Unconventional livestock: Classification and potential uses

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Summary

ALTHOUGH *unconventional livestock species are reservoirs of valuable genetic resources, and many have traditionally been used as sources of animal protein, fiber, transport and draught power, very little has been done to develop their commercial exploitation. This paper attempts to classify unconventional livestock according to their size, ecological affinity and economic importance. It also discusses their use in systems with limited production resources, their complementarily with conventional livestock and the potential of multipurpose species for specialised production of products vital for the sustenance of the human population.*

Introduction

More than 60 animal species contribute to man's daily needs of food, shelter and energy. Of this diverse genetic resource only the domestic species of cattle, sheep, goats, pigs and poultry play an important role in livestock production throughout the world. The reasons for this may be due to the evolution of human culture and the changing attitudes of hominids to animals, man's migratory movements, the availability of natural resources for animal husbandry and, last but not least, the presence of socio-economic factors favouring improvement of particular breeds in particular ecological zones.

Breed development is closely correlated with economic development, such that performance specialisation, market demands and the need for more controlled and intensive production have encouraged the widespread use of a few genetically improved species of the so-called conventional livestock. However, because of climatic and ecological diversity, as well as the different levels of economic development in various parts of the world, there is a large number of other animal species which are potentially suitable for domestication and commercial production. These animals are regarded by the developed world as ‘unconventional’.

The importance of unconventional animal species for livestock development, and their role in improving the diet of the very poor, have only recently been widely recognised. A considerable amount of information on unconventional livestock has been collected by the National Research Council of the USA (see also Mason, 1984) and many universities are incorporating the study of unconventional animals in their animal science programmes. In addition, some development agencies are advocating the exploitation of the production reserves of unconventional livestock to improve human nutrition in developing countries.

Commercial exploitation of unconventional livestock is justified on the following grounds: firstly, unconventional livestock are adapted to harsh environments and can utilise natural resources that conventional stock cannot. They are thus suitable for complementary production with conventional species, which will enable stratified utilisation of vegetation. Secondly, integrating them into modified or intensified production systems will enable more efficient recycling of nutrients in the ecological chain. Thirdly, many of the smaller unconventional animals are easy to feed, manage and handle, and can therefore be raised by landless and smallholder farmers within the household (Vietmeyer,1984; Pich and Peters, 1985).

Despite their now generally recognised usefulness, there is as yet no exhaustive record available of unconventional livestock species. In his recent review of the evolution of domesticated animals, Mason (1984) refers to 56 animal species in 31 families for which the term 'unconventional' is appropriate, but even his list is not comprehensive. This paper attempts to classify unconventional livestock species according to their ecological and economic importance. In addition, the factors determining husbandry of unconventional livestock are defined.

Classification of unconventional livestock

Table 1 shows the ecological distribution of economically promising unconventional livestock species. The species with wide ecological distribution (e.g. rabbit, guinea pig, guinea fowl, turkey, duck, pigeon, bee and silkworm) appear to be capable of adapting to a range of ecological conditions[1]. They are often small, which may confirm the belief that the smaller the animal, the better chance it has to survive in areas where forage is limited.

[1] These animals were studied by Costa (1978); FAO (1981); Lebas (1981); GTZ (1985); Müller-Heye (1984); Mongin and Plouzean (1984); Ayeni (1983); TüVer (1978); Wriessnig (1979); Crawford (1984); Clayton (1984a,b); Hetzel (1981); Wai-Ching Sin (1979); Hawes (1984); Drescher and Crane (1982); FAO (1976,1978,1979).

The second group of unconventional livestock distinguished on the basis of distribution are those adapted to specific ecological conditions, the so-called 'ecological niche' animals. This group includes the camel, llama, alpaca, yak, banteng, water buffalo, eland, oryx, deer and such small animals as capybara, cane cutter, snails, frogs and reptiles[2].

