been reported by other workers with sheep (Alden and Young, 1964; Alden, 1970; Graham and Searle, 1979). The reason for lower daily gains for lambs on HH at 9th–16th week period compared to H lambs at 0–8-week period was not clear but possibly the lambs had passed the phase of accelerated growth rate, Orskov et al (1976) observed that when lambs change from high to low dietary regime, they tend to eat less and grow slower than lambs on low plane of nutrition. The results of this study confirm their observation.

Winchester and Ellis (1957) commented that the refed animal tends to grow at a rate appropriate to its physiological age rather than its chronological age. The present study confirms this statement in that lambs on low plane of nutrition were physiologically younger as measured by live-weight, and lean and fat contents. On changing from a low to a high plane of nutrition, these animals grew faster and almost caught up with animals maintained continuously on a high plane of nutrition.

Dressing percentage is both a yield- and value-determining factor and is therefore an important parameter in assessing performance of meat-producing animals. Lambs on H treatment dressed higher than lambs on L treatment in accordance with findings reviewed by Owen (1976). Mukhtar and El-Hag (1978) found that tropical sheep fed roughage diet only dressed 10% units lower than those fed 3:1 concentrate to roughage ratios. In this study, differences in liveweight, age and level of fatness in the carcass could have accounted for variation in dressing percentage (Berg and Butterfield, 1976; Owen, 1976) which was 35% for L lambs and 28% for H lambs. The percentage gut fill was 36, 32, 29 and 20 for LL, HL, LH and HH lambs, respectively.

Berg and Butterfield (1976) reported that fat is the most labile tissue in the animal's body and can easily be manipulated by nutrition and management. The treatment effects on gut, kidney and carcass fat in the present study can be attributed to energy and protein in the diets of these animals. In accordance with the views of Berg and Butterfield (1976), lambs on a low plane of nutrition were leaner and had less carcass dry matter, fat and energy contents but higher crude protein, bone and ash.

It was shown that compensatory growth was partly due to the deposition of more lean and hence more protein and less fat and therefore less energy (Sheehy and Senior, 1942). Recent studies have also supported this hypothesis (Butterfield, 1966; Keenan and McManus, 1969; Drew and Reid, 1975). This hypothesis is also supported in this study (Tables 4, 5 and 6).

Some workers have reported a similar body composition for both realimented and continuously grown lambs (Graham and Searle, 1975; 1979; O'Donovan, 1974). Others have reported increased fat and reduced protein percentage in realimented sheep. The phenomenon of compensatory growth has been reviewed in detail by Goodchild and Mtenga (1982). Factors such as age at the onset of restriction, severity of undernutrition, body weight at slaughter, sex and breed may singly or in combination cause disparity in results between workers.

Conclusion

This study shows clearly that Tanzanian lambs have the ability to compensate in terms of growth if switched from a low to a high plane of nutrition and this seems to be brought about by a number of factors such as increased food intake, greater digestibility of the diets and higher protein deposition. It appears that the merits of supplementation are the prevention of mortality, improved growth rates and the production of better carcasses. The phenomenon of compensatory growth can be exploited through strategic supplementation to produce enough and good quality but relatively cheap meat at a time of relative scarcity. However, more research work is needed on the applicability of this phenomenon in field situation taking into account all factors associated with it, including the availability of supplements. More data are also required on the economics of feeding manipulation in different parts of Tanzania.

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Lamb production from Stargrass– Silverleaf Desmodium pastures

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Summary

The possibility of finishing lambs on Stargrass-Silverleaf pasture was investigated. Twenty-five male and female lambs (30 Dorpers and 20 Merinos) were used in the trial. The lambs were weaned at 12 weeks of age and stratified according to breed, sex and mass and randomly assigned to five groups. The first group was slaughtered to give an estimate of the initial carcass mass of the lambs on experiment, the second group consisted of lambs receiving the conventional high energy (10-12 MJ/kg DM): protein finishing diet. The other three treatments were made up of lambs grazing on low (800 kg livemass/ha), medium (1000 kg livemass/ha) medium (100 kg livemass/ha) and high (1200 kg livemass/ha) stocking rates.

The lambs fed on the concentrate diet grew significantly ($P < 0.001$) faster (251 g/d) than those on low (103 g/d), medium (101 g/d) and high (87 g/d) stocking rates. There were no significant differences in growth rate between lambs on the different stocking rates. Production per hectare in terms of livemass was significantly higher ($P < 0.05$) on the high stocking rate (617 kg/ha) than on the low (483 kg/ha) and the medium (595 kg/ha) stocking rates. Stargrass dry-matter yield was significantly higher ($P < 0.001$) than legume yield. Crude protein content increased whilst crude protein per cent decreased after a month in both grass and legume herbage.

The growth rates obtained on the pasture were low and lambs failed to reach slaughter mass. A period of pen-fattening before slaughter would benefit the lambs.

Finition d'agneaux sur pâturages de chiendent et de *Desmodium uncinatum*

Anna Warambwa

Resumé

*Cette étude visant à évaluer la possibilité d'entreprendre la finition des agneaux sur pâturage de chiendent et de *Desmodium uncinatum* a été effectuée sur 25 mâles et un nombre égal de femelles (30 Dorper et 20 Mérinos) sevrés à l'âge de 12 semaines. L'échantillon, stratifié fut réparti au hasard au sein de cinq groupes de traitement. Les animaux du premier groupe ont été abattus au départ en vue d'une estimation du poids de carcasse au début de l'essai. Le deuxième groupe fut composé d'animaux recevant la ration classique de finition à forte teneur en énergie (10-12 MJ/kg MS) et en protéine. Enfin, les agneaux des trois autres groupes furent élevés sur pâturage, avec une charge faible (800 kg de poids vif /ha), moyenne (1000 kg de poids vif/ha) ou élevée (1200 kg de poids vif /ha).*

La croissance des animaux sur concentré fut significativement ($P < 0,001$) plus rapide (251 g/jour) que celle de leurs homologues élevés sur pâturage, que la charge soit faible (103 g/jour), moyenne (101 g/jour) ou élevée (87 g/jour).

Aucune différence significative n'a été enregistrée entre les taux de croissance de ces trois derniers groupes. La production de viande fut significativement plus élevée avec la forte charge (617 kg/ha) qu'avec la charge moyenne (595 kg/ha) ou faible (483 kg/ha). La production de matière sèche de chiendent fut significativement ($P < 0,001$) plus élevée que celle de la légumineuse. La teneur en protéines brutes de l'une et l'autre espèce végétale s'est accru alors que son taux a commencé à baisser à partir du premier mois.

Les taux de croissance sur pâturages furent faibles et le poids atteint par les agneaux à la fin de l'expérience inférieur au poids classique à l'abattage: Une période d'embouche en claustration avant l'abattage s'avère nécessaire.

The role of caged layer waste as a nitrogen supplement to fibrous crop residues commonly fed to sheep and goats

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Abstract

A study was carried out to assess the value of caged layer waste (CLW) as a nitrogen (N) supplement to fibrous crop residues commonly fed to sheep and goats in Kenya. Three crop residues namely maize stover (MS), maize cobs (MC) and wheat straw (WS) were mixed with graded levels of sun-dried CLW from 0, 10, 20, 30, 40, or 50% (as-is basis). The mixtures were incubated for 12, 24, 36, 48, and 72 hours in the rumen of five fistulated Galla goats to study dry-matter degradability (DMD) using the nylon-bag technique. In another study, the effect of method of processing poultry waste on DMD in the reticulo-rumen was investigated. CLW was processed according to the following methods: sun-drying for 4 or 8 days; ensiling for 21 or 42 days; deep-stacking for 21 or 42 days; or fumigation with formaldehyde, four or eight times. The results showed that the DMD of crop residues significantly ($P < 0.01$) increased with increasing level of CLW inclusion up to 40%, beyond which there was no further increase. DMD of all crop residues and at all levels of CLW inclusion increased with increasing duration of incubation in the rumen. Maize stover and maize cobs had a similar ($P > 0.05$) DMD which was higher ($P < 0.01$) than that of wheat straw. The results of the study suggested that poultry waste could be used as a supplemental source of N to fibrous crop residues to increase their degradability in the reticulo-rumen. Among the methods of processing studied, deep-stacking resulted in a higher ($P < 0.01$) DMD than the other methods. Duration of sun-drying or deep-stacking or number of times the CLW was fumigated did not ($P > 0.05$) affect DMD in the rumen. However, ensiling for 42 days gave

a higher ($P<0.01$) DMD of CLW than 21 days. DMD was higher ($P<0.01$) for longer incubation time irrespective of the processing method. It was concluded that the processing methods used did not adversely affect degradability of CLW in the reticulo-rumen.

Utilisation des fientes de volaille comme complément azoté de résidus de récolte fibreux dans l'alimentation d'ovins et de caprins

S.B. Kayongo et M.M. Wanyoike

Résumé

Cette étude a été effectuée pour déterminer la valeur des fientes de pondeuses élevées en batterie comme complément azoté pour des résidus de récolte fibreux. Des fientes séchées au soleil ont été mélangées à trois types de résidus de récolte, à savoir les tiges de maïs, les rafles de maïs et la paille de blé chaque fois à raison de 0, 10, 20, 30, 40 et 50%. Ces mélanges ont été incubés pendant 12, 24, 36, 48 et 72 heures dans le rumen de chèvres fistulées, afin d'en étudier la dégradabilité de la matière sèche par la technique des sachets de nylon.

Une seconde étude a porté sur l'effet de divers traitements des fientes sur la dégradabilité de la matière sèche de l'aliment dans le réseau. Les traitements utilisés étaient le séchage au soleil pendant 4 ou 8 jours, l'ensilage pendant 21 ou 42 jours, l'empilage pendant 21 ou 42 jours, et la fumigation au formaldéhyde.

Il ressort des résultats obtenus que l'addition de taux de fiente croissants augmente significativement la dégradabilité des résidus de récolte ($P<0,01$), jusqu'à 40%, seuil au-delà duquel elle s'est stabilisée. Cette dernière a toujours augmenté avec la durée d'incubation, quel que soit le taux de fiente considéré. Les taux de dégradabilité de la paille et des rafles étaient comparables ($P>0,05$), mais supérieurs à celui de la paille de blé ($P<0,01$). Il ressort de ces résultats que les fientes de volaille pourraient être utilisées comme source d'azote complémentaire pour augmenter la fermentescibilité des résidus de récolte fibreux dans le réseau.

En ce qui concerne les traitements, la dégradabilité des aliments traités par empilage était supérieure ($P<0,01$) à celles obtenues avec tous les autres procédés. La durée du séchage au soleil et de l'empilage ainsi que le nombre de fumigations n'avaient pas d'effet

($P > 0,05$). Par contre, la dégradabilité était plus élevée ($P < 0,01$) pour l'ensilage de 42 jours que pour celui de 21 jours, et quel que soit le traitement considéré, augmentait ($P < 0,01$) en outre avec l'allongement de la période d'incubation. Les traitements des fientes de volaille, particulièrement l'empilage, peuvent donc améliorer l'utilisation des résidus fibreux de culture en accroissant leur dégradabilité.

Session 5

**Small ruminant genetic
resources and breeding**

**Ressources et amélioration
génétique des petits ruminants**

Breeding strategies for small ruminant productivity in Africa

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Summary

The combined population of small ruminants in sub-Saharan Africa numbering 350 million is approximately 31% of the world total and substantially contributes to human nutrition and the economic requirements of the African people. However, the majority (62%) of the small ruminants (sheep and goats) are raised in arid and semi-arid zones where the nomadic production systems do not render systematic genetic improvement feasible. However, animals found in the arid/semi-arid areas have, for a long time, been naturally selected for the harsh conditions and should be the best genotypes for those areas. A relatively smaller (38%) proportion of small ruminant populations are traditionally kept in humid, semi-humid and highland ecozones. Human populations in these areas practice sedentary agriculture and agropastoral production systems. It is in these zones that strategic small ruminant breeding schemes could be applied. However, under smallholder production systems in the agricultural and agropastoral areas, conventional breeding methods are constrained by communal grazing, small flock sizes, single-sire flocks, low levels of literacy and lack of proper recording practices. Under these circumstances breeding strategies will have to be modelled along stratified schemes based on central nucleus elite breeding and multiplier flocks to generate sires for distribution to smallholder farmers. As recording improves, cooperative breeding schemes based on central nucleus herds without concurrent multiplier herds could also be adopted following on-farm performance evaluation for selection of elite females for comprehensive testing in the on-station nucleus herd. The implications of instituting a successful small ruminant breed improvement complemented by on-farm performance testing are also discussed.

Stratégies de sélection visant à accroître la productivité des petits ruminants en Afrique

G.H. Kiwuwa

Résumé

L'ensemble des effectifs ovins et caprins de l'Afrique subsaharienne s'élève à 350 millions de têtes et représente environ 31% du cheptel mondial. Ces animaux, qui permettent aux populations africaines de subvenir à une bonne partie de leurs besoins alimentaires et économiques, sont dans leur grande majorité (62%) élevés dans les zones arides et semi-arides du continent, où les systèmes de production pastorale à caractère nomade font obstacle à la mise en oeuvre de programmes systématiques d'amélioration génétique. En revanche, l'hostilité du milieu a opéré une sélection naturelle qui a donné lieu à la constitution de génotypes particulièrement adaptés à la région. Une part relativement moins importante (38%) des populations ovines et caprines est élevée traditionnellement dans les zones humide et semi-humide et dans les hauts plateaux de l'Afrique. De type agricole sédentaire ou agropastoral, les systèmes de production en vigueur dans ces régions autorisent la mise en oeuvre de programmes stratégiques de sélection, encore que l'exploitation en commun des pâturages, la taille réduite des troupeaux, l'insuffisance du nombre de géniteurs au sein des troupeaux, le faible taux d'alphabétisation et l'absence de méthodes adaptées de relevés de données qui caractérisent les systèmes de la petite exploitation agricole rencontrés dans ces zones viennent s'opposer à l'utilisation des méthodes classiques de sélection. Dans ces conditions, les stratégies adoptées en matière de sélection devront se modeler sur des schémas stratifiés s'appuyant non seulement sur des troupeaux de sélection composés d'animaux d'élite mais aussi sur des troupeaux de multiplication destinés à produire des mâles reproducteurs aux fins de diffusion auprès des petits exploitants. Avec l'amélioration des contrôles, des schémas de sélection à l'échelle collective, fondés exclusivement sur des noyaux de sélection, pourront être mis en place. L'évaluation des performances au niveau des exploitations aura pour objectif de sélectionner des mères d'élite. Celles-ci seront intégrées au noyau de sélection de la station en vue d'une évaluation exhaustive de leurs performances. Les conditions indispensables à la réussite d'un programme d'amélioration génétique des petits ruminants et de l'évaluation en exploitation sont également analysées.

Introduction

The goat, a key actor in the small ruminant production theatre of animal agriculture in Africa was once referred to by the colonialists as "a problem child of African agriculture", causing soil erosion and deforestation and being an absolute nuisance in crop-based farming systems. Not until work carried out in the late 1950s at Serere Research Station in Uganda proved these allegations to the contrary, did the scientific world realise that small ruminants are not villains but have a role to play in the overall livestock production systems on the African continent.

This meeting, today, bears witness to one of the major achievements of the last two decades, regarding animal agriculture in Africa. That achievement has been the fact that greater awareness of the role that small ruminants play in subscribing to the animal protein pool for human consumption has been created. Yet there are still numerous constraints against increased small ruminant productivity. Some of these have been spelt out by Adeniji (1989) and include low genetic potential for milk and meat production, inadequate nutrition and poor management practices, prevalence of diseases and reproductive wastage and limited market outlets for small ruminant products. Secondary limitations cover a range of logistic inadequacies including inappropriate technologies, poor extension services and linkages between research and extension, lack of economic incentives and unavailability of inputs for the utilisation of research findings.

In this address, privilege has been accorded to the speaker to switch on the state of the art and focus on breeding strategies for small ruminants in Africa. In the process, attempt will be made to highlight some of the critical bottlenecks against genetic improvement through known conventional methods and suggestions will be made in relationship to unconventional approaches that could be pursued for various farming systems in the different ecological zones that characterise the environments of sub-Saharan Africa.

State and Focus

Sheep and goat populations in Africa have recently been put at about 191 and 159 million heads, respectively. These estimates represent about 30% and 32% of the world's total population of sheep and goats, respectively. Distribution trends by ecozones indicate that the arid areas take a substantial share of the African small ruminants, accounting for 36% of sheep and 39% of goat populations. The semi-arid, the subhumid and the humid zones account for 22%, 14% and 8% of sheep and 27%, 16% and 9% of the goat populations, respectively.

It would appear therefore that the majority of small ruminants (58% sheep and 66% goats) are kept in arid and semi-arid zones which predominantly practise pastoral-nomadic system of livestock production. Implications from distribution trends are clear. Breeding strategies for nomadic flocks face contradictions between adaptation and absolute productivity. The type of small ruminant breeds for the harsh environment are determined by the ability to survive prolonged droughts, walk and cover long distances in search of water and forages, and utilise coarse forages for growth, reproduction and lactation (Osinowo and Abubakar, 1989).

Breeding strategies for intensive small ruminant production presuppose a sedentary rather than a nomadic system of production. It is under the subhumid and humid ecozones, where communities practice agropastoral and sedentary agricultural farming system, that breed improvement technologies are likely to be successfully adopted. These areas, however, constitute roughly 35% to 40% of the small ruminant population out of which about 10% are on the extreme humid side with the attendant problems arising out of the stressfully humid climate, low nutritive value of fodder and major disease vectors such as ticks, tsetse flies and helminthic parasites. Breeding for heat and disease tolerance would be desirable but could in the process contradict the genetic improvement of the economically productive traits.

However, irrespective of the strategic options, it would be highly desirable that breeding plans match small ruminant breed resources to the available feed, management and socio-economic resources in a given ecozone. The bottom line to future approaches in genetic improvement should be to promote the utilisation of the more promising and adapted indigenous breed resources rather than opting for introduction of temperate goat and sheep germplasm that are often ill-adapted to the tropical conditions. The main goal would be to develop simple breeding procedures involving farmers at the grassroot level and be able to register progress towards predictable and sustainable levels of small ruminant meat and milk productivity in agricultural and agropastoral farming systems around Africa.

Constraints

In designing breeding strategies for small ruminant improvement in Africa one should not overlook a number of constraints that must be overcome before strategies are put in place. A few that come to my mind include:

- Lack of adequate data on breed/type characterisation and standardisation of breed names within and between the five regions of Africa (North, West and Central, East and South). It is possible that there could be a lot of duplication of breed names by country or region. Determination of genetic distances among some of the populations may therefore be useful. The developments

in genome mapping and biochemical genetics may, in future, be able to provide information on DNA sequences that can be used to measure genetic distances and thereafter narrow the present breeds/strains to a smaller number that can be evolved into a dominant type for a given ecozone.

- Much as on-farm breeding data recording schemes would promote participatory research, extension and feedback attributes of a strategic breeding plan, flock mobility under the extensive nomadic systems would pose a major problem. In smallholder systems, small flock sizes coupled with communal herding and single sire flocks also creates problems for isolating sire, farm or flock effects from the true genetic effects. These problems immediately suggest that breeding strategies will have to be modelled along group breeding schemes with on-station nucleus breeding units to provide tested sires to participating farmers.
- Small ruminants, particularly goats, tend to perform less satisfactorily under on-station than on-farm environment. Peters (1989) attributes this phenomenon to differences in management practices. On-station production systems follow modern husbandry methods (fencing, routine disease control, restricted breeding, housing etc.). These lead to reduced feed selection possibilities, higher disease risks and restricted mating freedom. Hence, transposing on-station results on breed comparison to field conditions may not necessarily reflect the true life situation on the range or free choice herding systems in villages. On the other hand, on-farm studies deal mainly with non-genetic factors and may not lead to proper assessment of the desired genotypes.
- Much as some sheep breeds (Dorper Blackhead Persian, Yankasa, Balami, Uda:Ouda etc.) and goats (West African Dwarf, Sudan Desert, Nubian, Galla, Mubende, Boer, Red Sokoto and Somali) have been reasonably documented, there are other types that have not received sufficient attention to explore their full potential. Low genetic potential among the majority of small ruminants is often assumed and breeding plans to cross the indigenous stocks with exotic germplasm are implemented regardless. This is a constraint in a sense that breeders are pushed by economic forces to adopt germplasm for immediate (short-term) benefits without projecting sustainability consequences. The results have been improvement in productive traits at the expense of fitness traits, which in all, could lead to disaster in the long run.

Breeding Strategies

Strategic planning for small ruminant breeding must, from the start, therefore, put into consideration a number of factors. These include the production system (i.e. nomadic, sedentary, agropastoral, mixed farming etc.), the priority order of

economic traits (i.e. meat, milk, fibre skins etc.), the national flock structure and the socio-economic mix, including level of literacy, product consumption habits, market outlets and type of ownership (i.e. smallholder, pure or mixed ranching).

With regard to the production system, the majority of small ruminant populations are located in arid and semi-arid zones of Africa. The owners pursue a nomadic production system which is ecologically imposed but makes full exploitation of arid and semi-arid ranges possible. Nomadism, however, does not render itself to systematic genetic improvement of productive traits other than ensuring and promoting traits for survival.

Strategies for nomadic systems will, for some time, be restricted to disease control and regulation of carrying capacities by creating socially acceptable market outlets.

When we turn to the prioritisation of traits, and assuming that breeding strategies will be best suited to the agropastoral and smallholder crop production systems, two issues come to the fore:

First, with the exception of the milking Nubian–Riverine and the Abyssinian goats, most of the goat and sheep breeds are kept for meat. Those that produce limited amounts of milk (40–80 kg/year) are mainly located in arid and semi-arid environments (i.e. Sudan Desert/Sahel, Maradi/Red Sokoto, Small East African upland semi-arid, Sudan Desert sheep and Ethiopian fat-tailed sheep).

Having noted already that breeding efforts should focus on sedentary farming and agropastoral production systems, one would be inclined to exclude milk production as a key trait for genetic improvement. The effort to breed for milk production would involve importation of exotic dairy goat breeds for cross-breeding. The associated costs of importation followed by ill-adaptation of the crossbreeds to the ecosystems in the sub-Saharan region cannot be justified. Increases in milk yield from 0.5 kg to 2 kg per day are possible, but would still be less than what could be obtained from similar efforts with cattle.

Second, accepting that milk can more effectively be obtained from cattle than from goats or sheep under intensive agro-farming practices, the next consideration is to decide between sheep and goats as meat sources. Sheep can be cheap sources of mutton as they tend to weigh more than goats. However, by the nature of their coat, sheep may not adapt well to the humid climatic zone. Their natural ecosystem is the highlands whose total geographical area is relatively small with extremely high human population densities as compared to the semi-humid and semi-arid areas. Sheep breed, improvement strategies for semi-arid zones may be hampered by the nomadic nature of the production systems in those areas.

Furthermore, due to their close-to-the-ground grazing behaviour, sheep kept together with cattle can easily cause soil erosion, particularly in the hilly and

mountainous areas of eastern Africa. In the West African region, breeds of sheep such as the Yankasa, Uda and Balamí may have a role to play in the agropastoral production systems of that region. Overall, it would appear that for the humid and semi-humid zones breeders should concentrate on goat improvement for meat and skins which offer decisive advantage as goats fit in well with peasant smallholder production systems in those areas.

The **third** issue to consider is that modelling breeding strategies along the conventional methods of progeny testing over a wide range of farm conditions, often supported by recording and artificial insemination services will not work for small ruminants. In most of sub-Saharan Africa, record keeping for meat animals has been difficult to institute due to range production systems where animals stay away from homesteads for some period of time and kidding or lambing are asynchronous with seasons. Furthermore, ownership of small ruminants ownership is in small numbers and is scattered far and wide in the area.

Concentrating large numbers of small ruminants for conventional breeding techniques may not be feasible in the near future, as most progressive farmers and agropastoralists would rather invest the high capital outlay into cattle than goats or sheep. Under such circumstances it would be strategic for breeders to pursue procedures that would enhance superior gene flow from nucleus elite herds to the farmers, supported by performance testing under smallholder production systems.

In short, and according to Olayiwole and Adu (1989), since conventional selection methods are not feasible for small flocks where recording is inadequate or hard to institute, breeding programmes for such a situation should be carefully planned, easy to operate, sufficiently flexible and should incorporate the utilisation of available genetic resources. Within a given breeding scheme emphasis on meat should supersede consideration for other secondary traits such as milk and fibre (skins being a by-product of meat production improvement efforts).

Strategic small ruminant breed improvement could then be approached from three angles:

- a) screening and selection within the locally adapted breeds for prolificity, faster growth rate, larger body size and conformation. The programme should be carried out in elite nucleus flocks to generate superior sires for distribution to smallholder farmers.
- b) crossbreeding or inter-breeding between two most promising local breeds that developed in nearly similar ecozones but that can complement each other's attributes.
- c) blending several local breeds irrespective of their original environment with the hope of evolving a synthetic breed for a given production system.

Strategic Breeding Schemes

Three possible approaches are hereby proposed with the following assumptions:

- a) Meat is the primary target for small ruminant improvement.
- b) Body size at maturity is generally categorised into three groups: small (20–30 kg), medium (30–45 kg) and large (45–60 kg).
- c) Heritability estimates for growth characters are reasonably medium to high (0.30–0.45) and litter size, though it may register low heritability estimate, responds somehow to selection.
- d) The majority (over 90%) of small ruminant production is still under traditional systems of production but can change gradually to modern systems with improved extension services.

Open nucleus elite breeder and multiplier flocks

The scheme involves assembling animals through purchases to a central station. The number of animals (does or ewes) should be sufficiently large (300–500) with about one-third to act as control group. High selection pressure is thereafter imposed on the offspring and the dams according to productivity indices for male and female offspring on the one hand and selection of dams to stay in the herd, on the other. The progeny selection index takes into account the reproductive rate of the dam and the offspring's growth rate and weight at weaning, or better still up to one year to avoid maternal effects at weaning stage. Dam selection index is on the basis of fertility and is calculated at the end of each breeding season. It considers the dam's present and previous records in relationship to those of its contemporaries. These indices have been described by Osinowo and Abubakar (1989).

The selection pressure would allow the top 10% of the males to be retained in the elite herd for further breeding while the next top 30–40% would be transferred to form the flock sire multiplication scheme after performance testing and the 50–60% would be culled. On the side of the dams, about one-third would be culled remaining during each cycle and replaced by the progenies of the top (10%) performing offspring. The next one-third of the females would be moved to the flock sire multiplier station. The flock sire multiplier station would ensure an increase of the number of males available for distribution to farmers after further screening. The system would ensure improved males from the elite breeder flock entering multiplier flocks, from which greater numbers of improved males are generated for distribution to smallholder village flocks.

Open nucleus elite breeder and participatory farmer flocks

The procedure under this scheme would be essentially similar to the first except for the starting and ending stages of animal selection. It also does away with the intermediate sire-multiplier flock stage and requires full cooperation between participating farmers and the Elite Nucleus Breeders. The scheme requires some minimum level of literacy on the part of the beneficiaries (farmers) and outright goodwill to release and receive animals between the station and the farm flocks.

In essence the proposed scheme is a private cooperative breeders' organisation pivoted around a public government institution that funds the central nucleus breeding flock. The procedure assumes that there has been preliminary on-farm performance appraisals of animals that would enter the nucleus flock.

The scheme involves organising groups of interested participants on a provincial or state basis to discuss the concepts, aims and benefits, including the legal and genetic aspects of the scheme.

Each member of the cooperative group, assisted by the field staff, contributes the top-performing females to the elite nucleus central station. This is the concept of preliminary screening of the population for elite females based on weight for age and histories on prolificity.

The next step would be to decide on the exchange rate for the top females contributed to the central nucleus flock, in return for the highly selected sires to pass back to the cooperative farmers. Perhaps a ratio of five females contributed to one tested sire and two super dams received back from the station could be a useful starting point.

Within the central nucleus flock, the top performing females will acquire an elite status as more performance data accumulate. These females must then be bred to the top (1–5%) sires for use within the nucleus flock.

Under this scheme faster genetic progress comes from the relatively high selection pressure made possible in the initial on-farm screening operation followed by equally intensive selection and the technology transfer and extension service between the central nucleus station and the farmer-contributor of superior foundation animals.

On-farm performance testing

Much as intensive selection programmes under centralised elite nucleus flocks generate superior germplasm for distribution to farmers, the final benefits can only be gauged through on-farm performance evaluation. Performance testing identifies and quantifies the nongenetic constraints in order to improve management, disease control and feeding practices. Since we cannot breed beyond the environment the improved animal's genetic abilities should

periodically be tested against the prevailing environmental conditions on the farmers' farms.

Performance evaluation is a logistical complement to genetic improvement schemes. It diagnoses constraints pertaining to a given production system, provides on-spot checks and analysis of husbandry problems, and generates feedback information to breeders and farmers alike. Very often, the results obtained from central station tests are of little relevance to traditional production systems and may not contribute much towards understanding of the specific adaptation ability of animals to farmers' conditions.

One further attraction of on-farm performance testing, is that it provides information on location-specific production conditions that could lead to breed improvement options that are appropriate to the system. Individual animal appraisals and breed comparisons, however, can best be carried out under controlled on-station conditions.

Successful implementation of on-farm performance evaluation is, however, likely to be constrained by a number of problems. Peters (1989) gave a comprehensive outline on the subject and highlighted the following aspects:

- a) on-farm recording must be based on a large sample of flocks carefully stratified following a baseline survey.
- b) comprehensive recording of farm covariates is required to explain systematic differences and major reasons for variation in performance.
- c) where small ruminants are reared on an extensive scale, flock mobility is often a major problem to performance testing.
- d) in smallholder systems, small flock sizes and communal herding also create problems for isolating farm or flock effects.
- e) seasonality of production would facilitate accurate recording of reproductive data, but asynchronous production is most common in African systems and demands regular visits and data recording in herds participating in the on-farm performance schemes.
- f) in order to delineate covariates such as season, disease, age of dam, parity, litter size and sex effects and adjust the data accordingly, one would require a data base spanning over a period not less than two years.
- g) individual animal identification may face difficulties when herds have mixed ownership and continuity may be disrupted by decisions of the owner to sell or slaughter the animal.

However, there are a number of complementarities between on-farm performance evaluation and central nucleus herd stations. According to Peters (1989), genetic improvement schemes on the latter require a field base if they are

to be successful. Furthermore, where nucleus breeding units are integrated with on-farm performance evaluation, immediate improvement through selection of superior foundation animals (see strategy 2) to attain faster and more effective progress can be achieved.

