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Global Agenda for
**Livestock
Research**

**Proceedings of a Conference on Development
of Livestock Research Priorities in Asia**

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National Institute of Animal Husbandry
Hanoi, Vietnam

edited by
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International Livestock Research Institute

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Introduction

The development of the livestock research agenda in Asia by the International Livestock Research Institute (ILRI) is consistent with the research priorities of livestock development within the framework of the Consultative Group on International Agricultural Research (CGIAR) priorities and strategies. The emphasis in Asia is a demand-led process, and recognises that while rice is the most important crop, and the impact of the 'Green Revolution' will continue to enhance rice production, livestock have an important, complementary role to play with rice in the improvement of food production and economic development.

The demand-led initiative recognises in particular the following trends:

- Massive population growth rates, urban migration and continuing poverty especially in South Asia
- Increased demand for livestock food products due to rapid economic development, increased income, affluence and changing consumer preferences
- Decreasing availability of arable land
- Shifts from subsistence farming, intensification and specialisation to market-oriented production
- Considerable opportunities to improve livestock production especially in crop-animal systems and integrated natural resource management and use that can alleviate poverty and enhance food security and environmental protection.

Against this background, ILRI initiated a process that started with a global consultation in Nairobi in January 1995. This meeting involved senior representatives of livestock research and development programmes in Asia, sub-Saharan Africa, the Middle East and Latin America and the Caribbean who identified the general requirements for livestock research in these regions (Gardiner and Devendra 1995).

Following this meeting, and in order to define more precisely research priorities and opportunities in ecoregional terms, ILRI undertook two consultations in Asia, one at the International Rice Research Institute (IRRI) in May 1996 for the humid/sub-humid region in South-East Asia (Devendra and Gardiner 1995a) and the other at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in June 1996 for the arid/semi-arid region of South Asia (Devendra and Gardiner 1995b). These ecoregional consultations were undertaken jointly with the other sister CGIAR centres and were aimed at improving animal agriculture in the respective ecoregions. The consultations brought together representatives of national and international programmes, and donors interested in the improvement of livestock development and agriculture in both regions. Both meetings were very useful in defining priority research problems, opportunities and potential partners.

Against the background of the results of the two consultations, ILRI completed two studies in order to provide the basis for priority setting and programme development in Asia in the medium term:

- ILRI in Asia: an assessment of priorities for Asian livestock research and development
- Improvement of Livestock Production in Crop-Animal Systems in Rainfed Agro-ecological Zones of South-East Asia

Both studies have their origin in the opportunities identified during the two regional consultations. The first report presents an assessment of economic trends in major countries in Asia, and how these impact on the components of the animal industries. The second report is more specific, and targeted at the rainfed agro-ecological zones (AEZs) of South-East Asia, where there are significant opportunities for livestock improvement. Both studies provided recommendations on what ILRI can do through utilising its strengths and comparative advantage, and modalities for working with NARS in the Asian region. The studies were overseen by a steering committee comprising representatives from livestock research and the development sectors in Asia, as well as donor agencies.

The ILRI conference on Development of Livestock Research Priorities in Asia in Hanoi, Vietnam, was aimed at discussing the results of these two reports, the most advantageous strategies for ILRI in Asia, as well as to seek consensus on the modalities of project development and implementation. More particularly,

the meeting was also aimed at identifying active partners and the formulation of collaborative research programmes that can be launched shortly.

The meeting was attended by senior government representatives of national agricultural research systems (NARS), ministries of agriculture, national and regional experts, other agencies as well as donors.

With the exception of Pakistan and Myanmar, who were invited but unable to attend the Hanoi Conference, representatives of 15 national programmes in Asia participated, including advanced research institutes and donors. Country participants were requested to prepare a brief written paper on research priorities in their individual countries, but more specifically to indicate the following:

- Relevance to their country of research priorities recommended for ILRI in Asia
- Extent to which livestock research fits these priorities, amount and source of resources supporting livestock research in their country
- Interest and ways in which their country might participate in collaborative research and possibilities of funding

The conference thus provided a very valuable forum for further understanding of ILRI's mission in Asia, active discussions and exchange of views on the draft reports and country positions as well as the next steps. ILRI was pleased to receive in the process much helpful advice, views and suggestions. The smaller group discussions further enabled identification of clear research priorities and opportunities in the priority AEZs to improve the contribution of livestock in these AEZs in Asia. For reason of brevity, as well as the availability of background data on individual countries in previous regional consultations (Gardiner and Devendra 1995; Devendra and Gardiner 1995a), only the research priorities in individual countries are presented here. However, readers who are interested in individual country papers can get copies from the ILRI Directorate.

The country research priorities are followed by five comprehensive presentations on ILRI vision, mission and goals to include an introduction by the Director General, ruminant genetics, animal health improvement, sustainable production systems and policy, feed resources and strengthening partnerships with NARS.

This proceedings presents the results and conclusions of ILRI's role in livestock research and development in Asia. It provides a detailed testimony of the success of the consultation, and especially about ILRI's commitment to form integrated programmes for livestock and agricultural research with national partners and others. ILRI's mission to provide leadership in animal agriculture in Asia is largely dependent on the development and sustainability of these partnerships.

Programme

The programme was initiated by a welcome speech and official opening of the conference by the Minister of Agriculture and Rural Development (Appendix I). This was followed in the programme (Appendix II) by the presentation of two study reports on the assessment of livestock research development priorities:

1. ILRI in Asia: an assessment of priorities for Asian livestock research and development
2. Improvement of Livestock Production in Crop-Animal Systems in Rainfed Agro-ecological Zones of South-East Asia

These were followed by 15 country reports (Appendix III) and a session on ILRI's vision, mission and goals (Appendix IV).

There were six working group sessions: South-East Asia, South Asia, interdisciplinary systems research, biological component research, cross-cutting priorities and issues, and building partnerships. The results of the group discussions were presented in individual sessions and finally in a plenary session to focus on the major issues, commonalities and the way ahead in Asia. These are presented in the following sections.

Participation

The consultation was attended by 49 people from 16 countries including 15 in Asia. Participants included representatives from ministries of agriculture, research centres and universities (Appendix V).

References

- Gardiner P. and Devendra C. (eds). 1995. *Global Agenda for Livestock Research. Proceedings of a Consultation, ILRI, Nairobi, Kenya, 18–20 January 1995*. ILRI (International Livestock Research Institute), Nairobi, Kenya. 118 pp.
- Devendra C. and Gardiner P. (eds). 1995a. *Global Agenda for Livestock Research. Proceedings of the Consultation for the South-East Asia Region, IRRI, Los Baños, The Philippines, 10–13 May 1995*. ILRI (International Livestock Research Institute), Nairobi, Kenya. 280 pp.
- Devendra C. and Gardiner P. (eds). 1995b. *Global Agenda for Livestock Research. Proceedings of the Consultation for the South Asia Region, ICRISAT Asia Center, Patancheru, India, 6–8 June 1995*. ILRI (International Livestock Research Institute), Nairobi, Kenya. 146 pp.

Summary of working group reports

South-East Asia

Research priorities

1. Feed resources
2. Animal health
3. Animal genetic resources
4. Livestock and the environment
5. Socio-economics and policy
6. Institutional building
7. Production systems
8. Technology assessment and transfer

Issues

1. Feed resources: in cropping systems, synchronisation, utilisation, production in dry areas, grass/forage seed technology, new varieties, nutritional requirements, ration compounding, feed processing.
2. Animal health: epidemiology and identification of pathogens, helminths and resistance, immune mechanisms, toxic plants, local isolants, diagnostic reagents, vaccine delivery and production.
3. Animal genetic resources: characterisation, utilisation, disease resistance, multiplication, preservation.
4. Livestock and the environment: nutrient cycling, land degradation (uplands), waste disposal, feed additives, climatic stresses.
5. Socio-economics and policy: input/output markets, veterinary inputs and services, co-operatives, private sector involvement, rural credit, inter/intra regional trade in livestock and products.
6. Institution building: training, information exchange.
7. Production systems: systems analysis, characterisation, modelling.
8. Technology assessment and transfer: technology assessment (impact and socio-economics).

South Asia

Research priorities

1. Feed resources
2. Animal genetic resources
3. Animal health
4. Farming systems

Issues

1. Feed resources: production levels (including cost of production/purchase), improving forage genetic resources, integrated cropping systems, seasonal and fluctuating supplies, feeding systems (crop residues, by-products, feed processing, conservation), quality and quantity of grazing land, land tenure and policies, transport and marketing.

2. Animal genetic resources: conservation, lack of genotypes, lack of information on available genotypes, shortage of breeding stock, breeding policies.
3. Animal health: diagnostic reagents/tests, epidemiology/disease monitoring and surveillance, policies for and delivery of veterinary services, lack of vaccines, enforcement of regional disease control policies, emerging new diseases.
4. Farming systems: characterisation and environmental impacts, changing farming systems, optimisation of resource base, appropriate technologies, socio-economics, marketing and policy issues, sustainability, livestock and the environment.
5. Others: urbanisation and demographic changes, gender issues, macro-policies for credit and investment, infrastructure needed for animal agriculture, human resource capacity development, information resources and dissemination.

