Mid-Term Meeting, May 23-28, 1993
San Juan, Puerto Rico

Agenda Item 12 - Progress Report by the Livestock Strategy Working Group

Priorities and Strategies for Livestock Research in the CGIAR

Attached are a paper by TAC which presents a revised statement on priorities and strategies for livestock research in the CGIAR, and the transmittal letter from the Chairman of the Technical Advisory Committee (TAC) to the Chairman of the CGIAR.

The paper is a revision of a discussion draft which was discussed at ICW'92. In finalizing this paper, TAC took into account issues raised during those discussions, interaction with the Working Group on Livestock Research, and discussions at TAC 59 and TAC 60.

At the Mid-Term Meeting, the TAC Chairman will introduce the paper and present the main recommendations made by TAC.

Members of the Group will have the opportunity to discuss the report of the Working Group and TAC's new recommendations and decide on the action to be taken.

Attachment

Distribution

CGIAR Members
Center Board Chairmen
Center Directors
TAC Chairman
Dear Mr. Rajagopalan,

In the 1992 Review of CGIAR Priorities and Strategies, TAC deferred making recommendations on livestock research pending the completion of the Winrock Study on Animal Agriculture in sub-Saharan Africa and the External Reviews of ILCA and ILRAD. At International Centres Week 1992, TAC submitted a draft statement on Priorities and Strategies for Livestock Research in the CGIAR for discussion with stakeholders and members of the Group. TAC subsequently revised this draft statement, taking into account issues raised during these discussions, as well as at TAC 59 and TAC 60. The Committee also benefited from interactions with members of the CGIAR Working Group on Livestock Research.

TAC now puts forward for consideration by the Group the attached statement on 'Priorities and Strategies for Livestock Research in the CGIAR'. In this paper, the Committee discusses programmatic needs of CGIAR livestock research. It also considers institutional options for the organization of future livestock research in the CGIAR and makes explicit recommendations.

I hope that the attached statement will contribute to a productive discussion on livestock research issues at the CGIAR Mid-Term Meeting in Puerto Rico.

Yours sincerely,

[Signature]

Alex McCalla
TAC Chair

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THE CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE

PRIORITIES AND STRATEGIES FOR LIVESTOCK RESEARCH

IN THE CGIAR

TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

April 1993
PRIORITIES AND STRATEGIES FOR LIVESTOCK RESEARCH IN THE CGIAR

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REFERENCES
1. LIVESTOCK IN DEVELOPING COUNTRIES

Livestock are an integral component of agricultural systems and contribute to meeting human needs for food, income, employment and work-power. Animal products (milk, meat and eggs) play a significant role in human diets. Foods of animal origin are the only reliable dietary source of the essential vitamin B12 and supply an array of readily absorbable minerals, protein and other nutrients. Livestock are important in providing critical inputs to sustainable crop production (manure and draught energy), output such as animal fibre, hides and skins and, in many developing countries, short distance transport.

Livestock enhance the economic viability and sustainability of farming systems. They diversify production and management options, increase total farm production and income, promote year-round employment, and spread risk. Sales of livestock products promote funds for purchasing critically needed crop inputs and for financing farm investments, particularly for resource poor farmers. Livestock often form the major capital reserve of farming households.

Livestock play a variety of economic and social roles and contribute about 19% to the total value of production of agriculture, forestry and fisheries in developing countries. This does not include the significant contribution of livestock to national economies by way of draught energy and manure that, aggregated with product offtake, would place livestock’s contribution to overall output in the range of 25 to 30 percent.

On the other hand, livestock present some environmental and health hazards. Diseases that are communicable to humans such as brucellosis, tuberculosis, rabies and salmonellosis are widespread causes of morbidity and mortality among people of developing countries. Sprays and dips used to control livestock pests are potential pollutants, and ruminants are a major source of methane. Without careful management, livestock can damage plant life severely, particularly in the harsher environments and at the forest margins.

Livestock species of major economic importance are ruminants (cattle, sheep, goats, camels, buffaloes), equines (asses, mules, horses), and monogastric species such as poultry and pigs. There are a number of other species of local or regional importance such as llamas, yaks, deer, guinea pigs and rabbits. During 1986-88, of the global total of 1,041 million TLU, 51% were found in Asia and the Pacific, 27% in Latin America and the Caribbean, 16% in sub-Saharan Africa and 6% in West Asia/North Africa (WANA).

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1 In order to express different species of livestock in a common reference unit that reflects the large disparity in body size, livestock biomass can be aggregated in tropical livestock units (TLU). A TLU is equivalent to an animal of 250kg liveweight.
Livestock production systems are largely characteristic of the ecological and social environment in which they are found. They can be classified in three types:

- **Range-livestock production systems** are based on the use of natural vegetation, and can be purely pastoral (sedentary or nomadic), agro-pastoral or of the ranching type.

- **Landless-livestock production systems** refer to situations where livestock derive feed from roadside grazing, household refuse and/or purchased feeds.

- **Crop-livestock production systems** refer to land use patterns where crops and livestock are produced in association. They can be of two basic types: segregated or integrated systems.

The types and distribution of livestock production systems are largely dependent on the nature of land, climate and ecosystem in which they are located. These factors dictate the plant species grown, environmental stresses, and the incidence and severity of disease. Range systems are particularly important in arid and semi-arid zones, mixed crop livestock systems in the semi-arid, sub-humid and cool zones, and landless systems are usually found in the humid zones.

Productivity levels of livestock in terms of output of milk and meat are generally low. While developing countries account for nearly two thirds of the world's livestock, they only produce one third and one fifth of world meat and milk production respectively; consequently production efficiency is only about a quarter of that of developed countries. This suggests that major improvements in productivity can be achieved. Livestock productivity differs greatly among regions. Animal production is most developed in Latin America and Asia, and least developed in sub-Saharan Africa.

The demand for livestock products is driven by human population increases, demographic shifts and income growth. Past experience indicates that with increased urbanization and improved incomes, dietary patterns will shift to increased consumption of meat, milk and eggs. The population of developing countries is expected to increase from 4.2 billion in 1990 to 7.1 billion in 2025. For the developing world as a whole, population growth will amount to 1.9% p.a., ranging from 3.1% in sub-Saharan Africa to 1.4% in East Asia. Urbanization is increasing rapidly. Between 1990 and 2025, the proportion of population living in cities is projected to increase from 29 to 54% in sub-Saharan Africa, from 57 to 75% in WANA, from 32 to 57% in Asia and from 70 to 83% in Latin America and the Caribbean.