A successful on-farm performance evaluation scheme should be concerned with the whole farm environment; cover all components of the farm environment; identify factors limiting production within the system; initiate integrated research to find solutions based on on-station controlled procedures; test breeding or production interventions (on-farm); evaluate the consequences of the interventions; and be instrumental in the design of small ruminant programmes (Peters, 1989).

Conclusion

Breeding strategies for small ruminant improvement in Africa should focus on meat production characteristics, with skins as a by-product. Multiple births phenomenon should be effectively exploited to provide the maximum meat output per unit of input. Under smallholder production systems of humid and subhumid zones of Africa, conventional breeding methods are constrained by communal grazing, small flock sizes, single-sire flocks, low levels of literacy and poor recording schemes. A partial solution has been suggested to institute elite nucleus breeding stations, screen and test animals (sires) for distribution to farmers. These schemes, however, in the long run should be complemented by simple but systematic on-farm performance evaluation programmes to reinforce and monitor continual genetic improvement.

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The performance, potentials and limitations of the West African Dwarf goat for meat production in the forest belt of Ghana

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Abstract

Production records (1970–1989) for a flock of West African Dwarf (WAD) goats kept on the farm of the University of Science and Technology, Kumasi, in the forest belt of Ghana were analysed. The mean age at first kidding and the mean kidding interval were 543.18 and 284.26 days, respectively. The month of kidding did not ($P < 0.05$) affect kidding interval. The prolificacy of the does was 185.5%. Type of birth affected ($P < 0.01$) birthweight (1.207, 1.145, 1.008 and 0.847 kg for singles, twins, triples and quadruplets, respectively) and weaning weight (5.49, 5.30, 4.86 and 4.34 kg for singles, twins, triplets and quadruplets, respectively). Pre-weaning growth rate (39.6, 33.1, 31.6 and 29.0 g/day for singles, twins, triplets and quadruplets, respectively) was not ($P < 0.05$) affected by type of birth. Pre-weaning mortality rate was affected ($P < 0.01$) by type of birth (34.92, 34.78, 36.25 and 55.56% for singles, twins, triplets and quadruplets, respectively).

The breed has good qualities such as adaptation to the environment, trypanotolerance, high prolificacy and good kidding interval but growth rate is low.

Performances, potentialités et limites de la chèvre naine d'Afrique de l'Ouest pour la production de viande dans la zone forestière au Ghana

A.K. Tuah, M.K. Buadu, F.Y. Obese et K. Brew

Résumé

Des données de production rassemblées de 1970 à 1989 sur un troupeau de chèvres naines d'Afrique de l'Ouest élevé à l'University of Science and Technology de Kumassi, dans la zone forestière du Ghana, ont été analysées. L'âge moyen à la première mise-bas et l'intervalle moyen entre parturitions ont été respectivement de 543,18 et 284,26 jours. Le mois de la mise-bas n'a pas eu d'effet significatif ($P < 0,05$) sur l'intervalle entre parturitions. Le taux de prolificité des femelles était de 185,5%. Le type de naissance, qui avait une influence significative ($P < 0,01$) sur le poids des chevreaux à la naissance (1,207, 1,145, 1,008 et 0,847 kg respectivement pour les naissances simples, les jumeaux, les triplets et les quadruplets), n'avait en revanche aucun effet significatif ($P < 0,05$) sur le rythme de croissance avant le sevrage (39,6, 33,1, 31,6 et 29,0 g/jour respectivement pour les naissances simples, les jumeaux, les triplets et les quadruplets). Le type de naissance avait un effet significatif ($P < 0,01$) sur la mortalité avant sevrage (34,92, 34,78, 36,25 et 55,56 respectivement pour les naissances simples, les jumeaux, les triplets et les quadruplets).

Dotée de qualités telles que l'adaptation au milieu, la trypanotolérance, une prolificité élevée, un faible intervalle entre parturitions, cette race de chèvres est en revanche limitée par un faible taux de croissance.

Introduction

Chevon is the meat used most for preparing food in public restaurants (popularly known as "chop bars") in Ghana. The West African Dwarf goat (WAD), the commonest breed in Ghana, is known for its prolificacy and trypanotolerance. Its small size (15–21 kg; Devendra and McLeroy, 1982) makes it suitable for butchering in small communities where there are no cold-storage facilities. It is therefore not surprising that the government intends to encourage farmers to increase the production of goats during the implementation of its medium-term agricultural development programme (Ministry of Agriculture, 1988). The

expected increase in the population of goats (1 901 000 in 1987 to 9 172 000 by the year 2000) is greater than the expected increase in the populations of sheep (1 989 000 in 1987 to 6 319 000 by the year 2000) and cattle (1 170 000 in 1987 to 1 853 000 by the year 2000). Since the population of goats is expected to increase about ninefold, it is necessary to assess the performance of the dominant breed in all the ecological zones of the country so as to know its potentialities and limitations. This will help the policy makers to decide whether new genes should be introduced or not.

The aim of this paper therefore is to assess the performance of the WAD goat on the farm of the University of Science and Technology, Kumasi, which is located in the humid forest zone of Ghana.

Materials and Methods

Location, climate and management of the flock

The data used in this study were obtained from the production records of the flock of WAD goats belonging to the University of Science and Technology, Kumasi. The study covered the period January 1969 to December 1970. The location, climate and vegetation of the University farm have been described by Tuah and Baah (1985).

Kiddings were recorded and kids were weighed within 24 h after birth. The kids were ear-tagged for identification and were weaned when they were four months old. The males not needed for breeding were castrated using the burdizzo at the time of weaning. The breeding males ran with the females throughout the year, thus there was no controlled seasonal breeding. Routine drenching against endoparasites was carried out fortnightly. Dipping was also carried out fortnightly to control ectoparasites. The goats were kept under a semi-intensive system throughout the year as described by Tuah and Baah (1985). They were housed in pens at night and allowed to graze during the day. Straw or wood shaving bedding was provided in the pens.

The animals grazed mainly *Cynodon* spp interspersed with *Centrosema pubescens* from morning up to 1700 h GMT. They were supplemented with wet brewer's spent grains.

Methods of parameter computation and statistical analysis

Age at first kidding was computed as the difference (in days) between birth and first kidding dates of does.

Kidding interval was calculated as the difference (in days) between two successive kiddings for all does with more than one kidding record.

Prolificacy was calculated as the percentage of kids dropped of does kidding. Percentage incidence of twins, triplets and quadruplets was also calculated as

$$\frac{\text{Number of multiple births}}{\text{Total number of births}} \times 100$$

Secondary sex ratio was calculated as the ratio of the total number of male kids dropped to the total number of female kids dropped. The chi-square test was used to test for the significance of the observed ratio from the expected (Snedecor and Cochran, 1967).

The effects of type of birth and sex on birthweight, weaning weight and pre-weaning growth rates were analysed separately using the completely randomised design (CRD) and Tukey's Honestly Significant Test (Steel and Torrie, 1980). The effect of month of kidding on kidding interval was analysed using completely randomised design (Steel and Torrie, 1980).

Mortality rate was calculated as follows

$$\frac{\text{No. dead}}{\text{No. born}} \times 100$$

The effects of type of birth on mortality rate was determined using chi-square with the mortality rate of singles used as expected (Steel and Torrie, 1980).

Results and Discussion

Age at first kidding and kidding interval is shown in Table 1. The mean age at first kidding was less than two years (543.18 ± 192.10 days). Goats on the University farm are more precocious than the sheep kept on the same farm. Tuah and Baah (1985) reported the mean age at first lambing on the same farm to be 638 days with a range of 338 to 1542 days. The mean kidding interval (284.26 ± 100 days) was, however, greater than the mean lambing interval (264 days) reported by Tuah and Baah (1985) and the mean kidding interval reported for the same breed (258 days) by Vohradsky and Sada (1973) on the Accra Savanna plains. The minimum kidding interval is similar to that reported by Ali et al (1973; 151 days) for Black Bengal goats. The month of kidding did not significantly affect the length of the kidding interval (Table 4; SE 7.33). This is an indirect evidence showing

Table 1. *Reproductive performance traits of the West African Dwarf goat.*

	No. of records	Range (days)	Mean (days)	Standard deviation
Age at first kidding	56	323-1061	543.18	192.10
Kidding interval	207	152-731	284.26	100

that on the farm, kidding interval is not affected by changes in quantity and quality of forages which occur during the various seasons of the year as these forages form the staple diet of these animals. It is also possible that the practice of feeding wet brewers' spent grains ameliorated the effects of nutritional stresses, hence the no significant effect of the month of kidding on kidding interval. It must also be noted that in the forest belt the dry seasons are not as severe as in the savanna areas of the country and feed shortage is not very great. The prolificacy of the goats was 185.5%. On the same farm, goats were more prolific than the Djallonke sheep (Tuah and Baah, 1985; 130.3%). The incidences of single births and births of twins, triplets and quadruplets were 35.69, 45.61, 16.15 and 2.55%, respectively. It is not desirable to have a prolificacy value of more than 200% as kid mortality is increased with an increase in prolificacy (Table 2). In this country, artificial milk replacers are not fed to the extra kids which cannot get access to teats. In an earlier study covering a ten-year period (1969–1978), Tuah (1989) reported that prolificacy in goats on the same farm was affected ($P < 0.01$) by the age of dam. The values for the various age groups involving 234 kids were 124.1, 196.8, 182.8, 206.7, 277.8 and 233.3% for does aged one, two, three, four, five and six years, respectively.

Table 2. *The effect of month of kidding on kidding interval.*

Month of kidding	No. of records	Kidding interval (days)	Range (days)	Standard deviation
January	27	257.37 ± 5.47	166–431	67.82
February	9	347.38 ± 9.47	186–510	106.37
March	27	276.19 ± 5.47	163–521	90.31
April	19	252.42 ± 6.52	167–404	73.28
May	14	323.93 ± 7.59	169–731	151.51
June	16	258.25 ± 7.10	167–470	90.02
July	9	291.67 ± 9.47	192–391	75.24
August	14	280.07 ± 7.59	202–435	73.59
September	13	255.85 ± 7.88	152–477	110.91
October	26	245.04 ± 5.57	154–486	70.42
November	12	315.50 ± 8.20	205–715	149.91
December	21	249.76 ± 6.20	196–358	43.70

The effects of type of birth on birthweight, weaning weight and pre-weaning growth rate are shown in Table 3. Birthweight was affected ($P < 0.01$) by type of birth. Generally birthweight decreased with increase in litter size. Robinson et al (1977) reported that, for lambs in utero, as the number of foetuses increases, the number of caruncles attached to each foetus decreases thus reducing the feed supply to the foetus and hence the birthweight of the lambs. Pre-weaning growth was not affected by the type of birth perhaps because most of the kids were raised as singles and twins (Table 4). Hunter (1957) observed that each twin lamb suckling its mother obtained 68% of the milk obtained by a single lamb, hence the differences in the pre-weaning growth rates of single-born lambs and twin-born lambs. The overall mean pre-weaning growth rate (32.88/day) falls just outside range reported by Reynolds (1989) for kids kept in Nigeria (17.4 g/day to 31.9 g/day).

Weaning weight was affected ($P < 0.01$) by type of birth, decreasing with increase in litter size. Sidwell et al (1962) reported that type of birth had the greatest influence on weaning weight. In an earlier study Tuah (1989) reported that birthweight and weaning weights of kid were not affected by sex, season of birth, age and parity of dam. The mean overall post-weaning (4–12 months) growth rate (24.04/day) was less than the mean overall pre-weaning growth rate (32.8 g/day) but well within the range reported by Reynolds (1989; 14–28.3 g/day) for the same breed in Nigeria.

Table 4 contains the pre-weaning mortality rate of kids. Mortality rate increased as litter size increased but only the mortality rate of quadruplets was significantly ($P < 0.01$) different from that of the other birth types. The overall mortality rate of 36.3% was higher than the rate (20.95%) reported by Tuah and Baah (1985) for lambs on the same farm. The rate is, however, similar to the rates reported by Wilson et al (1985; 30%) and Vallerand and Branckaert (1975; 35%) for unweaned lambs. The major causes of pre-weaning deaths in kids on the same farm according to Tuah (1989) were starvation (24.27%), pneumonia (16.50%), helminthiasis (20.38%), bacterial infection (6.80%), diarrhoea (5.8%) and heartwater (4.85%). About 21% of the mortalities occurred during the neonatal period (0–7 days). These causes of mortality can be controlled if proper management practices are instituted.

Potentialities and limitations of the breed for meat production

The breed is prolific (185.6%) and this trait needs no improvement since mortality rates of kids can be high with prolificacy values exceeding 200%, especially when kids which have no access to teats are not artificially fed in this country. Mortality rates of kids are high (36.34%) but this source of wastage can be reduced with proper management practices. Kidding interval is greater than the ideal of 240 days. It must be observed here that there is no culling of poor producers on the university farm. Perhaps if culling of poor producers is carried out, the kidding

Table 3. *The effect of type of birth on birthweight and growth performance to weaning (0-4 months) *.*

Type of birth	Mean birthweight (kg)	Range	Mean weaning weight (kg)	Range	Mean pre-weaning growth rate (g/day)	Range (g/day)
Single	1.207±0.031 (126) ^a	0.500-2.000	5.49±0.149 (82) ^a	3.00-10.00	39.6±1.23 (82)	15.00-70.00
Twin	1.145±0.02 (322) ^{ab}	0.500-2.500	5.30±0.093 (210) ^a	3.00-9.00	33.1±0.767 (210)	15.00-61.00
Triplet	1.008±0.027 (171) ^{bc}	0.500-2.000	4.86±0.13 (109) ^{ab}	3.00-8.00	31.6±1.065 (109)	16.00-71.00
Quadruplet	0.847±0.059 (36) ^c	0.450-1.500	4.34±0.338 (16) ^b	2.50-7.50	29.0±2.78 (16)	14.00-56.00
Overall	1.105±0.038 (655)	0.450-2.50	5.185±0.20 (417)	2.50-10.00	32.8±1.66 (417)	14.00-71.00

* Figures in parenthesis indicate the number of observations.
Means carrying different superscripts are different ($P < 0.01$).

Table 4. *Effect of type of birth on pre-weaning mortality and weaning rates of kids.*

	Type of birth				Total
	Singles	Twins	Triplets	Quadruplets	
Total No. born	126	322	171	36	655
No. dead before weaning	44	112	62	20	238
Mortality rate(%)	34.92 ^b	34.78 ^b	36.25 ^b	55.56 ^a	36.34
No raised to weaning	141	212	60	4	417
Kids raised to weaning (%)	33.81	50.84	14.39	0.96	63.66

Means carrying different superscripts are different ($P < 0.01$).

interval could be shortened. The mean age at first kidding (543.18 days; 18.1 months) is higher than the value reported for Katjang goats in Malaysia (15–16 months) by Devendra (1966).

The greatest limitation of the breed is its slow growth rate. There is the need to carry out selection within the breed or to introduce new genes to improve the trait. Introduction of new genes should be done with caution so as not to adversely affect the good characteristics of the breed. The feed conversion efficiency of the breed should also be studied.

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Comparative performance of improved meat goats in Malya, Tanzania

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Abstract

Records on liveweight, growth and reproductive performance of Blended (BLD), Blended x Galla (BG) and Kamorai x indigenous goats for a period of over 10 years (1970–1980) were analysed. For BLD, BG and KI goat kids, birthweight averaged 2.9, 2.9 and 2.7 kg ($P < 0.01$), respectively, averaged 13.4, 12.1 and 12.7 kg ($P < 0.05$), and liveweight at 72 weeks of age averaged at 29.8, 27.1 and 29.3 kg ($P < 0.05$), respectively. Sex and birth type had significant effects on all liveweight measures while year of birth did not.

Mean litter size for six parities for BLD, BG and KI does were 1.35, 1.21 and 1.43, respectively. It was concluded that BLD goats with higher liveweights and efficient reproductive performance compared to BG and KI goats should be used for crossbreeding purposes to improve the meat production from goats in the rural areas.

Comparaison des performances de caprins à viande à Malya (Tanzanie)

S.M. Das et D.S. Sendalo

Résumé

Des données rassemblées pendant 10 ans (1970–1980) sur le poids vif, la croissance et les performances de reproduction de caprins Blended (BLD), Blended x Galla (BG) et kamorai x race locale (KL) ont été analysées. Le poids à la naissance moyen des BLD, BG et de KL fut respectivement de 2,9, 2,9 et 2,7 kg ($P < 0,01$) pour un poids moyen au sevrage de 13,4, 12,1 et 12,7 kg ($P < 0,05$) et un poids vif de 29,8, 27,1 et 29,3 kg ($P < 0,05$) à l'âge de 72 semaines.

Contrairement à l'année de la naissance, le sexe du chevreau et le type de naissance eurent des effets significatifs sur tous ces paramètres. L'âge à la première parturition fut respectivement pour des BLD, des BG et des KL de $780,3 \pm 8,5$, $766,8 \pm 17,3$ et $757,0 \pm 24,7$ jours. Évalué pour six parturitions, l'intervalle moyen entre mises-bas fut respectivement de $379,6 \pm 12,5$, $388,2 \pm 13,2$ et $373,5 \pm 11,6$ jours, pour une taille de la portée moyenne de 1,35, 1,21 et 1,43 chevreaux. Compte tenu de leur poids vif plus élevé et de leurs meilleures performances de reproduction, les BLD devraient être préférés aux BG et aux KL dans les programmes de croisements destinés à améliorer la production de viande des caprins en milieu rural.

Introduction

Small ruminants have been frequently used as a source of meat in both rural and urban areas of Tanzania, although meat from goats is both scarce and expensive. The high demand for goat meat led to the improvement of indigenous goats through crossbreeding with bigger breeds so as to increase the per capita animal protein consumption levels of Tanzanians. A breeding programme to develop a meat goat breed based on indigenous goat was started in the early 1960s. The indigenous goats termed as "Small East African goat" by Devendra and Burns (1983) was crossed with Kamorai and Boer breeds to develop the Blended goat.

The present study reports on growth and reproductive performance of Blended goats at the Livestock Research Centre, Malya. Progeny crosses between Blended x Galla and Kamorai x Small East African goat (SEA) genotypes were used for comparative purposes. The results in this study would indicate the benefits of using the meat goat genotypes developed to be used in improving the indigenous goat population.

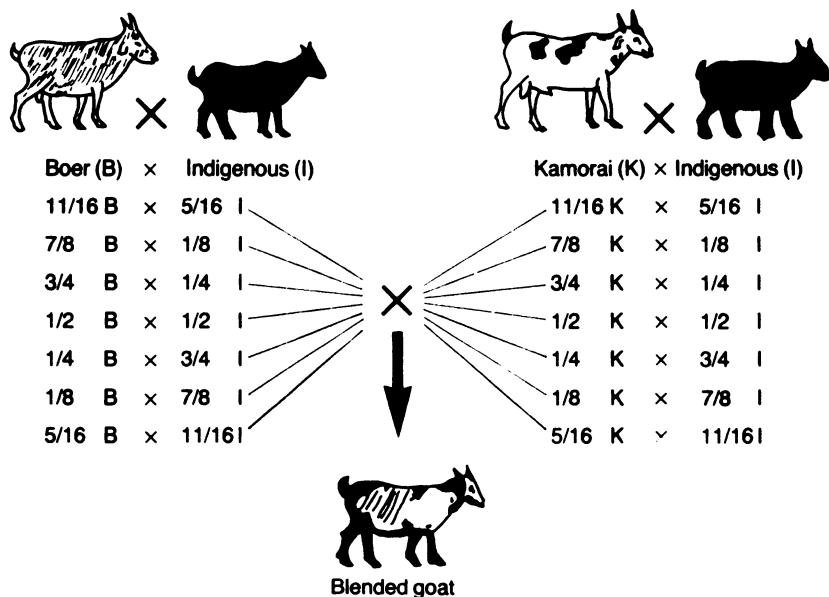
Materials and Methods

The study was undertaken at the Livestock Research Centre (LRC), Malya, situated near Lake Victoria at an altitude of 1250 m above sea level. The mean precipitation at the Centre ranges from 640 mm to 1020 mm extending from late October to early May. The natural pasture is dominated by *Hyparrhenia* spp with isolated patches of *Setaria sphacelata*, *Cynodon dactylon* and *Chloris gayana*. The main browse plant was *Acacia tortilis*.

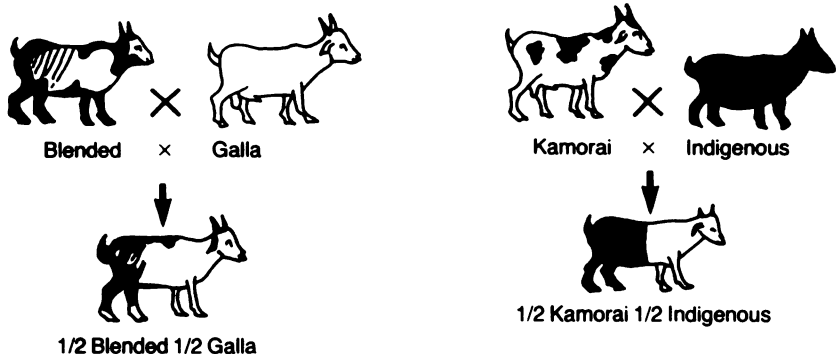
Records for this study were obtained from LRC, Malya and the National Livestock Registry at Mpwapwa. A total of 4824 records on liveweights and 1258 kidding records covering over a 10-year period (1970–1980) of Blended (BLD), Blended x Galla (BG) and Kamorai x SEA (KI) were used in the present study. Computation of the genetic constitution of BLD goat showed the following proportions:

Kamorai 55%, Boer 30% and indigenous 15%. Blended x Galla goats considered in this study were 50% Blended and 50% Galla, while KI goats were 50% Kamorai and 50% indigenous. The schematic evolution of blended goats, BG and KI is shown in Figure 1.

Figure 1. Evolution of Blended, Blended x Galla and Kamorai x indigenous goats.



1. Kamorai 55%, Boer 30%, Indigenous 15%



Managerial practices of goats at LRC, Malya did not vary during the period of study, whereby kids weaned at 16 weeks of age were subjected to grazing on natural pasture. At the age of 72 weeks, maiden does were mated for the first time, and mating period extending for 50 days (mid-July to early September) was conducted once per annum. The ratio of buck to does during mating was about 1:40.

Kids at birth were ear-tagged for identification and weights were recorded at birth, and at ages of 16 weeks (weaning), 24 weeks (post-weaning), 48 weeks (puberty) and at 72 weeks (maturity). Weights were also recorded at mating and kidding for females and at yearly interval for males. Main diseases of goats encountered at the centre included tapeworm infestation, pneumonia and foot-rot. Routine treatment and disease control measures (deworming and dipping) was regularly done for all goats at the Centre.

Traits investigated in this study included birthweight, weaning weight, weights at 24, 48 and 72 weeks of age and growth rate. Reproductive traits investigated included size of litter, percentage of birth with twins and sex ratio of kids born. The liveweight data were analysed by a least-squares method.

Results

Mean liveweights of kids from birth to 72 weeks of age by genotype, sex and birth-type are shown in Table 1.

Blended kids having 2.9 kg birthweight, 13.4 kg weaning and 29.8 kg at 72 weeks of age were observed to have significantly higher liveweights than BG and KI kids. At 48 weeks of age KI kids were significantly heavier than BG kids. Male kids exhibited higher liveweights ($P < 0.05$) than females, while single-born kids were heavier than twins at all ages of weight recording.

Growth rates from birth to weaning, 24, 48 and 72 weeks of age are shown in Table 2. Blended kids showed higher growth rates from birth to weaning and from birth to 72 weeks of age. Single-born kids exhibited higher growth than the twins from birth to weaning and to 24 weeks of age, while at higher ages their growth rates were not significantly different.

Blended does showed higher incidence multiple births with twinning rate of 40.9%, overall for six parities compared to BG does, whereas KI does had higher twinning rates compared to both BLD and B does (Table 3).

Litter size computed by dividing the total number of kids born by the total number does kidded showed a tendency to increase from first parity to fifth parity and a reduction in sixth parity. Sex ratios for kids born were observed to be slightly less males than females but were not significantly different across parities and genotypes in the study.

Table 1. *Mean liveweights of kids at the Livestock Research Centre, Malya, by genotype, sex and birth-type.*

	Age in weeks				
	Birth	16	24	48	72
Mean liveweight (kg)					
Overall	2.6	12.7	14.4	19.8	28.7
Breed ¹ : BLD	2.9a	13.4a	14.8a	19.9a	29.8a
BG	2.6b	12.1b	14.3b	19.6b	27.2b
KI	2.7b	12.7c	14.5b	20.4a	29.3a
Average SE	0.01	0.13	0.17	0.21	0.33
Sex: male	2.7a	13.5a	15.5a	20.9a	30.2a
female	2.5b	11.3b	13.3b	19.1a	20.4b
Average SE	0.01	0.15	0.19	0.25	0.38
Birth-type					
Single	2.9a	13.3a	15.6a	20.6a	29.3a
Twin	2.4b	11.6b	13.4b	19.4	27.2b
Average SE	0.03	0.14	0.19	0.23	0.36

Means within a column of class with different letters differ significantly ($P < 0.05$).

1. BLD = Blended; BG = Blended x Galla; KI = Kamorai x Small East African.

Discussion

Liveweights at birth and weaning of BLD, BG and KI kids in the present study are lower from those reported for BLD kids at Malya and Kongwa by Das (1989). It was also observed that weights at birth, weaning and at 72 weeks age of goat kids in this study were lower than those reported for Boer goats by De Haas (1978), Malawi goats by Ayoade and Butterworth (1982) and Tsana goats (APRU, 1984). Blended goat kids showed higher liveweight and average daily gain compared to BG and KI kids. These parameters were also higher than that of Black Bengal goats reported by Singh et al (1983) and Black Bengal x Beetal crossbred goats reported by Kanaujia et al (1986).

At birth, males were only 0.2 kg heavier than females, which was smaller than the 0.3 kg reported by Kyomo (1978) for Small East African goats. Singles were heavier than twins and grew faster from birth to 24 weeks of age. Similar observations were reported by Nath and Chawla (1978) for Beetal, Alpine and their crossbred kids. The pre-weaning daily gain of BLD kids of 94.3 g/day exceeded that of BG and KI kids by 6.4 and 12.8, respectively. Similar

Table 2. Mean daily gain of goat kids at the Livestock Research Centre, Malya, by genotypes, sex and birth-type.

	Age in weeks			
	0-16	0-24	0-48	0-72
	Mean daily gain (g)			
Overall	88.5	71.3	52.8	52.6
Genotype ¹ :BLD	94.3a	72.1	52.3	54.6a
BG	88.7b	70.4	52.3	50.2b
KI	82.7b	71.3	53.5	53.4a
Average SE	0.83	0.94	0.44	0.37
Sex: male	94.1a	76.0a	53.1a	54.7a
female	81.4b	67.1b	51.0b	50.3b
Average SE	0.85	1.02	0.47	0.45
Birth-type				
single	95.4a	76.3a	52.2	53.8
twin	80.5b	65.9b	51.5	51.4
Average SE	0.91	1.06	0.35	0.31

ab = Means within a column of a class with different letters differ significantly ($P < 0.05$).

1. BLD = Blended; BG = Blended x Galla; KI = Kamorai x Small East African.

observations were made by Kassuk (1974) who attributed lower pre-weaning average daily gain of BG and KI kids to lower milk yields of their dams.

Weaning weight would reflect mothering ability of dam as well as the inherent growth potential. Thereafter growth potential would predominate. In this study, males were significantly heavier and grew faster from weaning onwards ($P < 0.05$). Their differences increased from 16 to 72 weeks of age implying that sex effects are more pronounced with age after puberty.

Blended and KI does showed higher multiple births than BG does. The incidence of multiple births tended to increase from first parity to fifth parity. Twinning per cent of does in the present study were lower than that reported for Black Bengal and Beetal x Black Bengal does in India by Kanaujia et al (1986). The sex ratio of kids born are similar to that reported by Sinha and Sahni (1981) for Indian goats.

Table 3. *Kidding performance of goats at the Livestock Research Centre, Malya.*

Parity	n	Parameter		
		Twinning %	Litter size	Sex ratio (% males)
Overall				
BLD ¹	799	40.9	1.44	49.8
BG	248	34.3	1.39	47.5
KI	193	43.5	1.46	47.8
I BLD	279	19.4	1.19	52.9
BG	92	7.6	1.08	52.5
KI	52	36.5	1.41	49.3
II BLD	204	35.3	1.38	55.3
BG	53	32.1	1.32	48.6
KI	34	36.5	1.41	49.3
III BLD	155	47.1	1.48	50.7
BG	38	44.7	1.45	43.6
KI	34	50.0	1.52	48.1
IV BLD	60	41.6	1.45	46.8
BG	27	40.7	1.41	47.4
KI	19	57.9	1.58	46.7
V BLD	60	56.7	1.57	46.7
BG	27	44.4	1.44	45.5
KI	18	50.0	1.50	48.5
VI BLD	41	46.3	1.46	46.7
BG	11	36.5	1.35	47.1
KI	10	46.0	1.40	47.0

n denotes number of does kidded.

1. BLD = Blended; BG = Blended x Galla; Kamorai I = Small East African

The results of this study indicate that BLD goats, given proper management and nutrition, have a potential as a meat-producing goat. The mean age at kidding could be lowered by mating goats immediately after puberty. The superiority of BLD goats over BG for both growth rate and reproductive performance suggests that there is little point in crossing Blended goats with Galla goats.

Acknowledgements

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Dairy goat breeding in Malawi: Gestation length, birthweights and growth of the indigenous Malawi goats and their Saanen crosses

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Abstract

Some Malawi local goats were mated to Saanen bucks and others to local bucks under the same management at the Bunda College farm. Gestation length, birthweights, weaning weight, weight gain per day and weights at one year were observed and compared.

The average gestation length of local dams sired by Saanen bucks (146.90 ± 2.68 days) was not significantly different from that of dams sired by local bucks (147.76 ± 3.44 days). Sex of kids and litter sizes did not affect gestation length and although younger dams and dams kidding in the hot wet season had shorter gestation lengths than older dams and those kidding in the cool dry and hot dry seasons, respectively, the differences were not statistically significant.

With the exception of twin-born males, birthweights of Saanen crosses were significantly higher than local kids. Likewise, weaning weights and weights at one year were higher in the Saanen crosses than in the local kids. Weight gains per day were higher before weaning than after and were higher in Saanen crosses than in the local kids. Mortality was 22% in Saanen crosses and 21% in the local kids.