[2] See Mason (1984); Mukasa-Mugerwa (1981); Novoa and Wheeler (1984); Femandez-Bata (1975); Hofmann et al (1983); Bonnemaire (1984); Epstein (1974); Rollinson (1984); Cockrill (1974; 1984); Ughtfoot (1977); Fletcher (1984).

Table 1. *World ecological distribution of unconventional livestock species potentially suitable for economic exploitation.*

Species	Distribution by zone						
	Continental	Temperate	Arid	Semi-arid	Sub-humid	Humid	Tropical highland
Bactrian camel	—						
Dromedary			—	—			
Llama							—
Alpaca							—
Guanako		—					—
Yak	—						
Banteng						—	
Water buffalo				—	—	—	
Eland					—	—	
Oryx			—	—	—		
Reindeer	—						
Other deer	—	—					
Rabbit	- - —	—	- -	—	—	— - -	—
Capybara					—	—	
Guinea pig		—		—	—	—	—
Cane cutter					—	—	
Guinea fowl	—	—	—	—	—	—	
Turkey		—		—	—		—
Duck		—		—	—	—	—
Pigeon		—	- -	—	—	—	—
Honey bees							
Apis mellifera	—	—	- -	—	—	—	—
A. cerana					—	—	—
A. dorsata					—	—	
Mulberry silkworm	—	—			—		—
Non-mulberry silkworm					—	—	
Snails							
Helix pomatia	—	—					
Achatina					—	—	
Archachatina					—	—	
Edible frogs		- -			—	—	
Crocodilians				- -	—	—	
Turtles					—	—	

Another useful classifying factor with respect to the role of unconventional animals in agricultural development is body size. Large animals can utilise feed resources under harsh eco-climatic conditions, while many small animals subsist on household scraps and can therefore be reared on small farms or within the household.

Finally, using both classifying factors, unconventional livestock can be divided into three main groups:

- Animals with a large body size and high ecological affinity, which include several members of the Artiodactyla. These animals can be defined as true ‘ecological niche’ animals.
- Animals with a small body size and high ecological affinity, which include the capybara, the cane cutter, snails, frogs and reptiles, and which can be classified as animals suitable for particular ecological and economic niches.
- Animals with a small body size and low ecological affinity, such as the rabbit, guinea pig, guinea fowl, turkey, duck, pigeon, bee and silkworm, can be defined as true ‘economic niche’ animals.

Not all unconventional livestock are domesticated; some have been closely associated with man since ancient times, others have been tamed and are used to provide man's basic needs in some parts of the world, while still others have remained wild and are used only occasionally (Table 2). The three main types of utilisation are:

- Production as domesticated animals, i.e. the animals are bred under human control and have undergone selection for specific traits;
- Production of undomesticated animals whose breeding is controlled but not selective; and
- Utilisation of wildlife, with humans exercising no control over reproduction and population dynamics.

However, as Table 2 shows, some species can be used in more than one way. Attempts are being made, for example, to commercialise the production of such animals as alpaca, deer, the tropical bee and even the crocodile.

Factors determining production of unconventional livestock

The success of integrating unconventional livestock species in different production systems can be influenced by a number of biological and economic factors.

Table 2. *Utilisation of unconventional livestock in developing countries.*

	Production with		Utilisation as wildlife
	Domesticated animals	Undomesticated animals	
Bactrian camel	X		
Dromedary	X		(X)
Llama	X		
Alpaca	X ←	(X)	
Guanaco			X
Yak	X		
Banteng	X		(X)
Water buffalo	X		
Eland	(X)	(X)	X
Oryx	(X)	(X)	X
Reindeer	X	X	X
Other deer	(X) ←	X	X
Rabbit	X		
Capybara		(X) ←	X
Guinea pig	X		
Cane cutter		(X) ←	X
Guinea fowl	X	X	(X)
Turkey	X		(X)
Duck	X		(X)
Pigeon	X	X	X
Honey bee	(X) ←	X	(X)
Silkworm	X	(X)	
Schildbug		X	
African snail		(X) ←	X
Frog		X	(X)
Crocodile		X ←	(X)
Turtle		(X)	X

(X) indicates less significant type of utilization.