Per caput incomes in developing countries are projected to increase by about 3.5% p.a. during the next decade. The fluid geopolitical situation makes such projections tenuous and only minor growth is expected in sub-Saharan Africa. The expected growth of population and incomes would, however, result in a rapid increase in global demand for livestock products.

Domestic production of meat and milk is projected to grow rapidly, but not to keep pace with demand. All regions are major importers of milk and WANA and
sub-Saharan Africa also import meat. Imports, therefore, are likely to continue at near current levels.

By 2025, poultry and pigs are expected to provide a much larger proportion of meat produced in developing countries because of finite limits on land to produce forages for ruminants. This shift will require expanded production of coarse grains and protein feeds, as well as other biomass feeds for poultry and pig diets.

2. CONSTRAINTS TO INCREASED LIVESTOCK PRODUCTION

2.1 Technical constraints

2.1.1 Feed supply

Inability to feed animals adequately throughout the year is the most important and widespread technical constraint for livestock producers in developing countries, except in those areas where livestock production is almost excluded, because of prevalence of diseases. In arid and semi-arid areas, the quantity of forages in the dry season is usually insufficient. In wetter regions, the nutritive value of pastures and forages is low. In cool areas, plant growth is limited by low temperatures. In all areas and regions, feed shortages and deficiencies are more acute in the dry season. For poultry and pigs, expanded production is hampered by the lack of a reliable and economical supply of concentrate feeds and feed supplements.

2.1.2 Animal health

Animal diseases are also a major constraint to livestock production in developing countries. They cause mortality, reduce productivity and constrain trade. Epidemic diseases such as rinderpest, swine fever, African swine fever, Newcastle disease, and ‘peste de petits ruminants’ seriously inhibit livestock development in parts of Africa and Asia. Some diseases are endemic to specific regions, such as trypanosomiasis and its vector the tsetse-tsetse fly to sub-Saharan Africa. Non-tsetse transmitted trypanosomiasis also exists and can be of importance in Latin America, Asia and West Asia/North Africa. Tick-transmitted hematoprotozoan infections are particularly predominant in sub-Saharan Africa and parts of Asia. Diseases of the newborn, specific nutritional deficiencies and reproductive disorders are important constraints to production in all developing countries. However, the greatest economic losses due to disease result from internal and external parasites in all livestock species. The impact of these prevalent diseases is most severe when animals are also poorly fed.

2.1.3 Genotype

In developing countries, indigenous animal genotypes impose limits on productivity in terms of output of milk and meat that can be achieved in the areas of higher potential and from the application of new production technologies. Introduced breeds of higher production potential are usually poorly adapted to tropical climates. In contrast, many indigenous breeds have special adaptive traits for disease resistance, heat
tolerance and ability to utilize poor quality feed or to survive with irregular supplies of feed and water. This genetic resource is often at risk due to the use of imported stock in breed substitution and cross-breeding programmes in which the importance of genotype x environment interactions is not adequately considered. Few indigenous breeds have been researched adequately, in terms of the potential to exploit this inherent genetic variation. Conservation and enhancement of indigenous animal germplasm is therefore an important activity.

2.1.4 Livestock management

Prevailing livestock management practices both contribute to and detract from the productivity of livestock. Recent research on the productivity of traditional pastoral systems has shown that, in some traditional systems, livestock are managed efficiently. However, many traditional practices and systems need to be modified to realise increased output and, as appropriate, to move towards higher levels of intensification.

2.2 Agroecological constraints

Ecological factors that constrain livestock production are land (topography and soil fertility), and climate (rainfall, temperature and seasonality). The root cause of feed constraints in the arid zones is of human origin, i.e. overstocking and mismanagement of grazing land and encroachment of cropping into grazing lands which are not suitable for arable farming. In the semi-arid areas, land degradation also occurs as use of marginal land shifts from grazing to cultivation. The major constraint is insufficient feed to maintain productivity all the year round as well as declining soil fertility. In the sub-humid zones major biophysical constraints limit an increase in livestock productivity. Soils are usually acid and deficient in nitrogen, phosphorus, calcium and sulphur and some trace elements. Forages are of low quality because of high lignocellulose content during most of the year due to the rapid growth rate, particularly in the tropics. Disease and pest problems of ruminants are much more serious than in the drier and highland zones, particularly in sub-Saharan Africa where trypanosomiasis and tick-borne diseases assume major importance. Disease problems in Latin America and Asia are fewer in number and pose less of a threat to livestock production. Humid zones are sometimes vulnerable to severe and irreversible degradation. Constraints found in the sub-humid zones are accentuated in the humid zones. Disease and pest problems are intensive and widespread, soils are fragile and often infertile, and forages tend to be of low nutritive value.

The highland zones have the highest density of both human and livestock populations and are more intensively farmed. Because of the continuing intensification of systems, the sustainability of crop and livestock production is at risk in many of these areas. Where forests and other vegetative cover have been removed from erodible lands severe land degradation has often followed. Crop-livestock interactions are particularly important. As little land area is available for expansion, additional production must come from increased crop and livestock productivity. The highlands of sub-Saharan Africa and Latin America have substantial potential for further livestock development. In many instances, infrastructure is inadequate to provide needed inputs for more intensified
agriculture and will need to be improved to enable realization of the potential for
development of the highlands.

2.3 Policy, socioeconomic and institutional constraints

Macroeconomic and agricultural government policies often have very unfavourable
effects upon the livestock sector. These include over-valued exchange rates, distorted
markets due to dumping practices, price controls, inefficiencies of parastatal enterprises,
quantitative controls on trade, restricted movement of animals, controlled pricing of
products with uncontrolled pricing of inputs, centralization of authority on the use of
natural resources by local communities, high rates of inflation and excessive government
involvement in breeding and health programmes. In many countries, excessive
government regulations and unfair competition from the public sector have hampered
private sector development, especially in product processing and trade. Subsidized
governmental programmes and the lack of entrepreneurial incentives have slowed the
privatization of services to producers. In sub-Saharan Africa, present land tenure systems
constrain the investments needed to intensify animal production, particularly in crop-
livestock systems. In pastoral systems, government policies and controls have limited the
opportunities for productivity improvement in these systems.