Elevage de caprins laitiers au Malawi: durée de la gestation, poids à la naissance et croissance de la race locale et de ses croisements avec des Saanen

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Résumé

Des chèvres de race locale du Malawi ont été croisées avec des boucs Saanen ou de race locale à la ferme du Bunda College of Agriculture. La durée de la gestation, le poids des chevreaux à la naissance, au sevrage et à l'âge de 1 an et le gain journalier de poids ont été enregistrés et comparés.

La durée moyenne de la gestation des femelles saillies par des mâles Saanen ($146,90 \pm 2,68$ jours) n'était pas significativement différente de celle des femelles saillies par des boucs de race locale ($147,76 \pm 3,44$ jours). Ni le sexe des chevreaux ni la taille de la portée n'avaient d'effet sur la durée de la gestation. Sans présenter des différences significatives, celle-ci était plus courte pour les chèvres plus jeunes et pour les naissances intervenant au cours de la saison chaude et humide par rapport à la saison fraîche et sèche ou à la saison chaude et sèche,

Exception faite des jumeaux mâles, le poids à la naissance des croisements de Saanen était significativement supérieur à celui des chevreaux de race locale. De même, les poids au sevrage et à l'âge de 1 an de ces croisements étaient significativement plus élevés que ceux des chevreaux de race locale. Le gain de poids journalier était plus élevé avant qu'après le sevrage et plus élevé chez les croisements de Saanen que chez les chevreaux de race locale. Le taux de mortalité des premiers était de 22% contre 21% pour les seconds.

Introduction

The zebu cow has remained the major source of milk in rural areas of Malawi where 89% of the people live. Improved dairy cattle breeds are concentrated in areas surrounding urban centres designated as Milk Shed Areas.

Figures on milk consumption in rural areas are not available. However, FAO (1986) reported that total milk production in Malawi was 40 million kg which gave an estimated per capita consumption of 5 kg. With a population which is

increasing at 3.2% per annum but with about 0.95 ha of land per capita (Munthali, 1987), the likelihood of improving this per capita milk consumption is remote. The goat, due to its small size and hence lower feed and capital requirements, can supplement cattle as a source of milk specially for rural areas.

Keeping goats is already popular among the smallholder farmers in Malawi. A survey conducted by Banda and Phiri (1990) indicated that goat milk is not discriminated against and is actually preferred in some cases. However, milk production from local goats is low (Mwenefumbo and Phoya, 1982; Banda, 1989). As an effort to improve milk production from goats, crossbreeding Saanen bucks to Malawi local goats commenced on an experimental basis at Bunda College of Agriculture in 1988. So far, observations have been on gestation length, birthweights, weaning weight and growth to one year.

Materials and Methods

Indigenous (local) Malawi does were mated randomly either to Saanen bucks or to local bucks at the Bunda College farm (latitude 14°35'S, longitude 33°50'E, 1200 m above sea level). The doe were herded on natural pastures together with a vasectomised buck. Any doe noticed on heat was separated and mated to a fertile buck. This provided an opportunity to record accurately the mating day, kidding day and calculate gestation length. Also recorded at kidding was kid weight, litter sizes and sex of kid. All male kids in both groups were castrated at two weeks of age. Age of the dams was determined using dentition (Wilson and Durkin, 1985).

All kids together with their dams were fed indoors on Star grass (*Cynodon nlemfuensis*) and Napier grass (*Pennisetum purpureum*) for the first one month. Thereafter they were herded on natural pastures together with the rest of the flock. No supplementary feeding was done and the dams were not milked. Mortality was also recorded.

The data were analysed using Statistix 2.0 Program on the Unisys Computer available at Bunda College.

Results and Discussion

Gestation length

Effect of breed of sire on gestation length

The average gestation length of dams sired by Saanen bucks was not different from that of dams sired by local bucks (Table 1). Although previous data on

gestation length of Malawi local goats are not available, that of Saanen has been reported to be 150 days (Peaker, 1978). This seems to indicate that the sire of the litter has no effect on gestation length. Overall gestation length was 147.17 ± 2.58 days and agrees with reports by Wilson (1957) on the Mubende goat in Uganda (146 1/2 days).

Table 1. *Gestation length (days) of local dams sired by Saanen and pure local bucks.*

According to	No. of kiddings	Gestation length	SE
Overall	74	147.17	2.58
Breed of sire: Saanen	56	146.90	2.68
Local	18	147.76	3.44
Age of dam: 1 pair (14–18 months)	9	144.89	3.10
2 pairs (19–23 months)	7	145.60	5.17
3 pairs (24–31 months)	35	147.80	2.85
4 pairs (over 32 months)	23	146.95	2.69
Litter size: Single birth	62	147.14	2.86
Multiple births	12	147.09	3.05
Sex of kid: Male	38	146.94	2.79
Female	36	147.34	2.79
Season of kidding: Cool dry season (May to Aug)	19	147.00	2.38
Hot dry season (Sep to Nov)	26	147.23	3.20
Hot wet season (Dec to Apr)	29	146.46	2.92

Effect of age of dam and season of kidding on gestation length

Although dams that kidded in the wet season and were younger had shorter gestation lengths than the others, the observed differences were not statistically significant. However, results reported by Asdell (1929) seem to have shown significant age and seasonal differences.

Effect of litter size and sex of kid on gestation length

Gestation length in dams kidding single kids (147.14 ± 2.86 days) was about the same as in dams kidding multiple kids (147.09 ± 3.05 days). Similarly, the gestation length in those kidding male kids (146.94 ± 2.7 days) were the same as those kidding female kids (147.34 ± 2.98 days). The results therefore agree with Asdell (1929) that gestation length is not affected by litter size and sex of kid.

Birth and mortality of kids

With the exception of males born as twins, birthweights of Saanen crosses were significantly higher than those of pure local (Table 2). Birthweights of males were also higher than that of females in both groups. Mortality rates of kids were 22% in local kids and 21% in Saanen crosses. It is difficult to suggest reasons for these mortality rates since post-mortem examination of dead kids was not conducted.

Growth performance

As in birthweight, weaning weights and weights at 1 year (364 days) were significantly higher in the Saanen crosses than in pure locals in both male and female kids (Table 3). Weight gains per day were also higher in the Saanen crosses than in the pure locals both before and after weaning.

Unlike the Saanen crosses where males had higher weaning weights (12.80 ± 5.14 kg) and weight at one year (25.00 ± 3.00 kg) than females (11.96 ± 2.77 kg at weaning and 22.50 ± 1.78 kg at one year), in the pure local kids, the females had higher weaning weight (8.33 ± 0.7 kg) and weight at one year (16.16 ± 1.55 kg) than males (7.60 ± 1.53 kg at weaning and 14.99 ± 1.66 kg at one year). Similarly, weight gains per day were higher in males (92.32 gm before and 48.41 gm after weaning) than in females (82.67 gm before and 41.82 gm after weaning) in the Saanen crosses, but higher in females (56 gm before and 31 gm after weaning) than males (50 gm before and 29 gm after weaning) in pure local kids. This could be attributed to the effect of castration. However, similar results have been reported by Kasowanjete et al (1987) in the Malawi goats.

Conclusions

So far, these observations indicate that Saanen crosses are performing better than pure local kids (higher birthweights, weaning weights, weight gains per day and weight at one year) under the same management. However, this was at a research station and further investigations are planned for village conditions. Similar studies are planned for 3/4 and 1/4 Saanen under both station and village management before a firm recommendation is made.

Table 2. Birthweights of Saanen x Local (SL) and Pure Local (PL) at Bunda College farm (kg).

Breed	Singles			Twins		
		M	F	M	F	
Saanen x Local	x	2.61±0.39a	2.48±0.54a	2.08±0.45	2.00±0.35a	4
Pure x Local	n	16	23	11	7	
	x	1.93±0.53b	1.84±0.48b	1.95±0.26	1.75±0.24b	

Means with different superscripts in each column differ significantly (P).

Table 3. Growth performance of Saanen x Local and Pure x Local goats at Bunda College Farm.

Breed	n	Weaning weight (X±sd) (112 days)	Weight gain per day to weaning (g)	Weight at (X±sd) 364 days	Weight gain/day (gm) from weaning to 364 days
Saanen x Local	17	12.80±5.14	92.32	25.00±3.00	48.41
	18	11.96±2.77	82.67	22.50±1.78	41.82
Pure Local	16	7.60±1.53	50.00	14.99±1.66	29.32
	19	8.33±2.07	56.16	16.16±1.55	31.07

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Composition and yield of milk from non-dairy goats and sheep in Malawi

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Abstract

Milk yield, milk composition and growth rates of offspring from goats (local-LL, Boer-BB and their crosses-BL) and of sheep (local-LL, Dorper-DD and their crosses-DL) were estimated over two kidding/lambing seasons for 12 weeks of lactation using three techniques of milk-yield estimation, namely kid/lamb suckling, hand-milking and oxytocin + hand-milking.

Mean total milk production in the dry and wet seasons was 84.6 ± 3.1 , and 66.8 ± 2.6 kg, respectively, for goats; 50.2 ± 1.7 and 49.3 ± 1.9 kg, respectively, for sheep. Only the seasonal difference in goats was significant ($P < 0.001$). Estimates of milk yield by suckling and oxytocin techniques were similar. Hand-milking produced 26.8% and 40.5% less milk than the other two techniques in goats and sheep, respectively. The yields of LL (70.6 ± 2.5 kg) and BB (75.0 ± 3.8 kg) were similar, but significantly lower ($P < 0.001$) than those of BL does (81.6 ± 2.3 kg). Local, DL and DD ewes produced, respectively, 37.8 ± 1.8 , 48.9 ± 1.6 and 62.7 ± 2.1 kg milk and the differences among these genotypes were significant ($P < 0.001$). Dorper ewes did not perform as well in the rainy season as they did in the dry season.

The overall mean levels of total solids, fat, SNF, ash, protein, lactose and energy for goats were 17.4%, 6.8%, 10.6%, 0.88%, 4.5%, 4.7%, and 4.44 MJ/kg, respectively. The respective values for sheep were 18.3%, 6.0%, 12.3%, 0.94%, 5.2%, 4.9% and 4.39 MJ/kg. Within each species, significant differences in compositional values between

seasons, among techniques of milk-yield estimation and among genotypes were observed and are discussed.

Overall mean birth, weaning weight at 17 weeks and pre-weaning daily liveweight gains for kids were 2.77 ± 0.08 kg, 13.0 ± 0.41 kg and 87.0 ± 3.5 g, respectively. The values of sheep were, respectively, 3.19 ± 0.05 kg, 18.5 ± 0.32 kg and 128.9 ± 2.5 g. In goats, season of kidding had significant effect on all these traits, but genotype had effect only on kid birthweight. In sheep, season and genotype exerted significant influences in all the lamb traits. Correlations between milk yield and growth rate of the young were significantly high and positive. Regressions of growth rate on milk production for kids were poorer than those for lambs.

Composition, production et classement du lait de caprins et d'ovins non laitiers au Malawi

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Résumé

Cette étude a été effectuée sur des caprins de race locale (LL), Boer (BB) et leurs croisements (BL) ainsi que sur des ovins de race locale (Lo), Dorper (DD) et leurs croisements (DLo). La production et la composition du lait ainsi que le rythme de croissance des petits ont été estimés pour deux parturitions et une période totale de 12 semaines. Trois méthodes ont servi à évaluer la production de lait, à savoir la tétée, la traite manuelle et l'association de l'injection d'oxytocine à la traite manuelle. En outre, 206 personnes ont répondu à un questionnaire destiné à déterminer l'accueil fait au lait de chèvres et de brebis et aux produits dérivés par rapport à celui de la vache et aux produits identiques dérivés.

La production de lait des chèvres s'élevait à $84,6 \pm 3,1$ et $66,8 \pm 2,6$ kg respectivement pour la saison sèche et la saison humide contre $50,2 \pm 1,7$ et $49,3 \pm 1,9$ kg respectivement pour les brebis. La saison n'avait d'effet significatif ($P < 0,001$) que sur la production des chèvres. Les valeurs obtenues par la tétée et l'association de l'injection d'oxytocine à la traite manuelle étaient analogues. La traite manuelle permettait d'obtenir plus de lait que les deux autres méthodes, les chiffres étant supérieurs de 26,8 et 40,5% respectivement pour les caprins et les ovins. La production des chèvres de race locale ($70,6 \pm 2,5$ kg) et celle des Boers ($75,0 \pm 3,8$

kg) étaient analogues mais significativement ($P < 0,001$) supérieures à celle de leurs croisements ($81,6 \pm 2,3$ kg). Quant aux brebis Lo, DLo et DD, leurs productions étaient significativement différentes, s'établissant respectivement à $37,8 \pm 1,8$, $48,9 \pm 1,6$ et $62,7 \pm 2,1$ kg. La production de saison sèche des brebis Dorper était supérieure à leur production de la saison des pluies.

La teneur moyenne en matière sèche, en matière grasse, en matière sèche non grasseuse, en cendres, en protéine, en lactose et en énergie du lait de chèvre était respectivement de 17,4%, 6,8%, 10,6%, 0,88%, 4,5%, 4,7% et 4,44 MJ/kg contre respectivement 18,3%, 6,0%, 12,3%, 0,94%, 5,2%, 4,9% et 4,39 MJ/kg pour le lait de brebis. Au sein de chaque espèce, des différences significatives avaient été mises en évidence et décrites, notamment en ce qui concerne la composition suivant la saison, les valeurs relatives aux différentes techniques d'évaluation et les génotypes.

Comparés à leurs homologues nés et élevés pendant la saison des pluies, les petits nés et élevés pendant la saison sèche avaient un poids à la naissance plus faible, mais un poids vif à 12 semaines, au sevrage et après le sevrage et un taux de croissance plus élevés (généralement au niveau de 0,001). Les paramètres de la croissance étaient systématiquement meilleurs chez les agneaux que chez les chevreaux. En ce qui concerne la croissance, les différences génotypiques étaient plus prononcées chez les ovins que chez les caprins. Par ailleurs, il existait une corrélation élevée et positive entre la production de lait et la croissance des petits ($r = 0,54$ et $0,81$ respectivement pour les caprins et les ovins).

Il ressort des résultats de cette enquête que les principaux obstacles à la consommation du lait de chèvre et de brebis sont le faible niveau de l'offre ($P < 0,001$) suivi du fait que traditionnellement, les populations concernées n'ont pas pour habitude de traire ces espèces animales et de consommer leur lait. En ce qui concerne le test réalisé sur le goût, le lait de chèvre venait en tête, suivi du lait de brebis, le lait de vache venant en dernière position.

Introduction

Research with non-dairy goats and sheep both in temperate and tropical areas has assessed the variation in the milking ability of dams, and demonstrated that the amount of milk produced by various breeds at various stages of lactation has a strong influence on kid and lamb growth during the pre-weaning period, with 20 to over 60% of the variation in weaning weight accounting for the volume of milk produced (Peart, 1982).

Due to influence of milk yield on weaning weights and due to the large variation in milking ability among the wide ranging genotypes available in the tropics, several methods for estimating milk production, namely kid/lamb suckling, hand-milking and hand-milking after oxytocin injection, must be tested and the best selected (Steinbach, 1988). Results reported in literature on the use of suckling and oxytocin methods are very variable. Moreover, in extensive systems of management, season exerts significant indirect effects on the quantity and quality of feedstuffs as well as on the levels of diseases and parasites which, in turn, affect the milk production ability of the animals. For example, Sacker and Trail (1966) reported higher milk yields in goats and sheep during the rainy season while Mittal et al (1977) reported significant seasonal effects in Barbari goats, but not in Jamnapari goats. Malawi has about 1.6 and 0.8 million goats and sheep, respectively, of various genotypes (local, imported and their crosses). The introduction of dairy goats between 1986 and 1987 raised further questions as to the acceptability of their milk. Such information is needed to develop optimal breeding, development and marketing strategies for both meat and milk production programmes.

The objectives of this study were:

- to describe and evaluate the present and potential milk production capacity of the existing local and imported small ruminant stock (goats and sheep)
- to compare different goat and sheep genotypes with respect to the composition of their milk
- to assess the potential influence of season on milk production and milk composition of goats and sheep in Malawi
- evaluate and compare the acceptability of goat and sheep milk relative to cow milk and
- to make recommendations for on-farm improvements, policy changes and draw suggestions for further research.

In addition, the growth rate and milk conversion efficiency of kids and lambs were studied.

Materials and Methods

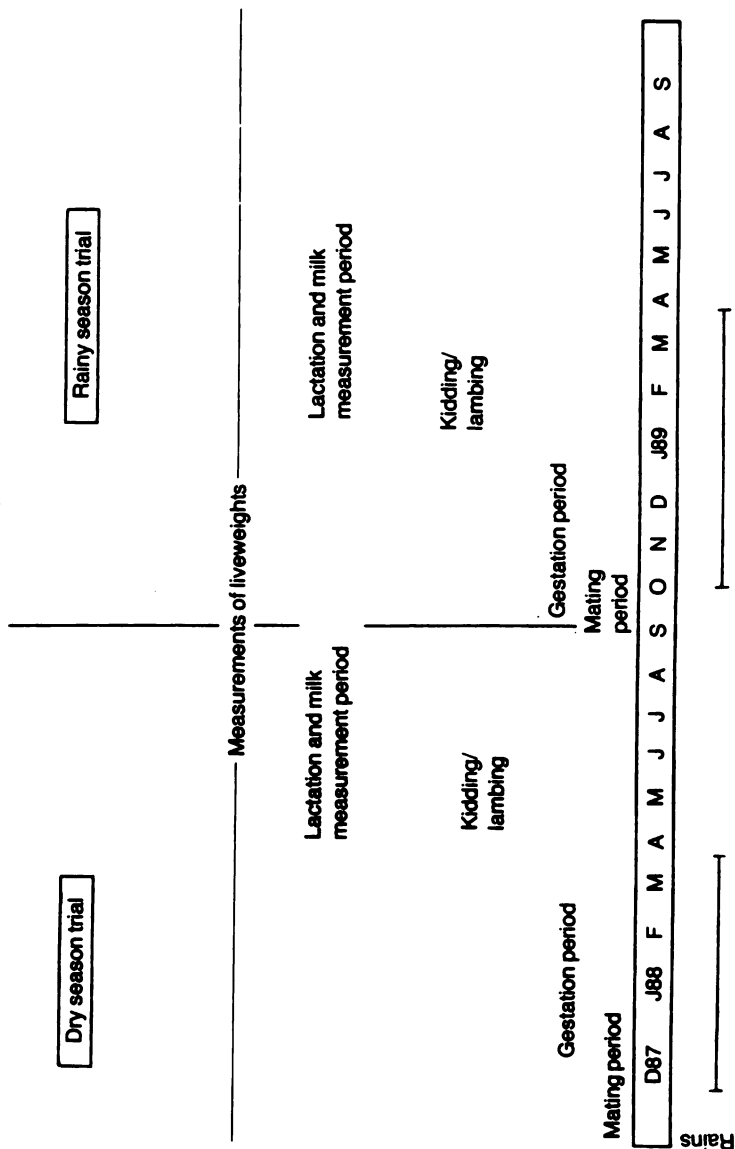
The study was carried out at Lifidzi Goat Breeding Centre near Salima in Central Malawi. Lifidzi Goat Breeding Centre lies at 13°50' south and 34°30' east with an altitude of 600 meters. The Centre is one of the four farms run by the Malawi-German Livestock Development Programme (MGLDP) established in 1983.

In the study on milk yield and milk composition, data were collected from the same 20 goats and 38 sheep in the dry season and in the rainy season. In addition to the animals used in both seasons, 5 goats and 7 sheep were used during the dry season only and 18 goats and 5 sheep during the rainy season only. Local (LL), Boer (BB) and crossbred (BL) goats and local (LL), Dorper (DD) and crossbred (DL) sheep were used. Each genotype was composed of first and second parity animals in the dry season and, second and third parity animals in the rainy season. Milk production of these animals was estimated by kid/lamb suckling, hand milking and oxytocin + hand-milking techniques on 3 different days in each of the 12 weeks following parturition. The techniques were alternated every three weeks. Animals were incorporated each week as they kidded or lambled. All these factors were arranged in a 2 x 2 x 3 factorial design.

The breeding and management of all the animals are presented in Figure 1. In the dry season, all dams reared kids/lambs of their own genotypes. In the rainy season, LL does reared 50% BL kids, BL does 75% BL kids and BB does BB kids; LL ewes reared 50% DL lambs, DL ewes 75% DL lambs and DD ewes DD lambs. All animals were kept under the same feeding and general management practices. Throughout the trials, the animals grazed natural pastures from 0700 to 1700 hours except for one hour at mid-day. At night they were kept in raised houses fitted with slats. During milking only, animals on the trial received a concentrate mixture composed of 91% maize bran, 8% dried leucaena leaves and 1% common salt (NaCl) at a rate of 300 g per animal/day. Refusals were weighed. The concentrate mixture contained 12.7% crude protein and 19.7 MJ GE (about 13 MJ ME)/kg DM.

The initial milk yield for each animal was determined about one week post-partum. Thereafter, milk yields were determined every week until the 12th week of lactation. On the days of yield determination, kids and lambs were separated from their dams for two 4-hour periods: 0700 to 1100 hours and 1110 to 1510 hours. For the suckling method, the young were allowed to suckle at 1100 hours and at 1510 hours. They were weighed before and at completion of suckling. The difference in weight was taken as the milk production during the separation period. For the hand-milking technique, animals were milked out before going out for grazing. The amount of milk was not measured at this time. At 1100 and 1500 hours, they were milked out by hand for 10 minutes each time and the amount of milk measured. The daily milk production for both methods was calculated by summing up the two 4-hourly yields and multiplying the results by 3. The oxytocin technique (oxytocin + hand-milking) was done by milking the animals after injection of oxytocin at the beginning of each milking. Ten international units or 1 ml of oxytocin was injected intramuscularly into the rear flank. After 3 to 5 minutes animals were milked out rapidly until no more milk could be withdrawn. Only one milk yield determination was carried out for health reasons. The amount of milk obtained during this single separation period was multiplied by 6 to obtain daily milk production.

Figure 1. *The management of sheep and goats throughout the milk production trials.*



During the days and times that hand-milking and oxytocin techniques were employed, 50 to 100 ml of milk samples were obtained. The samples were immediately frozen at about -20°C and stored for analysis in order to determine the chemical composition of the milk.

Liveweights of dams and the young were taken at parturition and at weekly intervals until the young were weaned at 17 weeks of age. At the time of weighing, condition scores of the dams were done. The scale used for the score was that described by Russel et al (1969) except that for goats the subcutaneous fat deposition component was ignored.

All the milk samples collected were analysed for fat by the Babcock method, for protein ($N \times 6.38$) by the Kjeldahl method and for total solids and ash by methods described by AOAC (1980). Lactose was determined by Nelson's colorimetric determination of sugars. Solids-not-fat (SNF) concentration was derived from total solids and fat concentrations by difference. Energy values were calculated using equations developed by Economides (1986) for sheep and goats as follows:

a. Goats: $Y = 1.64 + 0.42X_1$

b. Sheep: $Y = 1.94 + 0.43X_1$

where Y is the calorific value of milk in MJ/kg and X_1 is the per cent fat.

Dependent variables were milk yields, milk composition, liveweights and growth rate. Fixed least squares models described by Harvey (1977) for use on data with unequal subclass numbers were used. They included fixed effects of season, technique of milk-yield estimation, genotypes and their first order interactions. The effects of parity and the number of kids/lambs suckled were included as regressions. The model for the analysis of milk composition included in addition, the effect of lactation stage.

Results

Milk production and lactation pattern

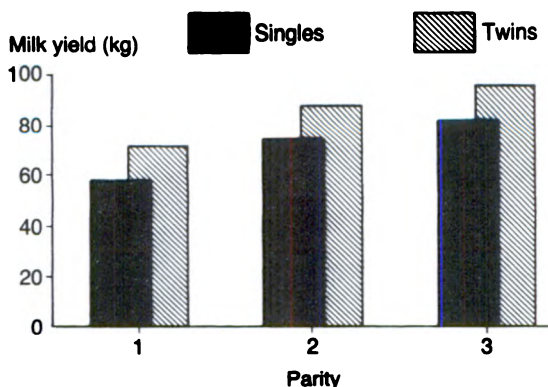
Analysis of variance and tests of significance for total lactation yields in goats and sheep are given in Table 1. In goats, season of kidding, technique of milk-yield estimation and genotype exerted significant effects on the total 12-week lactation yield. None of the interaction effects was significant. Parity of the dam had a quadratic relationship to the total lactation yield. The linear effect of the number of kids suckled was significant. In sheep, technique of milk yield

Table 1. Analysis of variance for factors affecting total milk yields in goats and sheep.

Source of variation	Goats			Sheep		
	df	MS	F	df	MS	F
Season (S)	1	4722.33	19.16***	1	22.81	0.12
Technique (T)	2	6817.26	27.65***	2	144281.60	76.14***
Genotype (G)	2	2068.39	8.39***	2	9909.09	52.83***
Interactions						
G x T	4	454.92	1.85	4	577.52	3.08*
G x S	2	460.25	1.87	2	1370.57	7.31***
T x S	2	257.90	1.05	2	43.08	0.23
Regressions						
Parity linear	1	5792.75	23.50***	1	28.09	0.15
Parity quadratic	1	994.66	4.04*	1	701.97	3.74*
No. suckled linear	1	6849.78	27.29***	1	4969.01	26.90***
Remainder	146	246.53		233	187.56	

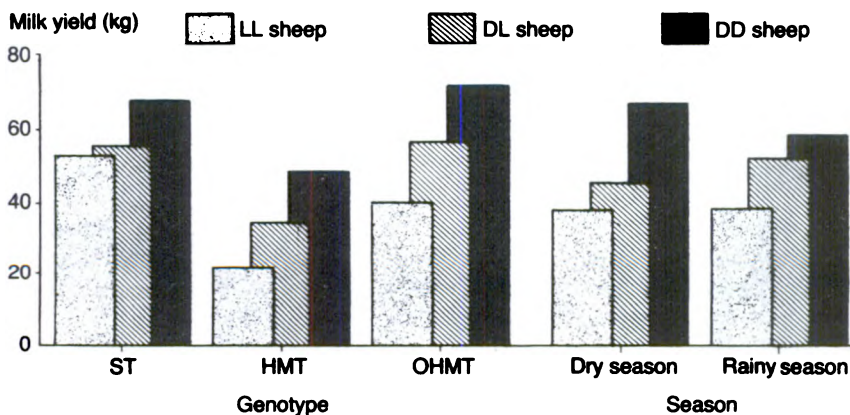
* P<0.05; ** P<0.01; *** P<0.001.

Figure 2. The relationship between milk production (MP) and litter size suckled (L) and parity (P) of the dam in goats.



$$MP = 16.78 + 13.86L + 32.67P - 6.07P^2$$

Figure 3. The influence of genotype, technique of estimation and season on total 12 week milk yield in sheep.



ST = suckling; HMT - hand-milking OHMT = oxytocin - hand-milking

estimation, genotype, genotype by technique and genotype by season interaction effects significantly influenced total lactation yield. Parity had only a quadratic effect on milk yield. The linear effect of litter size suckled was highly significant.

The least squares means and standard errors for total milk yields in both goats and sheep are presented in Table 2. In goats, milk production of does kidding in the dry season was significantly higher ($P < 0.001$) than that of those kidding in the rainy season, irrespective of genotype or technique of milk-yield estimation. Estimates of milk yield obtained by the suckling technique and the oxytocin technique were similar. The quantity of milk harvested by hand-milking was 36.5% less ($P < 0.001$) than that harvested by the other two techniques. Boer x local crossbred goats showed higher ($P < 0.001$) 12-week milk production over the local and Boer goats which gave similar milk-yield estimates. The regression of the total 12-week milk production on parity was 12.83 and -5.15 for the linear and quadratic terms, respectively. Total milk production increased by 13.64 kg with the increase in number of kids suckled. Coefficients of variation obtained from within-genotype analysis of variance were 24.5%, 118.9% and 20.9% for local, Boer x local crossbred and for boer goats, respectively.

In sheep, mean total milk yields were similar. The overall difference in 12-week milk production estimated by the lamb-suckling or oxytocin methods (58.6 or 56.6 kg, respectively) was not significant. Over the whole lactation period, hand-milking estimates were 40.5% less ($P < 0.001$) than those of either the lamb-suckling or the oxytocin methods. Dorper ewes produced the largest quantities of milk and local ewes produced the least. Dorper x local crossbred ewes produced total milk yields which were intermediate between the two other genotypes. Differences among these genotypes were significant ($P < 0.001$). Milk production performance among genotypes differed according to the technique milk yield estimation employed ($P < 0.05$) and according to season of lambing ($P < 0.001$). The local ewes produced 47.6% and 30.9% higher milk yield by the suckling method than by the hand-milking and oxytocin methods, respectively. Dorper x local crossbred and Dorper ewes on the other hand gave higher milk yields by the oxytocin method than by the hand milking and suckling methods. Dorper ewes produced 15% less milk in the rainy season than in the dry season, but the other two genotypes produced slightly more milk in the rainy season than in the dry season. The regression equation of total milk production (MP) on litter size (L) and parity (P) was $MP = 21.31 + 16.33L + 16.33L + 12.84P - 3.38P^2$. The effect of litter size suckled and parity on total milk yield are presented in Figure 4.