Large unconventional livestock

The factors favouring production of large unconventional animals are summarised in Table 3. The most important is that they are physiologically and behaviourally adapted to live in unfavourable environments. For example, the yak and the two-humped camel have an undercoat which enables them to tolerate low ambient temperatures and large variations in seasonal temperature (Epstein, 1974; Mason, 1984); the llama and alpaca have an insulating coat over the exposed body parts, which helps them to withstand large diurnal fluctuations in temperature, and a heat dissipation mechanism, which reduces the animal's heat load from solar radiation (Novoa and Wheeler, 1984; Hofmann et al, 1983); the one-humped camel, oryx and eland can live in hot and arid environments because they have efficient water conservation mechanisms, long limbs and heat-reflecting coats (Mason, 1984; Lightfoot, 1977); and some animals (e.g. the water buffalo) respond to high heat loads and humidity through behavioural adaptations (wallowing and shade seeking), while others (e.g. the banteng or its domesticated variety, the Bali cow) have developed less profuse thermoregulatory mechanisms, such as cutaneous evaporation (Cockrill,1984; Rollinson,1984).

Large unconventional animals can thrive on natural browse and forage alone. They are physiologically adapted to utilising feed resources of very poor quality, owing to the specific morphology of their stomachs and the use of rumen bacteria to break down cellulose into simpler, digestible compounds. The larger species in this group, such as the camel and the buffalo, are more efficient ruminants than the smaller ones, which are more selective in their feeding.

Table 3. *Factors determining production of large unconventional livestock.*

Adaptability and environmental tolerance
Continental montane—Bactrian camel, yak Tropical montane—Llama, alpaca, guanaco Tropical arid—dromedary, oryx, eland Tropical humid—water buffalo, banteng
Ability to utilise low-quality feed resources
Rumination
Complementary utilisation of natural vegetation
Selective feeding—bulk-and-roughage (oryx), intermediate feeders (eland), bulk roughage (buffalo) Feeding behaviour—grazing and browsing Rangeability
Wide range of products
Meat, milk, fibre, manure, draught/transport

Another factor in favour of large unconventional livestock is that, because of their different feed preferences (e.g. the camel feeds on thorny shrubs and salt bush, the oryx on sparse grasses and succulents, the eland and deer on browse, the banteng on coarse tropical grasses, and the yak on dry, coarse mountain grass), they can be husbanded in mixed herds or along with their domesticated relatives, thus enabling complementary utilisation of feed resources. In addition to being complementary in their feeding behaviour, large unconventional animals also have good rangeability, and as a result do not destroy fragile environments as quickly as conventional livestock (Lightfoot, 1977; Mason, 1984; Rollinson, 1984; Fletcher, 1984; Epstein, 1974).

Lastly, when managed properly, large game animals can be an efficient means of producing food and other products from marginal environments. Examples are meat and manure (all animals in this group); milk from camels, the yak and water buffalo; and coarse and fine fibres from camels, the camelids and the yak. In addition, camels are also used for draught (the Bactrian camel) and transport (the dromedary) in many semi-arid and arid areas. The camelids are used for transport in the inaccessible Andean regions of South America, while the yak is useful as a riding and pack animal in mountainous central Asia and the buffalo and the banteng are a source of farm power in Southeast Asia. Without doubt, multipurpose animals such as these are of great importance for sustaining economic activity in harsh environments, but their productive versatility may prove to be a constraint to their exploitation in specialised systems.

Small unconventional livestock

Table 4 shows the factors determining production of small unconventional livestock. The biological determinants include genetic adaptation to specific ecological niches, high reproductive performance, and efficient utilisation of feed resources, including seeds, insects, offal and weedy vegetation.