There are also strong socioeconomic constraints to improving livestock
productivity in developing countries. In many smallholder mixed farming systems, one of
the principal constraints on the development of increased product offake (meat and milk)
is the importance given by the farmers to the intermediate outputs of livestock, viz.,
draught power, manure, security, investment, wealth and prestige. The productivity of
livestock in these intermediate roles is usually more related to animal numbers than output
per animal. This has resulted in overstocking and overgrazing, reduction in productivity
in terms of animal output of meat and milk, and poor design of many livestock
development projects. Sociological and religious factors also frequently have an adverse
effect on livestock productivity. Throughout the developing world, national research,
extension and veterinary support services, as well as the linkages among them, are
generally weak in the livestock sector. Infrastructure needed for livestock development is
also usually deficient.

3. CURRENT LIVESTOCK RESEARCH

3.1 National research systems

National agricultural research systems (NARS) are the focal point for research and
transfer of technology and provide the primary link to the extension service, farmer
organizations and nongovernmental bodies. Availability of financial resources is a major
constraint, operating resources and personnel are often inefficiently managed, and many
NARS give inadequate attention to the priority research needs of the farmers. Except for
a few large developing countries with strong research systems, NARS generally focus on
applied research, and on adaptive on-farm trials to verify the relevance of new
technology. Overall, 18.7% of researchers in developing countries are engaged in
research related to livestock production. At the regional level, this share amounts to 20%
in sub-Saharan Africa, 17.4% in Asia and the Pacific (excluding China), 21.4% in Latin America and the Caribbean and 16.2% in WANA. The capacity of NARS for conducting livestock related research varies widely, both within and across regions. Examples of strong national research systems can be found in sub-Saharan Africa: Zimbabwe, Côte d'Ivoire and Senegal; in Asia: China, India and Indonesia; in Latin America: Brazil, Colombia and Argentina; and in WANA: Egypt, Turkey and Morocco. In general, national systems for livestock research are much stronger in Asia and Latin America than in sub-Saharan Africa.

3.2 Regional research programmes

Regional programmes complement the functions of NARS and international research centres and serve as a mechanism for NARS to pool resources and to share responsibilities in the accomplishment of individual and collective objectives. They can be particularly useful for the study of specific regional problems often manifested on an agroecological basis. As the provision of support for regional programmes is often ignored, they frequently lack funds and collaborative programmes are weak. Examples of regional initiatives are Centro Agronomico Tropical de Investigacion y Ensenanza (CATIE) in Central America, Centre International de Recherche-Developpement sur l'Elevage en Zone Subhumide (CIRDES) in West Africa, and the International Trypanotolerance Centre (ITC) in The Gambia, or the International Buffalo Information Centre (IBIC) in Thailand.

3.3 International agencies

FAO addresses livestock development across a broad spectrum. It provides technical advice and assistance to the agricultural community, to governments and funding agencies; it collects, analyses, and disseminates information; it advises governments on policy and planning and provides opportunities for governments to meet and collectively discuss food and agriculture problems. It is also taking the lead in organizing work on the conservation and utilization of animal genetic resources. Other important international agencies involved in the livestock sector include the World Bank, IFAD, UNDP, UNEP, WHO, EEC and the International Atomic Energy Agency.

3.4 Bilateral and non-governmental agencies

The Institut d'Elevage et de Médecine Vétérinaire des Pays Tropicaux (IEMVT) in France undertakes major livestock research activities in developing countries. Other important institutes dealing with tropical health and disease research are, among others, the Institute for Tropical Veterinary Medicine in Antwerp, and the Universities of Edinburgh, Glasgow, Bristol, Milan and Wageningen. Several bilateral donors also have a major involvement in livestock development projects in developing countries, many of which have a research component. Nongovernmental organizations (NGOs) also play an important role in the advancement of animal production; they tend to have close contact with producers. Their potential to expand delivery of technical services to producers and to participate in field testing activities is high; many donors are increasingly channelling support to the nongovernmental sector.
3.5 Private sector

Overall, the role of the private sector in livestock research for developing countries is still relatively limited. Its investment in research is almost exclusively directed at intensive livestock production in the developed countries, much of which is not immediately relevant to developing country conditions. With respect to animal health there is a critical need for the development of drugs and vaccines that are effective against the major infectious livestock diseases in the tropics. Despite past reluctance conditions must be created to encourage the private sector to invest in this area. Adaptive private sector research on existing livestock improvement technologies, such as artificial insemination (AI), is currently important. In the future, developmental private sector research will become increasingly important as advances in biotechnology provide new mechanisms of harnessing animal production efficiency.

3.6 CGIAR

The CGIAR, in 1991, allocated 26.1% of its core resources for commodity work to livestock research, compared with 44.3% to cereals, 16.3% to food legumes, 11% to roots and tubers, and 2.3% to banana and plantain. Such commodity-related work accounted for a total of US$145 million or approximately 58% of total core resources of the CGIAR. This commodity-related work refers to activities in categories 2 and 3 (Germplasm Enhancement and Breeding, and Development and Management of Production Systems) in the classification of CGIAR activities. The estimate for livestock research only refers to contributions by ILCA and ILRAD (the two main CGIAR Centres involved in livestock research), CIAT and ICARDA. It does not include contributions to livestock research made by ICRAF, ISNAR, IBPGR or IFPRI.

An estimate of the allocation of total CGIAR core resources to livestock-related activities can only be made in very approximate terms. Given a total allocation in 1991 of US$19.4 million to ILCA and of US$13.5 million to ILRAD, and an allocation to livestock research of US$6.0 million by CIAT, US$3.2 million by ICARDA and US$0.9 million by ICRAF, then total allocation of CGIAR core resources to livestock research excluding contributions made by ISNAR, IFPRI and IBPGR would amount to US$43 million, or 18.2% of total core resources of the CGIAR in 1991.

The CGIAR has focused its efforts on the most important ruminants in developing countries, i.e. cattle, sheep and goats. Approximately 65% of the CGIAR’s efforts are allocated to research on animal production and 35% to research on animal diseases and health.

The first major thrust of the CGIAR system’s livestock research programme on ruminant production is to enhance nutrition through improved management practices and the development of better pastures, forages, and other feed resources; as stated earlier, inadequate year-round feed supply is the major constraint to ruminant production in many areas of Asia, Latin America and the Caribbean, WANA and sub-Saharan Africa.