Interdisciplinary systems research

Research priorities

1. Systems characterisation (i.e. smallholder farming systems within which livestock are a component)
2. Economic trends and policies
3. Assessment of technologies
4. Validation and transfer of technologies

Issues

1. Systems characterisation: livestock within existing biophysical characterisation, typify main Asian farming systems involving livestock, quantify biophysical interactions and energy flows between subsystems, add socio-economic and cultural interactions within and outside the farming systems.
2. Economic trends and policies: changes in farming systems as they respond to economic trends and policies, reasons and constraints limiting response of farming systems to increasing demand, effects of macro-policies on livestock production, productivity and investment.
3. Assessment of technologies: relevance of existing technologies, beyond their place/country of development, *ex ante* assessment of potential technologies.
4. Validation and transfer of technologies: validate technologies on-farm, evaluate mechanisms and policy options that facilitate or constrain technology transfer, promote new technologies, including *ex post* impact assessment, feed validation results and impact studies into research priority setting.

Target farming and production systems

1. For South-East Asia to focus on:
 - arable crop–livestock systems in rainfed lowlands
 - tree crop–livestock systems in uplands
2. For South Asia to focus on: market-oriented dairy production in crop–livestock systems
3. For socio-economic and policy studies: the linkage between rainfed and irrigated systems through markets.

Research approaches

1. Holistic, interdisciplinary and participatory systems research built on existing indigenous and formal knowledge

2. Partnerships within benchmark sites, with division of responsibilities between sites
3. Networking to share information from benchmark sites
4. ILRI to co-ordinate and facilitate partnerships and networking (including south-south links); provide training and information as required; guide project formulation for funding.

Partners

1. Bangladesh, China, India, Indonesia, Nepal, Philippines, Sri Lanka, Vietnam and Thailand expressed interest in target farming systems research. Malaysia expressed interest in tree crop-livestock systems, and Bhutan expressed general interest in participation.
2. Different countries offered research expertise, research facilities, funds for local expenses and training facilities.
3. Principal contact institutions are:

Bangladesh	Bangladesh Agricultural Research Council
China	Ministry of Agriculture, Chinese Academy of Agricultural Sciences
India	Indian Council of Agricultural Research, National Dairy Development Board
Indonesia	Agency for Agricultural Research and Development
Nepal	Nepal Agricultural Research Council
Sri Lanka	Department of Animal Production and Health
Philippines	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
Thailand	Department of Livestock Development
Vietnam	Ministry of Agriculture and Rural Development

Building partnerships

1. ILRI training to upgrade and create research skills for system analysis and modelling

Time frame

1. ILRI to prepare draft funding proposal and circulate to potential partners listed under 'Partners' above
2. Find funding by early 1998 for a 3-4 year project

Biological component research

Research priorities

1. Animal health
2. Animal genetic resources
3. Feed resources

Issues

1. Animal health: prioritisation of diseases of economic importance, improved diagnostic kits, improved disease control (vaccines).
2. Animal genetic resources: nutritional requirements of indigenous breeds, innate resistance or tolerance to disease, information on indigenous genetic resources.

3. Feed resources: quantification and characterisation of feed resources, utilisation of feeds and the interaction of genotype \times feeds, feed conservation, feeding strategies and feed budgeting, adverse consequences of grazing and migratory livestock.

Research approaches

1. Animal health: epidemiological monitoring, improved diagnostics (impact, database modelling), diagnosis, vaccines, vector control and management, improved policy and improved delivery.
2. Animal genetic resources: *in situ* characterisation of indigenous breeds (phenotypic, genetic and performance traits), conservation and sustainable use, exploitation of characteristics.
3. Feed resources: identification and classification of feed resources, characterisation of rumen ecosystems, improved methods of processing, conservation and storage of feeds, modelling feed availability, ecology and environment modelling.

Partnerships

1. Animal health: core group—Malaysia, Thailand, India, China, Bangladesh
2. Animal genetic resources: core group—Vietnam, Philippines, Sri Lanka, Nepal, India, Bangladesh
This work will be done in collaboration with FAO
3. Feed resources: core group—China, Bangladesh, Philippines, Indonesia, Vietnam, Bhutan

Time frame

1. Animal health: 5 to 10 years
2. Animal genetic resources: 5 to 10 years
3. Feed resources: 10 years
4. Research in these areas are subject to available funding

Cross-cutting priorities and issues

Priorities

1. Research methodologies and priority setting
2. Policy and socio-economics
3. Technology transfer
4. Training
5. Information
6. Networking

Issues

1. Research methodologies and priority setting: multidisciplinary and systems approach, diagnostic and *ex ante/ex post* assessments, providing tools for priority setting and resource allocation.
2. Policy and socio-economics: national/regional/international livestock development, trade and marketing, poverty alleviation and natural resource base, need to influence policy makers.
3. Technology transfer: process (not products) for extension/user linkages (two-way process linkages to research methodologies and priorities).

4. Training: build new capacity, strengthen existing capacity, relevant training driven by research needs and built on existing expertise and facilities of region, training materials to support national/regional training.
5. Information: lack of information and relevant information at all levels (researchers, extension staff and farmers), build on existing national/regional resources.
6. Networking: review recent/existing networks to build on positive experiences, sustainable networking with clear objectives and subject focus to allow resource sharing and joint funding.

Building partnerships

Objective

1. Maximising NARS–ILRI research benefits and transfer of technologies through effective partnerships.
2. Building on existing mechanisms for partnerships (hence need to audit existing activities and facilities before planning new activities).

Activities

1. Provision of information and knowledge
2. Training
3. Networking
4. South–south exchange

Issues and actions

1. Provision of information and knowledge
 - Audit existing information resources and services for animal agriculture in Asia. To be co-ordinated by ILRI with information from in-country/regional contacts.
 - Establish ‘network’ of information resources and services to provide scientists with access to information on animal agriculture.
 - Develop, maintain and distribute database of literature on Asian animal agriculture. First version in 1998, produced by ILRI and in-country/regional information systems.
 - Collect non-conventional literature relating to animal agriculture. To be done in selected countries.
 - Produce knowledge products for researchers and trainers based on research results of NARS–ILRI research in Asia and existing information.
2. Training
 - Audit existing training activities/facilities for animal agriculture in Asia. To be co-ordinated by ILRI with information from in-country/regional sources.
 - Establish regional training courses to strengthen existing research capacity for NARS–ILRI collaborative research. Topics driven by needs of research (see ‘Time frame’ below). Using regional training facilities, and trainers from the region and ILRI.
 - Training materials development, based on regional training courses, to support other national/regional training activities.
 - Graduate training—degree-related research projects within ongoing NARS–ILRI collaborative research, with students registered at universities within region, and supervision by national and ILRI scientists.

3. Networking
 - Audit existing and recently closed networks having partial or whole focus on livestock. Determine possible entry point for ILRI into existing network(s). To be co-ordinated by ILRI with information from in-country/regional contacts.
4. South-south exchange
 - Establish annual programme of 3-4 day seminars leading to exchange of experiences and knowledge. Proceedings of each seminar to be published. First seminar proposed on small-holder dairy production and marketing in Asia and Africa.

Nature of partnerships

1. Partnerships to be established with:
 - international organisations (e.g. FAO, OIE, WHO etc)
 - other international research centres
 - regional organisations
 - national ministries, universities, research institutes
 - funding agencies
2. Partnerships built around:
 - shared goals, defined objectives and agreed benefits
 - shared resources (human, physical and financial)
 - open communication based on agreed tasks and time frames
 - clear facilitation

Prioritised list of areas for training courses

1. List of possible areas for training courses were drawn up by participating countries, to support the NARS-ILRI research being planned.
2. In order of priority:
 - animal genetic resources/biodiversity (to be planned and delivered in collaboration with FAO)
 - farming systems research with livestock
 - feed and feed management; feed utilisation and budgeting; forage genetic resources; rumen microbiology
 - animal health and disease epidemiology; disease diagnostics
 - socio-economics and policy issues
 - research/extension/user linkages for technology transfer

Task force for building partnerships

Malaysia	Abd Aziz Jamaluddin
Nepal	Uendra Mishra
Thailand	to be confirmed
FAO Regional office	Denis Hoffmann
ILRI	Michael Smalley

Time frame

1. Audits of information resources, training activities and networks to be completed by December 1997.
2. Network of information resources and services to start 1998 and evolve over five years.
3. Collection of non-conventional literature to take 12–18 months per country, with 1–2 country collections being carried out at any one time.
4. Development of knowledge products tied to NARS–ILRI research. Each product will be a ‘project’, expected to take 12–18 months.
5. Training courses and materials development start in 1998 and continue for life of NARS–ILRI Asian programme.
6. Graduate training tied to NARS–ILRI research projects.
7. South–south exchange to start in 1998 with one seminar each year.

All activities subject to agreement by partners to detailed proposals and donor funding.

Speech by H.E. Nguyen Cong Tan, Minister of Agriculture and Rural Development, Vietnam

Dear Chairmen,

Distinguished representatives,

On behalf of the Vietnamese Government, I would like to welcome you, the representatives from the International Livestock Research Institute (ILRI), and the delegates from 18 countries and international organisations to participate in the ILRI Conference on 'Development of Livestock Research Priorities in Asia' which is being held for the first time in Vietnam. I wish the conference every success.

I am very happy to know that in 1996 the International Livestock Research Institute conducted an assessment of livestock development needs and research priorities in Asia and that in this important conference scientists and policy makers from Asia will evaluate the ILRI recommendations as well as present their own governments' views on livestock development. I suppose this is a good chance for the representatives to exchange their experience and ideas for livestock development directions. At the same time the conference will create opportunities for strengthening co-operation and understanding between the countries in the continent in general, and between the country members and ILRI in particular.