Table 4. *Factors determining production of small unconventional livestock.*

Specific adaptability to ecological niches
High reproductive capacity
Short generation interval Large litter size Fast juvenile growth
Efficient utilisation of nutrients
Low input for the reproduction unit
Extended utilisation of feed resources
Minute feed — pigeon, guinea fowl, duck, turkey, bee, snail Household scraps — guinea pig, rabbit Live or dead animal material — crocodile
Limited competition with humans for feedstuffs
Utilise roughages and edible byproducts of food processing
Flexible adjustment of livestock holding to available resources
Animals are small, prolific and have a fast turnover
Low production risk
Small initial investment, fast returns
Easy to market or consume at home
Can be transported alive without difficulty; provide cash or meat in small quantities

The capybara, the largest living rodent, is adapted to the hot and humid conditions of Latin America (Gonzales-Jimenez, 1977), while other microlivestock, such as birds, bees and snails, have become adapted to specific ecological niches by developing into different breeds and races (Mongin and Plouzean, 1984; Drescher and Crane, 1982; Elmslie, 1984). Small animal species are generally characterised by short generation intervals, large numbers of offspring and fast growth of young, and these are precisely the attributes that make their use particularly important in the context of smallholder farming. The high reproductive capacity of small unconventional animals reduces the proportional energy requirement of the reproductive unit, resulting in a more efficient utilisation of nutrients in the production process. Thus they can improve resource utilisation in small-scale and backyard production systems or in marginal environments.

The economic determinants for producing small unconventional livestock are associated with the biological efficiency of these animals. For example, rabbits, guinea pigs and the cane cutter can digest almost any form of edible greenstuff, ranging from coarse grasses to roughages and household scraps (GTZ, 1985; Müller-Heye, 1984; Asibey, 1974; Ewer, 1969; Pich and Peters, 1985). Apart from not competing with humans for food, these animals are easy to house and manage, and can thus be incorporated into mixed production systems to expand the available food resource base. Similarly, the freeranging ducks, pigeons and bees, and edible snails which utilise decaying material, could be used to achieve more efficient recycling of nutrients in the ecological chain (Wai-Ching Sin, 1979; Hawes, 1984; Crane, 1978; Drescher and Crane, 1982; Elmslie,1982,1984).

Commercial production of small unconventional animals is undemanding in terms of capital investment and skills needed for their husbandry. It also presents minimal economic risks. Some species (e.g. rabbits) are commonly eaten, while others (such as snails in France and grasscutters in Ghana) are in great demand as gourmet delicacies; marketing these animals can therefore provide cash in addition to valuable protein for home consumption. Last but not least, the smaller quantities of meat from small animals can be consumed at once without wastage, which is an important consideration where refrigeration is not available for storing the carcass (Vietmeyer,1984; Mensah, 1985; Pich and Peters, 1985; Lebas, 1981; Hodasi, 1984; Castillo, 1981).

Factors limiting production of unconventional livestock

The use of unconventional livestock to exploit marginal natural resources or the production capacities of small economic units is constrained by a number of problems combining socio-economic, organisational and infrastructural aspects. The most important constraints limiting the production of different categories of unconventional livestock are discussed in the following subsections.

Large domesticated animals

Table 5 summarises the specific problems limiting production of large domesticated animals.

Table 5. *Constraints limiting production of large domesticated animals.*

- Strong association with ethnic groups
- Depriving animals of their original functions, which endangers animal populations and human existence
- Insufficient information about genetic resources for specialised production systems
- Limited genetic progress, due to lack of breeding strategies, small population sizes and multipurpose production
- Lack of information on productivity in modified and intensive production systems

The selection of animals for different production and behavioural traits during the process of domestication, and the strong dependence of man on livestock for subsistence, may have contributed in large part to the close associations which exist between ethnic groups and particular animal species. These associations can be observed across ecological zones, as in the case of colonialists who prefered to import their own breeds of cattle and smallstock rather than use the local species, and within zones, where they often serve as a basis for distinguishing between related ethnic groups. Examples are the camel-owning Gabbra and the cattle-owning Borana pastoralists of East Africa.