The second major research thrust is to control ruminant diseases, particularly tsetse-transmitted trypanosomiasis, which is a major constraint in large parts of
sub-Saharan Africa, and theileriosis (East Coast fever), a major constraint in East and Southern Africa. Much of this research is of a basic and strategic nature. Progress being made in understanding the biology of these diseases, the nature of host defence mechanisms and novel means of vaccination also provide a basis for developing improved methods of control for other economically important livestock diseases worldwide.

ILCA, established in 1974, is the largest centre and conducts research on livestock production systems in the different agroecological zones across sub-Saharan Africa. Its research programme is organized in six thrusts (cattle milk and meat, small ruminant meat and milk, animal traction, animal feed and resource use, trypanotolerance and livestock policy) and built on three major disciplines (animal science, plant science and livestock economics).

ILRAD was established in 1974 as an international laboratory to improve the control of diseases which constrain livestock productivity in developing countries worldwide and has a global mandate. The Laboratory’s initial focus has been on the control of trypanosomiasis and theileriosis as they occur in Africa, and the Institute is in the process of applying its results and research technologies to related disease complexes in other regions. ILRAD has developed a strong research capability, for example, in physiology, immunology, and genetics.

The three other centres which conduct research to improve livestock production within the CGIAR are CIAT, ICARDA and ICRAF. CIAT’s work has been focused on pasture improvement on the acid soils in tropical America, but the programme is now expanding into a germplasm development programme for tropical forages. CIAT assumes a worldwide responsibility for herbaceous legume and grass species adapted to low-fertility acid soils of the lowland tropics. ICARDA’s programme aims at improving rangeland management and the forage base for small ruminants, primarily by replacing fallows in barley rotations. ICRAF is involved in livestock research though its work on agroforestry, particularly with respect to the evaluation of fodder production potential of multipurpose trees, and evaluation of agroforestry technologies involving livestock components.

4. FUTURE PRIORITIES FOR LIVESTOCK RESEARCH IN THE CGIAR

4.1 Principles

The main principles that have guided TAC in its assessment of research priorities are:

(i) relevance and contribution to the CGIAR mission and goals;

(ii) relative importance of species, production systems and commodities;

(iii) importance and the international character of the development problem which generates the need for research, as well as its researchability;
opportunities for international research of a strategic nature and the potential to achieve technical breakthroughs in improving productivity;

advantage of the CGIAR system and the complementarity of its efforts with those of other research and development agencies, and of national research systems;

cost effectiveness of the research;

economic, social and environmental impact of the activity under consideration.

4.2 Issues related to livestock research in the CGIAR

The analysis of CGIAR priorities (TACKGIAR, 1992) indicated that there were no compelling reasons to change the overall relative allocation of resources to livestock research in the CGIAR. On the basis of the modified congruence analysis, it was suggested that livestock research should receive 25.8% of the CGIAR's resources for commodity research, compared to an actual allocation of 26.1%. Congruence on livestock research thus appeared to be close.

However, TAC expressed serious reservations about the high level of resources allocated to livestock research in sub-Saharan Africa relative to other regions. The regional distribution of the CGIAR's effort in the commodity-related aspects had been estimated in the Review of CGIAR Priorities and Strategies at 73% to sub-Saharan Africa, 16% to Latin America, 9% to WANA and 1% to Asia. Yet, sub-Saharan Africa accounts for only 8% of the total value of livestock production, WANA for 10%, Latin America for 30% and Asia for 52%. This estimate relates to the value of all livestock production however, including that of non-CGIAR commodities such as pigs and poultry. In addition, the modified congruence analysis used by TAC for the review of CGIAR priorities suggests that the priority ranking of sub-Saharan Africa would increase threefold compared to congruence on the basis of value of production when modifying variables, such as poverty, strength of national research programmes or rate of resource degradation, were taken into account. Finally, in making the estimate on the regional distribution of the CGIAR's effort in livestock research, it was assumed that all of ILCA and ILRAD's work was targeted at sub-Saharan Africa. In the case of ILRAD particularly, this assumption may not have been entirely valid, because of the relevance of the Centre's work to other regions, as noted in the ILRAD External Review report.

In addition to the regional emphasis, major questions remain about relative priorities among species and between animal production and animal health research. To date, the CGIAR has limited its research to ruminants, except for the brief existence of a swine programme at CIAT during its initial years.

Single approaches to tackling complex production problems related to disease, productivity, genetic improvement and feed sources are unlikely to be successful. There is a clear need for a more integrated holistic approach through combined programmes of productivity improvement and disease management. It is now also clear that the livestock
feed problems will have to be addressed through greater research emphasis on high biomass crops, coarse grains and higher protein feeds. Finally, while CGIAR investment in livestock research has allowed for many achievements and generated a wealth of information useful to policy makers, TAC is concerned about the limited farm level impact on livestock productivity resulting from this investment.

4.3 Species

TAC has carefully considered the distribution of effort among livestock species, and recommends that the focus of the CGIAR should remain on the improvement of the productivity of ruminants, particularly cattle, sheep and goats. Ruminants have a dominant social and economic significance throughout the developing world. They have special importance because they convert into edible products crop residues, by-products, weeds and other biomass that cannot be directly consumed as food by humans. Ruminants provide the only practical means of using vast areas of natural grasslands in regions where low, unreliable or seasonally limited rainfall combined with poor soils make crop production impractical. On arable land, ruminant-based traction raises crop productivity while manure enriches the soil. In addition, ruminants provide farmers with the economic incentive required to plant nitrogen-fixing forage crops, and to maintain pastures in crop rotations which reduce erosion, conserve soil moisture and enhance soil fertility. The key to enhancing these positive aspects of livestock production is good management. It should also be noted that poor management, and especially overstocking, can cause land degradation. Population growth in semi-arid rangeland areas is exacerbating these problems.

Poultry and swine account for almost half the monetary and nutritive value of livestock in developing countries. However, TAC has considered that the CGIAR does not have a clear advantage to conduct research on these non-ruminants. Evidence from Asia and from Latin America and the Caribbean indicates that, as the demand for chicken and pig meat increases, more intensive production systems are adopted, and technology from developed and other developing countries is rapidly and effectively applied in these systems. The poultry and pig sectors also benefit substantially from private sector research. However, consideration needs to be given to the production of feed crops to meet the rapid growth in demand associated with the anticipated expansion of poultry and swine production as human population and urbanization increase in the next 20 to 30 years.