The Vietnamese Government and people have been implementing an economic renovation policy step-by-step to industrialise and modernise agricultural activities, including livestock production. We are promoting agricultural diversification, encouraging and developing animal husbandry by smallholders to meet increasing demand of animal products, and to create more jobs and increase income for farmers.

Recognising the importance of science and technology, the Vietnamese Government has adopted the policy of facilitating the contribution of scientists, including livestock scientists, to the country. We attach the utmost importance to staff training and to exchanges of experience, especially with you, our international friends.

On this occasion, I would like to express my sincere thanks to the Consultative Group for International Agricultural Research (CGIAR), ILRI and ILRI's General Director for initiating this important meeting. I would also like to thank the participants for visiting our beautiful country. I know you will develop a good impression of our hospitality and friendship in a very short and valuable time.

I hope that after this important conference, the co-operation between countries in Asia in livestock development and research will be strengthened, and that the livestock industries will be developed for the prosperity of each country and for better lives for farmers.

Finally, I would like to wish all distinguished guests and representatives every success in your discussions. I trust that the conference will be worth while. I am pleased to declare this conference open.

Thank you.

Appendix II

**Programme for ILRI's Conference on Development
of Livestock Research Priorities in Asia
13–15 May 1997**

Tuesday, 13 May

- 0830–0900 Registration
0900–1000 Official welcome
Le Viet Ly, Vice Director, NIAH
Introduction to participants
Nguyen Dang Vang, Director, NIAH
Hank Fitzhugh, Director General, ILRI
Official opening
H.E. Nguyen Cong Tan, Minister of Agriculture and Rural Development
1000–1030 *Coffee/tea break*

Session 1: Assessment of livestock research development priorities

- 1030–1045 ILRI—International livestock research for Asia. *Hank Fitzhugh*
1045–1100 Conference organisation and outcomes. *Shaun Coffey*
1100–1145 ILRI in Asian livestock development. An assessment of Asian animal agriculture. *John Vercoe*
1145–1230 Improvement of livestock production in crop–animal systems in rainfed agro-ecological zones of South East Asia. *C. Devendra*
1230–1300 General discussion
1300–1400 *Lunch break*

Session 2: Country reports and key issues

- 1400–1420 Bangladesh
1420–1440 Bhutan
1440–1500 India
1500–1520 *Coffee/Tea break*
1520–1540 Nepal
1540–1600 Pakistan
1600–1620 Sri Lanka
1620–1640 Cambodia
1640–1715 General discussion
1930–2100 Welcome dinner, hosted by *Hank Fitzhugh*, Director General, ILRI

Wednesday, 14 May

Session 2 (Continued)

- 0830–0850 Laos
0850–0910 Myanmar

0910-0930	Vietnam
0930-0950	China
0950-1020	<i>Coffee/tea break</i>
1020-1040	Indonesia
1040-1100	Malaysia
1100-1120	Philippines
1120-1140	Thailand
1140-1220	General discussion
1220-1330	<i>Lunch break</i>

Session 3: ILRI vision, mission and goals

1330-1400	Introduction, <i>Hank Fitzhugh</i>
1400-1430	Ruminant genetics, <i>Tony Irvin</i>
1430-1500	Health improvement, <i>Tony Irvin</i>
1500-1530	Crop-livestock systems, including policy, <i>Hugo Li Pun</i>
1530-1600	Feed resources, <i>Jean Hanson</i>
1600-1630	Strengthening partnerships with NARS, <i>Michael Smalley</i>

Thursday, 15 May

Session 4: Workshops—ILRI and the major issues

0830-0945	Plenary identification of key issues
0945-1115	Workshop discussion groups on key issues in South-East Asia, South Asia and on key cross-cutting issues
1115-1215	Group reports to plenary session

Session 5: Identifying the way ahead

1215-1230	Formulation of new working groups
1230-1330	<i>Lunch break</i>
1330-1700	Working groups
1730-1930	Visit to National Institute of Animal Husbandry

Friday, 16 May

0830-1145	Reports from working groups and discussion of major outcomes and draft actions
1145-1230	Official closing of the Consultation
1230-1800	Field trip to the Ba Vi Cattle Research Centre and Goat and Rabbit Research Centre
2000	Dinner hosted by the Ministry of Agriculture and Rural Development

Research priorities in individual countries

This section presents the research priorities in individual countries that were made at the conference. They highlight the relevance to these countries of the research priorities recommended for ILRI in Asia. Some countries have re-emphasised the main constraints and major issues to livestock improvement, and these are indicated. Others have indicated ways in which their countries might participate in collaborative research. China also identified ten research projects relevant to South China which ILRI should participate in, and also indicated matching funds from the national programmes.

Bangladesh

Research priorities

- Increasing the availability and improving the quality of conventional and non-conventional feeds for livestock and maximising their utilisation
- Determination of the epidemiology and development of effective control measures of the most serious infectious livestock diseases
- Development of potent local vaccines for newly emerged, as well as for existing, livestock diseases
- Evaluation of production efficiency of dairy cattle types for urban and rural systems and designing appropriate breed improvement programmes for Bangladesh
- Breed improvement programme for buffaloes and selective breeding for Black Bengal goats
- Draft power improvement
- Development of suitable scavenger chickens and ducks for village use
- Generation of technologies for storage, preservation and processing of livestock products to improve quality standards determined by consumer preference and competition for products
- Livestock production and industry economics
- On-farm livestock research
- The development of multiple ovulation embryo transfer technique, and establishment of molecular biological techniques in the quick and efficient diagnosis of livestock diseases

Bhutan

Major issues confronting the future development of the livestock sector

- Controversy and issues around biodiversity
 - Preservation of existing breeds: which animals/breeds warrant preservation, how can they be best preserved?
 - Preservation of wild animal species: how can we combine a large population of wild animal species with livestock and agricultural production?
- Access to resources and stability of resource bases
 - Rules and regulations on land and forest resources
 - Increasing cattle, yak and wild animal populations puts high pressure on resource base and threatens its stability
 - Credit facilities
 - Growing interest from other sectors such as parks/wild life sanctuaries, hydro-power projects and forestry which infringe on the traditional resources for livestock production

- Geophysical conditions of the country. Tremendous variations in climate and access to markets lead to
 - Wild range of production systems with specific research and development needs
 - Problems in setting research and development priorities
 - Difficulties in identifying suitable technologies for the prevailing conditions
- Economic issues
 - Market for livestock products
 - Opportunities for rural population other than agriculture and livestock will influence the economic threshold for livestock production
 - Sustainability of extension programmes in animal health, fodder production and use
- Social resistance against culling of animals
 - The Buddhist religion inhibits the taking of life. In many parts of the country, there is a strong resistance by the community against selling animals for slaughter. A large percentage of livestock population is unproductive
- Mithun crossbreeding
 - Traditional crossbreeding programmes optimise heterosis effect but do not allow for selection and development of stable and productive dairy breeds

Areas for collaborative research

- Description of traditional livestock breeds and realistic methods for their preservation
- Development of socio-economic and monitoring research methodologies for existing development programmes in animal health and fodder

Cambodia

Main constraints to livestock production

- High rate of mortality caused by some contagious diseases
 - For cattle and buffaloes (haemorrhagic septicaemia, blackleg, foot-and-mouth disease and anthrax)
 - For pigs (swine fever, pasteurellosis and salmonellosis)
 - For chickens (Newcastle disease and cholera)
 - For ducks (cholera)
- Feeds (quantity, quality and relatively long dry season)
- Poor quality breeding animals
- Shortage of funds
- Inadequate materials, equipment and transportation for vaccination campaigns
- Inadequate staff in the field
- Communication difficulties
- Limited government support services, research and extension
- Lack of mass media information systems
- Limited access to credit for small farmers

Research priorities

- Integrated farming systems involving crops/livestock/fish
- Causes of the haemorrhagic septicaemia outbreak in cattle and buffaloes

- Fodder tree production for smallholders
 - Sugar cane for cattle and buffalo feeding
 - Duck weed for pigs and duck feeding
- Breed improvement by using artificial insemination
- Need for ILRI support for advice on improvement of livestock husbandry and animal health

China

Research priorities and projects

Name of project	ILRI contribution ('000 USD)	Matching funds from China ('000 USD)
Protection and utilisation of animal resources, including buffaloes, yellow cattle, sheep, goats and geese	200	200
Study of household crop-animal sustainable systems and economic analysis in different agro-ecological and economic zones of South China	180	200
Production structure and model of the food-economic plants-feed stuff agricultural patterns and production model of feed stuff to meet animal needs	200	300
Exploitation of grassland resources and the model of crop-animal production, including improvement of the grasslands and pasture production technique	200	300
Nutrient requirements and feeding standards of ruminants in South China	180	580
Study of the dynamic environment change for animal production in South China	240	400
Improvement of the production and utilisation of feed stuff resources, including by-products and forages in agriculture in South China	300	800
Control of the main diseases, including the production of vaccine for foot-and-mouth disease and the control of helminthiasis in cattle and sheep	220	600
Nutrient recycling and crop-animal production systems	400	2000
Exchange and training of researchers and information exchange	400	400

Research institutes suggested by the China Academy of Agricultural Sciences (CAAS) for co-operation with ILRI

- Institute of Animal Science
- Institute of Agro-Economy
- The Institute of Rice Science
- The Institute of Buffalo Science
- The Institute of Veterinary Science in Lanzhou
- The Institute of Parasitosis Science

Relationship with ILRI

China can co-operate with ILRI through its many research institutes, scientists and technicians, equipment and facilities. The national and provincial levels have interest in co-operating with ILRI. China welcomes

ILRI to set up a liaison station in Beijing. CAAS will attempt to facilitate ILRI's co-operation with China to improve the development of animal production in South China, as well as facilitate ILRI's own development.