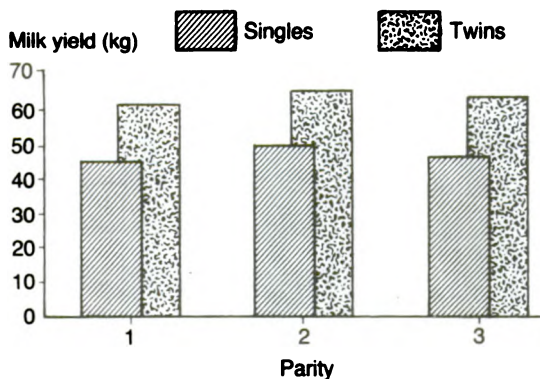
The average daily milk yields and lactation pattern for goats and sheep are presented in Figure 5. The average daily milk yield in goats increased to a maximum of 1076 g at two weeks post-partum and then decreased steadily till the end of lactation at 12 weeks when production averaged 962 g/day. In sheep,

Table 2. *Least squares means and standard errors (kg) for total milk yields of goats and sheep.*

Main effect	Goats			Sheep		
	No.	Mean	SE	No.	Mean	SE
Subclass						
Overall	163	75.7	2.00	250	49.80	1.30
Season						
Dry	73	84.6b	3.10	131	50.20	1.70
Rainy	90	66.8a	2.60	119	49.30	1.90
Technique						
Suckling	51	82.2b	3.10	82	58.60b	1.80
Hand-milking	56	60.9a	2.80	84	34.30a	1.80
Oxytocin	56	84.1b	2.80	84	56.60b	1.80
Genotype						
Local	65	70.6a	2.50	84	37.80a	1.80
Crosses	76	81.6b	2.30	102	48.90b	1.60
Exotic	22	75.0a	3.80	64	62.70c	2.10

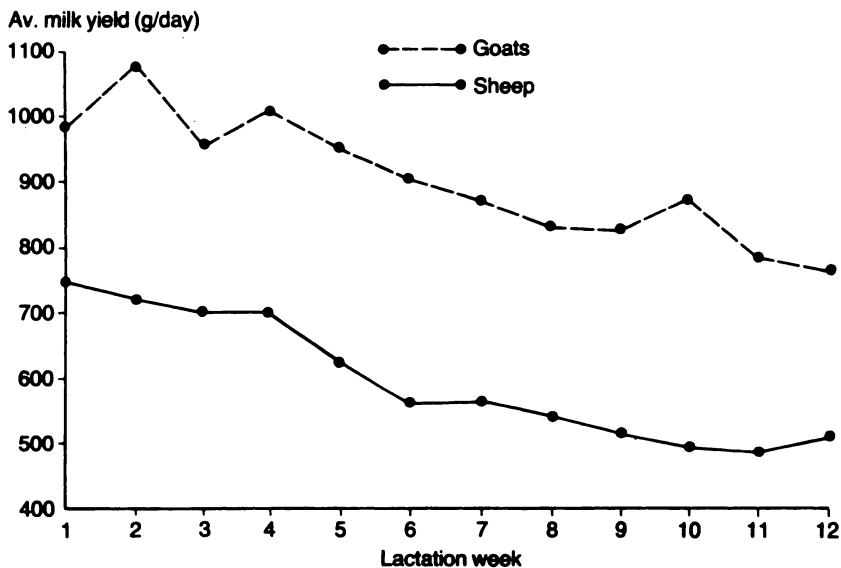
Means within variable groups bearing different letters differ significantly ($P < 0.05$). Those without letters did not show any difference in the analysis of variance.

Figure 4. The relationship between milk production (MP) and litter size suckled (L) and parity (P) of the dam in sheep.



$$MP = 21.31 + 16.33L + 12.84P - 3.38P^2$$

Figure 5. Overall lactation curves of sheep and goats.



on the other hand, the average daily milk yield was practically linear in decline, maximum production of 745 g occurring in the first week, decreasing throughout lactation until 12 weeks of lactation when production was 508 g/day.

Milk composition

The composition of goats and sheep is shown in Table 3 and Figure 6. Local and BB goats had essentially the same milk composition in terms of total solids, butterfat, lactose and energy and these values except those for lactose, were significantly higher ($P < 0.001$) than those for the Boer x local crossbred goats. There were no significant differences between BL and BB goats for SNF but SNF was significantly higher ($P < 0.001$) in LL goats. Ash content was highest in BL goats and lowest in BB goats. Protein content was highest in LL goats and lowest in BB goats.

Local sheep produced milk with the lowest total solids ($P < 0.05$), butterfat ($P < 0.001$) and energy ($P < 0.001$) contents, but had the highest levels of SNF ($P < 0.001$), ash ($P < 0.01$), protein ($P < 0.001$) and lactose ($P < 0.001$). The differences between DL and DD ewes in total solids, butterfat, SNF, ash and energy were not significant. However, the contents of protein and lactose in DD ewes were least and lower ($P < 0.001$) than those in DL ewes whose values were intermediate.

Live weights and growth rates of kids and lambs

Mean liveweight and liveweight gains of kids from birth to weaning at 17 weeks are given in Table 4. Although kids born during the dry season were lighter (P) at birth than those born during the rainy season, they weighed more at weaning (P) and gained more ($P < 0.001$) weight until statistically significant differences among dam genotypes were detected only for kid birth-weights. Kids born to LL does were lightest and those born to BB does were heaviest (P). Those born to BL does were intermediate. However, between birth and weaning, no statistically significant differences among dam genotypes for kid growth traits were observed.

Least squares means and standard errors of lamb live weights and liveweight gains from birth to weaning are shown in Table 5. Although the mean birthweight of lambs born in the dry season was lower (P) than that of those born in the rainy season, the performance of the former group was significantly superior to that of the latter group until weaning. Performance of lambs born to and reared by LL ewes was the least ($P < 0.001$) in all growth traits. Weaning weights and liveweight gains were highest ($P < 0.001$) in lambs born to and reared by DD ewes. The performance of those born to and reared by DL ewes was mostly intermediate. However, only the difference in birthweight between DL and DD ewes was

Table 3. *Table contents (%) of total solids, butterfat and protein in goat milk.*

Main effect Subclass	No.	Total solids		Fat		Protein	
		Mean	SE	Mean	SE	Mean	SE
Overall	1352	17.4	0.07	6.75	0.06	4.46	0.02
Season							
Dry	600	18.1b	0.10	6.71	0.09	4.46b	0.02
Rainy	752	16.7a	0.09	6.80	0.08	4.31a	0.03
Lactation week							
1-2	114	17.6b	0.18	6.00a	0.15	4.77b	0.05
3-4	114	17.1a	0.18	6.16ab	0.15	4.46a	0.05
5-6	112	17.1a	0.18	6.57b	0.15	4.37a	0.05
7-8	112	16.8a	0.18	6.48b	0.15	4.40a	0.05
9-10	112	17.8bc	0.18	7.55c	0.15	4.36a	0.05
11-12	112	18.1c	0.18	7.79c	0.15	4.41a	0.05
Technique							
Hand-milking	676	17.0a	0.09	6.24a	0.07	4.53b	0.02
Oxytocin	676	17.7b	0.09	7.27b	0.07	4.40a	0.02

Means within variable groups bearing different letters differ significantly ($P < 0.05$). Those without letters do not differ.

Figure 6. *Changes in the composition of milk from sheep and goats at two weekly intervals.*

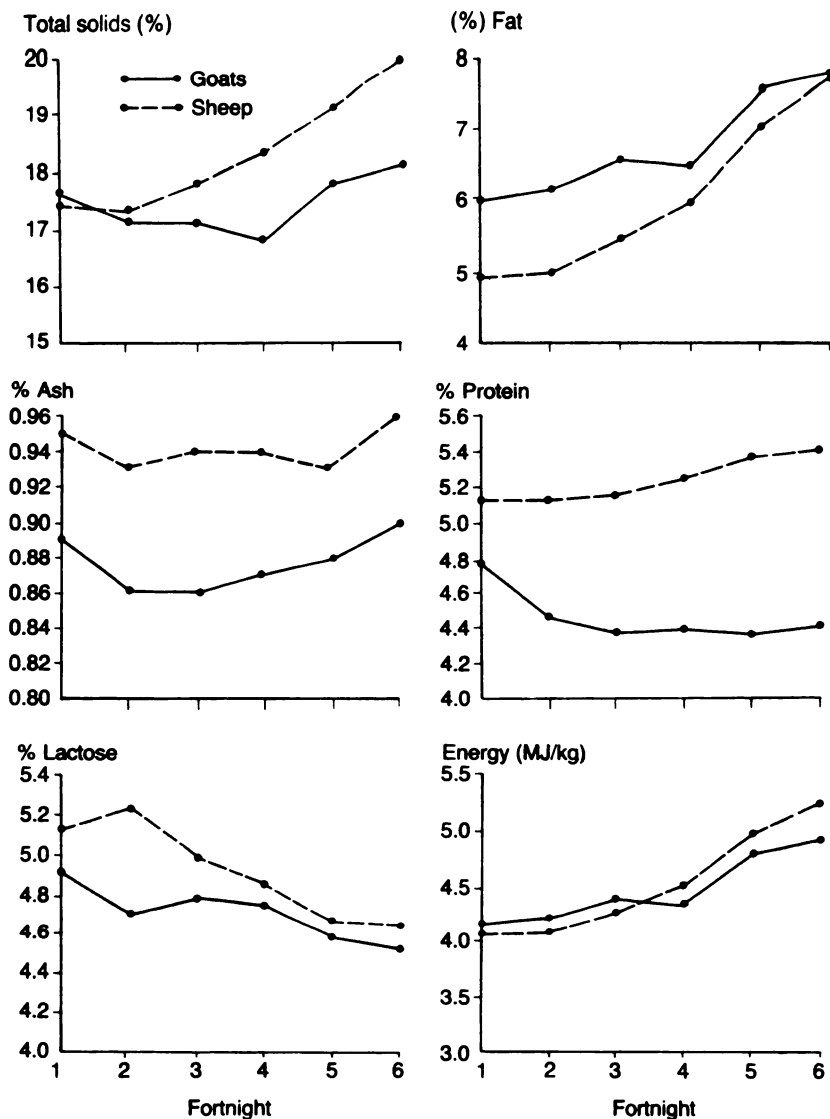
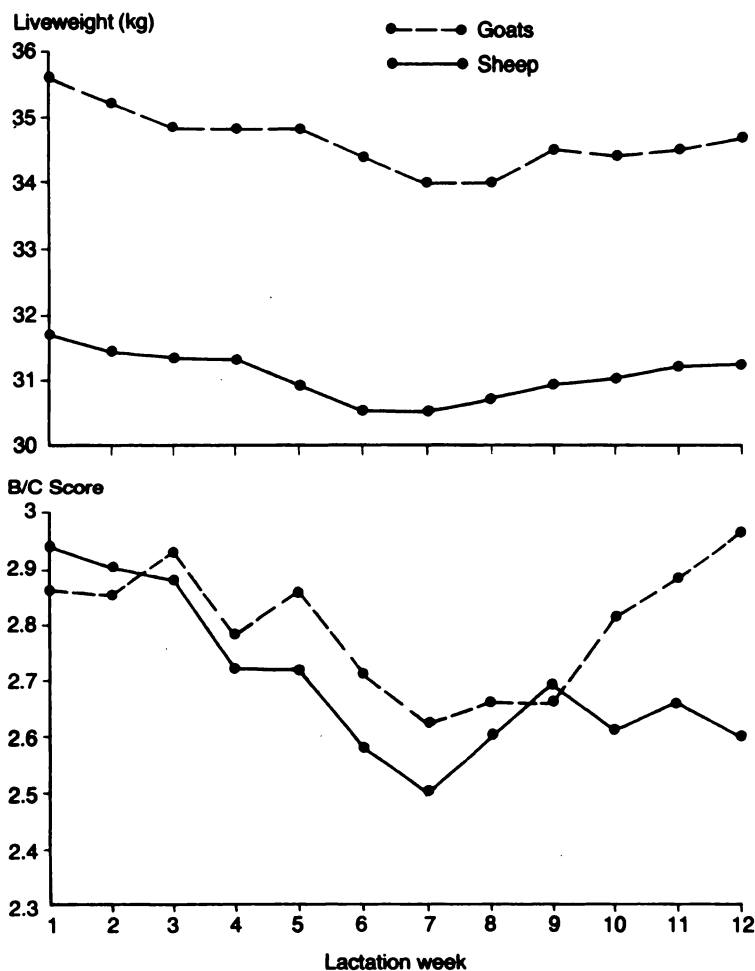


Figure 7. Changes in liveweight and change condition scores of sheep and goats during the experimental period.



significant ($P < 0.05$). The differences between other performance traits between the two genotypes were not significant.

Changes in liveweight and body condition scores of goats and sheep during lactation are shown in Figure 7. In goats, the overall weight ($\pm$ SE) was 34.7 ± 0.25 kg and the mean body condition score was 2.87 ± 0.05 . In sheep, overall mean weight was 31.1 ± 0.16 and mean body condition score was 2.70 ± 0.04 .

Table 4. *The content (%) of total solids, fat and protein in sheep milk.*

Main effect Subclass	No	Total solids		Fat		Protein	
		Mean	SE	Mean	SE	Mean	SE
Overall	2024	18.30	0.06	6.02	0.05	5.23	0.02
Season							
Dry	1056	19.00b	0.08	6.14b	0.07	5.58b	0.02
Rainy	968	17.70a	0.09	5.90a	0.07	4.89a	0.02
Lactation week							
1-2	172	17.40a	0.15	4.93a	0.13	5.12a	0.04
3-4	172	17.30a	0.15	5.00a	0.13	5.12a	0.04
5-6	170	17.80b	0.15	5.48b	0.13	5.15a	0.14
7-8	167	18.30c	0.16	5.99c	0.13	5.24a	0.04
9-10	166	19.10d	0.16	7.03d	0.13	5.73b	0.04
11-12	166	20.00e	0.16	7.69e	0.13	5.41b	0.04
Technique Hand-milking	1010	17.80a	0.07	5.25a	0.06	5.37b	0.02
Oxytocin	1014	18.90b	0.07	6.79b	0.06	5.10a	0.02

Means within variable groups bearing different letters differ significantly ($P < 0.05$). Those without letters do not differ.

Table 5. Least squares means and standard errors of the milk composition in goats and sheep (in % unless stated).

	Overall		Local		Crosses		Exotic	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
A. Goats								
Total solids	17.40	0.070	17.70b	0.090	17.00a	0.080	17.50b	0.130
Fat	6.75	0.060	6.94b	0.070	6.36a	0.070	6.69b	0.110
SNF	10.60	0.060	10.70b	0.080	10.60a	0.070	10.50a	0.110
Ash	0.88	0.003	0.88b	0.004	0.90c	0.004	0.85a	0.006
Protein	4.46	0.020	4.66c	0.020	4.51b	0.020	4.21a	0.040
Lactose	4.71	0.020	4.68a	0.030	4.90b	0.030	4.54a	0.050
Energy (KJ/kg)	4.47	0.020	4.56b	0.030	4.30a	0.030	4.55b	0.040
B. Sheep								
Total solids	18.30	0.060	18.10a	0.090	18.30b	0.080	18.50b	0.100
Fat	6.02	0.050	5.54a	0.070	6.08b	0.070	6.44b	0.080
SNF	12.30	0.050	12.60b	0.070	12.30a	0.060	12.00a	0.080
Ash	0.94	0.002	0.95b	0.004	0.94a	0.003	0.93a	0.004
Protein	5.53	0.020	5.34c	0.020	5.25b	0.020	5.12a	0.020
Lactose	4.92	0.020	5.12c	0.030	4.98b	0.030	4.65a	0.030
Energy (MJ/kg)	4.53	4.390	4.32a	0.030	4.55b	0.030	4.70b	4.480

Means within variable groups bearing different letters differ significantly ($P < 0.05$).

SNF = Solids-not-fat.

Discussion

In the present study, goats produced significantly less milk in the rainy season than in the dry season which disagrees with the observations of Mukundan and Bhat (1983). During the year when rainy season trials were set up, rainfall had increased from 976 mm to over 1300 mm which was obtained from October 1988 to early April 1989. These much longer and intensive rains disturbed the normal grazing period and pattern. In addition, the level of worm infestation observed in faeces and the higher level of disease incidences during this season could have accounted for the productive performance.

The non-significant difference in estimates of total and daily milk yields between suckling and oxytocin techniques throughout lactation does not agree with the results of Mill and Steinbach (1984) who obtained higher estimates when oxytocin technique rather than when suckling technique was used. Hand-milking produced 36.5% less milk than either of the other two methods. Similar findings have been reported by Ueckermann et al (1974). These findings and the present results might show that all the breeds used in the present study have never been selected for milk production and indicate very strong mothering instinct.

Differences in dam genotypes in total and daily milk production were evident. Previous estimates of milk production of the three goat genotypes are limited. Levels attained by the LL does are much higher than those reported for other tropical/subtropical breeds (Devendra and Burns, 1983). The breed is, however, surpassed by far by the Beetal and Jamnapari of India and the Damascus of Cyprus. The estimates of Boer goats are very much lower than those observed on the same breed elsewhere in Africa (Ueckermann et al, 1974). The present milk-yield estimates of BL does are 112% of the mid-parent average, 116% of the LL goats and 109% of BB goats. This might suggest that crossbreeding the BB and the LL goats could be beneficial for increased milk production.

The total milk yields of sheep in the dry rainy seasons were similar. Similar findings were reported by Aboul-Naga et al (1981a). Much earlier, Sacker and Trail (1966) observed that the growth rate of lambs of the East African Blackheaded sheep lambing in the dry season was restricted.

Total milk intake by lambs (suckling technique) was similar to total milk production of the ewes (oxytocin + hand-milking). The oxytocin + hand-milking technique usually gave no second milk let-down or residual milk in the udder as confirmed by palpation. This might suggest that either the ewes had adjusted their daily milk secretion to equal that consumed by their lambs or that all the lambs were consuming all the milk the ewes were capable of producing as suggested by Wohlt et al (1984). Similar findings were reported by Doney et al (1979) and Aboul-Naga et al (1981b).

Although previous estimates on the sheep breeds used in the present study are not available, the levels attained by LL ewes are similar to those of Malpura and Chokla in India, higher than those of West African Dwarf sheep in Nigeria (Gatenby, 1986), but surpassed by Rahmani, Ossimi and Barki (Aboul-Naga et al, 1981a). Ueckermann et al (1974) reported that of the South African non-woolled sheep, Dorper breed produced an average daily milk yield of 1262 g in 100 days. The present yield of about 750 g/day recorded in 84 days is too low and might be indicative of the existing insufficient nutritional environment.

The pattern of daily milk yields in goats significantly rising to maximum within two weeks and then decreasing afterwards to end of lactation was also observed by Ehoche and Buvanendran (1983) in the Red Sokoto goat. The pattern of milk yields as observed in sheep was also reported by Gatenby (1986).

The overall contents of total solids, fat, SNF, ash, protein, lactose and energy observed in the present study are much higher than those of all other breeds, except those of the West African Dwarf and the pygmy goats, as summarised by Parkash and Jenness (1968) and Devendra and Burns (1983). The contents in sheep are lower than those reported for Middle Atlas of Morocco (Gatenby, 1986). The changes in the composition of sheep and goat milk in this study are different from the results reported for dairy goats in the temperate areas (Parkash and Jenness, 1968).

Kids and lambs born in the dry season weighed less at birth, but weighed and grew more up to weaning. The lighter birthweight in the dry season might probably be due to nutrition of the dam in the last third of pregnancy. Most goats and sheep gave birth between May and June when rains had stopped and plan of nutrition was getting low. Peart (1982) concluded that when nutrition of the dams during the last stages of gestation is low or restricted, birthweight of kids and dam milk yields in the first lactation weeks are reduced. However, the higher performance of these kids and lambs until weaning is probably due to the higher yields of milk and milk components produced by the dams during this reason. Observations made in the present study are contrary to expectations and to most published results (Sousa et al, 1987; Hendy, 1987). The controversy might have arisen due to differences in location, management, environment and genotype.

Genotypic effect of dams was evident for differences in kid birthweight, but not for weights and gains to weaning. The least and heaviest birthweights in kids born to local and Boer does, respectively, are expected. Similar results were observed in sheep. The intermediate birthweights of kids born to crossbred goats may imply some additive gene action among the dams for kid birthweight and an advantage over the local goats as regards this trait. These results are contrary to the report published by De Haas (1977). Later, similar findings to the present results were reported by Ayoade and Butterworth (1982). However, similarity among genotypes in most of the pre-weaning traits might indicate that the milk yield differences may have been inadequate for the kids to show differences. In

sheep, lambs born to and reared by local lambs performed the poorest. Weaning weights and pre-weaning gain differences in lambs born to and reared by Dorper on the one hand and crossbred ewes on the other hand were not significant, implying that the differences in milk yield only were not adequate to show differences in growth traits of the lambs.

Conclusion

Goats produced more milk than sheep irrespective of genotype used. The milk yields are much lower than those for temperate and other Indian-recognised breeds. Due to reproductive problems in exotic genotypes, especially in Boer goats, no clear conclusions can be drawn. The content of all milk constituents in sheep, except fat, was higher than that in goats. The average composition is much higher than that of most tropical genotypes recorded. Lambs grew faster than kids. The low milk yields of the goats and sheep used could probably be increased by both selection and crossbreeding with well known high milk producing breeds. Although no valid recommendations could be drawn from this short-term study, the study has brought out some specific areas and problems that need attention. Some suggestions to be made need to be backed up by long-term studies through multidisciplinary approach.

Suggestions for further research

- If at all feasible, more research is required to include a larger number of Boer goats in order to come up with valid conclusions.
- There should be a continuation of the evaluation and description of the performance potential (milk and meat) of all the existing stock to cover all the genotypes in all the zones of the country.
- Evaluation of the milk production potential should be extended to include the newly introduced Saanen breed and its crosses with local goats. Assessment should include even post-weaning period to effectively evaluate milk production persistency, a character suitable for dairy production. The three milk measurement techniques should be tried to find the differences in milk production response. The suckling method needs refinement.
- Possible causes of mortalities and disease incidences should be found. There is need to search several new treatment strategies to improve the health status of the small ruminants. Causes of reproductive problems in Boer goats and Dorper sheep should be promptly investigated.
- Testing of several lamb and kid rearing regimes. This should include different suckling regimes and time of weaning, different feeding systems and housing types to help reduce mortality. Effect of milk removal on performance of the young should be examined.

- Test several feeding, health, breeding and management technologies on the existing stock and evaluate their economic viability.
- Selection of the existing small ruminant stock for growth rate of the offspring and milk production should be expanded or established.
- Comparative technical and economic evaluations of goat and cattle milk and meat production enterprises at farm and station level need to be conducted.

Acknowledgements

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Les performances de différents niveaux de croisements: chèvre alpine et petite chèvre de l'Afrique de l'Est à la Station d'élevage caprin de Vyerwa (Burundi)

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Résumé

A partir de 1980, le projet de développement caprin dans la Buyenzi a réalisé un programme de croisement d'absorption de la petite chèvre d'Afrique de l'Est par des chèvres alpines importées, à la Station d'élevage de Vyerwa. Cette communication résume les performances des différents génotypes produits (50%, 75%, 87% de sang alpine) de 1981 à 1990.

Le croisement entre ces deux races caprines améliore sensiblement les performances de croissance et laitière de la petite chèvre d'Afrique de l'Est, et ce, dès la première génération:

- *poids à 3 mois: 10,0 kg, 14,3 kg, 14,1 kg, 15,2 kg pour respectivement F₁ (sang alpin), R₁ (3/4 alpin), R₂ (7/8 alpin) et la race pure alpine, alors que la R.L. (race locale) pèse 8,5 kg au même âge.*
- *La production laitière allant jusqu'à 236 litres pour les F₁, 355 litres pour les R₁ par lactation tandis que la race locale n'a que 33–36 litres en 90–100 jours.*

Ce croisement paraît toutefois affecter négativement les performances de reproduction (fertilité, fécondité, intervalle entre mise-bas)

Performance of Alpine x small East African Dwarf goats with varying proportions of Alpine blood at Vyerwa Livestock Breeding Station, Burundi

C. Ntahimpereye

Abstract

In 1980, the Goat Development Project in Buyenzi region introduced a crossbreeding programme at Vyerwa Breeding Station aimed at upgrading the local breed by crossing it with imported Alpine goats. This paper presents a summary of data on the performance of animals with different levels of Alpine blood (1/2, 3/4, 7/8 Alpine) recorded between 1981 and 1990.

Crossbreeding markedly increased milk yield and adult liveweight relative to the local race, even in the first cross, but resulted in poorer reproductive performance (lower prolificity and fecundity and longer parturition interval).

Introduction

Les caprins, ovins, comme d'ailleurs les bovins de races locales sont peu productrices et leurs performances sont insuffisantes pour rentabiliser les investissements et les frais d'entretien occasionnés par l'intensification de l'élevage.

Dans certaines régions où la densité démographique est élevée comme la région du Buyenzi (nord du Burundi: 300 à 400 hab./Km²), l'élevage bovin en système traditionnel semble en nette régression au profit des petits ruminants. Cette diminution entraîne une baisse sensible des quantités de viande et surtout de lait.

Compte tenu du faible niveau de production laitière de la race bovine locale, cette même production pouvant être obtenue à partir des chèvres laitières importées, un croisement d'absorption entre la chèvre locale et la chèvre alpine a été effectué dans cette région par le placement des boucs de race alpine dans des centres de monte.

Les performances de reproduction, de croissance, et de production laitière des différents génotypes obtenus en station par croisement de la petite chèvre d'Afrique de l'Est avec les boucs de la race alpine font l'objet de la présente communication.

Matériel et méthodes

Les performances ont été relevées de 1981 jusqu'en 1990 à partir d'un troupeau caprin de 250–300 têtes élevé à la Station d'élevage de Vyerwa au Burundi.

Le troupeau utilisé était composé de génotypes suivants:

- Race pure alpine (R.A.)
- Les croisés F_1 (R.L.; R.A.)
- Les croisés R_1 (1/4 R.L.; 3/4 R.A.)
- Les croisés R_2 (1/8 R.L.; 7/8 R.A.)

Ces croisés ont été obtenus par le croisement d'absorption des mâles importés (R.A.) étant mis sur les femelles petite chèvre de l'Afrique de l'Est.

Le troupeau R.A. sert de noyau de production de géniteurs destinés à la diffusion en milieu rural dans les centres tandis que les croisés étaient élevés dans le but d'avoir les données sur les paramètres zootechniques.

Le relevé des paramètres de croissance s'est effectué par pesée sur balance des chevreaux, à la naissance et une fois tous les mois.

Le calcul de poids type à 30 jours, à 60 jours, à 90 jours et à un an est fait par moyenne simple.

Relevés des performances laitières:

Alors qu'avant 1985 tous les chevreaux (R.A. et croisés) étaient allaités naturellement, après la détection de l'arthrite encéphalite des caprins en 1985–1986, tous les chevreaux de race alpine pure sont allaités artificiellement tandis que les croisés étaient toujours soumis à l'allaitement maternel.

Ainsi pour les R.A., toute la quantité de lait produit est pesée directement, et pour les croisés la quantité de lait consommé par les chevreaux a été calculée par le pesage des chevreaux avant et après l'allaitement. Le sevrage a lieu à 15 kg à peu près à l'âge de 3 mois.

Les données ont été stockées pendant 9 ans et l'enregistrement sur ordinateur (Logiciel IDEAS) a eu lieu en septembre 1990 par Hahn (1990).

Résultats et discussion

Les paramètres de reproduction

Les taux suivants ont été déterminés pour étudier les performances de reproduction (tableau 1): taux de fertilité apparente (nombre de mises-bas par rapport aux femelles en âge de reproduire); taux de fécondité (nombre de

chevreaux nés par rapport aux femelles en âge de reproduire); taux de prolificité (nombre de chevreaux moyen par mise-bas) et intervalle entre mise-bas.

En conclusion, le croisement d'absorption entre la petite chèvre d'Afrique de l'Est et le bouc de race alpine a une influence négative sur les paramètres de reproduction.

Tableau 1. Paramètres de reproduction à la Station de Vyerwa (Ngozi)

Paramètres	Type génétique			
	F1	R1	R2	alpine
Taux de fertilité apparente (%)	114,3 %	109,9 %	103 %	124,7 %
Taux de fécondité (%)	181,1 %	172,9 %	161,2 %	191,4 %
Taux de prolificité (%)	161,4 %	157,8 %	155,3 %	148,9 %
Intervalle entre mise-bas (jours)	313	335	357	329

Les performances de croissance

Le tableau 2 présente les valeurs pondérales moyennes des chevreaux à la naissance, à 30 et à 90 jours.

A la naissance les mâles de tous les niveaux de croisement sont plus lourds que les femelles, et les chevreaux nés simples sont plus lourds que ceux nés jumeaux et triples. Ces poids sont toujours supérieurs à ceux des chevreaux de race locale (tableau 3).

A 1 mois les mâles sont encore plus lourds que les femelles chez tous les génotypes sauf les F1 où le poids est le même pour les deux sexes. Les R₁ et R₂ (mâles et femelles) sont plus lourds que les chevreaux de race alpine. Cela peut être dû au système d'allaitement, puisque les R₁ et R₂ restaient avec leurs mères tout le long de la journée, alors que les R.A. avaient un allaitement artificiel, à partir de 1985. Cette différence n'est cependant plus notable au sevrage (90 jours). A cet âge, on note surtout que les chevreaux demi-sang sont plus légers que les trois autres types.

Les performances laitières

Les résultats des performances laitières des différents niveaux de croisement sont exprimés dans le tableau 4 (Schmidt, 1990). Ces résultats ont été relevés à la même station de Vyerwa sur une période n'arrivant pas à 9-10 ans comme les autres paramètres déjà vus.

Tableau 2. Poids à la naissance à 30 et 90 jours des chevreaux de différents niveaux de croisement selon le sexe et le type de naissance

Mâles	Poids à la naissance						Poids à 30 jours						Poids à 90 jours					
	F1 (kg)	R1 (kg)	R2 (kg)	R.A. (kg)	F1 (kg)	R1 (kg)	R2 (kg)	R.A. (kg)	F1 (kg)	R1 (kg)	R2 (kg)	R.A. (kg)	F1 (kg)	R1 (kg)	R2 (kg)	R.A. (kg)	F1 (kg)	R1 (kg)
Naissance simple	(32)	(30)	(16)	(113)	(26)	(22)	(9)	(91)	(10)	(17)	(6)	(46)	(10)	(17)	(6)	(46)	(10)	(17)
	2,6	3,9	3,7	4,0	5,6	9,0	8,7	8,3	11,1	18,0	14,7	16,9	11,1	18,0	14,7	16,9	11,1	18,0
Naissance double	(66)	(56)	(32)	(172)	(49)	(42)	(25)	(138)	(22)	(21)	(11)	(98)	(22)	(21)	(11)	(98)	(22)	(21)
	2,2	3,3	3,5	3,6	4,7	7,9	8,2	7,5	9,6	14,2	14,1	15,8	9,6	14,2	14,1	15,8	9,6	14,2
Naissance triple	(4)	(6)	(2)	(19)	(3)	(43)	(2)	(13)	-	(4)	-	(9)	-	(4)	-	(9)	-	(4)
	2,3	2,9	2,3	3,0	5,0	7,5	7,1	8,3	-	14,0	-	17,0	-	14,0	-	17,0	-	14,0
Moyenne	(102)	(92)	(50)	(304)	(78)	(67)	(36)	(242)	(32)	(42)	(17)	(153)	(32)	(42)	(17)	(153)	(32)	(42)
	2,3	3,4	3,5	3,7	5,0	8,2	8,2	7,8	10,1	15,7	14,3	16,3	10,1	15,7	14,3	16,3	10,1	15,7
Femelles																		
Naissance simple	(24)	(22)	(10)	(100)	(22)	(15)	(4)	(85)	(8)	(10)	(5)	(54)	(8)	(10)	(5)	(54)	(8)	(10)
	2,5	3,5	3,4	3,5	5,6	7,9	8,3	7,2	10,3	13,8	13,4	15,2	10,3	13,8	13,4	15,2	10,3	13,8
Naissance double	(63)	(44)	(19)	(149)	(50)	(34)	(17)	(124)	(19)	(20)	(13)	(80)	(19)	(20)	(13)	(80)	(19)	(20)
	2,1	2,8	3,1	3,2	4,8	6,6	7,6	6,8	9,7	11,9	14,1	12,9	9,7	11,9	14,1	12,9	9,7	11,9
Naissance triple	(2)	(6)	(1)	(32)	(2)	(4)	(1)	(28)	(1)	(4)	-	(3)	(1)	(4)	-	(3)	(1)	(4)
	1,9	2,9	2,9	2,9	4,6	7,1	6,7	6,9	11,1	13,2	14,0	14,0	11,1	13,2	14,0	14,0	11,1	13,2
Moyenne	n = 89	(72)	(30)	(281)	(74)	(53)	(22)	(237)	(28)	(34)	(18)	n = 147	(28)	(34)	(18)	n = 147	(28)	(34)
	2,2	3,1	3,2	3,3	5,0	7,0	7,7	6,9	10,0	12,6	13,9	13,7	10,0	12,6	13,9	13,7	10,0	12,6

Les chèvres de race alpine produisent plus que leurs croisées avec la petite chèvre de l'Afrique de l'Est. Parmi les croisées, les 3/4 sang alpin (R₁) produisent plus que les demi-sang. Le niveau de production laitière paraît donc étroitement lié au taux de croisement alpin.