TAC has recognized the importance of the domesticated buffalo in areas to which it is climatically adapted. TAC's position to date has been that the research needs for this species could best be met through regional efforts. Similarly, TAC has recognized the importance of the camel in arid and semi-arid environments. Again, TAC feels that the research needs for this species could best be met through network activities or by regional institutions. At this time TAC considers that the CGIAR has no particular advantage initiating commodity improvement programmes for the buffalo or camel. Similarly, TAC does not recommend initiation of CGIAR programmes with respect to equines, yaks or non-conventional livestock.
TAC recognizes the importance of other animal species for many smallholder farming systems and for incomes of landless rural poor. While TAC does not endorse the initiation of commodity improvement programmes per se, centres could engage in research on livestock of importance in particular farming systems within the framework of ecoregionally focused systems research, if centres would consider that there were genuine arguments to do so.

4.4 Products

In terms of ruminant livestock products, the most important ones are meat, milk, traction and manure. CGIAR efforts should continue to have their major focus on meat, milk and traction.

4.5 The research challenge

The challenges to livestock research are many and increasingly complex as concerns for natural resources management and global warming are integrated in the planning process. On the one hand, knowledge and research principles in animal nutrition, animal health, animal management systems and genetic improvement need to be improved through applied and adaptive research within the major agroecological zones across the developing world. On the other hand, the longer term sustainable development of animal agriculture calls for strategic research on the genetics, biochemistry and physiology of the major determinants of animal production efficiency and fundamental expansion of the feed base. Whereas TAC’s vision of future livestock research within the CGIAR envisages a delineation of this broad research challenge into global and ecoregionally focused programmes, it also is fully conscious of the importance of a link between the two and the need for programmatic and inter-centre mechanisms to enhance programme balance and impact.

4.6 Research programmes/activities

As already noted in Section 4.2, TAC recognizes that single, discipline-oriented approaches to tackling complex production problems are unlikely to be successful. Interactions between constraints (such as, for example, nutrition-genotype-health interactions) are of major importance. A holistic approach to problem definition and research is required. In overview, TAC considers that the major research areas that merit the involvement of the CGIAR are listed below, together with indicative topics in each area.

1. Animal Health: Strategic research on the epidemiology of, and genetic variances associated with, vector-borne diseases such as trypanosomiasis, theileriosis, cowdriosis and dermatophilosis, leading to a better understanding of the host-pathogen relationships and development of vaccines and/or other control measures; identification of the genetic basis of resistance to parasites coupled with the development of herd/flock-health control measures and preventive animal health technology appropriate to small holder farmers.
2. **Animal Nutrition/Biology**: Physiological, biochemical, endocrine and genetic manipulation of the animal so as to increase the efficiency of feed utilization, control of reproduction, growth and milk production.

3. **Animal Genetics**: Characterization of indigenous animal genetic resources with emphasis on adaptability and disease tolerance; and use of molecular genetics to enhance indigenous germplasm.

4. **Feed Resources**: Development of more digestible, nitrogen efficient forages and by-product feeds to support ruminant production within integrated crop-livestock systems; development of forage and pasture production.

5. **Livestock Production Systems**: Constraint analysis; Development and evaluation of livestock production systems with emphasis on integrated crop-livestock farming, evaluated in terms of socioeconomic criteria, technical efficiency and resource sustainability.

6. **Natural Resources Management**: The study of soil-plant-animal interactions in reference to integrated crop-livestock systems, land use and sustainable resource management; role of livestock in processes that increase or decrease the rate of land degradation.

7. **Policy Analysis**: Identification of key policy changes needed to support livestock development, to protect fragile marginal lands used for livestock production and to enhance the development and integration of crop and livestock production.

Viewed in their entirety, all seven areas listed above have research dimensions that fit into both the global and ecoregional research domains. However, TAC considers that most CGIAR activities within areas 1 to 3 may be categorized as global research of a strategic nature, whereas the bulk of activities within areas 5, 6 and 7 broadly fit into an ecoregional research context. Research activities within area 4, the most broadly based programme area, have both ecoregional and global relevance.

4.7 **Animal health and animal production**

TAC considers the current balance of effort, in system-wide terms, of one third to animal health/disease research and two thirds to animal production research to be generally appropriate, and recommends continuation of this distribution in the medium term. It also recommends close integration, in programmatic terms, of production and animal health research activities, particularly through the use of joint research programmes, consortia and collaborative research networks.

4.8 **Integration of crop, animal, agroforestry and fisheries research**

The major constraint to the improvement of livestock productivity is the lack of an appropriate year-round supply of feed. To date, there is only limited evidence of the adoption of special purpose pasture or forage crops on arable land by smallholder farmers. This is because of shortage of land and the higher priority assigned by these
farmers to growing food crops. Crop by-products, crop residues and natural grazing remain the major source of feed supply for ruminants in developing countries.

The growing importance and evolution of crop-livestock farming systems, as well as the increasing emphasis by the CGIAR on self-reliance rather than self-sufficiency, are additional arguments to give greater emphasis to a more holistic approach to livestock research. Plant-oriented international research centres need to recognize the importance of crop by-products for livestock and give consideration to animal nutritional needs, particularly to the digestibility of by-product feeds (e.g. straws and stovers) and residues of target food crops. At the same time, TAC understands the trade-offs involved in plant breeding, and that incorporation of such considerations could be at the expense of lower grain yields. TAC also considers that crop residue management in itself offers little scope for major improvements in livestock productivity.

There is a need to enhance the development of higher biomass feeds and protein rich leguminous crops and trees. The need to closely integrate crop and livestock research with tree cropping, within a broad agroforestry research context, is pertinent, especially with respect to issues such as competition for nutrients, water and light. Research on multipurpose trees for enhanced leaf biomass of higher nutritive value would also benefit livestock production.

4.9 Regional priorities

TAC recommends a redistribution of CGIAR support from livestock research currently concentrated primarily on sub-Saharan Africa to both more global and broadly-based ecoregional programmes. This can be achieved by developing a global research programme on the basis of the activities of one or more of the existing centres and by the integration of regionally focused livestock research activities into the evolving ecoregional research programmes. In this context, additional emphasis should be given to the livestock research needs of Asia and Latin America. In sub-Saharan Africa, particularly high priority should be given to the integrated crop-livestock research in the subhumid tropics and in the highlands. In Asia, livestock research might become a component of ecoregional consortia, particularly for upland rice production systems. In other zones, livestock research should constitute an appropriately important component of ecoregionally oriented production systems research.