Indonesia

Research priorities

- Method of setting up priority areas relevant to commodity–species–disciplines
- Relevance of the Central Research Institute for Animal Sciences (CRIAS) priorities with ILRI priorities for the Asian region
 - Feed resources: fodder, legumes, rumen microbes manipulation
 - Animal health: disease-resistant breeds, vaccine development
 - Identification of superior local genotypes and composite breeds
 - Environmental protection and sustainability—starbio, bioplus and residues detection in animal products
 - Classification of agro-ecological zone for different production systems
 - Scientific exchange, training and recruitment of staff
 - Exchange of information—internet, web site, catalogue

Areas of national strength

The Central Research Institute for Animal Sciences co-ordinates two research institutes: the Research Institute for Animal Production (RIAP) and Research Institute for Veterinary Science (RIVS).

- RIAP is responsible for livestock production research on breeding, reproduction, nutrition, biotechnology, feed technology, production systems, post-harvest, agrostology, socio-economics and commodity analysis. It has 42 PhD, 39 MSc, 56 BSc, an annual government budget of Rp 2.5 billion and funds from the World Bank and the Asian Development Bank (ADB). It carries out collaborative research with the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australian Centre for International Agricultural Research (ACIAR), United States Agency for International Development (USAID), Food and Agriculture Organization of the United Nations (FAO), universities, the private sector and professional associations.
- RIVS is responsible for research in animal diseases and veterinary medicine including virology, bacteriology, parasitology, mycology, toxicology, pathology, epidemiology and biotechnology. It has 15 PhD, 26 MSc, 90 BSc, an annual government budget of Rp 1.8 billion and funds from the World Bank and the ADB. It carries out collaborative research with ACIAR, USAID, the British Overseas Development Administration (ODA), universities, the private sector and professional associations.

India

Research priorities and future programmes

- Bio-informatics, genetic evaluation, biological markers and production of quality male germplasm
- Development of latest diagnostics and vaccines for augmenting animal health
- Crop–livestock integrated farming systems
- Feed resource utilisation and improvement
- Improved reproductive efficiency
- Socio-economic analysis, policy issues and developing alternative technologies

Collaborative research

The Indian Council of Agricultural Research (ICAR) can contribute in strengthening livestock improvement programmes in the following areas.

- Buffalo development
- Supply of superior germplasm and breeding strategies for improvement in livestock
- Germplasm processing and semen freezing technology
- Reproductive biotechnology (ET, IVM and IVF)
- Rural livestock management and productivity
- Co-operative movement for smallholder farmers
- Semi-intensive poultry production including backyard poultry development
- Nutrient requirements and germplasm evaluation
- Straw enrichment and urea–molasses blocks
- Resource management
- Human resource development including degree programmes and specialised vocational training

Laos

Present constraints

- No international quarantine station in the strategic border areas
- No international markets, marketing channels and international trade arrangements
- Lack of sufficient, well-trained and skilled manpower as well as technical know-how
- Insufficient annual budget and assistance in this matter
- Lack of adequate understanding of smallholders and their participation and that of the sector

Major issues and priorities for livestock development

- Livestock production in different agro-ecological zones
- Animal health
- Promote livestock production for smallholders
- Forage improvement
 - Research on grass-legumes for different agro-ecological zones
- Genetic improvement
 - Cross-breeding
- Production systems
 - Characterise prevailing production systems
 - Improve production to commercial sector

Priority projects

- Study on Yellow cattle
- Urea-treated rice straw and agricultural by-product utilisation
- Production of urea–molasses blocks

- Mineral deficiency and supplementation in Xiengkhoung Province
- Selection and introduction of grasses, legumes and fodder trees for different agro-ecological zones
- Cut-and-carry fodders for smallholders and pasture development for commercial livestock owners
- Introduction of selected acid tolerant grass cultivars

Malaysia

Research priorities

- Feed resources and nutrition
 - Production of local feed crops
 - Improvement of oil palm and rice by-products as feeds
 - Utilisation of forages for integrated and semi-intensive systems
 - Feeding strategies for efficient feed utilisation
 - Feed budgeting
 - Feed additives
 - Nutrient (protein and energy) and mineral supplementation
 - Nutrient partitioning
 - Rumen ecology for improved feed utilisation
 - Determination of nutrient requirements
- Animal genetic resources and breeding
 - Breed evaluation for suitability to tropicalised environment
 - Development of national breeding schemes for ruminants
 - Early selection using molecular techniques
 - Improvement in fertility rates and multiplication of superior breeding stock through reproductive biotechnological techniques
 - Molecular approach to identification of superior stock
 - Overcoming reproduction problems
 - Development of unexploited potential meat sources
- Animal health and diseases
 - Epidemiology and control of diseases
 - Disease diagnosis
 - Development of novel diagnostic techniques and diagnostic kits
 - Development of improved diagnostic test kits by molecular methods and biotechnology
 - Disease monitoring and surveillance
 - Epidemiological study of diseases by conventional and molecular methods
 - Epidemiological modelling of economically important diseases
 - Disease control and eradication
 - Development of local and improved (hybrid) vaccines
 - Development of therapeutic medicaments for parasitic diseases
 - Development of biological control
 - Development of immune enhancers and novel delivery systems for vaccines
- Environmental protection and sustainability
 - Waste management from intensive systems
 - Pollution abatement and effluent management through good agricultural practice
 - EIA guidelines for livestock
 - Sustainable livestock–tree crop production system

- Livestock production modelling and simulation
- Heat stress management
- Nutritional manipulation to improve production efficiency
- Training and information exchange

Nepal

- Research priorities
- Animal and crop agriculture as mixed farming systems
 - Transhumance animal-keeping system (yak, chauries, sheep, goats, musks) in the mountains and the Himalayan rangeland supported by horticultural pastures, buckwheat, millet, potato and wheat production systems
 - Integrated livestock (ruminants and non-ruminants) with crop production (rice, maize, millet and wheat) including vegetables and fruits and agroforestry particularly in the mid-hill regions
 - Rice/wheat-based livestock (cattle and buffalo) production systems particularly in the Terai region
 - Dry and upland crop with small ruminant and non-ruminant production system
 - Smallholder mixed farming systems
- Production and utilisation of feed resources
 - Forage production from marginal land in the mid-hill and Terai regions
 - Agroforestry in the mid-hill region
 - Range management, horti-pasture and silvi-pasture in the mountain and high hill regions
 - Stall feeding, cut-and-carry systems for animals
 - Development of suitable varieties of pasture, forage and fodder tree species
 - Conservation of feed resources
 - Crop residues and agro-industrial by-products
 - Utilisation of balanced feed formulation for different animal production systems in different agro-ecological zones
- Biodiversity and animal breeding
 - Genetic improvement and maintenance of genetic diversity of different breeds of livestock, poultry and fish
 - Heat synchronisation and controlled breeding
 - Crossbreeding through artificial insemination (AI) for determination of appropriate blood levels
 - *Ex situ* and *in situ* conservation of animal genetic resources
 - Selection within indigenous breeds
 - Development of new breeds or strains of different domestic animals and birds
- Animal health improvement
 - Improve disease diagnosis and treatment of prevailing diseases (khari, setariasis, mastitis, infertility, foot-and-mouth disease, RP, PPR, tuberculosis, brucellosis and parasitic diseases)
 - Vaccine production and distribution
 - Evaluation of herbal drugs and traditional remedies
 - Identification of toxicological plants and their remedies
 - Study of residual effects of various drugs
- Socio-economics and policy analysis
 - Investment and impact analysis
 - Trade and transit (GATT)
 - Exports and imports of live animals and their products
 - Pricing and credit policy of breeding animals, animal products and value-added products such as carpets

- Quality control of animal products, feeds and feeding, biological products
- Environmental issues
- Drug manufacturing, export, import, storage, supply, sales and distribution
- Strengthening of research capability
 - The Nepal Agricultural Research Council (NARC) was recently established as an autonomous organisation. NARC wants to urgently develop divisions and commodity programmes with subject-matter specialists who can use newly developed technologies to boost livestock/fish production in the country. The following suggestions are made.
 - ILRI does not yet have a well-established regional livestock research station in the Asian region. Nepal would appreciate if ILRI establishes a regional livestock research station in Nepal to build up research capability
 - Strengthening livestock research capabilities at regional research stations as a multipurpose farming system
 - Presently ODA, the World Bank, the Advanced Technology Support Program (ATSP), Japan International Cooperation Agency (JICA), the International Service for National Agricultural Research (ISNAR), the German Agency for Technical Cooperation (GTZ) and the ADB are helping through financial, training expertise and logistic support
 - Post-graduate study programme for scientists
 - Collaboration with international research institutes for post-doctoral fellowship, laboratory establishment and for basic research
- Natural resource management (soil, forest, water, energy and germplasm). Research areas include land degradation, loss of soil nutrients, deforestation, water quality and waste management. The research needs are as follows:
 - Land use pattern in diverse agro-ecological zones
 - Protection of soil erosion from natural or man-made calamities
 - Study of proper and hygienic waste management
 - Proper and efficient use of surface and ground water for quality production
 - Selection of plant species for afforestation that grow faster and provide sufficient fodder, fuel and housing materials
 - Selection and conservation of disease-resistant, hardy, dual-purpose breeds for sustainability of livestock production
 - Integration of efforts of the various national/international agencies for better protection of these scarce resources
 - Political commitment