Tableau 3. *Poids à la naissance de la petite chèvre de l'Afrique de l'Est*

	Mâle	Femelle
Simple	2,29	2,15
Double	1,96	1,92
Triple	1,57	1,26
Moyenne	1,94	1,77

Source Branckaert et Nivyobizi (1984).

Tableau 4. *Lactation des différents génotypes*

Genotype	Qté de lait (l)	Durée de lactation (j)
R.A	432-480	260-280
R1 (3/4 Alpin)	246-355	247-259
F1 (1/2 Alpin)	198-236	203-208

Conclusion

Le croisement d'absorption entre la chèvre alpine et la petite d'Afrique de l'Est améliore les performances pondérales et laitières dès la première génération, mais son influence négative sur les paramètres de reproduction (taux de fertilité apparente, taux de fécondité) mérite d'être étudiée.

Ces deux éléments, au côté d'autres facteurs comme la résistance aux maladies, sont à considérer dans le choix d'un meilleur génotype à diffuser et à maintenir en milieu rural en vue d'améliorer à long terme l'approvisionnement de la population en protéines animales (lait, viande) et de mieux intégrer l'agriculture à l'élevage.

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Bodyweight measurements relationship in Nigerian Red Sokoto goats

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Abstract

Bodyweight and linear body measurements (body length, height-at-withers and heart girth) of 201 male and female goats in three age groups (1–2, 3–4, 5 years and above) averaged 16.41, 22.94, 30.02 kg; 79.15, 87.33, 96.57 cm; 57.49, 62.77, 67.39 cm; 61.78, 67.86 and 75.77 cm, respectively.

The coefficients of variation (CVS) were 23.0, 17.3, 16.8; 6.9, 6.1, 5.8; 8.4, 4.6, 5.8; 11.2, 6.2, 6.9%. Males were heavier ($P < 0.05$) and longer ($P < 0.01$) than females at 3–4 years of age. Females stood higher ($P < 0.01$) at withers at 1–2 years of age but were shorter than the males ($P < 0.001$) at 3–4 years of age. The heart girth of the males was bigger than those of females at 3–4 years ($P < 0.01$) and also 5 years ($P < 0.05$). Significantly ($P < 0.05$) affected by sex at 3–4 years; sex effect was also highly significant ($P < 0.01$) on body length at the same age. Height at withers differed significantly between males and females at 1–2 years ($P < 0.05$) and 3–4 years ($P < 0.001$). Significant sex effect was also observed on heart girth at 3–4 years ($P < 0.01$) and 5 years and above ($P < 0.05$). Bodyweight was correlated with body length (0.45, 0.53, 0.75), height-at-withers (0.73, 0.47, 0.55) and heart girth (0.78, 0.38, 0.58).

Based on the magnitude of the correlation coefficients, body length and height-at-withers could be used for predicting liveweight of the animals at 1–2 years and 3 years and above, respectively.

Relations entre le poids vif et les mensurations du corps chez la chèvre rousse de Maradi

W.A. Hassan et A. Ciroma

Résumé

Le poids vif et les mensurations du corps (longueur totale, hauteur au garrot et périmètre thoracique) de 201 caprins mâles et femelles répartis en trois groupes d'âge (1-2 ans, 3-4 ans et 5 ans ou plus) ont été mesurés. Les valeurs moyennes suivantes ont été enregistrées respectivement pour les trois tranches d'âge évoquées: 16,41, 22,94 et 30,02 kg pour le poids vif, 79,15, 87,33 et 96,57 cm en ce qui concerne la longueur totale, 57,49, 62,77 et 67,39 cm pour la hauteur au garrot et 61,78, 67,86 et 75,77 cm pour le périmètre thoracique. Les coefficients de variation (CV) étaient respectivement de 23,0, 17,3 et 16,8; 6,9, 6,1 et 5,8; 8,4, 4,6 et 5,8; 11,2, 6,2 et 6,9%. Entre 3 et 4 ans, le sexe de l'animal a montré un effet significatif ($P < 0,05$) sur le poids vif et hautement significatif ($P < 0,01$) sur la longueur totale. Le sexe a de même un effet significatif sur la hauteur au garrot à 1-2 ans ($P < 0,05$) et à 3-4 ans ($P < 0,001$) ainsi que sur le périmètre thoracique à 3-4 ans ($P < 0,01$) et à 5 ans et plus ($P < 0,05$). Pour les trois groupes d'âge, une corrélation positive entre le poids vif et la longueur totale (0,45, 0,53 et 0,75), la hauteur au garrot (0,73, 0,47 et 0,55) ou le périmètre thoracique (0,78, 0,38 et 0,58) a été montrée. Ces coefficients de corrélation montrent que la longueur totale et la hauteur au garrot peuvent déterminer le poids vif de l'animal à 1-2 ans et à 3 ans et au-dessus.

Introduction

In Nigeria, goats are the most numerous of all types of livestock numbering about 27.6 million (FOS, 1986). The animals are primarily for meat production. The Federal Ministry of Agriculture (FMA, 1981) estimated that goats contributed about 17 per cent (65 000 tonnes) of the total meat supply in Nigeria. Of the three breeds of goats in Nigeria Red Sokoto is the predominant and the most widely used and distributed breed in the northern savannah belts of the country (Ngere et al, 1984). To increase meat yield from this breed requires genetic improvement of its liveweight. Proper measurement of this trait, which often is hard in the villages due to lack of weighing scales, is a requisite for achieving this goal. The need for estimation of the trait from simpler and more easily measurable variable such as linear body measurements therefore arises.

Very few studies have been carried out on the linear body measurements of Nigerian breeds of goat and their possible use for estimating the animals' live weights (Mason, n.d. ; Robinet, 1967; Ngere et al, 1979; Moruppa and Ngere, 1986; Ibiwoye and Oyatogun, 1987; Osinowo et al, 1989).

This study was carried out to establish the relationship between liveweight and some linear body measurements in the Red Sokoto goat as a step towards employing such in bodyweight estimation for selection and other purposes in the semi-arid zone of Nigeria.

Materials and Methods

The animals and their management

The data used for this study were collected on 111 male and 90 female Red Sokoto goats aged 1–5 years at Dan' Maraya Farms, Kano, Nigeria. The animals were managed semi-intensively and separated into three age groups (1–2, 3–4 and 5 years). Groups were housed in separate compartments especially at night. The animals were released daily for grazing at 0800 hours and they remained outside until about 1600 hours. In the wet season, seed cakes and cereal offals were offered as supplement. In the dry season, the goats were fed cowpea and/or groundnut hay. Drinking water and salt lick were provided *ad lib*. Animals received routine inspection and dipping; drenching and vaccination were done for herd health maintenance.

Records kept on the farm included stock-taking and disposal, breeding and reproduction, weight and health-care records.

Data collection

In all 201 sets of measurements were obtained for the four variables considered. Bodyweight was taken using weighbridge and the following linear body measurements were made using the tailor's tape measure.

- (a) Body length (BL) was measured as the distance from the external occipital protuberance to the base of the tail.
- (b) Height-at-withers (HAW) was measured as the distance from the surface of a platform to the withers and
- (c) Heart girth (HG) represented the circumference of the chest.

Statistical analysis

Data collected were classified on the basis of sex and age. Three age groups (1–2, 3–4, and 5 years) were used. Means $\pm$ SE for the bodyweight and linear body

measurements (BL, HAW and HG) were calculated. Analysis of variance was done to examine possible sex and age effects on the variables measured. The interrelationship of bodyweights and linear body measurements were estimated by simple correlation (Steel and Torrie, 1980). This was done separately for the two sexes in cases of significant sex effect.

Results and Discussion

Table 1 summarises the average measurements obtained for all the traits studied. Except for the linear body measurements at 1–2 years of age all the values obtained for the four traits were higher in the males than in the females. This male advantage was more conspicuous and statistically significant at 3–4 years of age. Only the values for heart girth showed a significant ($P < 0.05$) advantage for males 5 years of age.

Values obtained for the linear body measurements in the present study are very close to those reported by Moruppa and Ngere (1986) for Red Sokoto goats in similar age groups. The differences observed in all the traits studied especially in favour of the male goats agree with earlier reports (Ngere et al, 1979; 1984) on the same and other Nigerian goat breeds.

The correlation coefficients obtained between the variables are presented in Table 2. These values are with no respect to effect of sex of goat on the variables. The high and significant correlation coefficients between height at withers and heart girth and bodyweight at 1–2 years of age suggests that either of these variables or their combination would provide a good estimate for predicting liveweight in Red Sokoto at an early age. The higher coefficient of correlation ($r=0.0871$) obtained between the two variables attests to this. Moruppa and Ngere (1986) and Osinowo et al (1989) reported a similar trend in the same breed.

Mukherjee et al (1981; 1986) and Singh et al (1987) reported the highest and significant correlation value of bodyweight with chest circumference in various Indian goat breeds. At later stages (3–5 years) body length assumes more importance as an indicator of liveweight ($r=0.532, 0.754$). Results of the correlation analysis carried out with respect to the significant effect of sex ($P < 0.01$) on the variables are given in Table 3. The higher correlation coefficients for the male goats in most of the cases indicate that on the basis of the dimension of the various body lengths the bodyweight could be predicted more accurately in the male than in their female counterparts.

The results of the analysis have underlined the significant effect of sex on the linear body measurement covered and pointed to the need not to ignore it in employing any of them for predicting liveweight in Red Sokoto goats. Heart girth would give the best estimate for predicting liveweight of Red Sokoto goats at 1–2 years of age. Body length would be a better predictor at later stages.

Table 1. Means ($\pm$ SE) for bodyweight (kg) and linear body measurements (cm).

Age (yrs)	Sex	No.	Body weight	Body length	Height at withers	Heart girth
1-2	Male	45	16.67 $\pm$ 0.56	78.80 $\pm$ 0.82	56.44 $\pm$ 0.72a	60.76 $\pm$ 1.03
	Female	47	16.16 $\pm$ 0.55	79.49 $\pm$ 0.80	58.49 $\pm$ 0.70b	62.77 $\pm$ 1.01
	Total	92	16.41 $\pm$ 0.39	79.15 $\pm$ 0.57	57.49 $\pm$ 0.51	61.78 $\pm$ 0.73
3-4	Male	41	24.01 $\pm$ 0.62a	88.90 $\pm$ 0.82a	64.17 $\pm$ 0.45a	69.09 $\pm$ 0.66a
	Female	34	21.65 $\pm$ 0.68b	85.43 $\pm$ 0.91b	61.07 $\pm$ 0.49b	66.38 $\pm$ 0.72b
	Total	75	22.94 $\pm$ 0.47	87.33 $\pm$ 0.64	62.77 $\pm$ 0.37	67.86 $\pm$ 0.51
5	Male	25	30.30 $\pm$ 1.01	99.66 $\pm$ 1.13	68.32 $\pm$ 0.78	77.14 $\pm$ 1.05a
	Female	16	29.75 $\pm$ 1.26	96.44 $\pm$ 1.41	65.94 $\pm$ 0.97	73.63 $\pm$ 1.31b
	Total	41	30.02 $\pm$ 0.78	96.57 $\pm$ 0.87	67.39 $\pm$ 0.63	75.77 $\pm$ 0.86

Values within each age group with different superscripts differ significantly ($P < 0.001-0.05$).

No letter indicates subclass groups did not show a significant sex effect in the analysis of variance.

Table 2. *Coefficients of correlation between the variables.*

Age (years)	Variables ¹	BW	BL	HAW
1-2	BL	0.450		
	HAW	0.728	0.573	
	HG	0.783	0.565	0.871
3-4	BL	0.532		
	HAW	0.470	0.349	
	HG	0.377	0.175	0.482
5	BL	0.754		
	HAW	0.554	0.522	
	HG	0.583	0.516	0.435

1. BL = body length; BW = body weight; HG = heart girth; HAW = height-at-withers.

Table 3. *Coefficient of correlation between bodyweight (kg) and linear body measurements (cm).*

Age (yrs)	Sex	BL	HAW	HG
1-2	M	0.578	0.733	0.883
	F	0.390	0.812	0.838
	M&F	0.450	0.728	0.783
3-4	M	0.637	0.554	0.380
	F	0.265	-0.025	0.232
	M&F	0.532	0.470	0.377
5	M	0.993	0.675	0.642
	F	0.706	0.407	0.572
	M&F	0.754	0.554	0.583

BL = body length; HAW = height at withers; HG = heart girth.

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Eruption of permanent incisors in indigenous goats and sheep

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Abstract

Ages at eruption of permanent incisor teeth of 292 goats and 392 sheep of known dates of birth, born in October and November 1984, 1985 and 1986, were established. The animals were mouthed at 14-day intervals between October 1985 and September 1989 at approximately one year of age to full mouth for females. Data for males were for the eruption of the first pair of permanent incisors only since most males were slaughtered at 18 months.

Average age of eruption of permanent incisors in goats was at 14.1, 19.4, 23.0 and 30.6 months for the first, second, third and fourth pairs, respectively. Sheep, except for the first pair of incisors, erupted their respective permanent incisors at slightly older ages: 13.9, 20.2, 26.6 and 32.7 months for the first to the fourth pair.

Eruption des incisives permanentes chez les ovins et les caprins de race locale

O. Matika, R. Sibanda et M.L. Beffa.

Résumé

En l'absence de relevés précis, l'âge des bovins et des ovins est généralement déterminé grâce à l'examen de la dentition. La date de naissance des animaux est rarement connue en élevage traditionnel; une connaissance appropriée de la dentition peut permettre de mettre au point un système de classement des carcasses qui permettrait à l'éleveur de vendre ses animaux pendant que ceux-ci sont encore en condition optimum.

L'âge des animaux au moment de l'éruption des incisives permanentes a été déterminé pour 292 caprins et 392 ovins de dates de naissance connues. Leur dentition fut examinée tous les 14 jours entre octobre 1985 et septembre 1989, à partir de l'âge de 1 an. L'observation fut poursuivie jusqu'à la dentition complète pour les femelles, et à l'apparition de la première paire d'incisives permanentes seulement pour les mâles, dans la mesure où la plupart d'entre eux furent abattus à l'âge de 18 mois. L'âge moyen à l'apparition de la première, de la deuxième, de la troisième et de la quatrième paires d'incisives permanentes fut de 14,1, 19,4, 23,0 et 30,6 mois chez les caprins. Chez les ovins, exception faite de la première paire, les autres paires d'incisives apparaissaient à un âge légèrement plus avancé: de 13,9, 20,2, 26,6 et 32,7 de la première à la quatrième paire d'incisives permanentes.

Introduction

Where records are absent, the ages of cattle and sheep are commonly estimated by examining their teeth. However, there are very few published reports on permanent incisor eruption in small ruminants, especially on goats (Wilson and Durkin, 1984). Since date of birth is rarely known in traditional management systems, estimating age by means of dentition offers an opportunity method for establishing population structure. Furthermore, carcass-grading systems for sheep in Zimbabwe entail classification into categories by age, as well as fleshing and fat cover, while that of goats only takes fleshing into consideration. It is suggested that inclusion of age in the grading and pricing of goat carcasses could encourage farmers to sell their stock when in prime condition. Therefore, knowledge of dentition in relation to age in goats would be a useful management tool. This study was designed to examine the relation between age and dentition among indigenous goats and sheep. Influence of year and type of birth, sex and species differences were investigated.

Materials and Methods

Ages at eruption of permanent incisor teeth of 292 goats and 392 sheep of known dates of birth were determined. The animals were born in October and November in 1984, 1985 and 1986. Indigenous sheep (Sabi) and the large Matebele goat (Sibanda, 1990) were used. These animals were grazed on semi-arid thorn veld (Ward et al, 1979) for 8 hours a day and were penned at night. Dipping was carried out weekly in the wet season (November to April) and once every two weeks during the dry season. Vaccination against pulpy kidney and strategic deworming were practised.

Measurements

A tooth was considered to have erupted when it had broken through the gum and the age at which animals attained a particular pair of permanent incisors was defined as the number of days from birth to the time when both incisors making up a pair had cut the gum. Animals were mouthed at 14-day intervals between October 1985 and September 1989, starting when they were approximately a year old with milk teeth still present (except in 1986 when sheep data on age of first eruption were discarded) continuing to full mouth in females. Data from males were available for the eruption of the first pair of permanent incisors only because males were slaughtered at 18 months of age.

Data analysis

Data were analysed by analysis of variance using a General Linear Model (SAS, 1987). Within each species the effects of year and type of birth, sex, birthweight, daily weight gain and weight at eruption of permanent incisors on age at teeth eruption were examined. Correlations between age at eruption of first pair and those of subsequent pairs of permanent incisors were determined, in addition to examining the correlations between ages and weights at eruption. A comparison between species was also made.

Age at eruption of permanent incisors was indicated by a 95% range (mean plus or minus two standard deviations).

Results and Discussion

The mean ages for permanent incisor eruption for goats (Table 1) were similar to those reported by Wilson and Durkin (1984) and Otesile and Obasaju (1982). However, the second to the fourth eruptions tended to occur relatively earlier than those reported by Wilson and Durkin (1984). Age at first permanent incisor eruption was correlated ($P < 0.01$) to age at subsequent eruptions.

The effects of sex and type of birth were not significant in goats, though the effect of year of birth was marked ($P < 0.01$). Eruption of first and second pairs occurred later in twins which were also lighter in bodyweight than singles. Although weight tended to exert an influence on age of eruption, there were no significant correlations. Daily weight gain between birth and age at first eruption was correlated to age at eruption of first, second and third pairs of permanent incisors ($P < 0.01$). The effects of year of birth could have been manifested through daily weight gain as influenced by nutrition.

Ages at which the first to fourth pairs of permanent incisors erupted in sheep (Table 1) are similar to those reported by Starke and Pretorius (1955). The

Table 1. Least squares means for age (days) and bodyweight (kg) at eruption of permanent incisors for goats and sheep.

Effect	First pair			Second pair			Third pair			Fourth pair		
	n	Age	Weight	n	Age	Weight	n	Age	Weight	n	Age	Weight
Goats:												
Year of birth	109	430 ^a	22 ^a	59	582 ^a	31	60	706 ^a	34 ^a	58	926	36 ^a
	119	424 ^a	28 ^b	59	565 ^b	32	60	677 ^b	32 ^b	56	922	32 ^b
	59	445 ^b	18 ^c									
Type of birth	53	431	23 ^a	25	578	28	25	692	33	22	933	34
	234	435	22 ^b	93	587	27	95	692	33	92	915	34
Sex	166	432	22									
	121	435	23									
Sheep:												
Year of birth	141	429 ^a	28 ^a	69	610 ^a	38 ^a	68	800 ^a	37 ^a	66	1002 ^a	40 ^a
	106	409 ^b	33 ^b	63	588 ^b	41 ^b	63	770 ^b	35 ^b	59	942 ^b	37 ^b
	120	614 ^a	33 ^c	109	814 ^c	33 ^c	88	998 ^a	37 ^c			
Type of birth	157	412 ^a	30 ^a	152	596 ^a	38 ^a	145	791	36 ^a	127	972	38
	90	426 ^b	28 ^b	100	612 ^b	37 ^b	95	799	34 ^b	86	989	38
Sex	131	417	28 ^a									
	116	421	29 ^b									

a, b, c Means within variables and pairs of eruptions with different superscripts significantly differ at $P < 0.05$.

variables affecting age at eruption were year of birth and to a lesser extent type of birth.

Daily weight gain from birth and age at first eruption was correlated ($P < 0.01$). Gain between successive eruptions were also correlated ($P < 0.01$) with their respective ages at eruption. This, as in goats, may have been a reflection of nutrition from birth to first eruption. Since only breeding females were available from second to fourth eruption, the effects of year of birth on weight and weight change were confounded by physiological status of animals which was not taken into account in the present analysis.

Sheep and goats differed ($P < 0.01$) in age of eruption of their second to fourth pairs of permanent incisors, the magnitude of the difference increasing between each pair (Table 2). The mean interval between first and second, second and third and third and fourth was 151, 114 and 227 days for goats and 184, 192 and 183 days, respectively, for sheep. Overall, goats attained full mouth at a significantly ($P < 0.01$) younger age than sheep (Table 2). Goats were lighter ($P < 0.01$) than sheep by 6, 8, 3 and 4 kg for first to fourth eruptions, respectively. Daily weight gain from birth to first eruption differed ($P < 0.01$) between species with sheep gaining 14 g per day more than goats.

Table 2. Mean age and 95% range (days) at eruption of permanent incisors for goats and sheep.

Dentition	Species	n	Age	Least squares contrast (goat minus sheep)	Range
First pair	Goats	287	423		377-487
				7	
	Sheep	247	418		367-469
Second pair	Goats	145	581		509-653
				-24 **	
	Sheep	252	605		525-685
Third pair	Goats	120	691		597-786
				-96 **	
	Sheep	240	798		700-896
Fourth pair	Goats	114	918		773-1064
				-55 **	
	Sheep	213	982		823-1141

** Significant at $P < 0.01$.

Commercial Implications

Though other studies have found no direct correlation between normal skeletal development and incisor development (Tagle and Helman, 1943), age determination facilitates market transactions and identification of carcasses of possible superior eating quality. A goat grading system, taking age classification of carcasses (which are different from sheep) into account is proposed. The large variation in ages at eruption of incisor teeth recorded here resulted in some overlapping of the distributions for successive pairs (Table 2). This limitation should be considered when using dentition to determine age.

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Growth traits of the Dorper sheep

I. Factors influencing growth traits

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Abstract

Data on 969 Dorper lambs collected over a 10-year period (1978 to 1987) at Ol'Magogo were used in this study. Lamb traits studied were weights from birth to yearling and absolute growth rates between adjacent stages of growth. All the fixed effects studied influenced growth in one way or another. Sex was highly significant for all traits ($P < 0.01$) except growth rates between weaning and six months (GR2), and six to nine months (GR3), and season of birth influenced all traits significantly ($P < 0.05$) except birthweight (BIRTHW), growth rates between weaning and six months (GR2), and between nine and twelve months (GR4). The effect of parity was confined to pre-weaning traits ($P < 0.05$), while period of birth was significant ($P < 0.05$) on all traits except yearling weight (ADJTMW) and growth rate between weaning and six months (GR2).

Paramètres de croissance du mouton Dorper

I. Facteurs agissant sur les paramètres de croissance

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Résumé

Cette étude repose sur les données recueillies pendant 10 ans (1978 à 1987) sur 969 agneaux de race Dorper à OL'Magogo Naivasha. Les paramètres étudiés sont le poids des agneaux de la naissance, à l'âge de 1 an, et leurs taux de croissance absolus à intervalles de

temps consécutifs. Tous les effets fixes examinés influençaient la croissance d'une manière ou d'une autre. L'effet du sexe était très significatif pour tous les paramètres étudiés ($P < 0,01$), à l'exception des taux de croissance entre le sevrage et l'âge de 6 mois (GR2) et entre 6 et 9 mois (GR3). La saison de naissance a montré un effet significatif ($P < 0,05$) sur tous les paramètres excepté sur le poids à la naissance (BIRTHW), et les taux de croissance entre le sevrage et l'âge de 6 mois (GR2) et entre 9 et 12 mois (GR4). Alors que l'effet du rang de la naissance se limitait aux seuls paramètres examinés avant le sevrage, la saison de la naissance avait un effet significatif ($P < 0,05$) sur tous les paramètres étudiés excepté sur le poids à 1 an (ADJTMW) et le taux de croissance entre le sevrage et l'âge de 6 mois (GR2)

Introduction

The Dorper breed was developed in South Africa around 1942, mainly at Grootfontein College of Agriculture from initial crosses between Blackhead Persian ewes and Dorset Horn rams. The Dorper has a reputation for its adaptability to rather harsh environment. Characteristics of the breed include the ability to walk long distances and forage well in permanently dry areas and in times of drought, good mothering ability in the ewes, high ram fertility and vigour, excellent carcass conformation for good mutton production in comparison with the indigenous breeds and an unrestricted breeding season.

In Kenya, Dorper sheep accrue income mainly from meat and sale of surplus stock. Bodyweight and rate of gain are among the most economically important and easily measured traits of meat animals. Although weight is an important objective in selection, knowledge of the particular phase of the animal's growth upon which to base selection is of utmost importance. Studies on the environmental factors influencing growth traits are few for sheep reared under Kenyan conditions. Gumedze (1979) studied fertility in Dorper sheep at Ol'Magogo. Ouko Odenya (1982) and Kiriro (1986) studied lamb traits only up to weaning. A majority of studies have reported the performance of temperate sheep. There is an extreme paucity of information regarding the performance of sheep raised in Kenya.

The purpose of this study was to investigate environmental sources of variation influencing growth traits in a flock of Dorper sheep at various stages of growth, from birth to yearling.

Materials and Methods

The data used in this study consisted of growth records of 969 Dorper lambs. These data were collected from records of the Sheep and Goat Development

Project (SGDP) based at Ol'Magogo, a substation of the National Animal Husbandry Research Centre (NAHRC), Naivasha, between 1978 through 1987.

Bodyweights analysed included weight at birth, at three months (weaning), at six months, at nine months and at months (yearling). Lambs were nursed by their dams up to weaning. Each lamb record included sire, dam and lamb identifications, type of birth and sex. Three seasons of birth were defined on the basis of the monthly rainfall distribution. Two rainy seasons were identified with April and May (season 1) forming the peak of the long rains while October and November were classified as a season of short rains (season 2). The remaining months were classified as a dry season (season 3).

Parities were defined based on the number of times the ewes had lambed giving rise to parities 1, 2, 3 and 4, the latter comprising ewes with 4 or more lambings. Due to disproportionate distribution of data across years which resulted into discontinuity in the data, it was not possible to include actual years in the analysis. Therefore, to adjust for differences in weather conditions across years, periods of birth were defined by grouping adjacent years on the basis of annual rainfall pattern. This otherwise uncommon grouping method was implemented after examination of meteorological data, and was felt to be the best method under the circumstances. Period 1 consisted of the years 1978–1980 which received the highest rainfall, period 2 (1981–1985) received intermediate amounts while period 3 (1986–1987) received the lowest.

The absolute growth rates were derived by taking the difference in weight within the period and dividing it by the time interval in days. The absolute rate of gain for each lamb was calculated over five growth periods namely: Birth to weaning (GR1), weaning to six months (GR2), six to nine months (GR3), nine to 12 months (GR4) and birth to 12 months (OVRGRT). These, together with the bodyweights, constitute the 10 traits analysed in this study.

In view of the differences in actual age at which weights were taken, the latter were pre-adjusted as follows:

ADJWWT (adjusted 90-day weaning weight)

$$= \text{GR1} \times 90 \text{ days} + \text{birthweight (BIRTHW)}$$

ADJSMW (adjusted six-months weight)

$$= \text{GR2} \times 90 \text{ days} + \text{ADJWWT}$$

ADJNMW (adjusted nine-months weight)

$$= \text{GR3} \times 90 \text{ days} + \text{ADJSMW}$$

ADJTMW (adjusted 12 months weight)

$$= \text{GR4} \times 90 \text{ days} + \text{ADJNMW}.$$

Adjustment for fixed effects (sex, season of birth, period of birth, parity and dam breed) was achieved by including them in the model.

Statistical analysis: The statistical model used to relate observations with independent variables was as follows:-

$$Y_{ijklmn} = u + a_i + b_j + c_k + d_l + f_m + e_{ijklmn}$$

where

Y_{ijklmn} = the $ijklmnp^{\text{th}}$ observation.

u = an underlying constant for the trait

a_i = effect of the i^{th} sire ($i = 1, \dots, 63$)

assumed random, $N(0)$

b_j = effect of the j^{th} season of birth ($j = 1, 2, 3$)

c_k = effect of the k^{th} parity ($k = 1, 2, 3, 4$)

d_l = effect of the l^{th} period of birth ($l = 1, 2, 3$)

f_m = effect of the m^{th} sex (1= male, 2=female)

e_{ijklmn} = random error associated with the $ijklmnp^{\text{th}}$ observation; $N(0,)$

The Least Squares Method (Harvey, 1982) in which sires were cross-classified with fixed effects was used in the analysis of the data.

Results and Discussion

Analysis of fixed effects

Analysis of variance for bodyweights and growth rates are presented in Tables 1 and 2, respectively. Corresponding least squares means are presented in Tables 3 and 4 by subclasses.

Sex

Least squares means (Tables 3 and 4) indicate that male lambs performed, in all cases, considerably better than their female counterparts. These differences were significant (at least at $P < 0.05$ level) for all the traits except for pre-weaning growth rate (GR2) and (GR3) for which it was not significant. Consistent superiority of male lambs has been widely reported (Dass and Acharya, 1970; Vesely and Robison, 1970; Magid et al, 1981; Fitzhugh and Bradford, 1983; and Kiro, 1986). This has been attributed to hormonal differences between sexes and their resultant effects on growth (Velardo, 1958; Bell et al, 1970).