5. FUTURE STRATEGIES FOR LIVESTOCK RESEARCH IN THE CGIAR

5.1 Global and ecoregional responsibilities - evolving System strategies

Future strategies for livestock research in the CGIAR must be seen in the broader context of evolving strategies within the System as a whole. TAC considered the needs and priorities of livestock research in relation to the CGIAR medium-term vision and, in particular, to the proposed distinction between global and ecoregional responsibilities.

The organizational and operational implications of an "ecoregional approach to research" are currently being considered by the Centre Directors, TAC and the CGIAR.
Although the outcome of these deliberations may well have implications for the future of livestock research, TAC recognizes that any new modes of operation will take time to evolve. Consequently, the proposals that follow are designed to maintain continuity of effort in a process of gradual change.

TAC undertook its analysis sequentially. Thus, the next section considers programmatic linkages between centres given current institutional arrangements. The analysis clearly highlights the already substantial degree of interaction and the potential for more. The Committee concludes that there is a need for greater coordination and integration of programmes. TAC subsequently considered institutional options which might facilitate more effective delivery of desired programmes. The final chapter concludes with TAC’s recommendations.

5.2 Current and potential inter-centre programmatic linkages

TAC considers that there is a clear rationale to link global and ecoregionally-focused research on livestock in a coordinated research framework. The Committee examined the programmatic implications of this in relation to the major CGIAR centres engaged in livestock research, responsibilities of the other IARCs and the potential roles of other organizations. TAC reviewed the programmes of ILCA and ILRAD, in terms of their current research foci and the need for joint programmes across these two centres. An overview of this analysis in reference to the seven major livestock research areas stated in section 4.6 above follows:

Animal Health: Responsibility for the major part of this programme currently falls within ILRAD’s domain. As recommended in its recent External Review it should extend its expertise in immunology and molecular biology to other tick borne parasitic diseases in sub-Saharan Africa, Asia, Latin America and WANA in collaboration with appropriate regional and national institutions. TAC considers this research to be global and strategic in nature. ILRAD’s work on the epidemiology and socioeconomics of disease control is ecoregional in nature and could be undertaken jointly with ILCA and appropriate NARS. The development and evaluation of herd/flock health control strategies and the field testing of vaccines and diagnostic kits could also be carried out in collaboration with ILCA, regional institutes and NARS.

Animal Nutrition: Strategic research on animal nutrition, specifically as it relates to the manipulation of biochemical, physiological or microbial interventions has broad-based global significance. A joint ILCA/ILRAD research team, possibly located at ILRAD where appropriate research facilities already exist and working in close collaboration with advanced animal nutrition laboratories in developed countries, could enable the CGIAR to best exploit research advances in this strategic area. In a similar vein, promising biotechnological advances in the control of animal reproduction, growth and milk production, could be appropriately modified and evaluated by ILCA/ILRAD scientists working in close collaboration with scientists in other advanced institutes. Other aspects of animal nutrition, being more production-system oriented and of an ecoregional nature, would currently fall in the domain of ILCA in sub-Saharan Africa, ICARDA in WANA, and of ecoregional mechanisms in other regions. This work should be conducted in partnership with NARS, advanced research institutes and other IARCs.
Animal Genetics: TAC considers that the greatest opportunity for a strong collaborative programme between ILCA and ILRAD is in the area of animal genetics. ILRAD’s strengths in molecular genetics coupled with ILCA’s capacity in population genetics, and access to animal populations in sub-Saharan Africa, provide important elements of an effective research programme to characterize and enhance the genetic capacities of indigenous tropical livestock populations. The programme would have two major components, viz., germplasm (breed) characterization and germplasm (breed) improvement. Each component in turn would have strategic and applied research elements and would encompass global and ecoregional foci. A brief description of each of these subprogrammes is outlined below.

Breed characterization: The characterization of animal genetic resources (AGR) on a global basis demands major inputs of funding and staff that are far beyond the capacity of the CGIAR; FAO, supported by UNEP, has developed a framework for a global programme on AGR and currently is advancing this long-term programme. ILCA has cooperated with FAO in the development of an AGR database and could possibly continue in this collaborative work, particularly as regards the characterization of breeds of livestock in sub-Saharan Africa; this work would be essentially ecoregional in focus. ILRAD could contribute to the genome mapping component of the programme. The work on animal genetic resource characterization would require close collaboration with national and regional organizations including ITC and CIRDES.

Breed improvement: Neither ILCA nor ILRAD has the capacity to engage in broadly-based programmes of breed improvement, nor is there a strong research justification, at this time, that they should do so. However, they can make unique contributions to some important components of this work. ILRAD, for example, could continue to work on the genetic basis of disease tolerance, a subject of global significance in the development of the indigenous tropical livestock populations across the world. The genetics of trypanotolerance is just one of the major challenges in question; tolerance to other parasitic infections also merits serious attention. This work would also require close collaboration of ILRAD (laboratory facilities) and ILCA (field studies) with regional centres such as ITC and CIRDES (access to indigenous disease-tolerant breeds, e.g., N’Dama and Baoule) in sub-Saharan Africa and, if it is to have appropriate global significance, with advanced NARS and regional research organizations in other parts of the developing world. TAC considers that the current trypanotolerant network provides a good working model for the further development of these collaborative arrangements.

Feed resources: The applied components of this research programme are necessarily ecoregional in nature and, as regards sub-Saharan Africa, the animal-based studies would currently fall largely in ILCA’s domain. ICARDA and CIAT have important responsibilities in this regard concerning WANA and Latin America respectively. TAC considers that the other plant-based or resource management centres, and in particular IITA, ICRISAT, ICARDA, CIAT, and ICRAF should place greater research emphasis on animal feed resources. Much of this work will demand ecoregionally focused applied research; but some research inputs of a strategic nature will also be required. Research
on the in-vitro screening and characterization of animal feed resources is also important in this context. IBPGR would have a significant role in this regard.