Apart from the one-humped camel, which in many ways sustains the life of nomads in northeastern Africa and in the Near East (Gauthier-Pipers and Dagg, 1981; Mason, 1984), the yak and the camelids also have very strong associations with ethnic groups (Epstein, 1974; Fernandez-Baca,1975; Hofmann et a1,1983). For example, the llama and alpaca played a major role in the Andean culture, reaching their maximum distribution and population numbers under the Inca empire, and even now they are kept mainly by the Puna ethnic group in Peru. The yak, on the other hand, plays an important role in the life of Tibetan and Mongolian pastoral societies, providing milk, fibres, leather, meat, manure and draught power. Thus the existing ethnic barriers, which may have very strong historical, religious and economic roots, must be overcome before these animal species can be introduced successfully into other countries with comparable eco-climatic conditions.

Another serious limitation to the production of large animals with high ecological affinity can arise if they are deprived of one of their original functions. For example, the introduction of mechanised transport into some arid and semi-arid areas has reduced the importance of camels as draught, pack and riding animals in these areas, which, in turn, has resulted in declining stocks and, in extreme cases, depopulation. The buffalo met a similar fate in Southeast Asia, where the adoption of improved rice production systems in the 1960s was accompanied by an expanded use of tractors for soil cultivation. Similarly, the exploitation of camelids and the Bactrian camel for high-quality fibre is limited by the preference given in many cultures to sheep wool and by fashion trends.

Information is urgently needed about the genetic resources of large unconventional livestock for specialised production of milk (camels, yak, water buffalo), meat (camels, yak, buffalo, banteng, eland, oryx) and fibre (camels, camelids and yak). However, due to the remoteness of current production, research on these animals has not progressed beyond a few systematic genetic studies end breeding programmes initiated mainly by wildlife conservationists. Furthermore, their genetic improvement through selective breeding is severely restricted by the small, active breeding populations available. Useful genes may be lost if suitable breeding strategies are not developed soon. Studies are also needed on the productivity of large unconventional animals in improved or intensive production systems.

Small domesticated livestock

The constraints limiting production of small domesticated animals are summarised in Table 6. As with poultry, the contribution of these biologically highly efficient animals to livestock production is seriously underestimated: livestock statistics give only estimates of their populations and virtually no indication of their offtake. Being generally considered a mere adjunct to 'mainframe' livestock enterprises, production of small animals receives very little attention from researchers, development planners and politicians. Moreover, improvements in backyard production are often difficult to achieve, due to its dispersed nature and because the people who keep micro livestock can ill afford to spend cash on production inputs. As a result, the management expertise and veterinary services necessary for more efficient production of small unconventional animals are lacking.

Table 6. *Factors limiting production of small domesticated animals.*

- Underestimated importance as sources of food and income
- Low priority given in research and development
- Lack of management skills and veterinary inputs
- Limited scope for improving backyard production systems
- Scarcity of scientific expertise and funding for commercial production of economically promising species
- High labour demand of commercial production

Small-scale commercial production of bees for wax and honey; silkworm for silk; rabbits for meat and fibre; guinea pigs, pigeons, turkeys, snails and frogs for meat; ducks for eggs and down; and guinea fowl for eggs and meat requires detailed studies on the management, health, nutrition, and reproductive performance of these species under improved conditions. Existing development strategies aim at developing specialised production systems, but there is also a need to develop integrated systems in which the production of these animals will be combined with other farm enterprises.

Although small animals are advantageous in that they require low initial investments and enable fast returns on capital and efficient resource utilisation, their commercial husbandry requires high labour inputs. As a result it is limited to countries with restricted employment options.