Table 1. Analysis of variance of bodyweights (Dorper sheep).

Source of variation	df	Mean squares				
		Birth	ADJWWT	ADJSMW	ADJNMW	ADJTMW
Sires	62	0.68**	18.14***	43.23***	66.03***	91.54***
Sex	1	9.44***	366.87***	525.05***	520.03***	1406.72***
Season of birth	2	0.04	65.18*	88.77**	105.03**	107.46*
Parity	3	2.13***	48.49**	23.27	7.48	1.16
Period of birth	2	1.40*	204.37***	321.42***	773.03***	73.20
Error	898	0.43	10.62	15.79	17.79	25.59

*** P < 0.001; ** P < 0.01; * P < 0.05.

ADJWWT = adjusted 90-day weaning weight

ADJSMW = adjusted six-months weight

ADJNMW = adjusted nine-months weight

ADJTMW = adjusted 12-months (yearling) weight.

Table 2. Analysis of variance of growth rate (Dorper sheep).

Source of variation	df	Mean squares				
		GR1	GR2	GR3	GR4	OVRGRT
Sires	62	0.002**	0.003***	0.005***	0.005***	0.001***
Sex	1	0.032***	0.002	0.000	0.027**	0.005***
Season of birth	2	0.009***	0.001	0.005*	0.004	0.004***
Parity	3	0.004*	0.001	0.001	0.001	0.000
Period of birth	2	0.022***	0.003	0.004***	0.070***	0.001**
Error	898	0.001	0.001	0.001	0.002	0.0002

*** P < 0.001; ** P < 0.01; * P < 0.05.

GR1 = birth to weaning

GR2 = weaning to six months

GR3 = six to nine months

GR4 = nine to twelve months

OVRGRT = birth to 12 months.

Table 3. Least squares means and standard errors of bodyweights (*Dorpers*).

Category	No. of observations	Birth (kg)	ADJWWT (kg)	ADJSMW (kg)	ADJNMW (kg)	ADJTMW (kg)
Overall mean $\pm$ SE	969	4.12 $\pm$ 0.10	19.48 $\pm$ 0.51	24.62 $\pm$ 0.85	29.68 $\pm$ 1.09	35.92 $\pm$ 1.28
Males	469	4.22 $\pm$ 0.10	20.12 $\pm$ 0.52	25.39 $\pm$ 0.87	30.44 $\pm$ 1.10	37.17 $\pm$ 1.29
Females	500	4.01 $\pm$ 0.10	18.84 $\pm$ 0.52	23.85 $\pm$ 0.86	28.92 $\pm$ 1.10	34.66 $\pm$ 1.29
Season of birth	1	4.10 $\pm$ 0.10	20.22 $\pm$ 0.50	25.15 $\pm$ 0.85	29.31 $\pm$ 1.08	36.44 $\pm$ 1.27
	2	4.16 $\pm$ 0.18	17.68 $\pm$ 0.93	22.89 $\pm$ 1.27	29.18 $\pm$ 1.48	34.08 $\pm$ 1.75
	3	4.09 $\pm$ 0.09	20.54 $\pm$ 0.46	25.82 $\pm$ 0.81	30.54 $\pm$ 1.05	37.22 $\pm$ 1.23
Parity	1	3.98 $\pm$ 0.10	18.61 $\pm$ 0.51	24.00 $\pm$ 0.85	29.36 $\pm$ 1.09	35.79 $\pm$ 1.27
	2	4.20 $\pm$ 0.10	19.52 $\pm$ 0.52	24.61 $\pm$ 1.87	29.47 $\pm$ 1.10	35.93 $\pm$ 1.29
	3	4.14 $\pm$ 0.12	19.73 $\pm$ 0.61	24.72 $\pm$ 0.95	29.55 $\pm$ 1.17	35.88 $\pm$ 1.38
	4	4.14 $\pm$ 0.12	19.73 $\pm$ 0.61	24.72 $\pm$ 0.95	29.55 $\pm$ 1.17	35.88 $\pm$ 1.38
Period of birth	1	4.37 $\pm$ 0.17	20.02 $\pm$ 0.86	24.37 $\pm$ 1.20	30.64 $\pm$ 1.41	38.14 $\pm$ 1.67
	2	3.91 $\pm$ 0.13	17.45 $\pm$ 0.66	22.41 $\pm$ 0.99	25.76 $\pm$ 1.21	34.51 $\pm$ 1.43
	3	4.06 $\pm$ 0.14	20.97 $\pm$ 0.72	27.07 $\pm$ 1.05	32.64 $\pm$ 1.27	35.10 $\pm$ 1.50

For abbreviations see Tables 1 and 2.

Table 4. *Least squares means and standard errors of rates of growth (Dorpers).*

Category	No. of observations	GR1 (kg/d)	GR2 (kg/d)	GR3 (kg/d)	GR4 (kg/d)	DVRGRT (kg/d)
Overall means $\pm$ SE	969	0.170 $\pm$ 0.005	0.057 $\pm$ 0.007	0.056 $\pm$ 0.009	0.069 $\pm$ 0.009	0.098 $\pm$ 0.004
Males	469	0.176 $\pm$ 0.005	0.058 $\pm$ 0.007	0.056 $\pm$ 0.009	0.074 $\pm$ 0.010	0.100 $\pm$ 0.004
Females	500	0.164 $\pm$ 0.005	0.055 $\pm$ 0.007	0.056 $\pm$ 0.009	0.063 $\pm$ 0.009	0.095 $\pm$ 0.004
Season of birth	380	0.179 $\pm$ 0.005	0.054 $\pm$ 0.007	0.046 $\pm$ 0.009	0.079 $\pm$ 0.009	0.089 $\pm$ 0.004
	1					
	2	0.150 $\pm$ 0.010	0.057 $\pm$ 0.011	0.069 $\pm$ 0.012	0.054 $\pm$ 0.013	0.114 $\pm$ 0.005
	3	0.182 $\pm$ 0.004	0.058 $\pm$ 0.006	0.052 $\pm$ 0.009	0.074 $\pm$ 0.009	0.090 $\pm$ 0.003
Parity	622	0.162 $\pm$ 0.005	0.059 $\pm$ 0.007	0.059 $\pm$ 0.009	0.071 $\pm$ 0.009	0.097 $\pm$ 0.004
	2	0.170 $\pm$ 0.005	0.056 $\pm$ 0.007	0.053 $\pm$ 0.009	0.071 $\pm$ 0.010	0.096 $\pm$ 0.004
	3	0.173 $\pm$ 0.006	0.055 $\pm$ 0.008	0.053 $\pm$ 0.009	0.070 $\pm$ 0.010	0.098 $\pm$ 0.004
	4	0.176 $\pm$ 0.008	0.056 $\pm$ 0.009	0.057 $\pm$ 0.011	0.063 $\pm$ 0.012	0.099 $\pm$ 0.005
Period of birth	578	0.173 $\pm$ 0.009	0.048 $\pm$ 0.010	0.069 $\pm$ 0.012	0.083 $\pm$ 0.013	0.099 $\pm$ 0.005
	2	0.150 $\pm$ 0.007	0.055 $\pm$ 0.008	0.037 $\pm$ 0.010	0.097 $\pm$ 0.011	0.092 $\pm$ 0.004
	3	0.187 $\pm$ 0.007	0.067 $\pm$ 0.009	0.061 $\pm$ 0.011	0.027 $\pm$ 0.011	0.101 $\pm$ 0.004

For abbreviations, see Tables 1 and 2.

Season of birth

The effect of season of birth was significant for all traits except birthweight, pre-weaning growth rate and growth in the interval six to nine months. The effect of season of birth arises from seasonal variation in the physical environment resulting from changes in weather conditions (including rainfall amounts, temperature, and humidity) which directly affect feed availability, especially in a situation (such as is the case in this study) with no supplementary feed. Seasonal influence on a trait such as birthweight operates through its effect on the dam's uterine environment mostly in late gestation (Eitawil et al, 1970). Such factors operating in seasons prior to lambing will be manifested in birthweight. This may explain the higher (albeit non-significant) birthweight of lambs born in the dry season, lambs born in the long dry season during the critical stages of gestation. Such lambs would be expected to weigh more at birth compared to those whose dams underwent a nutritionally stressful period during gestation. It is, therefore, expected that the season when the ewe is in gestation is likely to play a more important role in birthweight than the actual season of birth. On the other hand, season of birth plays an important role in growth performance indirectly through its influence on the dam's nutrition (and hence amount of milk available to the unweaned lamb) and later, directly, through its effect on the pasture availability and quality on which the lamb is subsequently weaned. Growth traits are known to have positive correlations, both genetic and phenotypic (Osman and Bradford, 1965; Dzakuma et al, 1978; Mavrogenis et al, 1980; Stobart et al, 1986). The significance of season of birth for early growth performance may thus be responsible, as a carryover effect, for its significant influence on growth traits up to yearling. That growth rate from weaning to six months was not significantly influenced by season of birth — although season of birth was a significant source for growth rate before and after this period — may be due to the post-weaning stress which may have obscured the effect of season of birth. In general, seasons 1 and 3 were associated with better performance than season 2 (the short rains). The impact of this advantage early in life appears to be perpetuated up to yearling. As far as the bodyweights are concerned, season 3 was consistently associated with superior performance. From the results of this study, it is evident that lambs born in the dry season performed better than those born in the rainy season. It is therefore recommended that breeding at Ol'Magogo should be planned so that lambing would occur in the dry season. This way, would lambs benefit from favourable prenatal nutrient availability via their dams. However, lambing in the dry season has serious nutritional implications to the ewes. This is a time when ewes require good pastures so as to support their young and improve their own body condition. The best compromise would be to time lambing to occur towards the end of the dry season just preceding the rainy season.

Parity of dam

Parity was a significant source of variation for birthweight, pre-weaning growth rate and adjusted weaning weight ($P < 0.01$). Least squares means (Tables 3 and 4) indicate that as far as pre-weaning growth rate and weaning weight are concerned, the performance of lambs improved with increase in parity. That young ewes tend to produce smaller lambs at birth has been documented (Dass and Acharya, 1970; Wilson, 1987). First parity ewes are still growing and thus must provide for their own growth in addition to the foetal demand. It is generally known that mothering ability, especially milk production, increases with parity; older ewes are larger in body and are better milkers (Dass and Acharya, 1970; Eltawil et al, 1970; Wright et al, 1975; Stobart et al, 1986). Hence, influence of the superior maternal environment of such ewes is expected to be translated into better lamb performance up to weaning. It was, therefore, not surprising that post-weaning growth performance was not significantly influenced by parity. The effect of parity of dam on lambs is thus imparted as maternal influence whose direct influence is limited to the nursing period.

Period of birth

Period of birth was a significant source of variation for all traits except birthweight and yearling weight. As has been alluded to in Materials and Methods, period of birth was defined by grouping adjacent years which, from meteorological data, generally had a similar rainfall pattern. To this end, the significance of this factor was only important because it facilitated the adjustments of records for the effect of 'periods'. Any particular period, on its own, has no important bearing on the interpretation of the results and therefore did not have any management implications.

Conclusion

In order to improve breeding value, selection must be based on genotypic rather than environmental superiority. Thus, variation due to definable environmental effects must be removed by use of suitable adjustment factors. Ideally, these adjustments would be developed individually for each management unit (i.e. flock), but only rarely is sufficient data available to allow this. The next possible level for development of adjustment factors is within either definable groups of management units, or definable genetic groups. It is necessary that all known sources of variation influencing the traits of importance be included in the model of analysis, otherwise the results of the study may not be reliable. If less factors are included there is often a tendency to obtain overestimates of the genetic parameters of interest. In this study, for example, it would have been quite useful to include such factors as age of dam, and type of birth and rearing as some of the adjustment factors. However, type of birth and rearing was not included in

the model of analysis because genetic parameters were also being estimated based on paternal half-sibs only, while age of dam was not available in the original data set.

The trait of interest ought to be investigated in the environment under which it is to be typically expressed, since this environment may be the one which is necessary for revealing certain desirable or undesirable genes or, in contrast, the sought-after genetic differences may be of little importance or indistinguishable in this environment. For instance, traits evaluated at Ol'Magogo should not necessarily be expected to behave in the same way in a quite different environment, such as the Kenyan highlands. Genetic improvement of many traits might be more effectively accomplished by evaluating them, and others correlated with them, under **particular** environmental circumstances or during a **specific** period in the life cycle, depending upon the particular genes involved and the correlations among them.

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Growth traits of the Dorper sheep.

II. Genetic and phenotypic parameters

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Abstract

Data on 969 lambs collected over a 10-year period (1978 to 1987) on Dorper sheep at Ol'Magogo were used in this study. Lamb traits studied were weights from birth to yearling and absolute growth rates between adjacent stages of growth. Heritability estimates from paternal half-sib analysis were: 0.15 ± 0.07 , 0.18 ± 0.08 , 0.39 ± 0.11 , 0.55 ± 0.13 , 0.53 ± 0.13 , 0.14 ± 0.07 , 0.28 ± 0.09 , 0.59 ± 0.14 , 0.49 ± 0.12 and 0.49 ± 0.12 ; for birthweight (BIRTHW), adjusted weaning weight (ADJWWT), adjusted six-months weight (ADJSMW), adjusted nine-months weight (ADJNMW), adjusted 12-months weight (ADJTMW), pre-weaning growth rate (GR1), weaning to six months (GR2), six to nine months (GR3), nine to 12 months (GR4), and birth to yearling (OVRGRT), respectively. Post-weaning heritability estimates were generally higher than those for pre-weaning suggesting a lower direct genetic influence early in life. Genetic and phenotypic correlations estimated between weights were mainly positive (0.15 to 0.99 and 0.02 to 0.98, respectively). There were generally high genetic and phenotypic correlations between adjacent weights, between weights and rates of growth, and among growth rates themselves.

Paramètres de croissance du mouton Dorper

II. Paramètres génétiques et phénotypiques

B.A.O. Inyangala, J.E.O. Rege et S. Itulya

Résumé

Cette étude repose sur les données recueillies pendant 10 ans (1978 à 1987) sur 969 agneaux de race Dorper à OL'Magogo Naivasha. Les paramètres étudiés sont le poids des agneaux de la naissance à l'âge de 1 an, et leurs taux de croissance absolus à intervalles de temps consécutifs. Les coefficients d'héritabilité obtenus à partir de demi-frères paternels étaient de $0,15 \pm 0,07$ pour le poids à la naissance, de $0,18 \pm 0,08$ pour le poids au sevrage corrigé, de $0,39 \pm 0,11$ pour le poids à 6 mois corrigé, de $0,55 \pm 0,13$ pour le poids à 9 mois corrigé, de $0,53 \pm 0,13$ pour le poids à 12 mois corrigé, et en ce qui concerne la croissance, de $0,14 \pm 0,07$ avant le sevrage, de $0,28 \pm 0,09$ du sevrage à l'âge de 6 mois, de $0,59 \pm 0,14$ de 6 à 9 mois, de $0,49 \pm 0,12$ de 9 à 12 mois, et de $0,49 \pm 0,12$ de la naissance à l'âge de 1 an. Les coefficients d'héritabilité des caractères étudiés après le sevrage étaient presque toujours supérieurs à ceux des caractères étudiés de la naissance au sevrage, ce qui signifie que l'influence directe du patrimoine génétique de l'animal est moins importante au cours des premiers mois de la vie qu'au cours des mois suivants. Les coefficients de corrélation génétique et phénotypique estimés entre les poids étaient essentiellement positifs, allant respectivement de 0,15 à 0,99 et de 0,02 à 0,98. Par ailleurs, il existait de fortes corrélations génotypiques et phénotypiques entre les poids moyens aux intervalles consécutifs, entre les poids et les taux de croissance et entre les taux de croissance eux-mêmes.

Introduction

The potential for genetic improvement is largely dependent on the heritability of the trait and its genetic relationship with other traits of economic importance upon which some selection pressure may be applied. Information on heritabilities is essential for planning efficient breeding programmes and for predicting response to selection. Genetic correlations, on the other hand, are essential in predicting indirect responses to selection and are needed in order to determine the optimum weighting and expected response to multiple trait selection.

Statistical techniques presently utilised for the estimation of breeding values in selection programmes rely on estimates of genetic variation within and between traits of economic importance. The overall impact of any selection programme

will depend on the direct and correlated responses that result from selection on the selection criterion. These responses can be predicted *a priori* by using estimates of genetic and phenotypic relationships between all traits of economic importance.

In Kenya, Dorper sheep are kept mainly for meat production. Thus, traits affecting economic viability include those associated with growth. Body weight and rate of gain are among the most economically important and easily measured traits of meat animals. Although weight is an important objective in selection, knowledge of the particular phase of the animal's growth upon which to base selection is of utmost importance. Genetic and phenotypic parameter estimates are scarce in sheep reared under Kenyan conditions and where such information is available, analytical methods used tend to be inadequate.

The purpose of this study was to estimate genetic and phenotypic parameters of growth traits in a flock of Dorper sheep at various stages of growth from birth to yearling.

Materials and Methods

The data used in this study consisted of growth records of lambs in a flock of Dorper sheep. These data were collected from records of the Sheep and Goat Development Project (SGDP) based at Ol'Magogo, a substation of the National Animal Husbandry Research Centre (NAHRC), Naivasha, between 1978 through 1987. A total of 969 records were available and were thus analysed for genetic and phenotypic parameters.

Bodyweights analysed included weight at birth, at three months (weaning), at six months, at nine months and at 12 months (yearling). Lambs were nursed by their dams up to weaning. Each lamb record included sire, dam and lamb identifications, type of birth, sex and dam breed. Three seasons of birth were defined on the basis of the monthly rainfall distribution. Two rainy seasons were identified with April and May (season 1) forming the peak of the long rains while October and November were classified as season of short rains (season 2). The remaining months were classified as dry season (season 3).

Parities were defined based on the number of times the ewes had lambed giving rise to parities 1, 2, 3 and 4, the latter comprising ewes with four or more lambings. Due to disproportionate distribution of data across years which resulted into discontinuity in the data, it was not possible to include actual years in the analysis. Therefore, to adjust for differences in weather conditions across years, periods of birth were defined by grouping adjacent years on the basis of annual rainfall pattern. This otherwise uncommon grouping method was implemented after examination of meteorological data, and was felt to be the best method under the circumstances. Period 1 consisted of the years 1978–1980 which received

the highest rainfall, period 2 (1981–1985) received intermediate amounts while period 3 (1986–1987) received the lowest.

The absolute growth rates were derived by taking the difference in weight within the period and dividing it by the time interval in days. The absolute rate of gain for each lamb was calculated over five growth periods namely: Birth to weaning (GR1), weaning to six months (GR2), six to nine months (GR3), nine to 12 months (GR4) and birth to 12 months (OVRGRT). These, together with the bodyweights, constitute the 10 traits analysed in this study.

In view of the differences in actual age at which weights were taken, the latter were pre-adjusted as follows:

$$\begin{aligned} \text{ADJWWT (adjusted 90-day weaning weight)} \\ = \text{GR1} \times 90 \text{ days} + \text{birthweight (BIRTHW)} \end{aligned}$$

$$\begin{aligned} \text{ADJSMW (adjusted six-months weight)} \\ = \text{GR2} \times 90 \text{ days} + \text{ADJWWT} \end{aligned}$$

$$\begin{aligned} \text{ADJNMW (adjusted nine-months weight)} \\ = \text{GR3} \times 90 \text{ days} + \text{ADJSMW} \end{aligned}$$

$$\begin{aligned} \text{ADJTMW (Adjusted 12-months weight)} \\ = \text{GR4} \times 90 \text{ days} + \text{ADJNMW} \end{aligned}$$

Adjustment for fixed effects (sex, season of birth, period of birth and parity) was achieved by including them in the model.

Genetic and phenotypic parameters estimated were heritability of each trait, and genetic and phenotypic correlations among these traits as traits of the lamb.

Statistical analyses

The statistical model used to relate observations with independent variables was as follows:

$$Y_{ijklmn} = u + a_i + b_j + c_k + d_l + f_m + e_{ijklmn}$$

where Y_{ijklmn} = the $ijklmnp^{\text{th}}$ observation.

u = an underlying constant for the trait

a_i = effect of the i^{th} sire ($i=1, \dots, 63$) assumed random, $N(0, \sigma^2)$

b_j = effect of the j^{th} season of birth ($j=1, 2, 3$)

c_k = effect of the k^{th} parity ($k=1, 2, 3, 4$)

d_l = effect of the l^{th} period of birth ($l=1, 2, 3$)

f_m = effect of the m^{th} sex ($1=\text{male}, 2=\text{female}$)

e_{ijklmn} = random error associated with the $ijklmnp^{\text{th}}$ observation; $N(0, \sigma^2)$

e

Parameters were estimated from covariances of relatives using paternal half-sib (PHS) analysis based on the Least Squares Method (Harvey, 1982) in which sires were cross-classified with fixed effects. The analytical complications introduced in half-sib analysis by use of litters was avoided by including only lambs born as singles. Heritability was estimated from variance components as

$$h^2 = 4 \sigma^2_s / (\sigma^2_s + \sigma^2_w)$$

where h^2 = heritability estimate

σ^2_s = sire variance component

σ^2_w = variance of records within sires

The approximate method of Swiger et al (1964) was used to estimate the standard error of the heritability estimate. Genetic correlations between two traits 1 and 2, r_{12} were estimated as

$$r_{12} = \sigma_{s1s2} / (\sigma_{s1}\sigma_{s2})$$

where σ_{s1s2} is the sire covariance component for the two traits and σ_{s1} and σ_{s2} are square roots of respective sire variance components.

Results and Discussion

Genetic and phenotypic parameters

Heritability

Heritability estimates are summarised in Table 1. Heritability of birthweight was found to be 0.15 ± 0.07 . This estimate compares favourably with estimates of 0.19 (Osman and Bradford, 1965) and 0.21 (Dzakuma et al, 1978). The estimate for weaning weight was 0.18 ± 0.08 which was lower than 0.28 ± 0.11 (Stobart et al, 1986) and 0.36 ± 0.12 (Mavrogenis et al, 1980). Thus, in general, both estimates for birth and weaning weight were lower than those in the literature. Heritability for six-months weight was estimated at 0.39 ± 0.11 . This was slightly above the estimates of 0.28 ± 0.10 (Dzakuma et al, 1978) and 0.21 (Ercanbrack and Price, 1972). The estimate for weight at nine months (0.55 ± 0.13) compares favourably with the range of 0.30 to 0.50 (Rae, 1982). However, few studies have reported heritability estimates of nine-months weight. That for 12-months weight was

Table 1. Heritabilities, genetic and phenotypic correlations from paternal half-sib analyses (Dorper sheep).

Traits	Traits									
	Birth	ADJWWT	ADJSMW	ADJNMW	ADJTMW	GR1	GR2	GR3	GR4	OVRGRT
BIRTHW	0.15a ±0.07	0.95b ±0.21	0.46 ±0.24	0.47 ±0.22	0.84 0.18	0.91 ±0.31	-0.04 ±0.29	0.15 ±0.24	0.67 ±0.22	0.57 ±0.22
ADJWWT	0.34c	0.18 ±0.08	0.80 ±0.12	0.59 ±0.16	0.70 ±0.15	0.99 ±0.01	0.44 ±0.28	-0.02 ±0.23	0.29 ±0.23	0.43 ±0.20
ADJSMW	0.19	0.64 ±0.11	0.39 ±0.11	0.64 ±0.11	0.46 ±0.15	0.86 ±0.13	0.89 ±0.08	-0.15 ±0.19	-0.13 ±0.19	0.32 ±0.17
ADJNMW	0.21	0.54 ±0.11	0.69 ±0.11	0.55 ±0.13	0.76 ±0.08	0.61 ±0.18	0.50 ±0.16	0.67 ±0.10	-0.15 ±0.18	0.82 ±0.07
ADJTMW	0.25	0.47 ±0.11	0.55 ±0.13	0.74 ±0.13	0.53 ±0.13	0.66 ±0.18	0.15 ±0.20	0.53 ±0.13	0.53 ±0.13	0.88 ±0.05
GR1	0.15	0.98 ±0.11	0.63 ±0.11	0.52 ±0.11	0.45 ±0.13	0.14 ±0.07	0.52 ±0.31	-0.05 ±0.25	0.21 ±0.26	0.39 ±0.23
GR2	-0.10	-0.17 ±0.11	0.65 ±0.11	0.35 ±0.11	0.24 ±0.11	-0.16 ±0.07	0.28 ±0.09	-0.22 ±0.21	-	0.42 ±0.20
GR3	0.61	-0.05 ±0.11	-0.27 ±0.11	0.51 ±0.11	0.32 ±0.11	-0.06 ±0.06	-0.31 ±0.09	0.59 ±0.14	-	0.06 ±0.10
GR4	0.11	0.04 ±0.11	-0.04 ±0.11	-0.15 ±0.11	0.56 ±0.11	0.02 ±0.02	-0.08 ±0.08	-0.16 ±0.16	0.18 ±0.12	0.27 ±0.17
OVRGRT	0.13	0.35 ±0.11	0.38 ±0.11	0.66 ±0.11	0.81 ±0.11	0.34 ±0.04	0.14 ±0.14	0.42 ±0.12	0.37 ±0.12	0.49 ±0.12

a. Heritabilities with standard errors below them on primary diagonal.

b. Genetic correlations with standard errors below them above the diagonal.

c. Phenotypic correlations below the diagonal.

BIRTHW = birthweight

ADJWWT = adjusted weaning weight

ADJSMW = adjusted six-months weight

ADJNMW = adjusted nine-months weight

ADJTMW = adjusted 12-months weight

GR1 = pre-weaning growth rate

GR2 = weaning to six months

GR3 = six to nine months

GR4 = nine to 12 months

OVRGRT = birth to yearling.

estimated at 0.53 ± 0.13 and was higher than values reported in other studies: 38 ± 0.23 (Dass and Acharya, 1970); 0.26 ± 0.11 (Stobart et al, 1986); and 0.11 ± 0.11 (Dzakuma et al, 1978). Heritability estimates of growth rates progressively increased from 0.14 ± 0.07 for pre-weaning growth rate to 0.59 ± 0.14 for growth rate between six to nine months, then declined to 0.49 ± 0.12 for rate of gain between nine to 12 months. The range of heritability for pre-weaning growth rate in the literature (Hundley and Carter, 1956; Givens et al, 1960; Vogt et al, 1967) was 0.18–0.37. Overall growth rate had a heritability estimate of 0.49 ± 0.12 . However, this was higher than 0.29 ± 0.11 (Stobart et al, 1986). Rae (1982) reported a range of 0.20–0.40 for post-weaning growth rate while a high figure of 0.58 ± 0.14 has been reported in Columbia sheep (Ercanbrack and Price, 1972).

It is clear from these and other results that post-weaning growth generally has higher heritability estimates than pre-weaning growth. This would indicate that environmental factors, in relation to additive genetic factors, had more influence on early lamb gain than on gains later in the lamb's life. This may be attributed to the high maternal influence associated with lamb growth performance early in life. High maternal influence has a tendency to increase the component of variance environmental to the lamb thereby lowering heritability estimates (Harrington et al, 1962; Thrift et al, 1973).

The best time to evaluate an animal's additive genetic value for a desired trait is under circumstances which assure maximum expression of the genes, that is under conditions when heritability is highest, provided that the genetic expression at this time is highly correlated with the genetic expression during the time period in life when the trait is most valuable or important (Ercanbrack and Price, 1972). However, one should not ignore the effect of time of evaluation on generation interval. Moreover, the desired genotype might be more accurately evaluated through another highly heritable trait, or an index, which is highly correlated genetically with it.

These results, therefore, indicate that to select lambs for their own genetic merit for weights and gains, it would be best to use bodyweight at nine months as the selection criterion rather than weaning weight as is often practised. This trait should be superior to weaning weight or pre-weaning growth rate since it is much less influenced by maternal effects which tend to obscure the direct additive genetic effect for growth. Although the generation interval may not be considerably shortened, overhead costs should certainly be curtailed when the rest of the lamb crop is disposed of at this stage. On the other hand, selection of ewes as dams must be based on lamb performance pre-weaning and at weaning. In any case, the objective should be to choose a practical selection criterion which will maximise the annual rate of progress for the trait to be improved without seriously impairing merit in important correlated traits (Ercanbrack and Price, 1972).

Genetic correlations

Genetic correlations between growth traits at various ages was generally high and positive ranging from 0.15 ± 0.24 to $.99 \pm .01$ (Table 1). Genetic correlations between adjacent traits were generally higher than the ranges reported in the literature: 0.21–0.77 for correlation between birth weight and weaning weight (Osman and Bradford, 1965; Mavrogenis et al, 1980), 0.13–0.22 for birthweight and 12-months weight, and 0.21–0.72 for weaning weight and 12-months weight (Dzakuma et al, 1978; Stobart et al, 1986). The high genetic correlations among these traits suggests that selection for any one of these traits would result in considerable positive change in other traits. The complications brought about by maternal environment early in the lamb's life (hence the lowered estimate of direct genetic effects) may be overcome by utilising correlated response. One could concentrate on traits with high heritability as long as there exists a high positive correlation with other traits of economic value. Moreover, selection directed towards weights at later ages would minimise response in birthweight and possible increased frequency of dystocia (Shelton, 1964; Thrift et al, 1967; Olson et al, 1976; Martin et al, 1980; Mavrogenis et al, 1980). However, selection for weights at later ages would be expected to lead to increased yearling weights which is desirable for meat animals, but may be associated with increased maintenance costs for breeding animals and those kept for wool production.

Genetic correlations between growth rates and various weights and between growth rates themselves ranged from medium and negative to high and positive (-0.42 to 0.99). Statistically, most of the estimates were not significantly different from zero. Such (negative) estimates could be explained by the effect of compensatory growth obscuring underlying genetic relationships. Thus, in general, genetic correlations were low to high and positive. There is, therefore, potential for exploiting correlated response for most of these traits. Traits such as birthweight, weaning weight and pre-weaning growth rate could be incorporated in a selection index aimed at selecting for yearling weight since these traits are highly correlated with 12-months weight. However, care must be taken to avoid problems related to dystocia which may result due to selection for increased birthweights.

Phenotypic correlations

Phenotypic correlations between weights were all positive and generally high (0.19 – 0.74) (Table 1). As was the case for genetic correlations among weights, phenotypic correlations between adjacent weights were higher. The correlations tended to decrease as the time interval separating the observed weights increased.