**Livestock Production Systems:** This programme is necessarily ecoregional in nature, mostly involves applied research and should constitute the major component of ILCA's programme. In this work ILCA could benefit to a much greater extent from ILRAD's expertise as regards the diagnosis of animal disease challenges and the development of herd/flock health management systems. Modelling, and systems analysis of smallholder production efficiency parameters, require a strategic research input which could have global significance to smallholder production systems outside sub-Saharan Africa. Equally, systems research on draught animal power would also have elements of global relevance.

**Natural Resources Management:** TAC considers that both ILCA and ILRAD have important roles to play to support research on natural resources management, which would be primarily ecoregionally focused, but recognizing that some of the work would be applicable to livestock disease research and control globally. The control of animal diseases constitutes a major component of natural resources management. Equally, grazing management systems and soil/plant/animal interactions in the sustainability of natural resources require a livestock research input. ILCA and ILRAD's involvement in this research would normally be limited to sub-Saharan Africa, whereas CIAT and ICARDA have important contributions to make on livestock research in their respective regions. In this work, collaboration with the major plant-oriented centres will be very important. It is noted that ILRAD has closely collaborated with CGIAR centres and other organizations in developing Geographic Information System (GIS) databases which constitute an essential component of natural resources management research.

**Policy analysis:** TAC considers that livestock research centres can make significant contributions to policy analyses, on their own initiative at the micro level and in partnership with IFPRI at the broader macro level. This work will include, for example, research on national and regional policies concerning the management of rangelands and grazing lands, trade policies that affect the development of animal production, and land use policies as they affect the integration of crop and livestock production.

**Arising from this analysis TAC concluded that:**

(i) **there are strong arguments for the integration of significant parts of the research programmes of ILCA and ILRAD;**

(ii) **there is a need to develop an inter-centre framework for coordination of livestock research within the CGIAR and its linkages with non-CGIAR IARCs, regional research centres, national research systems and advanced research institutes;**

(iii) **the coordination framework must foster the necessary complementarities and synergies between global and ecoregionally focused research.**
5.3 Institutional options

Following the analysis of the needs and opportunities for inter-centre programmatic linkages, as summarized in Section 5.2 above, TAC considered different institutional frameworks that might best support livestock research (global and ecoregional) within the CGIAR. These include: (i) the existing arrangements (status quo); (ii) a number of different inter-centre collaborative mechanisms; (iii) a merger of the two CGIAR livestock centres, viz., ILCA and ILRAD; and (iv) the establishment of a new entity where ILCA and ILRAD's human and physical resources would be integrated into a strategic livestock research undertaking of global significance. All other centres engaged in livestock improvement related research would focus their work in an ecoregional context. The roles of networks and programme-funded research consortia, to effect global and ecoregional coordination within and between CGIAR centres and other research entities such as ITC, CIRDES and ICIPE, are considered to be essential and implicit across all four options.

Option 1 - The 'status quo'. The analysis of the needs for and benefits of greater inter-centre collaboration, both in global and ecoregionally focused research, makes a compelling argument for change in the organization of livestock research in the CGIAR; this argument becomes increasingly relevant as the CGIAR faces greater constraints in resource availability.

Option 2 - Inter-centre collaborative mechanism(s). Based on its analysis of the recent External Reviews of ILCA and ILRAD and considering the need for greater collaboration between ILCA, ILRAD and other CGIAR centres in the future, particularly as regards ecoregional activities, TAC considers that the existing inter-centre linkage mechanisms are not adequate. A number of alternative inter-centre collaborative mechanisms could be considered, including the establishment of programme coordination mechanisms at Board and/or Directors General levels, the establishment of a joint Board of Trustees to effect common governance of ILCA and ILRAD, and other collaborative arrangements.

The establishment of a coordination mechanism whether at Board level (Advisory Board, overlapping Board memberships, one joint Board), or at Centre Director level (Inter-Centre Council) or both, to coordinate livestock research within the CGIAR across all centres could provide a useful forum for the planning and prioritization of global and ecoregional activities within the CGIAR. In practice it would be difficult to coordinate programmes effectively because of the divergent Centre mandates and research backgrounds, particularly in the absence of authority to allocate budgets. Also, other livestock-interested centres in the CGIAR and non-CGIAR organizations not associated with the planning and common governance mechanism could consider themselves to be inadequately represented in the overall organizational framework.

TAC has also considered the possibility of developing other collaborative mechanisms such as integrated CGIAR programme thrusts with respect to livestock research, particularly in sub-Saharan Africa. This would facilitate inter-institutional programme funding and provide an incentive to develop partnerships. One obvious programme area is in trypanotolerance, but opportunities for collaborative research also
exist in the conservation of animal genetic resources, animal epidemiology and socioeconomics.

**Option 3 - Merger of ILCA and ILRAD.** This option has been considered most recently by the External Review Panels of ILCA and ILRAD. Both Panels concluded that a merger was not appropriate at this time, citing the substantial differences in the mission, mode of operation and scientific cultures of the two centres. Such a merger had been envisaged in the foundation reports of ILCA and ILRAD. TAC recognizes that there could be a strong *a priori* case to keep the matter under review as the two Centres increase the scope of their collaborative programmes over the next five years.

The major advantage of a merger would be the integration of animal production and animal health research, of productivity improvement and disease management programmes, and of institution building efforts. It would also provide a framework for an integrated approach to livestock research in the CGIAR. A merger could assure more efficient use of resources (physical and economic) by sharing and avoiding duplication of central services (information, training facilities, field test stations, etc.).

A merger of ILCA and ILRAD would provide a formidable challenge to management in order to integrate different research cultures at geographically-remote sites. In addition, vested interests and resistance to change could lead to a loss of clear research focus. The 'new' institute would be likely to continue the previous activities of ILCA and ILRAD without revising their mandates and strategies.

**Option 4 - A global centre for livestock research.** Based on its assessment of the need to strengthen and integrate livestock research within the CGIAR, and to gain economies of scale, there might be considerable merit in a "clean-slate approach" and establishing one CGIAR centre with global responsibility to undertake strategic research on genetics, physiology, nutrition and health, all of which require the strong support of modern advances in biochemistry and molecular biology. This work would be supported, as well as guided by research of an ecoregional nature.