Philippines

Research priorities

- Breeding and genetics
 - Genetic improvement, use and conservation
 - Genepool
 - Progeny testing
 - Germplasm and data bank
 - Priority projects of the Philippine NARS
 - Carabao improvement
 - Philippine chicken
 - UPD
 - Dadiangas goat
 - Data bank

- Technology management
 - Ongoing programmes
 - Farmers' information and technology systems
 - Farmers–scientists bureau
 - Applied communication
- Biotechnology
 - Focused on water buffalo development
 - Breeding and production (IVF, IVM and ET)
 - Rumen microbiology—strategic supplementation
 - Animal health—immunology and vaccine development (FMD)
 - Other current efforts
 - Enzyme technology for non-ruminant nutrition
- Production systems
 - Current efforts
 - Coconut–ruminant production
 - Upland crops–chicken
 - Other production systems
 - Mature technology
 - Lowland rice–pullet–duck production
- Policy studies
- Management systems
 - Reducing neonate mortalities
 - Management practices for pregnant, lactating and young animals
 - Improvements on existing housing facilities
 - New housing design

Collaboration with ILRI

The Philippines is committed to collaborating with ILRI through the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), particularly in the following areas:

- Biotechnology for the improvement of the carabao (water and riverine buffaloes). The Philippine Carabao Center is the lead institution.
- Breeding and genetics on the improvement, use and conservation of priority livestock resource other than the carabao.
- The development of production strategies for small ruminants as a business enterprise particularly when raised under coconut farms.
- The Philippine livestock NARS is well organised with specific mandates and roles among the members of the network. The medium-term research and development (R&D) plan is focused and the limited resources are directed to address priority needs.
- The Agriculture Commission, created and based at the House of Senate, has almost completed its task of identifying needs to modernise agriculture. The Commission recognises the role of research and development for food production and national development. The livestock sector is a beneficiary in this exercises

Sri Lanka

Major issues

- Scarcity or fragmentation of land
- High cost of inputs
- Climatic and management stresses
- Low productivity of improved animals
- Need for fair pricing and better organised markets
- Political awareness of farmers

Research priorities

- Identification and characterisation of farming systems
- Attributes of indigenous breeds
- Development of a synthetic dual-purpose goat breed
- Development of strategies for better utilisation of feed resources
- Indigenous fodders and forest livestock systems
- Epidemiology of HS, BQ, FMD and identification of underlying factors
- Improve efficacy of vaccines and diagnostics with new biotechnologies
- Epidemiology, pathogenesis and control of parasites

Support from ILRI

- Exchange of information and scientists
- Co-ordination of regional programmes
- Facilitation of inputs from donors
- Research and services
 - Characterisation of native breeds
 - Modelling of farming systems
 - Introduction of new biotechnologies
 - Environmental impact of livestock

Thailand

Research priorities

- Ruminant animal production of indigenous species and breeds
- Feed resources for ruminants
- Research on biotechnology for improving animal feeds, management and conservation of local non-ruminant animals
- Information exchange and improved extension for smallholders
- Strengthening national livestock research and development
- Research collaboration with ILRI

Thailand Research Fund

Thailand has recently set up the Thailand Research Fund (TRF), which is an autonomous research funding agency in the Prime Minister's Office. The funds for TRF come from annual budgets to support multidisciplinary research. An example of a research project approved is dairy research, which has an earmarked budget of US\$ 5.8 million. A research project can include costs of graduate training, technical meetings, research-related items and publications. Experts and researchers from outside Thailand can be involved should this be required. Regional collaboration can be initiated through regional training activities and through research networks. Good opportunities exist for regional co-operation through the TRF.

Vietnam

Research priorities

- Feed resources
- Animal genetic resources
- Animal health
- Institution building
- System analysis
- Socio-economics and policy

Relationship to ILRI

We strongly support ILRI's initiative in supporting Asian countries in the development and improvement of livestock in the region. The National Institute of Animal Husbandry (Chem, Tu Liem, Hanoi, Vietnam) should be one of the key institutions for collaboration with ILRI and other NARS. The NIAH will co-operate with the Institute of Agricultural Sciences of South Vietnam and other universities in the country in research network and information exchange.

Recommendations

We appreciate the attention and support given to Indo-China in the proposals made by the Steering Committee and the specific report by Dr Devendra et al. The following are relevant:

- The first recommendation is to emphasise the need for staff training. We urge ILRI to support Vietnam in strengthening the capacity of the disease diagnosis laboratory.
- Vietnam supports the initiation of a crop-animal production systems project and wishes to be an active member.
- Vietnam is ready to share the experiences in establishing integrated systems in agriculture. It is also ready to take part in the training courses organised in the region including providing demonstration sites and exchange of experts.

ILRI: Mission, vision, programme and collaboration

H. Fitzhugh

Origins

The International Livestock Research Institute (ILRI) began operations in 1995 with the consolidation of two Consultative Group on International Agricultural Research (CGIAR)-sponsored livestock research centres: the International Laboratory for Research on Animal Diseases (ILRAD), in Kenya, and the International Livestock Centre for Africa (ILCA), in Ethiopia. Integration of the laboratory-based strategic research of the former with the field-based production system research of the latter created the first international research institute to address the severe problems of tropical animal agriculture in a holistic way.

Mission and vision

ILRI's mandate is global. Its research products are designed to raise livestock productivity without depleting the natural resources on which farming depends. ILRI's mission is to enhance the wellbeing of present and future generations in developing countries through research that improves sustainable livestock production.

Consistent with the above mission, ILRI has the following vision:

- to serve the priorities for development-oriented livestock research
- to deliver livestock research outputs that improve the wellbeing of poor people
- to develop and sustain full partnerships for international livestock research
- to assist in the identification of priorities and mobilisation of resources for international livestock research

Programme, staff and products

ILRI's strengths, facilities, location and partners give it comparative and competitive advantage in conducting research in tropical crop–livestock systems and ruminant genetics, health and feed resources, and strengthening collaboration with NARS. These programme areas address primarily smallholder crop–livestock systems in arid, semi-arid, humid, subhumid and highland agro-ecological zones, and societies in transition from subsistence to a market economy. The major scientific fields represented at the institute are cell and molecular biology; molecular and quantitative genetics; immunoparasitology; bovine immunology; epidemiology; animal science, nutrition and breeding; farming systems, ecology and socio-economics and policy. ILRI is the lead centre for a CGIAR System-wide Livestock Programme (SLP) to improve livestock feed resources and natural resource management in mixed crop–livestock production systems.

To fulfill its global mandate, ILRI is expanding its research work from sub-Saharan Africa to tackle high-priority livestock problems in Asia, North Africa, Latin America and the Caribbean. ILRI's activities are organised under three programmes, Biosciences, Sustainable Production Systems, Strengthening Partnerships with NARS, each headed by a director. The principal areas of interest under each programme are:

Biosciences

- ruminant genetics
- ruminant health
- ruminant feed resources

Sustainable Production Systems

- systems analysis and impact assessment
- livestock and environment
- market-oriented smallholder dairy
- livestock under disease risk
- livestock policy analysis
- system-wide livestock programme

Strengthening Partnerships with NARS

- training, information and networks

ILRI's research products include maps of bovine and protozoan genomes, improved vaccines and diagnostics, integrated disease-control strategies, economic and systems models, policy analyses, GIS-based decision-support systems, a tropical forage gene bank, technologies for incorporating forages onto smallholder farms, systems that improve feed supplies for smallholder dairy producers, feeding strategies for multiple purpose livestock (dairy-draft cows), and animal traction technologies that improve the productivity of heavy clay soils. ILRI's research products and related outputs are disseminated through an outreach programme that works to strengthen collaborations with and capacities within the national agricultural research systems of developing countries.

One hundred and ten internationally recruited scientific and administrative staff work at ILRI headquarters in Kenya and Ethiopia and with interdisciplinary teams of scientists based in Nigeria (International Institute of Tropical Agriculture (IITA) headquarters), Niger (ICRISAT's Sahelian Center), Burkina Faso (Centre International de Recherche-Développement sur l'Élevage en zone Sub-humide (CIRDES) centre) and India (ICRISAT headquarters). Another 769 supervisory and support staff are recruited from Kenya and Ethiopia, ILRI's co-hosting countries, in about equal numbers.

Collaboration and partnerships

ILRI research and research-related activities during the medium term will be conducted through partnerships that leverage ILRI's limited human and financial resource. These partnerships involve:

Scientific networks

ILRI scientists are contributing in world-wide networks of advanced research institutes, which collaborate on strategic research in genome mapping, tick-borne disease, helminth resistance, rumen ecology, GIS, conservation of genetic resources, improving utilisation of crop residues, *inter alia*.