In the case of genetic correlations between growth rates and weights, and among growth rates themselves, the phenotypic correlations ranged from low and negative to high and positive values (-0.17 to 0.98). The fact that there exists a

negative (although low) correlation between pre-weaning growth rate and growth rate in the intervals weaning to six months and six to nine months (-0.16 and -0.06, respectively), may indicate that a faster pre-weaning growth rate because of substantial milk available tended to be followed by slower post-weaning growth rate. It seems logical to suggest, in general, that the low negative correlations which appear in some growth periods such as between weaning to six months and nine to twelve months (-0.08), and six to nine months and nine to 12 months (-0.16), are consequences of compensatory growth and not antagonistic as such. There was, as would be expected, a consistent positive phenotypic correlation between overall growth rate and all other growth rates of the lamb before yearling indicating common environmental effects.

Conclusion

From the results of this study, it is concluded that selection for weight and weight gain would best be based on post-weaning traits though the generation interval is likely to be slightly longer. Positive correlated response should be expected in other correlated traits due to the generally large and positive genetic correlations. Preliminary selection could also be conducted during the pre-weaning period since Inyangala (1989) reported favourable repeatability estimates for birth weight, pre-weaning growth rate and weaning weight. However, the high maternal influence on pre-weaning must not be ignored as it tends to mask the true genetic merit in the lambs.

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Milk yield of Cameroon Dwarf Blackbelly sheep

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Abstract

Milk yield of Cameroon Dwarf Blackbelly sheep was estimated by the indirect method of weighing lambs before and after sucking during a period of 12 weeks. Twenty-two lactations were evaluated between February and December 1985.

Average daily milk yield ranged from 0.31 to 0.50 kg for ewes suckling single lambs. Maximum weekly milk yield (3.52 kg) was attained during the 4th week of lactation after which production declined. Differences in milk yield between ewes and weeks of lactation were highly significant ($P < 0.01$). Milk yield per lactation was positively correlated with the age of the ewe at the beginning of lactation.

Production laitière de moutons Djallonké au Cameroun

R.M. Njwe et Y. Manjeli

Résumé

La méthode de la double pesée d'agneaux (avant et après la tétée) a été utilisée pour déterminer la production laitière de brebis Djallonké à ventre noir camerounaises. Vingt deux lactations de 12 semaines de durée ont été estimées entre février et décembre 1985.

La production journalière moyenne fut comprise entre 0,31 et 0,50 kg pour des brebis allaitant un seul agneau. La semaine de production maximale fut la 4e après la mise-bas (3,52 kg); la production a ensuite décliné. La production laitière a varié de manière significative ($P < 0,01$) d'une brebis à l'autre et d'une semaine de lactation à l'autre. La production totale par lactation est positivement corrélée avec l'âge des brebis au début de la lactation.

Introduction

Sheep are generally not milked in Cameroon. However, it has been established that milk production has direct effect on weight gain by lambs. Barnicoat *et al* (1956) reported a positive correlation between growth rate of New Zealand Romney lambs (between 0 and 12 weeks) and fat content, and total milk consumption with correlation coefficients of 0.72 and 0.61, respectively. Milk production during lactation is an important factor affecting maternal ability in sheep. Estimates of milk production by Cameroon Dwarf Blackbelly sheep do not exist. The present study focused on estimating daily and total milk production during the lactation period of Cameroon Dwarf Blackbelly sheep; establishing the lactation curve; and investigating the relationship between age of animal at the commencement of lactation and total milk production during the lactation period of 12 weeks.

Materials and Methods

Animals

The sheep used for the study are popularly called Blackbelly sheep as a result of the distinct black abdomen and dominant brown colour on all other parts of the body. They are a strain of the West African Dwarf sheep found along the Atlantic coast from Senegal to Angola. This sheep is a hair type with a thin tail. It measures 55 to 65 cm at the withers. The head is small with a straight profile. The ears are small and droop a little. Males have short spiral horns. In general, females are hornless but sometimes they have spurs. The hair is short and quite smooth but is sometimes rough. Adult males weigh 25–35 kg while adult females weigh 20–25 kg. Birthweight ranges from 1.5 to 2.0 kg. Average age at first lambing is 534 days while the lambing interval is 228 days. The sex ratio is about 49 per cent male and 51 per cent female. Prolificity has been estimated at 107 per cent while fertility and fecundity rates are 113 and 121 per cent, respectively. This sheep is thought to be the ancestor of the Barbados Blackbelly sheep (Epstein, 1971). It is found in the forest region of Cameroon, Gabon, Congo and Zaire (FAO, 1979). Mason (unpublished data) reported that 10.5 per cent of sheep in the Central and South Provinces of Cameroon were the Blackbelly sheep.

The sheep had been collected from the East and South Provinces of Cameroon in 1980 and maintained at the University Farm at Nkolbisson near Yaounde until 1984 after which in December 1984 they were transferred to Dschang on the high plateau (with an altitude of 1450 metres, annual rainfall of 2200 mm and average temperature of 20–22°C).

Feeding of lactating sheep

The experimental period was between February and August 1985. Lactating sheep were fed cut fresh *Pennisetum purpureum* daily with concentrate supplement. The composition of the supplement is presented in Table 1. Enough forage was provided to each lactating ewe such that a residue of about 20 per cent was always left. Each animal received 200 grams of concentrate supplement which was served at 08.00 hours everyday.

Table 1. *Composition of concentrate and Pennisetum purpureum fed to lactating Cameroon Blackbelly sheep.*

	Concentrate*	<i>Pennisetum purpureum</i> **
Dry matter	88.05	25.60
Crude protein	19.36	10.59
Crude fibre	10.38	28.70
Ether extracts	4.80	2.40
Nitrogen-free extracts	54.87	49.96
Ash	10.59	8.35

* 100 kg concentrate composed of 50 kg maize, 30 kg wheat bran, 18.5 kg soybean and 1 kg bicalcium phosphate and 0.5 kg salt.

** Mean composition of *P. purpureum* samples for entire experimental period.

Assessment of milk production

The assessment of milk production started after the first three days of lactation to enable lambs suckled colostrum. Lambs were kept separated from ewes and only brought together at periods of suckling. Milk production of the ewes was estimated by the indirect method of weighing lambs before and after suckling using a sensitive balance. Estimates were carried out on alternate days up to weaning at 12 weeks. During the first four weeks lambs were allowed to suckle at 2-hour intervals between 8 a.m. and 6 p.m. Between the 5th and 12th week of lactation, four sucklings at 3-hour intervals between 8 a.m. and 5 p.m. were allowed. Milk production data collected for four days of the week were extrapolated for the week of seven days.

Weekly milk production was assessed for 22 ewes during lactation periods of 12 weeks. The data were subjected to analysis of variance using the randomised complete block design where week of lactation represents treatments and each ewe was a replicate. Total milk production of ewes was correlated with age to determine the relationship between them.

Results

Weekly milk production by Cameroon Dwarf Blackbelly sheep are presented in Table 2. From parturition there was an increase of milk production from 2.95 kg per week to a peak of 3.52 kg at four weeks and thereafter a gradual decline to 2.10 kg at 12 weeks of lactation.

Table 2. *Mean weekly milk production by Cameroon Blackbelly sheep.*

Lactation week	Total milk production (kg)	Number of observations	Average milk production (kg)
1	64.91	22	2.95
2	73.67	22	3.35
3	76.95	22	3.50
4	77.46	22	3.52
5	70.68	22	3.21
6	65.07	22	2.96
7	64.44	22	2.93
8	62.97	22	2.86
9	58.31	22	2.65
10	55.42	22	2.52
11	48.89	22	2.22
12	46.25	22	2.10

Average milk production per lactating ewe is indicated in Table 3. Total milk production per lactation ranged from 28 to 42 kg, corresponding to 0.33 to 0.50 kg per day.

Age at the time of parturition (days) was positively correlated with total milk production (kg) and the correlation coefficient of 0.71 was significant ($P < 0.05$). The regression equation describing the relationship was as follows:

$$Y = 21.497 + 0.021x \text{ (} r = 0.71 \text{)}$$

where Y = milk production per lactation (kg)

X = age of ewe at parturition (days).

Table 3. *Milk production by Cameroon Dwarf Blackbelly sheep during the first three months of lactation.*

Animal number	Age of animals (days)	Total milk production (kg)	Average daily production (kg)
1	na	27.79	0.33
2	na	32.40	0.39
3	528	26.00	0.31
4	707	36.81	0.44
5	844	42.15	0.50
6	na	34.03	0.41
7	na	35.00	0.42
8	597	37.59	0.45
9	na	37.06	0.44
10	na	39.59	0.48
11	628	37.06	0.44
12	na	39.59	0.48
13	na	37.18	0.44
14	847	31.27	0.43
15	435	34.21	0.41
16	635	33.33	0.40
17	na	34.21	0.41
18	na	30.63	0.36
19	na	31.47	0.37
20	na	37.12	0.44
21	758	36.33	0.43
22	877	40.18	0.48

na = not available.

Discussion

Maximum daily milk production was attained by the Cameroon Dwarf Blackbelly sheep at the 4th week for lactation. This implies a more gradual increase of milk production to attain a peak when compared to some breeds for sheep that do so more rapidly and earlier. Coombe et al (1960) reported that milk output reached a peak at 10–20 days; while Ricordeau and Denamur (1962) reported that Prealpes sheep attained milk production peak at 25 days.

The daily peak milk production of 0.50 kg obtained with Cameroon Dwarf Blackbelly sheep is low when compared to 1.25 litres per day with Prealpes sheep (Ricordeau and Denamur, 1962). Spedding (1963) has indicated that peak milk yield in sheep varies with breeds. Bonsma (1929) reported peak daily milk

production in Merino sheep of 0.77 kg while Owen (1957) indicated a value of 2.23 kg.

The yield of 28–42 kg of milk by Cameroon Dwarf Blackbelly sheep during a lactation period of 96 days is low when compared to 48 and 53 kg by Ossimi and Rahmani sheep, respectively (Sharafeldin and Mostageer, 1961), for a lactation period of 84 days and 100–150 kg by Awassi sheep for a period of 160 days (Koseoglu and Aytug, 1961).

The positive relationship between age and milk production obtained in the present study with Blackbelly sheep agrees with reports by Gruer (1959) that total milk production per lactation by Precoce, Stara, Zagora and Plovdiv sheep increased upto six to seven years before declining. However, the oldest ewe used in the investigation of the age/lactation total milk relationship had not attained three years.

The evaluation of milk production needs to be extended to other local breeds for which we do not have any information at the moment.

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Session 6

**Small ruminant development
in Africa: implication for research**

**Développement de l'élevage
ovin-caprin en Afrique:
conséquences pour la recherche**

Research highlights from the Small Ruminant Collaborative Research Support Program: The Dual-Purpose Goat (DPG)

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Summary

The Small Ruminant Collaborative Research Support Program (SR-CRSP) in Kenya is engaged in a multidisciplinary research programme with a farming-system perspective. Its overall objective is to carry out research on dual-purpose goat production systems, to enhance production of food protein through meat and milk, and to improve cash flow through sale of goats and products in small-scale intensive farming systems. Research highlights are presented on feed production, preservation and utilisation, goat production and management, development and performance testing of a composite dual-purpose goat breed, immunoprophylaxis and diagnosis of contagious caprine pleuropneumonia (CCPP), heartwater and helminthiasis. The economy of raising dual-purpose goats, their acceptability and the utilisation of their products by farmers in western Kenya are also highlighted.

La recherche au Small Ruminant Collaborative Research Support Program du Kenya: la chèvre à aptitudes mixtes lait/viande

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Résumé

Le Small Ruminant Collaborative Research Support Program du Kenya (SR-CRSP) est un programme de recherches

pluridisciplinaires dont les travaux sont essentiellement axés sur l'étude des systèmes de production. Son mandat consiste à effectuer des recherches sur les systèmes d'élevage caprin en vue de promouvoir la production de lait et de viande et partant d'augmenter le niveau d'alimentation protéique des petits éleveurs tout en accroissant le revenu monétaire de ces systèmes de production intensifs sur de petites exploitations grâce à la vente d'animaux sur pied, de viande et de lait. Les principaux résultats obtenus sont présentés, qui concernent notamment la production, la conservation et l'utilisation des aliments du bétail, la conduite des troupeaux caprins, la mise au point d'une race composite de caprins destinée à la production de lait et de viande et l'évaluation de ses performances ainsi que l'immunoprophylaxie et le diagnostic de la péripneumonie contagieuse des caprins, de l'hydropéricardite et des helminthiases. Il aborde également les aspects économiques de ce type d'élevage, l'accueil qui lui est fait par les paysans de l'ouest du Kenya ainsi que l'utilisation qu'ils font des produits ainsi obtenus.

Introduction

The twofold objectives of the Small Ruminant Collaborative Research Support Program (SR-CRSP) in Kenya are: (1) to carry out research on dual-purpose goat (DPGs) to develop production systems which would contribute to increased production of food protein through milk and meat and improved cash flow through marketable goats and goat products in small-scale intensive farming systems of Kenya, and (2) to provide training which would enhance the long-term capability for research and development with goats in Kenya and in other tropical countries. With this approach, it has been necessary to characterise existing farming systems to determine how DPG component can be introduced and sustained in western Kenya production systems. The research problem, therefore, has been to develop an animal of appropriate genotype, a health-nutrition-management package appropriate to the small farm resource base, and to ensure the component is economically and sociologically acceptable. Towards these goals a holistic and multidisciplinary approach has been taken by SR-CRSP, Kenya. Research, therefore, has been conducted on-station and on-farm in testing and evaluating the technical feasibility of DPGs including their management and nutrition, as well as their economic viability and social acceptability. On-farm research is conducted on 150 small-scale farms in Siaya, Kisumu and Kakamega districts. What follows are research highlights from on-farm and on-station trials conducted by SR-CRSP, Kenya.

Results and Discussion

Constraints

Following farming system characterisation, constraints were identified that would affect successful introduction and management of DPGs. They are appropriate genotype, shortage of pastures due to land pressure for production of staple and cash crops, diseases and lack of husbandry and production performance measures of DPGs. These constraints are not unique to western Kenya, but are found in many other areas with mixed farming practices. The approach undertaken to resolve them can be extrapolated in other areas. The following research efforts have been undertaken to resolve the above constraints.

Appropriate genotype

As no indigenous nor exotic breed fits the dual-purpose goat production characteristics ideal for Kenya, a new breed is necessary. Towards this goal indigenous goat breeds were evaluated for dairy potential and then strains and individuals from within a breed were selected for breeding with proven exotic dairy breeds. A composite dual-purpose goat was planned from a synthesis of two local goat breeds, the Galla (G) and the East African Goat (EA) and two exotic breeds, the Toggenburg (T) and Anglo Nubian (N). The breeding plan for evolving a composite dual-purpose goat breed is justified in performance as shown in Table 1, whereby F1's and four-way crosses outperform the Galla and East African Goat in milk production.

Table 1. *Daily milk yield least squares means $\pm$ SE (g)*.*

Breed type **	Mean	SE
East African Goat	88.9	207.9
Galla	542.4	143.2
F1's	709.0	98.4
4-way crosses	1077.8	153.0

* After Mwando et al (1990).

** F1's and 4-ways-pooled.

Feed shortage

Following on-farm determinations of dry-matter intake, it is clear that the most limiting nutritional factor is quantity rather than quality of available forages. This claim is substantiated in Table 2 which shows crude-protein (CP) content and dry-matter digestibility (DMD) of dietary component are above average, while dry-matter intake (DMI) is below average for a pregnant or lactating doe.

Table 2. Mean nutritive values of the diet of dual-purpose goats in western Kenya.

	DM %	CP%	DMD%	DMI kg	%BWT	ME
N	36	36	36	36	36	36
Mean	28	16	55	0.7	2.4	1.8
SD	12	3	6.5	0.3	0.8	0.6

Due to high population densities, up to 900 people per sq km in some areas in western Kenya, sub-division of farms has substantially reduced pasture and fallow lands rendering reduction in cattle population (Russo et al, 1983). Lack of adequate pasture has led to intensive management methods such as tethering and stall-feeding. In response to this challenge SR-CRSP scientists are solving the problem through integration of DPG with crop agriculture. This is achieved through dual-purpose crops, crop residues and by growing fodders and legume trees in alley cropping or soil conservation practices. Table 3 gives an indication of the quality of some of the forages derived from dual-purpose crops and crop residues.

In testing the hypothesis that integration of DPG with crop production would result in adequate production of forage for goats, a model farm was established at Maseno. The farm is 0.5 ha in size and is designed to produce enough major food crops for the farmer's needs as well as feeds for four goats or one adult cow. Food crops (maize, beans and sweet potato) one adult cow. Food crops (maize, beans and sweet potato) are planted on 60% of the land, while forages, Napier grass, two species of *Leucaena*, *Sesbania* and *Calliandra*, that are planted both as borders and alleys took 40% of the land. In one year this farm produced food crops and forage as shown in Table 4. Four DPGs were exclusively fed from the model farm forages for the whole year with large surpluses realised every month.

Diseases

The main goat diseases in western Kenya and in Kenya at large are contagious caprine pleuropneumonia (CCPP), heartwater and haemonchosis. SR-CRSP has had success in these diseases in vaccine and diagnostic kit development.

Contagious caprine pleuropneumonia

In an endeavour to evaluate the inactivated and lyophilised CCPP vaccine developed by SR-CRSP and Kenya Agricultural Research Institute (KARI) scientists, 50 goats were immunised with a single dose of vaccine and 50 others

Table 3. Chemical composition and digestibility values (mean $\pm$ SE) of forages derived from dual-purpose crops and crop residues in western Kenya.

Forage	CP %	NDF %	ADF %	ADL %	IDMD %
Sugar-cane tops	7.4 $\pm$ 3.1 (12)	73.1 $\pm$ 8.7 (10)	37.5 $\pm$ 9.6 (10)	3.7 $\pm$ 1.9 (10)	42.6 $\pm$ 5.2 (10)
Maize stover	5.4 $\pm$ 2.7 (401)	69.9 $\pm$ 10.1 (52)	37.6 $\pm$ 9.1 (49)	12.1 $\pm$ 2.0 (43)	55.3 $\pm$ 7.4 (31)
Maize thinnings	20.7 $\pm$ 4.5 (151)	—	—	—	63.5 $\pm$ 6.9 (15)
Maize fresh leaves	13.5 $\pm$ 5.1 (92)	72.8 $\pm$ 13.1 (21)	35.4 $\pm$ 16.6 (18)	14.4 $\pm$ 12.6 (16)	59.0 $\pm$ 8.0 (10)
Finger millet (stover)	7.4 $\pm$ 2.4 (21)	71.7 $\pm$ 4.7 (9)	47.3 $\pm$ 4.5 (9)	10.0 $\pm$ 3.0 (9)	50.8 $\pm$ 6.4 (13)
Sorghum stover (serena)	12.6 $\pm$ 1.8 (9)	69.2 $\pm$ 4.2 (6)	43.7 $\pm$ 5.4 (6)	22.8 $\pm$ 2.3 (6)	50.3 (1)
Cassava fresh leaves	17.6 $\pm$ 2.7 (10)	39.2 $\pm$ 3.9 (29)	29.6 $\pm$ 6.6 (29)	—	—
Rice stover	4.1 $\pm$ 1.1 (5)	—	—	—	40.7 $\pm$ 8.2 (3)
Sweet potato vines	17.9 $\pm$ 3.2 (100)	51.5 $\pm$ 9.6 (22)	34.3 $\pm$ 4.0 (21)	18.5 $\pm$ 6.5 (19)	62.6 $\pm$ 9.8 (15)
Bean haulms	7.2 $\pm$ 2.5 (100)	42.3 $\pm$ 6.5	25.8 $\pm$ 8.0 (19)	12.9 $\pm$ 5.2 (13)	54.7 $\pm$ 7.7 (20)
Pigeon pea fresh leaves	25.1 $\pm$ 1.9 (30)	56.5 $\pm$ 7.3 (23)	— (3)	—	63.8 $\pm$ 2.7

Note: () Number of samples analysed, — analysis not done.

Table 4. Food and forage output from a model farm on-station*.

Size	1/2 ha.
Food crops	Maize beans and sweet potato. Area taken 60%
Forage	Napier grass
Food production	1908 kg or 21 (90 kg) bags of maize 50 kg dry beans 273 kg sweet potato tubers
Forage production	26 kg DM – fresh maize thinnings 505 kg DM – fresh maize leaves 5286 kg DM – sun-dried maize stover 53 kg DM – bean haulms 2526 kg DM – fresh Napier grass 1303 kg DM – fresh forage – <i>Leucaena</i> 80 kg DM – fresh sweet potato vines

* Two cropping seasons per year.

were left as unimmunised controls. All the goats were left on the same farm for two months and then moved to Kabete Veterinary Laboratory farm for challenge. The two groups were mixed and allowed to graze during the day and at night they were housed with five goats with experimental challenge of CCPP. During the first two weeks after movement of the goats to Kabete, 12 vaccinates and 14 unimmunised goats died of diarrhoea. None of these goats had evidence of CCPP infection. Of the remaining 38 vaccinated goats, two became infected with CCPP and had a fever for two days. None of the 38 vaccinated died. At the end of the experiment (four months later), all 38 goats were euthanised and examined for lesions and organisms. Only the two with fever had mild adhesion of the cardiac lung lobes to the thoracic wall and no F38 organisms were isolated from any of the 38 vaccinated goats. In contrast, 30 of the 36 unimmunised goats developed fever and 27 died of CCPP. The three unimmunised goats that developed fever and survival had adhesions of the cardiac and apical lobes of the lungs to the thoracic wall. The six control goats without clinical signs did not have lesions or detectable organisms at the end of the experiment.

In summary, 75% of the unimmunised goats died when challenged by contact with CCPP-infected goats and none of the vaccinated goats died.

Heartwater

Heartwater is a severe infection of goats, sheep and cattle caused by rickettsia (*Cowdria ruminantium*). In goats, the disease causes a very high mortality and can be devastating in susceptible populations. Transmission is by ticks, primarily *Amblyomma variegatum*, which are widely distributed in Kenya. Currently, diagnosis is made by post-mortem examination of brain tissue. A more convenient method of diagnosis is needed as well as a method of prevention.

A published method was used to grow *C. ruminantium* *in vitro* in bovine endothelial cells. Establishment of the tissue culture system at Kabete made available a renewable source of organisms. Larger quantities of organisms provided Deoxyribonucleic Acid (DNA), protein and infectious organisms for a variety of studies and represents an important advance in our research program on heartwater.

Endothelial cells were infected with Kiswani isolate of heartwater, made in Kenya. DNA purified from *C. ruminantium* organisms isolated from infected endothelial cells was used to make genomic library. Size-fractionated fragments were ligated into p^{uc19} and used to transform *Escherichia coli*. Two cloned genes were identified that were from the heartwater organism and one of the genes p^{cr9}, a 744 base pair (bp) fragment has been characterised as DNA probe. Cloned *C. ruminantium* gene was isolated from plasmids, labelled with biotin and the specificity evaluated. The 744 bp insert from the recombinant plasmid p^{cr9} hybridised to *C. ruminantium*-infected endothelial cell DNA. The 744 bp insert

DNA probe did not hybridise to DNAs from uninfected endothelial cells, leukocytes, *Babesia bigemina*, *Mycoplasma* sp F38 *Anaplasma marginale*, *A. ovis*, *A. centrale*, *Chlamydia psittacci*, *Chlamydia trachomatis*, *Ehrlichia risticii* and 11 other bacteria. The 744 bp p^{cr} DNA probe detected *C. ruminantium* in *Amblyomma variegatum* ticks fed on *C. ruminantium* -infected goats but not in ticks fed on uninfected goats. Tick infection with *C. ruminantium* was confirmed by transmission of heartwater to uninfected goats either by feeding of nymphs fed as larva on infected goats or by subinoculation of tick gut homogenates. The p^{cr} insert DNA probe detected *C. ruminantium* in midguts of *A. variegatum* nymphs infected as larvae and in midguts of *A. variegatum* adult ticks infected as nymphs but not in midguts from control nymphs and adults. Nucleic acid sequence of this p^{cr} insert DNA was determined for eventual development of oligonucleotide primers for use in polymerase chain reactions in order to increase sensitivity of assays using the DNA probe.

Haemonchosis

Research on haemonchosis focused on the identification of genetically resistant or tolerant goats as one long-term solution to control this important internal parasite. This research emphasis is based on the findings that several expensive treatments per year are required to prevent clinical disease and associated production losses. The assumption that genetically resistant or tolerant goats can be identified is based on the identification of a resistance trait in sheep and on our work that indicated susceptibility differences occurred among breeds of goats.

Natural *Haemonchus contortus* infection of 300 kids was evaluated from two months to one year of age. Faecal samples were collected from the rectum and parasite eggs per gram of faeces determined. During the observation period, some kids had very low or no eggs while others had high egg counts. To extend the observation of differences among individuals to natural infection, two groups of goats were selected for further study. Group A contained 11 goats which had a mean egg count of 201 ± 200 . The two groups were confined in pens, cleared of worm infection using Ivermectin and challenged with 500 *H. contortus* larvae per kg bodyweight. Faecal samples were collected once a week for eight weeks and eggs per gram determined. Group A goats had significantly ($P < 0.05$) lower eggs per gram (mean 726 ± 213) than group B (mean 1643 ± 463). Also, individual goats in both groups had low numbers of eggs indicating resistance to the challenge infection. Some animals in group B had very high infection rates indicating that individual differences may be greater than group differences. This study emphasises the importance of experimental challenge to assess genetic resistance of goats to *H. contortus* and that individual differences in susceptibility occur among goats. Further studies are in progress to define more clearly the occurrence and basis for differences in susceptibility.

On-farm evaluation

As the name implies, on-farm evaluation calls for the researcher to take measurements on-farm and for interaction with the farmer, on the subject of the technology or intervention with regard to its biological and socio-economic aspects. In looking at the biological aspect, the on-farm performance of DPGs was compared with on-station over a period of two years. Results of the comparison are given in Table 5. Judging by these results, it is evident that the on-station DPGs are out-performing their counterparts on-farm. Causes leading to these differences give guidance for further investigations and trials. For example, the kidding rate on-station is 98% as opposed to 65% due to managerial rather than biological problems. Farmers are not fully conversant with heat detection and buck availability is limited to a few farms. This is not a researchable problem but one that requires education and more bucks.

Table 5. *Comparison of on-station with on-farm performance of dual-purpose goats in western Kenya.*

Variable	On-station	On-farm
Number of does	200	150
Doe survival	95	80
Kidding (%)	98	65
Kid survival (%)	90	85
Kid weight at the age of one year	20	18
Milk offtake (kg)	120	60
Average doe weight (kg)	38	35
Productivity/doe/year (kg)	27	11
Productivity/metabolic body weight/year (kg)	1.8	0.8

What is the verdict of farmers collaborating in SR-CRSP on-farm research? So far, research findings indicate that SR-CRSP DPG technology packages (techpacks) have been most enthusiastically taken up in the relatively high altitude (1630 m), high rainfall (1800 mm) (Onim et al, 1986), and high population density (700–1000 per km²; Kenya, Republic, 1979) clusters of Muhanda and Hamisi. Conversely, the techpacks have been least enthusiastically taken up in the relatively low altitude (1300 m), low rainfall (1100 mm), and low population density (200–400 per km²) clusters of Masumbi and Lela. For example, both Muhanda and Hamisi have consistently maintained a high proportion of their participating farmers growing all the recommended forages as well as, on average, the highest number of forage trees and a substantial area devoted to production of Napier grass and sweet potato vines (Table 6). Masumbi cluster, and to a certain extent Lela cluster lag behind on both counts.

Table 6. Average number of *Leucaena* and *Sesbania* trees; and area under Napier grass and sweet potato vines (SPV) per household and the proportion of households growing them.

Cluster	Leucaena		Sesbania		SPV		Napier	
	# trees	% households	# trees	% households	m ²	m ²	m ²	% households
Hamisi	22.2	81	56.4	74	195.3	98	231.6	94
Masumbi	18.4	37	27.8	25	54.6	39	74.9	60
Muhanda	51.4	98	55.9	99	238.4	98	153.2	96
Rabour	22.8	90	49.4	28	198.3	97	81.3	89
Lela	27.7	84	46.9	43	380.9	76	685.8	77

Similarly, both Muhanda and Hamisi clusters are noted to be most consistent in feeding the cultivated forages to the DPGs. By contrast, Masumbi farmers merely feed their DPGs with cuttings from growing on shrubs fallow land while Lela farmers prefer to "open graze" their DPGs rather than feed them with large amounts of cultivated forages in the cluster (Table 7).

Table 7. *Proportion of participating farmers doing "cut-and-carry" or "open-grazing" (%).*

Cluster	N	Cut-and-carry	Open-grazing
Hamisi	21	70	10
Masumbi	14	54	16
Muhanda	34	100	0
Rabuor	27	69	24
Lela	10	46	73

Linear programming (LP), a procedure for determining efficient resource allocation which uses mathematical procedures consistent with economic concepts to determine optimal farm plans, showed the following based on the results from Table 7, with regards to DPG enterprise (Nyaribo, 1989):

- Dairy production generated higher net returns than food crop production. This makes sense since milk and meat are both high (cash) value commodities.
- The DPG's market potential is very good and can easily out-compete the local zebu cattle.
- As we move from the medium to the large farm, there is a modest 7 per cent increase in livestock sales, but a significant 31 per cent increase in net farm income. This means that with additional factors of production (capital, land and management) farmers can increase their incomes significantly through livestock sales.

It is interesting to note that there were no livestock sales in the small Hamisi farms (0.69 ha) of which only 0.59 ha was cultivable land while the LP model production is at variance with actual observed practices since it does imply that the smallest farms in the area keep livestock under non-optimal conditions for risk aversion reasons and other reasons not related to profitability. In fact, the small farms have been observed to be more attracted to the DPGs and its techpacks than larger farms that are more in commodity agriculture. It is anticipated, with increased production level of the DPGs and particularly, with milk production of over one kg per doe/day, the larger farms are likely to capitalise on it as they are currently doing with cash crops.

Despite these trends, on-farm research results indicate that DPGs contribute positively towards nutritional and economic welfare of participating farmers in western Kenya. From an average of two does a small supply of milk has been produced and used as a nutritious or medicinal drink, in making tea, and vegetable and fish sauces. Culled does and some of their followers have been slaughtered for home consumption, while others have been sold for cash to meet essential needs, for example, paying school or medical fees, buying clothes and farm inputs. In addition, DPG manure has increased productivity of crop land resulting in higher yields of maize and other crops.