In this option, ILCA and ILRAD would cease to exist as independent institutes and be integrated, with their human resources and physical plants, into this new global entity with an expanded mandate. Given the strong need to develop and expand close linkages between global and ecoregional activities across the broad spectrum of livestock research, this option would demand close coordination between the global centre and ecoregional mechanisms. This global centre would provide analytical and scientific support to the ecoregional mechanisms. Programmes at the ecoregional level would provide feedback to the global Centre. They could be conducted either by staff of the global centre or by staff of the ecoregional mechanisms itself, but with strong disciplinary backing by the global centre. The global centre could conduct research on 'thematic' activities. Ecoregional activities could be conducted through other centres, networks, or consortia. This would involve joint planning, execution and evaluation of programmes. Some of the advantages and disadvantages of this option are as follows.

**Advantages.** (i) This option could bring 'under one roof' the core sciences that must underpin biotechnology and scientific advances in livestock research; in other words, the
centralization of CGIAR's global and basic/strategic research on animal production and health. (ii) Would allow sharing of costly biotechnology-oriented laboratory facilities and scientific support services and represent a significant saving in expenditure, but even more importantly could lead to a scientific environment in which interdisciplinary interactions can flourish. (iii) Would provide for integration of animal production and animal health research, of productivity improvement and disease management programmes, and of institution building efforts. (iv) Provides a forum for an integrated approach to livestock research in the CGIAR. (v) Would allow for provision of strong analytical support to ecoregional mechanisms. (vi) Would provide more efficient use of scarce resources. (vii) Potential for more effective modes of operation among Centres, national programmes and other organizations. (viii) Inter-institutional programme funding could be facilitated.

Disadvantages. (i) The proposed transformation could detract from current CGIAR focus on animal health and animal production. (ii) Livestock research is by nature relatively long-term and often location specific, and the development of a focused research programme for the new institute would provide a major challenge. (iii) Could cause a dislocation and discontinuity of certain ongoing highly-focused research programmes. (iv) May involve a period of uncertainty while an integrated strategy is developed. (v) Established relations between national research systems and ILCA and ILRAD could be affected.

5.4 Implications for other institutions

5.4.1 Future role of CIAT, ICARDA, ICRAF and other ecoregional mechanisms

TAC considers that livestock research activities that are ecoregional in nature should be addressed by the centre most closely related to the area in question. The small ruminant programme at ICARDA, and the tropical forages programme at CIAT, essentially are integral parts of ecoregional activities. In the ecoregions of Asia, in which the CGIAR may assume responsibilities, livestock research should become an integral part of the activities of an ecoregional programme and developed on a research consortia or network basis. In sub-Saharan Africa, IITA could assume primary responsibility for the humid and sub-humid areas, building on ILCA's experiences in the area. However, as mentioned earlier the organization of ecoregional research in the CGIAR is still under discussion. ICRAF will need to play a major role in fostering integration of crop and animal production in its agroforestry research programme.

5.4.2 Future role of CIRDES, ICIPE, ITC and other organizations

In the context of the need for closer integration of research on animal production and animal health, CIRDES, ICIPE and ITC are seen to be valuable components of an overall strategy for livestock improvement, particularly in the tropics where disease tolerance is important. For example, ICIPE's work on the vectors of theileriosis and trypanosomiasis is important in the understanding of the ecology and biology of the tick and the tsetse fly.
CIRDES and ITC are sub-regional institutes and focus their research on major trypanotolerant breeds of cattle, viz., the Baoule, and the N’Dama, respectively. These centres also work on trypanotolerant sheep. CIRDES has recently expanded its mandate to other aspects of livestock research, and consequently research on trypanotolerance is now only part of its activities. CIRDES and ITC have a unique access to genetic resources for specific research on trypanosomiasis, and bovine immunology, and for a global programme to map the bovine genome. ICIPE's work on the vectors of theileriosis and trypanosomiasis is also important. Consequently, CIRDES, ICIPE and ITC deserve continued support from the international donor community.

TAC recommends the continuation of the active collaborative research network on trypanotolerance which currently involves ILCA, ILRAD, ITC, CIRDES, ICIPE and national programme partners. The Committee recommends that ITC and CIRDES continue to be active members of the trypanotolerance research network, by participating in cooperative research and providing field facilities, genetic material and field testing possibilities. TAC also recommends that ICIPE remain a member of the network to cover research on vector control. If the CGIAR is to establish a global research Centre as discussed as option 4 in section 5.3, it will need regional and national linkages. The various members of the trypanotolerance network including ITC, CIRDES and ICIPE would become logical partners. Sub-contracting of specific tasks to these partners could be considered.

Given the current emphasis of CGIAR activities on sub-Saharan Africa, this section has given particular attention to the potential role of regional organizations and other Centres in that region. As the CGIAR develops a livestock research programme which has more global relevance, strong linkages will have to be developed with organizations in other regions also. The important role of FAO in characterization and conservation of livestock genetic resources, as well as in stimulating networks, should also be recognized.

6. CONCLUSIONS

TAC considers that livestock is of crucial importance in smallholder farming systems and that through research the CGIAR can make a major contribution to improving livestock productivity and the livelihood of resource poor farmers in developing countries. The major focus of the CGIAR’s work ought to remain on the improvement of the productivity of ruminants through research on animal health, animal nutrition, animal genetics, feed resources, livestock production systems, natural resources management and policy analysis. TAC considers that there is a need for a more holistic approach to livestock research in the CGIAR, and that there is substantial scope for much greater integration of CGIAR programmes. Such an approach would allow for a coherent and coordinated effort on livestock research in the CGIAR.

The overall allocation of CGIAR resources to livestock research relative to other commodities should be maintained. However, TAC recommends a redistribution of CGIAR support from livestock research currently concentrated primarily on sub-Saharan Africa to both more global and broadly-based ecoregional programmes. This can be
achieved by developing a global research programme on the basis of the activities of one or more of the existing centres and by the integration of regionally focused livestock research activities into the evolving ecoregional research programmes. TAC has carefully explored alternative institutional options that would allow for closer integration of livestock research programmes in the CGIAR, and for the development of a coordination framework to foster the complementarities and synergies between global research and ecoregionally focused research. TAC favours the establishment of a new CGIAR entity with global responsibility for CGIAR livestock research into which both ILCA and ILRAD would be integrated. Other livestock research activities of an ecoregional nature would be organized through ecoregional mechanisms. Both global and ecoregional research activities would need to be conducted in close partnership with national research systems, regional research entities, advanced research institutes and other international organizations. This option also corresponds to the medium- and long-term vision of the CGIAR, and offers the greatest scope for the development of an integrated livestock research programme in the CGIAR.
REFERENCES