Ecoregional consortia convened by CGIAR centres

Currently, ILRI interdisciplinary research teams are contributing to the Desert Margins Programme, the Ecoregional Programme for the Humid and Subhumid Tropics of SSA (EPTHA) and the East African Highlands Programme. Through the medium term, ILRI will contribute to the Tropileche consortium and the Consortium for the Sustainable Development of the Andean Ecoregion (CONDESAN) in Latin America and to subregional consortia in Asia and in the WANA region. The ILRI-led SLP will support livestock-related research by ecoregional consortia.

Multi-institutional initiatives

These include collaborative research on market-oriented smallholder dairy in East Africa and characterisation of indigenous animal genetic resources and involvement in the Confederation of Research Institutes Supporting Livestock Development in Tsetse Affected Areas of Africa.

System-wide programmes

ILRI convenes the SLP and the Inter-Centre Training Programme for sub-Saharan Africa and contributes to the System-wide Genetic Resources Programme, the System-wide Programme on Integrated Pest Management, the Property Rights and Collective Action Initiative, and the System-wide Soil Water Nutrient Programme.

Outsourcing

ILRI favours outsourcing when another institute has capacity and comparative advantage to undertake research for which ILRI is responsible. ILRI will also contract research to private and public institutions in developed and developing regions. ILRI will contract with commercial companies to develop and market biotechnological products on condition that products remain affordable for resource-poor livestock owners.

Animal genetic resources in Asia

T. Irvin

Concern about reduction in genetic diversity has been expressed primarily in terms of loss of breeds and strains. For the common livestock species such as cattle, sheep, goats and pigs, especially in the developed world, breeds are well defined and recognised as distinct intraspecific groups, the members of which share particular characteristics which distinguish them from other such groups, and formal organisations usually exist for each breed or breed group. In the developing world, breeds are not generally clearly defined in this way, yet there exist strains or geographically separated populations with potential for exploitation because of desirable traits such as disease resistance, adaptation to poor quality feeds or heat tolerance. Any selection or conservation of such strains or breeds will require characterisation to elucidate the unique genetic resources that are available.

Molecular genetic techniques, particularly those based on analysis at the DNA level, are the most accurate means of genetic characterisation. Complete characterisation of the different animal types must involve estimation of the genetic diversity and micro-evolutionary relationships through description of their genetic profiles. This will provide information as to which of these populations represent homogeneous breeds/strains and which of them are different. Such knowledge will enable decision-making regarding the choice of breeds for selection and conservation. Additionally, such genetic analysis could facilitate identification of genetic duplicates and/or separation of breeds on the basis of genetic distinctiveness. Pairwise genetic distances estimated among breeds/strains/populations of a species, and the single phylogeny constructed from these distances that best represents all the relationships among the breeds will aid objective and rational decision making in the choice of breeds for preservation, for utilisation and for evaluation studies to determine comparative genetic merit. Characterisation of the breeds in this way can then lead to identification of traits which may have potential for enhancing improved productivity. It is then possible to identify the genetic basis of these traits, phenotypic markers associated with the traits, and apply marker-assisted introgression techniques to introduce appropriate traits into more productive breeds. Ultimately, molecular genetic techniques can be applied to characterise the markers more precisely and even to identify and isolate the genes responsible for desirable traits. This then raises the prospect of introducing these traits through transgenic techniques into the genomes of other relevant breeds.

The measurement of genetic diversity within species and relationships among populations within species have been identified as priorities in the characterisation of domestic animal genetic resources (AnGR) by FAO and ILRI. ILRI scientists are currently involved in the molecular characterisation of African ruminant genetic resources—cattle, sheep and goats, and considerable capacity has been developed in this area. In the process of defining its global agenda for livestock research, ILRI has conducted extensive consultations in Asia to identify requirements and to set priorities for livestock research in Asia. These consultations have identified inadequate characterisation and poor utilisation of indigenous animal genetic resources as among the top constraints to livestock production in the region. Particular need for the characterisation of the bovini has been emphasised.

The current needs are to estimate genetic relationships among strains/breeds of different bovini and their relationships with their wild relatives; to estimate the extent of genetic diversity in these populations; to classify the strains/breeds on the basis of genetic distinctiveness in order to facilitate rational utilisation and conservation; to quantify the extent of genetic introgression into these populations by other breeds/strains, including closely related species; to build the capacity of Asian NARS in genetic characterisation of domestic animal diversity; and to assist NARS to develop appropriate breeding and selection strategies to exploit the wide livestock genetic diversity within the region.

If these objectives can be achieved, they will provide a basis for the classification of the populations into genetically unique categories and hence will facilitate a cost-effective assessment and choice of breeds or populations that have potential for selection and improvement or are in danger of extinction and thus need immediate attention.

An approach to characterising and identifying the potential of AnGR in Asia is through a three-way collaboration between ILRI, FAO and NARS. ILRI, through its Animal Genetic Resources Project, has established expertise in developing sampling protocols, marker selection and optimisation, genotyping and data analysis. Through collaboration with FAO, it would be possible to identify appropriate NARS and obtain logistical support for sampling through the national focal points already established through the regional project in 12 countries in the region. Selected NARS scientists would be involved in the genotyping either as collaborating scientists or as graduate fellows. ILRI's molecular genetics capacity, linked as necessary to other advanced laboratories, could be involved in the selection of markers, testing of these under different conditions, and exchange of samples to facilitate an envisaged 'global analysis' incorporating results from various studies involving different populations. In this context, ILRI already collaborates with scientists in Australia and Japan for work in Asia and has established strong links with other groups elsewhere in the world.

ILRI's Animal Health Improvement Programme (AHIP)

T. Irvin

Background

The contribution of livestock to the productivity and sustainability of smallholder farming systems can be severely compromised by ill health and diseases. However, disease is only one of the constraints which limit productivity in such systems. This means that improving animal health must form part of a strategy within which appropriate attention must also be given to improving management, nutrition and breeding in an integrated way. It is unlikely that any one intervention on its own will result in sustainable improvements.

Improving animal health must also adopt an integrated approach which includes: genetic improvement, improved management, chemotherapy, vaccination, vector control and diagnosis. Understanding the epidemiology of diseases in different farming systems will enable a correct balance of these interventions to be developed which are appropriate to different diseases and situations.

Current research within the AHIP

The AHIP currently focuses on improving control of tropical vector-borne haemoparasitic diseases (particularly theileriosis and trypanosomiasis, with increasing attention being given to heartwater, babesiosis and anaplasmosis) and helminthiasis of ruminant livestock, blending basic and applied research approaches to achieve programme objectives. These objectives are to improve methods for the control of ILRI's target diseases through development of new vaccines, improved diagnostics, non-immunological disease control techniques (including chemotherapy), genetically improved livestock resistant to disease, and strategies that incorporate these research products into an integrated approach appropriate to different regions and production systems.

The strength of the AHIP lies in ILRI's comparative advantage in ruminant immunology, molecular genetics, molecular biology, pathobiology, vector biology, chemotherapy, epidemiology and the development of diagnostic tools to support livestock disease control programmes and improved vaccine technologies. Activities in these areas are in turn linked to other research programme areas within ILRI's overall research programme. These include impact assessment, policy, crop-livestock systems and socio-economics. Effective integration of these disciplines provides a holistic approach to addressing disease control. This approach is exemplified by the work on development of the p67 vaccine against one of ILRI's main target diseases, East Coast Fever (ECF—*Theileria parva* infection of cattle). This work was initiated on the basis of epidemiological and socio-economic studies which showed the serious impact of ECF, particularly on smallholder dairy production in East and Central Africa, the inadequacy and limitations of current control methods (including a rather crude infection-and-treatment method utilising live, potentially lethal organisms for immunisation) and the demand from smallholder dairy farmers for a better vaccine. Fundamental molecular approaches were therefore adopted for identification and isolation of a protective antigen (p67) and production of this antigen in a bacterial expression system. From earlier work it was known that animals that recover from ECF are solidly immune to subsequent homologous challenge. In separate studies, therefore, the immunological mechanisms involved in protection were elucidated, and this information was used to study and analyse the effects of artificial immunisation with the p67 antigen. These studies led to formulation of an immunisation strategy combining an optimal formulation of antigen and adjuvant which induces protective immunity in cattle against the disease. In collaboration with colleagues in the epidemiological project areas, a protocol for field-testing and evaluation of the vaccine has been developed and field trials are about to begin. If these are successful, ILRI will evaluate the potential socio-economic impact of the vaccine and identify the most appropriate delivery mechanisms so that the vaccine can be applied in a way that is sustainable and affordable by smallholder farmers. This work offers

the first opportunity for control of this important disease with an assured quality and a safe product. A similar integrated approach is being adopted for trypanosomiasis, the other target disease with which ILRI is involved.

Another important approach being adopted within the AHIP is based on the fact that a number of indigenous breeds of livestock, which have evolved under natural selection pressures of disease, poor quality feeds and harsh environmental conditions, have acquired specific resistance traits to these selection pressures which enable them to survive and be productive in situations where less adapted and exotic breeds cannot survive. These resistance traits are under genetic control and are therefore inherited by subsequent generations. Currently, the work within the AHIP on genetics of disease resistance is focusing on trypanotolerance in cattle and resistance to helminth infections in sheep and goats to characterise and quantify the genetic basis of this resistance in indigenous breeds, and to identify phenotypic markers which can be used in marker-assisted selection and introgression programmes in order to exploit resistance genes more effectively by introducing them into more productive breeds. Again, this work forms part of an integrated approach to improving livestock productivity, which involves other relevant groups within ILRI in terms of molecular genetics through to exploitation of resistance traits within a farming systems context.