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Programme de développement de l'élevage des petits ruminants au Togo: essai de mise au point des possibilités d'association de la production vivrière et de l'élevage ovin

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Résumé

Afin de contribuer à la satisfaction de la demande en viande, le Togo a instauré un Projet national petits ruminants dont les trois volets sont présentés: l'encadrement du secteur traditionnel, la création d'élevages semi-intensifs, et le développement du centre d'appui de Kolokopé. Les recherches menées par le projet visent à l'intégration de l'agriculture vivrière et de l'élevage ovin- caprin : valeur alimentaire des sous-produits de cultures, qualité des savanes, utilisation du fumier.

Small ruminant development programme in Togo: Effort to integrate crop and sheep production

I.Y. Pessinaba

Abstract

A national small ruminant development project has been set up in Togo with the aim of increasing meat production. It has three components: extension activities within the traditional farming systems; creation of semi-intensive production units; and development of the supporting centre of Kolokope. Research carried out focuses on the integration of small ruminants production with arable, in particular on the feeding value of agricultural by-products, savannah quality and manure utilisation.

Introduction

Bien que l'élevage occupe au Togo par rapport à l'agriculture une place modeste dans l'économie nationale, son développement constitue une des conditions nécessaires pour atteindre l'objectif que s'est fixé le pays depuis une vingtaine d'années: l'autosuffisance alimentaire. Dans ce cadre, un Projet national petits ruminants a été mis en place au Togo, dont nous présenterons ici les principales activités.

Malgré les tentatives et efforts de développement de l'élevage des ovins et caprins, force est de constater que les paysans ont du mal à associer cette activité aux cultures vivrières. Nos recherches sont donc axées sur l'étude des éventuels avantages mutuels entre la culture vivrière et l'élevage des petits ruminants au niveau du paysan-éleveur et de définir dans quelles mesures nous pourrions les valoriser davantage. Une synthèse de ces résultats est présentée en deuxième partie.

Programme de développement de l'élevage des petits ruminants au Togo

Pour atteindre les objectifs lui étant assignés, réduire le déficit en viande du Togo et augmenter les revenus paysans, le Projet national petits ruminants (PNPR) comprend trois volets: celui de l'encadrement du secteur traditionnel, celui de la création et du suivi des élevages semi-intensifs, et le Centre d'appui technique de Kolokopé.

Encadrement

L'encadrement du secteur traditionnel vise à l'amélioration des pratiques de l'élevage traditionnel dans les domaines de l'alimentation, de l'habitat et de l'hygiène, ainsi qu'à la protection sanitaire contre la peste des petits ruminants et le charbon bactérien (vaccination), et d'autre part contre les parasitoses gastro-intestinales et les ectoparasites (déparasitages).

Les actions entreprises au niveau du secteur traditionnel sont reprises auprès des élevages semi-intensifs et intensifs avec un suivi plus marqué auxquelles s'ajoutent celles de l'amélioration génétique.

Les actions d'encadrement et de suivi (sanitaire et zootechnique) touchent 1220 élevages villageois répartis dans les régions maritimes, des plateaux, centrales et des savanes, qui comportent des troupeaux de 10 à 20 têtes; et 250 élevages semi-intensifs répartis dans les mêmes régions économiques du pays et comportant des troupeaux de 25 à 200 têtes.

Les campagnes de vaccination et de déparasitage ont permis une baisse moyenne du taux de mortalité de 25% à 8%, alors que les actions d'amélioration de l'alimentation, de l'habitat, de l'hygiène et de la reproduction ont permis d'enregistrer une amélioration du taux de productivité, qui est passé de 81% à 134%.

Dans le nouveau programme, ces actions seront poursuivies en considérant trois niveaux d'encadrement:

Niveau 1: encadrement sanitaire du secteur traditionnel. Il correspond à la protection sanitaire du cheptel promue par des campagnes de sensibilisation (radio, affiches), à la vaccination et au déparasitage, ainsi qu'à un conseil zootechnique élémentaire (castration, habitat, complémentation minérale).

Niveau 2: encadrement zootechnique du secteur traditionnel. Il vise à accroître la rentabilité des élevages pratiquant déjà les actions du niveau 1. Il les renforce et ajoute les thèmes de l'amélioration, de l'habitat (parcs et abris traditionnels) et de l'alimentation (pâturages, complémentation et supplémentation, mangeoire, etc.).

Niveau 3: établissement de fermes ovines améliorées (FOA). Il vise la poursuite de l'implantation et du développement des élevages semi-intensifs qui sont sélectionnés après une période de test dans le niveau 2 d'encadrement. Les cultures fourragères sont introduites et un système de prêts mis en place: prêt d'installation (construction et équipement de bergeries) remboursable en espèces en quatre ans, crédit de fonctionnement (aliments, médicaments sur douze mois) remboursable en espèce en dix-huit mois (8% d'intérêt annuel), et prêt d'animaux reproducteurs retournables en animaux après un différé de deux ans.

Le Centre d'appui technique du Kolokopé

L'effectif actuel du Centre est d'environ 2 000 têtes réparties comme suit: 5 troupeaux totalisant 760 brebis reproductrices; 1 troupeau de 40 géniteurs mâles confirmés; 4 troupeaux constitués de jeunes mâles et femelles en croissance.

Le Centre d'appui technique de Kolokopé s'est vu assigné comme objectifs la production et la sélection des géniteurs améliorés et leur diffusion dans les élevages encadrés, ainsi que l'exécution de programmes de recherche appliquée pour préparer les thèmes à vulgariser.

La sélection des animaux améliorateurs est basée essentiellement sur la vitesse de croissance des jeunes mâles et sur la conformation des jeunes femelles. Les mâles sont livrés pour la reproduction à l'âge de 12 mois avec un poids de 26 à 27 kg, tandis que les femelles sont mises à la reproduction à l'âge de 8 mois, avec un poids de 14 à 15 kg. Le programme de sélection permet de livrer annuellement:

- 300 à 400 agnelles, 30 à 50 béliers reproducteurs dans les élevages; et
- 400 à 500 têtes à la boucherie (animaux non retenus pour l'élevage ou à réformer).

Les thèmes de recherche appliquée, au niveau du Centre d'appui de Kolokopé sont les suivants:

- expérimentation de plusieurs types de gestion de troupeaux: lutte continue, lutte organisée avec "rattrapage", lutte organisée synchronisation de l'oestrus, etc.;
- insémination artificielle, avec l'assistance de la FAO: 264 brebis du Centre ont été inséminées à l'aide de semences récoltées sur des béliers de grande valeur du Centre de sélection ovine de Bouaké. 70% des inséminations furent fécondantes, et 22 agneaux mâles ont été sélectionnés pour la reproduction;
- expérimentation des programmes de lutte contre les tiques en faisant varier le rythme de baignades et en utilisant des produits nouveaux (étude faite en collaboration avec l'école des sciences de l'Université du Bénin, Lomé;
- mise en place de programme d'essais en collaboration avec le CIPEA sur la complémentation alimentaire d'agneaux avec *Leucaena* et pois d'Angole (*Cajanus cajan*), et sur la capacité de production fourragère de *Leucaena* et pois d'Angole en fonction de la densité du semis et de l'âge des plants.

Etude des possibilités d'association entre la production vivrière et l'élevage ovin

Les investigations ont concerné l'évaluation de la production et la détermination de l'appétibilité et de l'ingestibilité des résidus et les sous-produits agricoles (paille, sons, fanes et épluchures de tubercules) disponibles au niveau du paysan; les fourrages des pâturages naturels et artificiels (parcelles de *Panicum maximum* C1 et T58) ainsi que la constitution et l'analyse du fumier ramassé dans les parcs (bergeries).

Ces travaux se sont déroulés au Centre d'appui technique de Kolokopé du Projet (Centre de sélection et de recherche d'accompagnement) et chez les paysans-éleveurs au niveau du secteur amélioré encadré par le Projet.

Matériel et méthodes

Le disponible en sous-produits agricoles est évalué en pesant la paille de riz récoltée sur des carrés choisis au hasard dans un champ et les fanes d'arachide sèches stockées, les sons de céréales et les épluchures de manioc disponibles (après séchage). La matière verte et la matière sèche des prélèvements de

fourrages opérés dans les pâturages naturels du Centre de Kolokopé ont été déterminées.

Leur appétibilité est évaluée par la rapidité avec laquelle les animaux entament le sous-produit servi; le taux d'ingestion est déterminé par le rapport de la quantité de sous-produit ingérée et du poids vif total des animaux.

Les crottes de mouton sont récupérées par balayage des parcs (deux fois dans la semaine) et pesées après passage au tamis. La production est évaluée en fonction des modes de conduite des lots d'animaux constitués:

- pâture (8 h par jour) et stabulation (16 h environ) d'un troupeau de brebis et d'agneaux, avec complémentation (graines de coton) et supplémentation minérale (pierre à lécher);
- stabulation permanente d'un troupeau mixte et d'un troupeau de jeunes mâles en croissance (fourrage vert, foin, graines de coton et pierres à lécher).

Après précompostage des crottes mises en tas pendant 14 jours, quatre traitements ont été réalisés pour le fumier: en tas sous abri, en tas couvert, en fosse sous abri, et en fosse non couverte. Des échantillons ont été prélevés un et deux mois après la date de la confection du fumier, à des profondeurs différentes (20 cm, 50 cm, 80 cm) en vue de doser les différents éléments fertilisants après détermination de la matière sèche: N (méthode Kjeldahl), C (méthode Anne), P_2O_5 (par calorimétrie), K_2O (par photométrie de flamme), CaO et MgO (par spectrométrie d'absorption atomique).

Présentation et discussion des résultats

Sous-produits de cultures

Le disponible en paille de riz (tableau 1) est le double de la production de grain (respectivement 961 g/m² et 514 g/m², moyenne de 9 échantillons). La paille de riz bien séchée, très riche en matières minérales, peut être conservée et servie comme aliment de lest chez les moutons. Actuellement exploitée dans ce sens par les paysans du nord du Togo, elle est rarement, sinon jamais, utilisée par ceux du sud du pays.

Tableau 1. *Production et ingestion de panicules vides de sorgho*

Superficie récoltée	Sorgho paniculé	Panicules vides	Consommation	Refus	Taux d'ingestion
20 m ²	1 000 g	250 g	95 g	155 g	38%

Le tableau 1 montre que le taux de production de panicules vides de sorgho est de 25%. En considérant un rendement moyen de 500 kg à l'hectare de sorgho paniculé en culture associée (contre 850 kg à 1 tonne en culture pure de sorgho), le disponible est de 125 kg/ha de panicules vides. Le taux d'ingestion est de 38% pour des moutons habitués; ce taux, faible, peut être augmenté en abandonnant délibérément quelques grains de sorgho sur les panicules vides.

En dépit de son faible taux de production au niveau artisanal (19%), le son sec de maïs, de par sa richesse en MPD (80 g/kg de MS) et sa valeur énergétique (0,85 UF/kg de MS), constitue un bon complément dans l'alimentation des ovins.

Le tableau 2 permet d'évaluer la production d'épluchures sèches de manioc à 2 400 kg par hectare. Malgré leur taux de production faible (8,70%), les épluchures sèches de manioc sont très utilisées par les paysans-éleveurs dans la complémentation alimentaire de leurs animaux. Les tests sur l'ingestibilité de ces épluchures sèches montrent un taux de consommation de 80% prouvant ainsi la bonne aptibilité de ce sous-produit.

Tableau 2. Production artisanale d'épluchures de manioc

Superficie	Racines fraîches	Epluchures fraîches	Epluchures sèches	Taux d'épluchures fraîches	Production d'épluchures sèches
20 m ²	55 200 kg	14 500 kg	4 800 kg	26%	8,70%

Un hectare d'arachide produit 675 kg de fanes, dont le taux de consommation est d'environ 90%. La conservation et l'utilisation de ces fanes d'arachide séchées sont des pratiques courantes dans la complémentation alimentaire des ovins.

Disponibilité fourragère

Sur les différents types de pâturages au Centre de Kolokopé (naturels, naturels entretenus, et naturels améliorés), deux séries de coupes espacées de 60 jours ont été réalisées et ont donné les résultats illustrés dans le tableau 3.

Le pâturage naturel entretenu correspond à l'apport de fumier de ferme après réduction de l'effectif des espèces semi-ligneuses et ligneuses. Il s'agit de la pratique actuellement vulgarisée auprès des paysans-éleveurs. Le pâturage naturel amélioré correspond à un labour suivi d'un enrichissement de la flore avec d'autres espèces (*Panicum maximum*). Il n'est pas encore de pratique

courante au niveau du paysan-éleveur, car il nécessite du matériel qui n'est pas encore à sa portée.

Tableau 3. *Production de fourrages pour ovins*

Pâturage	Espèce	% de MS		Production (kg de MS/ha)
		1 ^{re} coupe	2 ^e coupe	
Naturel	Graminées locales (1)	44,62	32,40	6 120,40
Naturel entretenu	Graminées locales	42,66	31,17	7 198,82
Naturel amélioré	Graminées locales + <i>Panicum maximum</i>	33,73	28,01	5377,70

(1) Espèces recensées:

Hyparrhenia diplandra

Hyparrhenia sinuthiana

Hyparrhenia chrysargyrea

Cymbopogon gigantes

Sorghum arundinaceum

Panicum maximum

Setaria glabra

Hyperthelia dissoluta

Imperata cylindrica

Production de crottes et de fumier de mouton

En ce qui concerne la disponibilité en crottes de mouton, on constate (tableaux 4 et 5) que la quantité de crottes produites augmente avec celle de la matière sèche ingérée et que le temps de parcage conditionne positivement la disponibilité des crottes dans le parc.

Tableau 4. Aliments ingérés par les troupeaux stabulés et taux d'ingestion

Type de troupeau	Troupeau mixte stabulé		Troupeau de jeunes mâles stabulés	
	Quantité distribuée (kg)	Taux d'ingestion	Quantité distribuée (kg)	Taux d'ingestion
Graines de coton	42	65%	58,650	65%
Foin	30,800	31%	46,450	44%
Fourrage vert	162,600	44%	147,050	42%
Complément minéral	1,100	11%	0,550	5,5%

Tableau 5. Production de crottes en fonction du mode de conduite du troupeau

Mode de conduite	Production de crottes			
	Total 32 jours	1 kg* vif/j	1 kg* vif/an	25 kg* vif/an
Pâturage et stabulation d'un troupeau mixte	48,750	12	4,380	105,500
Stabulation permanente d'un troupeau mixte	59,550	15	5,415	136,875
Stabulation permanente de mâles en croissance	66,700	18	6,570	164,250

* Production de crottes ramenée à 1 kg et à 25 kg poids vif.

Tableau 6. Composition des crottes et du fumier de mouton après deux mois de compostage (avec un foin de graminées avarié) prélevé à 50 cm de profondeur

	MS%	Composition minérale (en % de MS)						
		C	MO	N	P ₂ O ₅	K ₂ O	CaO	MgO
Type de crottes	Crottes fraîches du jour	48,04	32,0	2,576	1,334	0,864	1,176	0,696
	Crottes pré-compostées	50,60	22,5	1,708	1,334	0,864	1,176	0,696
Fumier	Tas non couvert	80,66	11,0	18,9	0,79	0,792	1,260	0,730
	Tas sous abri	68,62	27,0	46,5	2,10	2,784	2,576	1,426
	Fosse non couverte	40,75	26,0	44,82	2,240	1,152	2,576	1,426
	Fosse sous abri	37,13	33,0	56,8	2,688	1,776	3,418	1,492

La stabulation permanente au niveau du paysan influe cependant négativement les productions de l'élevage (perte de poids, avortements éventuels, poids faibles des agneaux à la naissance, etc.) car le paysan-éleveur ne maîtrise pas encore les contraintes de cette technique de stabulation permanente. En conséquence, les conseils prodigués au paysan-éleveur portent sur le mode de conduite sur les parcours avec un temps de pâture assez long (8 h environ par jour) suivi d'un repos au parc.

La composition minérale des crottes fraîches et précompostées (tableau 6) montre que les taux des différents éléments fertilisants se révèlent identiques à l'exception de ceux du carbone et de l'azote.

Le tableau 6, qui résume aussi les analyses des différents types de fumier, permet de recommander la préparation du fumier sous abri (en tas ou en fosse) de préférence au fumier non couvert, car il fournit ainsi une meilleure concentration en éléments.

La constitution d'un fumier excrément permet de profiter de la proportion, même faible, des éléments fertilisants des crottes de mouton, et fait actuellement l'objet de vulgarisation.

Conclusion

Ce programme de développement de l'élevage des ovins et caprins suivi de recherche d'accompagnement vise l'amélioration du secteur traditionnel de cet élevage.

L'étude a permis d'une part de dégager la disponibilité des résidus et sous-produits agricoles et leur utilisation, d'autre part d'apporter des améliorations dans l'association agriculture-élevage ovin en vue de mieux implanter l'agropastoralisme au stade paysannal.

La mise à la disposition des paysans-éleveurs des animaux reproducteurs sélectionnés, la maîtrise des thèmes de vulgarisation par ceux-ci et enfin l'association de l'élevage à l'agriculture (exploitation des jachères pour pâturages, conservation et utilisation des résidus et sous-produits agricoles pour l'alimentation des animaux, bonne utilisation du fumier de mouton pour la fertilisation des champs, etc.) constituent une des solutions pour la réalisation de l'équilibre entre productions végétale et animale.

Recherche et développement des caprins et ovins au Burundi

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Résumé

La pression démographique sur le foncier dans les hautes terres de l'Afrique de l'Est donne au petit élevage un potentiel croissant dans des systèmes intégrant agriculture et production animale. Le Département de zootechnie de la faculté d'agronomie de l'Université du Burundi est chargé de la coordination du réseau national petits ruminants et a constitué le Centre de recherche universitaire sur le petit élevage. Ce Centre gère la station zootechnique de Maramvya et deux programmes de recherche en exploitation: Le PIPRA (Programme intégration petits ruminants agriculture) dans la commune de Mutaho, et des essais d'association de l'élevage ovin au reboisement et aux palmeraies.

Small ruminant research and development in Burundi

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Abstract

The high population density in the East African highlands encourages small ruminant production in integrated crop-livestock production systems.

This paper reports on research activities in Burundi on integrating sheep production with reafforestation and palm-tree plantation systems. These studies focus on improving forage resources, animal health and flock management.

Introduction

Dans les régions densément peuplées des hautes terres, l'élevage bovin perd régulièrement du terrain. Une politique de reboisement ambitieuse essaie de limiter les effets de l'érosion mais empiète systématiquement sur les parcours communautaires de faible valeur bromatologique.

L'effectif de chèvres et moutons semble augmenter parallèlement du déclin du gros bétail. Cependant, les systèmes de production traditionnels restent peu performants et le taux d'exploitation ne s'élève que très faiblement. Deux types de solutions sont à l'étude pour accélérer l'intensification de la production du petit bétail: l'intégration de l'élevage des petits ruminants à l'agriculture et l'association de l'élevage ovin aux reboisements et à l'élaiculture.

Projet intégration petits ruminants agriculture (PIPRA)

Les recherches poursuivies depuis 1986 ont porté essentiellement sur les possibilités d'intégrer l'élevage des petits ruminants à l'agriculture dans une des régions naturelles les plus densément peuplées du pays (Nord-Kirimiro-commune de Mutaho). L'enquête zoo-économique préalablement menée sur 60 exploitations agricoles a fait ressortir certaines caractéristiques:

- réduction extrême de la superficie cultivable des exploitations;
- agriculture intensive avec jachères de durée très courte, limitées le plus souvent à quelques ares en 1^{re} saison;
- effectifs animaux faibles, l'espèce bovine est en voie de régression;
- intérêt identique pour la chèvre et le mouton, sans préférence caractérisée.

En 1987, six exploitations-pilotes, associant l'élevage caprin à l'agriculture suivant un contrat-type, ont été installées et encadrées. Un certain nombre de contraintes ont pu être identifiées; difficultés d'installation de certaines cultures fourragères, soit par manque de semences, soit par utilisation d'une technique non appropriée; réceptivité laborieuse des exploitants à certaines techniques semi-intensives; effectifs restreints de reproducteurs du centre de Murongwe ne permet pas de satisfaire les souhaits de tous les demandeurs.

L'expérience acquise au cours des quatre dernières années dans l'installation et l'encadrement de 21 exploitations conduit à formuler un certain nombre d'observations:

- 1.1. Le projet a un succès certain; le nombre de volontaires dépasse largement les possibilités en intrants animaux et fourragers. Et les préférences sont aujourd'hui orientées vers le mouton.

1.2. Les conditions requises des éleveurs pour leur accorder un prêt de 5 reproductrices sont au départ correctement remplies. Par la suite, diverses difficultés surgissent:

1.2.1. Les cultures fourragères ne sont pas exploitées rationnellement. La supplémentation est épisodique. La récolte du fourrage n'est pas pratiquée en temps voulu.

D'autre part, plusieurs de ces cultures fourragères peuvent être utilisées à d'autres fins qu'à l'alimentation des animaux. Il en résulte évidemment que les performances des animaux s'en ressentent.

La diffusion, chaque année, de nouvelles boutures/graines de cultures fourragères et l'introduction du *creep-feeding* chez les éleveurs devraient pouvoir améliorer la productivité de ce système d'élevage.

1.2.2. Les aliments non conventionnels disponibles dans le rugo ne sont pas utilisés rationnellement.

Dans cette optique, il a été expérimenté avec succès une supplémentation avec une adventice de bonne valeur alimentaire: *Acanthus* sp. qui envahit les jachères, les fossés et les talus. Les éleveurs hésitent cependant à l'utiliser, parce qu'elle est difficile à récolter et que les épines dont elle est recouverte, favoriseraient l'apparition de l'echtyma contagieux. Les noyaux d'avocats ont donné d'excellents résultats mais leur récolte est saisonnière.

1.3. Les prévisions de projection de troupeaux se confirment. Au bout de deux années, l'objectif des 10 UZPR est atteint et les remboursements sont généralement terminés. Malheureusement, les éleveurs ont alors tendance à vendre trop rapidement leurs animaux, y compris les bonnes reproductrices. Il craignent en effet la malveillance de leurs voisins et pensent se mettre à l'abri de cette dernière par une commercialisation hâtive.

1.4. Intégration petits ruminants/agriculture: elle n'est pas réelle à l'heure actuelle. On parlera plutôt d'une association entre une composante agricole et une composante élevage. Cependant, en 1987-1988, une approche systématique des contraintes a été réalisée et son analyse devrait permettre de proposer des solutions rationnelles et satisfaisantes.

1.5. Méthodologie

1.5.1. Afin d'augmenter les possibilités d'approvisionnement en intrants animaux et fourragers:

- 1.5.1.1. Développement des troupeaux caprin et ovin de multiplication à Murongwe afin de pouvoir satisfaire les besoins des éleveurs locaux. L'effectif moyen de 50 UZPR devrait être atteint dans les deux troupeaux. Ceci devrait permettre d'approvisionner 15 à 20 éleveurs nouveaux par an.

Tous les paramètres classiques continuent à être collectés et interprétés, afin de les comparer utilement à ceux obtenus dans les rugos.

Les faibles superficies de parcours à Murongwe sont encore réduites par le débordement régulier de la Mubarazi en saison des pluies. L'effectif actuel de 83 reproductrices semble difficile à dépasser et même à maintenir. Toutefois, diverses améliorations pourraient être trouvées en intégrant davantage les petits ruminants aux parcours et ressources fourragères des taurillons élevés à Murongwe pour la production de fumier. Au cas où ces améliorations ne pourraient être obtenues, le développement de la Station de Maramvya permettra à l'avenir de produire les géniteurs nécessaires. La Station de Murongwe servira alors de Centre de transit et de quarantaine, avant la diffusion aux éleveurs.

- 1.5.1.2. Installation de centres de Saillie. En effet, afin de contrôler efficacement l'amélioration génétique du troupeau de la commune, les saillies se font exclusivement avec les mâles sélectionnées de la Station.

Les jeunes mâles, produits en Station ou dans les rugos encadrés, sont:

- soit castrés et mis à l'embouche,
- soit retenus pour la reproduction aux centres de saillie, selon les performances enregistrées sous la mère. Ils sont ensuite confirmés par test de descendance. Deux centres de saillie sont installés à Murongwe et Gitongo.

- 1.5.1.3. Les éclats de souche de *Setaria*, *Tripsacum*, *Pennisetum*, plants de *Leucaena* et semences d'avoine sont nécessaires.

Actuellement, 50 000 éclats de souche de *Setaria*, et 50 kgs de semences d'avoine sont distribués annuellement aux exploitants. Les graines de *Leucaena divesifolia* sont fournies de telle sorte que chaque exploitant puisse établir en saison sèche une pépinière de 2 000 plants. Les ressources en

éclats de souche de *Tripsacum* et de *Pennisetum* sont suffisantes chez les exploitants eux-mêmes pour leur permettre d'étendre leurs cultures.

1.5.2. La multiplication des exploitations petits ruminants devrait aboutir à moyen terme, à leur regroupement au sein d'une coopérative, dont la Station de Murongwe représentera le support logistique, destiné à fournir les intrants animaux et végétaux, et assurer l'encadrement vétérinaire et zootechnique.

1.5.3. Intégration petits ruminants/agriculture. Un accent tout particulier est porté:

1.5.3.1. aux problèmes de fertilisation. La diffusion de fumières améliorées devrait permettre de produire un abondant fumier de qualité si, toutefois, une litière suffisante est apportée.

Dans un premier temps ce fumier de petits ruminants est expérimenté sur le haricot cultivé en marais et sur colline. Dans un second temps les expérimentations s'étendraient sur d'autres cultures.

1.5.3.2. La faible croissance des plants de *Leucaena* chez les exploitants devrait être corrigée par l'inoculation des graines.

1.5.3.3. L'utilisation des aliments non conventionnels sera de plus en plus généralisée après qu'un bilan fourrager aussi précis que possible soit affecté au sein de chaque exploitation.

Sylvo-pastoralisme

Les opérations portent essentiellement sur l'élevage ovin et concernent deux secteurs: les reboisements et les palmeraies.

Reboisement

L'association entre élevage ovin et reboisement, entreprise à RUGAZI en 1981-1982 avec le concours de la CCE a été interrompue faute de financement. Elle a été reconduite à Vyanda, sur des reboisements à *Pinus Eliotii* grâce à la collaboration du Département des forêts et à un financement conjoint FAC/Banque mondiale. Elle est poursuivie, depuis 1987 à Ryarusera sur des boisements à *eucalyptus*.

Les programmes mis en place qui tendent essentiellement à mettre au point les systèmes de gestion les plus appropriés et les plus complémentaires des deux composantes, sont à long terme et devront se poursuivre.

Les troupeaux reproducteurs installés sont à l'heure actuelle en pleine évolution et aucun problème ne se pose quant à l'écoulement des agneaux produits.

Il est à noter que c'est le troupeau de Ryarusera qui fournit le plus de géniteurs.

Palmeraies

Un programme identique est prévu pour les palmeraies de l'IMBO-SUD, qui présentent l'avantage supplémentaire d'un excellent fourrage représenté par la plante de couverture, à savoir *Pueraria phaseloïdes*, abondante pendant les premières années de la plantation.

La station zootechnique de Maramvya

Depuis sa création la Station Zootechnique de la FACAGRO possède un projet petits ruminants.

La capacité d'accueil est actuellement de 150 reproductrices pour chaque espèce et l'on compte plus de 600 ovins et caprins à la Station de Maramvya.

Les recherches actuelles ou à venir portent sur:

- la caractérisation et la connaissance des races locales: toutes les données concernant la croissance et la reproduction, sont collectées et sont exploitées afin de sélectionner les meilleurs reproducteurs. Ceux-ci sont entre autre diffusés au niveau des projets comportant un volet développement des petits ruminants.
- l'alimentation: des études dans ce domaine ont porté sur le comportement des animaux au pâturage, la digestibilité du *Leucaena leucocephala*, du *Panicum maximum* et du *Pennisetum purpureum* et la paille de riz. Divers niveaux de complémentation à base de son riz sont testés sur les mères allaitantes et les jeunes non sevrés.
- la reproduction: des recherches plus fondamentales sont menées afin d'établir des profils hormonaux et de les mettre en relation avec les caractéristiques de reproduction de nos races locales.
- pathologie: un bilan des maladies des petits ruminants permet d'établir les taux de mortalité et de morbidité et d'instituer des programmes prophylactiques adéquats.
- un encadrement des éleveurs de la commune vient d'être lancé afin de collecter des données d'exploitation et d'assurer un suivi sanitaire rigoureux.

Le programme national de sélection ovine (PNSO) de Côte d'Ivoire: mise en place du contrôle de performances en ferme

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Résumé

En 1983–1984, a été créé le Programme national de sélection ovine (PNSO) dont l'objectif principal est d'améliorer, par la voie de sélection en race pure, le format du mouton d'origine locale: le Djallonké. Pour ce faire il a été mis en place une base de sélection où des contrôles de performances sont effectués, qui conduisent à présélectionner dans les élevages, les agneaux sur le critère de leur poids à 80 jours. Ces agneaux deviennent, après une autre sélection (en station), les béliers sélectionnés que le projet diffuse ensuite dans et hors de la base de sélection.

Cette base de sélection mise en place progressivement compte aujourd'hui 10 500 brebis réparties dans 100 élevages disséminés sur tout le territoire ivoirien. Par an, ce sont 400 à 500 agneaux présélectionnés que le PNSO achète aux éleveurs adhérents à ce système de contrôle des performances zootechniques des animaux.

Une meilleure intégration financière et technique des actions de sélection dans les activités des projets d'encadrement de la SODEPRA (Société de développement des productions animales) devrait permettre de résoudre les problèmes que rencontre le PNSO.

The national sheep selection programme (PNSO) in Côte d'Ivoire: Establishment of on-farm performance evaluation

A. Oya

Abstract

The objective of the National Sheep Selection Programme (PNSO) introduced in 1983–1984 was to improve the body conformation of the local West African Dwarf sheep through selection within the breed. To achieve this, it established a nuclear flock on which initial selection is performed on-farm, based on performance evaluation, with lambs being selected on their weight at 80 days old. Following further selection on-station, rams are distributed within the nuclear flock and to other flocks.

The nuclear flock now consists of some 10 500 ewes in 100 flocks throughout Côte d'Ivoire. Each year, PNSO purchases between 400 and 500 preselected lambs from breeders participating in this livestock performance evaluation system.

Further financial and technical integration of the selection activities into the development projects of SODEPRA (Livestock Production Development Society) should solve the problems currently encountered by PNSO.

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