Undomesticated livestock

Production of undomesticated animals encounters three main problems (Table 7). Most tame species have wild conspecies which are protected by wildlife legislation. While this legislation is undoubtedly important for the conservation of species which do not reproduce in captivity (e.g. turtle), it may constitute an obstacle to the economic utilisation of those animals that have been successfully bred under controlled conditions (e.g. crocodile) or those that are semidomesticated (e.g. eland, oryx and guinea fowl) (Lightfoot, 1977; Mongin and Plouzean,1984; de Vos, 1984; Schröder,1986; NRC,1983).

Table 7. *Factors limiting controlled production of undomesticated animals.*

- Legislation to protect wild conspecies imposes limitations on the economic utilization of undomesticated animals
- Higher disease tolerance; can act as natural disease reservoirs
- Lack of appropriate husbandry techniques

When developing production systems for complementary resource utilisation by species of the same order (e.g. cattle and eland; camel and oryx), the differences in their susceptibility to diseases must be taken into account. Undomesticated animals act as natural reservoirs of disease, but their role in transmitting it to conventional livestock is often exaggerated, and where transmission is possible, such as in the case of rinderpest and tick-borne diseases, it can be averted by applying some form of disease control.

Finally, we need to know more about the biological traits of small undomesticated animals (e.g. capybara, cane cutter, African snail and frogs) in order to develop husbandry techniques facilitating their efficient production in various ecological niches. A pioneering work in this respect has been done by GTZ (Gesselschaft für Technische Zusammenarbeit) which assists research and development schemes for cane cutter production and snail farming in West Africa (Mensah,1985; Pich and Peters, 1985).

Wildlife

The main prerequisite for sustained game utilisation is the availability of detailed information about population dynamics (Andreae, 1982; Bolton, 1980; Ehrenfeld, 1974). Collection of data on population size, reproduction rate, generation interval and potential offtake from game animals is technically feasible, but only at great expense. Thus lack of funds for data collection, coupled with difficulties in enforcing laws against indiscriminate hunting, are the major constraints to controlled game utilisation in developing countries. Other problems are lack of advanced management and hunting skills and suitable marketing infrastructures (Table 8).

Table 8. *Factors limiting controlled game utilisation.*

- Lack of funds to generate data on population dynamics
- Difficulties in enforcing game conservation laws
- Low product quality from traditional game utilisation systems
- Lack of improved management and hunting skills
- Lack of marketing infrastructures

Conclusions

Unconventional livestock species are valuable genetic resources which can contribute substantially to the economies of developing countries. Although many of them are used traditionally as sources of meat, fibre, transport and draught power, they have not been studied systematically and little thought has been given to improving their production. Yet their ability to utilise poor-quality feed under harsh environmental conditions and the ease with which they can be incorporated into systems with limited production resources make them highly suitable for commercial exploitation in many tropical regions.

A possible area of development is stratification of livestock production on the basis of the biological and economic advantages of conventional and unconventional animal species in order to achieve more efficient utilisation of natural resources. Integrating unconventional livestock into mixed crop–livestock production systems will improve the recycling of nutrients and expand the food chain. However, the successful use of unconventional livestock in modified production systems is subject to a thorough understanding of their biological potentials and of how they fit into these systems. This can best be achieved by intensifying multidisciplinary research.

Another pressing need is genetic improvement of large unconventional livestock species for specialised production of meat, milk, fibres and other products. With regard to micro livestock, research and development efforts should concentrate on improving nutrition, health and husbandry skills and on selecting new, more productive species. Commercial utilisation of game animals has limited prospects at present, mainly because many developing countries are unable to meet the financial commitments associated with this type of production. However, 'bushmeat' is and will continue to be an important source of animal protein for subsistence farmers in remote areas, and for this reason the contribution of wildlife to human diets needs to be recorded and evaluated.

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