Potential role for the AHIP in Asia

At present, the AHIP research is focused primarily on cattle with some work (particularly on the genetics of resistance to helminths) in sheep and goats. Although there is generic research capacity in areas such as molecular biology and immunology, our mandate does not extend to include viral and bacterial diseases, nor is there expertise on diseases of pigs and poultry. However, the programme will be expanded to include buffaloes. The areas where the AHIP can contribute to livestock disease research in Asia are therefore limited and one of the main outcomes of the present meeting will be an identification of the complementary areas where the AHIP can interact with relevant groups within Asia. This identification and prioritisation will be done in the context of the following general considerations:

- Proposed activities should be clearly focused and reflect ILRI's comparative advantage and mandate
- Project activities should be developed which complement the indigenous capability in many Asian countries and that of ILRI in complementary ways
- ILRI must become better aware of what research has already been conducted in the region and of the key players in this research, both within Asia and from outside
- ILRI should articulate clearly what expertise it can offer Asia
- Partnerships should be developed with both NARS and relevant ARIs to tap existing knowledge and expertise, and to develop collaborative research

On the above basis, the following areas may be appropriate for consideration within the context of ILRI's AHIP:

- Improved diagnostics, especially for babesiosis, anaplasmosis and *T. evansi*, including technology transfer
- Strengthening veterinary immunology, especially linking to appropriate veterinary research institutes
- Quantitative epidemiology and economic impact of disease, in collaboration with relevant NARS
- Biotechnology, including recombinant vaccine technology (e.g. for *T. annulata*)
- Genetic characterisation of indigenous breeds (cattle, sheep and goats)
- Genetics of helminthiasis resistance in specific farming systems
- Theileriosis in small ruminants

The AHIP looks forward to the prospect and opportunity of forging links and developing collaborative projects with Asian partners along the lines indicated, and to exploring other opportunities for obtaining joint funding to conduct such work.

Sustainable Production Systems Programme: current activities and future opportunities

H. Li Pun

Programme objective

The main objective of ILRI's Sustainable Production Systems Programme is to improve human welfare through the development of more productive and sustainable crop-livestock systems in developing countries.

Background

With nearly 2.9 billion more people to feed in 2025 than in 1996 in the developing countries and with limited scope for expanding cropped land, the increased demand for crop and livestock products will continue to drive tropical agricultural systems towards intensification and market orientation. In smallholder systems there will be greater interdependence of livestock and crop enterprises, accompanied by increases in the use of inputs such as draft power, manure and fertilisers, crop residues and planted forages, more productive animal genotypes and disease control strategies. These issues define the programme's focus on market-oriented smallholder crop-livestock systems taking a holistic approach.

In order to improve the productivity and sustainability of these systems, biological, environmental and socio-economic constraints have to be overcome. Therefore, opportunities for changing the systems in a sustainable manner have to be carefully identified and chosen. Special attention needs to be given to understand the complexities and similarities of the systems across ecozones, identify, generate and adapt technologies and policies that have wide recommendation domains and applications.

There is a wealth of information and technology already generated throughout the developing world but its adaptability and applicability beyond its place of origin is rarely known. Therefore, a good start can be made by building up from existing knowledge through partnerships among the NARS and ILRI.

Ongoing activities

Currently the programme has activities under four themes in three ecoregions. Issues being addressed under each are briefly outlined below.

Systems analysis and impact assessment

- Conceptual frame work and methodologies for systems analysis
- GIS and database
- *Ex ante* impact assessment
 - Economic—vector-borne diseases
 - Environmental—trypanosomiasis
 - Measuring returns to research—vaccines, feeds, market-oriented smallholder dairy
- *Ex post* impact assessment
 - Fodder banks
 - Smallholder dairy

Livestock policy analysis

- **Balancing livestock productivity and environmental sustainability**
 - Assessment of policy options to enhance the role of livestock in food security and fragile land management
 - Identification of property rights institutions and policy interventions to diversify household assets, mitigate poverty and reduce environmental degradation
- **Improving livestock productivity and technology uptake**
 - Assessment of policy options to facilitate domestic dairy development
 - Evaluation of the reform of economic policies on livestock technology adoption and production
 - Evaluation of policies and strategies for delivery of animal disease prevention and control

Market-oriented smallholder dairy

- Understand the evolution of dairy systems in developing countries
- Identify constraints and opportunities for dairy development
- Develop and test technologies, tools and methods that have wide applicability

Improving livestock productivity under disease risk

- Develop strategies and programmes for using or selecting productive livestock with enhanced resistance to tropical diseases
- Develop decision-support tools for targeting trypanosomiasis control interventions
- Design integrated control strategies for priority environments and production systems

Highlands—Ethiopia

- Watershed management
- Crossbred cow traction
- Feed resources—production and utilisation
- Genetic resistance to helminths

Subhumid—Nigeria

- Livestock and vegetation dynamics
- Peri-urban dairy
- Feeding strategies
- Legumes in crop–livestock systems

Semi-arid—Niger

- Socio-economic analysis of livestock production and natural resources management
- Nutrient transfers
- Feed resources and nutrition
- Policy reforms—input and output markets

Research opportunities

One of the purposes of this meeting is to identify research opportunities for improving the productivity and sustainability of Asian production systems. The following is a tentative list of topics under three different themes that may be considered for discussion.

Systems analysis

- Characterise major production systems and their pathways of development
- Model and quantify energy flows between crop and animal subsystems
- Model effects of technology interventions on subsystem relations and overall system evolution
- Identify recommendation domains for various technologies

Feed and natural resources

- Integration of forages in cropping systems
- Synchronisation of feed supply with demand by animals throughout the year
- Development of feed packages using local resources
- Strategic utilisation of feeds
- Nutrient cycling involving manure as well as legumes in production systems
- Other livestock–environment interactions for resource conservation

Socio-economics and policy

- Forces driving intensification and commercialisation
- Macro-economic and sector policies affecting investment and commercialisation of livestock sector
- Bio-energetics, economics and sustainability implications of various feed production and utilisation systems
- Structure and efficiency of input and output markets
- Gender roles in livestock management and food security
- Potential loss in output due to constraints

Ruminant feed resources research

J. Hanson

Background and justification

Poor nutrition because of poor quality feeds and fluctuating feed supply is a major constraint to tropical livestock productivity. The need to supply greater quantities of quality fodder requires development of both new forages and feeding strategies that will enhance the efficiency with which conventional on-farm feed resources are used. Research at ILRI has identified a range of herbaceous forages and fodder tree species which can be used to alleviate the constraints of lack of feed and which can be incorporated as part of sustainable farming systems. In particular leguminous forages are an important, high quality feed for supplementation of the more abundant but lower quality crop residues available in many tropical areas. Fodder trees also provide an important source of feed and have considerable potential for increased use, especially in semi-arid areas where they often maintain green leaf into the dry season. In addition to livestock feed they also provide fertiliser in the form of mulch, fuelwood, poles and building timber, shade, shelter and windbreaks and can be used for soil stabilisation, soil water management and increasing soil fertility through nitrogen fixation. Such plants offer advantages over herbaceous species in terms of superior persistence, higher yields, better resistance to mismanagement and a capacity to retain high quality forage under stress conditions. However, the presence of phytochemicals in the leaves, pods and seeds of many species act as anti-nutritional factors and prevent their widespread use.

Recognising the importance of feed resources research as part of integrated efforts in increasing livestock productivity, ILRI will continue strategic research on the estimation of feed value and use of forages and crop residues and will link this with new research capacity in rumen microbiology and phytochemistry. This will concentrate on identification and detoxification of anti-nutritional factors in both fodder trees and crop residues. ILRI will make full use of its extensive germplasm collection of tropical and subtropical forage species in the identification and development of new forages to support livestock production in a range of farming systems and environments. Research aimed at assessing the value and improving utilisation of tropical feeds, including forages and crop residues, will be carried out in collaboration with ICRISAT and the International Center for Tropical Agriculture (CIAT) as well as NARS partners in ecoregional consortia.

Ruminant feed resources research at ILRI studies the interactions between feeds and rumen function and includes three projects which cover the forage resources, their linkages with rumen function and their utilisation by the animal.

Conservation and characterisation of forage genetic resources

Forage germplasm is an essential resource for developing adapted and productive plants for livestock feed, increasing animal nutrition and productivity. However, forage biodiversity is being eroded through destruction of habitat as land is taken into cultivation to meet the demand for food for the rapidly increasing population. There is an urgent need to conserve this resource and to characterise and use the material in development of new forages. ILRI maintains a large collection of over 13,000 accessions of over 1000 species of grasses, legumes and fodder tree species for use in the development of livestock feeds. This collection is held in trust by ILRI under the auspices of FAO as part of the international network of *ex situ* collections and ILRI has made a commitment to ensure continued access to and availability of the germplasm in its gene bank. The objectives of this project are to conserve and characterise forage biodiversity and to ensure its use in the development of livestock feeds.

The outputs of this activity will be a diverse collection of forage germplasm conserved according to internationally accepted standards to meet the commitment to FAO. The morphological, molecular and phytochemical traits of key species will be characterised and disease-free germplasm distributed for forage research and development. These forages will be used for feeding livestock which will improve animal nutrition and increase productivity with related improvements in diets and income of rural people, thus

helping to alleviate poverty. Conservation of biodiversity will ensure that this germplasm remains available for a long-term benefit for future generations and to meet future demands. Incorporation of forages in sustainable farming systems will have positive environmental effects.

Rumen microbiology for feed utilisation enhancement

Although the presence of anti-nutritional factors limit the use of some forages, adapted and wild ruminants have evolved rumen fermentation mechanisms to utilise these forages. There is the potential to exploit these adapted rumen microbes to better utilise fibrous feeds and forages containing anti-nutritional factors for improved livestock nutrition. The objectives of this project are to characterise rumen micro-organisms for their effects on rumen fermentation and detoxification of anti-nutritional compounds and to promote the use of better adapted strains for increasing nutritional status of tropical livestock.

The outputs of this project will be characterisation of rumen micro-organisms for improved ability to utilise fibrous feeds and detoxify anti-nutritional factors. Specific strains or genotypes of rumen bacteria, fungi or protozoa with enhanced capacity will be identified and made available for further use in tropical livestock. Information on the effects of plant toxins on rumen microbes will be used in selection of plant species for livestock feed. Identification and use of rumen microbes better able to degrade fibre and detoxify anti-nutritional factors in forages will promote increased nutrition for livestock through improved utilisation of poor quality feeds and leguminous forages. This will also allow development and use of sustainable and low cost livestock feeding systems by smallholder farmers, resulting in increased productivity and subsequently, increases in smallholder income, food security, and welfare.

Feed utilisation improvement for enhancing livestock productivity

Feed resources development and utilisation offer major opportunities for improving livestock productivity in the tropics. Ruminants in the tropical developing world depend on a fluctuating supply of poor quality native pastures, crop residues, and increasingly on fodder trees as protein supplements. Strategic research aimed at using better quality crop residues and changing the diet through strategic supplementation will have positive effects on digestion, reducing particle size, increasing microbial protein synthesis and the rate at which solid and liquid phases of the digesta pass out of the rumen. The objectives of this project are to develop improved methods for assessing nutritive value of tropical feeds, to improve feed utilisation and determine the relationships between feeds and productivity.

The outputs of this research will be a better understanding of the factors limiting the efficiency of utilisation of poor quality feed. Robust screening methods for feed quality traits will be developed to be used for selection of better quality crop residues. Improved feed efficiency will be achieved through modified rumen ecosystems and improved kinetics of fibre digestion.

Information on feed quality and the efficiency of feed utilisation by ruminants will be used in production systems research to develop feeding strategies to increase livestock nutrition and productivity. Improved utilisation of poor quality feeds will enhance livestock productivity, leading to a reduced need for supplementation and, therefore, economical and sustainable smallholder feeding systems. The improved diets, increased weight gains, reduced reproductive wastage and increased milk production will ensure food security, income and thus poverty alleviation. Increased use of fodder trees will also contribute to protection of the natural resource base by preventing or minimising environmental degradation.

Milestones

The milestones by which success will be measured over the medium-term will be:

- A range of well-documented forage germplasm (15,000 accessions) and identified superior forage genotypes (100 accessions) available for use by NARS' partners

- Simple and robust assays for feed quality deemed to be more pertinent to farmers developed and validated for use in national livestock research and extension services
- Characterisation of rumen microbes and generation of information on the effects of toxic plant compounds on these microbes
- Rumen microbe genotypes with enhanced ability to degrade fibre or adapted to anti-nutritional factors identified
- Validation studies *in vivo* completed for these selected microbes in domestic ruminants
- The effects of dietary composition, especially fodder trees, and fluctuating feed supply on rumen function and animal performance better understood.

Partnerships with NARS for technology transfer

M. Smalley

Introduction

The International Livestock Research Institute (ILRI) works through partnerships which are critical for two reasons: for collaborative research on key components and constraints and for the development, testing and transfer of technologies, based on farmer's needs.

ILRI continues to enjoy many partnerships, but the most important are those with colleagues in national agricultural research systems (NARS), and it is important that these partnerships be as effective and productive as possible, ultimately leading to the successful transfer of new technologies.

The ILRI programme designed to strengthen partnerships with NARS has a set of integrated activities:

- training and training materials development
- information products and services
- networking

This paper briefly presents ILRI's activities in each of these three areas, before outlining some ways through which NARS and ILRI might together begin to strengthen opportunities for future collaboration in Asia.

Training

ILRI is a research institute with a commitment to training. ILRI's training aims to build new research capacity for NARS and to strengthen and update existing capacity. The training that ILRI offers must fit into ILRI's research mandate and programmes, and the institute is unable to provide training on topics, no matter how important, that are not within ILRI's current research programme.

Graduate Fellowships

NARS scientists who are registered for MSc or PhD studies (and their equivalents) are selected to join ILRI research projects to complete all or part of their degree-related research. An ILRI scientist provides intellectual supervision as well as logistical support on behalf of the registering university. Applications to become an ILRI Graduate Fellow must come through the applicant's employer and registering university.

ILRI looks forward to assisting graduate students from Asian countries, who can fit into existing ILRI research based in Africa which has relevance to Asian animal agriculture, or into new ILRI research beginning in South and South-East Asia. To that end we are looking for new partnerships with universities in Asia that will allow students registered for postgraduate degrees to complete their degree research at ILRI, with joint university-ILRI supervision.

Research Fellows

NARS scientists working on topics related to ILRI's research come to ILRI for up to 18 months for non-degree training, usually on a specific research methodology, or to analyse.

Technical Associates

Technical or scientific staff from NARS spend up to six months at ILRI to learn new research techniques or methods.

Training courses

ILRI's training courses are typically for up to 15 people and last two to three weeks. They are based on ILRI research expertise and are targeted at technical or early-career scientific staff, and are intended to strengthen existing NARS research capacity.

Training materials

ILRI is giving increasing emphasis to the development of training materials that are based on ILRI's research and the use of examples relevant to students and scientists in developing countries. The institute's training materials are also designed for self-instruction and distance learning.

Information Services

ILRI has established a substantial library and documentation service for the benefit of its scientists and partners. There are limits to the information service we can provide, and we are currently examining new ways through which we can usefully support NARS scientists.

ILRI libraries

ILRI libraries in Ethiopia and Kenya contain over 60,000 books and 25,000 bound journals; over 1600 journals are regularly acquired. The library collection covers all the main disciplines of animal agriculture. The libraries include an in-house bibliographic database of over 100,000 records.

ILRI also collects non-conventional or gray literature. It is estimated that almost 50% of the literature on animal agriculture is in the form of reports, unpublished documents and theses—the gray literature. Much of this literature has great value to all scientists, but particularly to scientists within the same region or comparable farming systems.

ILRI also publishes information products on CD-ROMs. The first version of three bibliographic databases on one CD-ROM recently produced contains:

- animal agriculture in Africa, based on the library holdings of six international research organisations
- a global database on animal traction
- selected records from ILRI's main bibliographic database

Networks

ILRI has provided co-ordination to a number of NARS networks involved with small ruminant, cattle and feed resources research. The networks are restricted to African countries and are presently being re-organised into three multidisciplinary networks. These networks are designed to strengthen NARS research capacity, encourage a peer-review process within NARS, and support multi-site collaborative research between NARS scientists in different countries.

Networking can be a very effective way of sharing resources, but time consuming to co-ordinate and all too rarely becomes financially self-supporting. For these reasons ILRI will join and encourage existing networks in Asia wherever possible.

ILRI and NARS in Asia

Priorities for strengthening research capacities

The NARS-ILRI consultations in Asia have concluded that there is need for training on farming systems research that integrates food crops-trees-livestock; and on the linkages between research-extension-users. Some countries have expressed the need for training on feeds and feed utilisation, socio-economics and policy

issues, and for animal health research, particularly incorporating the use of biotechnologies. Existing courses available in Asia will be surveyed to ensure that ongoing training is not duplicated. An important product from the courses will be the development of training materials, using Asian case studies, to be used in national and regional training programmes.

ILRI is also looking to establish links with key universities in Asia for the co-supervision of Asian students within ILRI research projects.

Information services and knowledge products

The consultations have shown that many NARS institutes in Asia lack access to current literature. ILRI has already completed the first phase of a global review of libraries that have literature on animal agriculture. This survey will be extended to cover more libraries in Asia and then it will be possible to plan how to network libraries together to share resources and better serve livestock research in Asia.

ILRI has also started work on a bibliographic database of Asian literature on animal agriculture. So far over 10,000 documents have been identified. The database, to be published on CD-ROM, will provide researchers with a consolidated source of the literature on regional animal agriculture. The first version of this bibliographic database will be ready by early 1998. Secondly, ILRI is developing a library of ILRI publications on a disk that will include all ILRI technical publications complete with references and graphics, and which will be fully searchable. This will also be ready by early 1998.

South-south technology transfer

ILRI can play an important role in encouraging the sharing of experiences and transfer of technologies between scientists in Asian countries, and between those in Asia and Africa.

There are many areas where these exchanges will have wide value and benefit. For example, with smallholder dairy production, scientists in India have world-wide recognised expertise in this area, and many scientists in other Asian countries, and in Africa, who are also working on smallholder dairy research, have much to share with colleagues elsewhere. There need to be opportunities for this sharing to occur.

A series of well-structured extended seminars and workshops is envisaged that will bring together experts from different countries and regions for discussions that will lead to a cross-fertilisation of ideas, experiences and research methods ultimately leading improved research and technology development, and the publication of these to reach as wide an audience as possible.

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