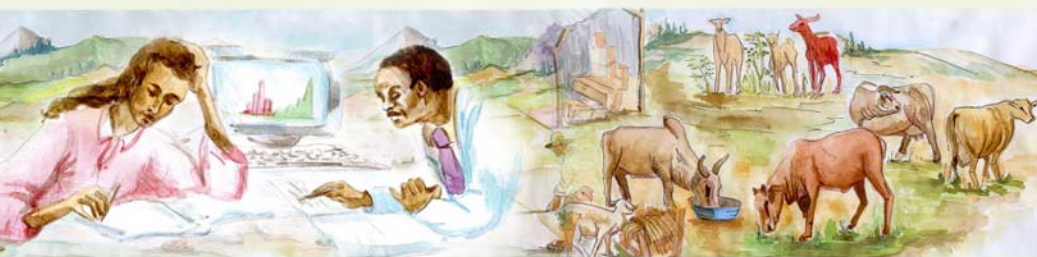


10 Years

1992–2002

Livestock Policy Analysis



ILRI

INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

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ISBN 92-9146-155-5

Correct citation: Ehui S.K., Ahmed M.M., Berhanu Gebremedhin, Benin S.E., Nin-Pratt A. and Lapar Ma.L. 2003. *10 years of Livestock Policy Analysis. Policies for improving productivity, competitiveness and sustainable livelihoods of smallholder livestock producers*. ILRI (International Livestock Research Institute), Nairobi, Kenya. 118 pp.

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Acknowledgements

Many people have contributed directly or indirectly to the realisation of this document. It will be difficult to list all names. First and foremost, we would like to express our sincere appreciation to the scientists whose works have been summarised in this report for their commitment and determination to publish their research results. Our colleagues in the International Livestock Centre for Africa/International Livestock Research Institute (ILCA/ILRI) have been great sources of inspiration and we would like to acknowledge their valuable contribution in thinking through some of the ideas and issues that led to many of the researches compiled in this review. We would also like to thank the research assistants and graduate research fellows who have helped the socio-economic and policy research activities. The research assistants from 1992–2002 included: Mr Nega Wubuneh, Mr Amare Teklu, Mr Mekonnen Ashenafi, Mr Yishak Mengesha, Mr Abebe Misgina, Mr Yigezu Atnafe, Mr Elias Mulugeta, Ms Zeleka Paulos, Mr Gemechu Degefa, Mr Mohamed Mussa, Ms Senait Seyoum, Mr Alemayehu Konde, the late Mr Solomon Tesfay and the late Mr Melaku Don. The graduate students during the same period included: Dr Abdul Kamara, Mr Aderie Adugna, Mr Amare Teklu, Dr Ben Okumu, Dr Carol Cabal, Dr Florence Tangka, Dr Geraud Laval, Dr Getachew Gebru, Mr Hailemariam Tefera, Ms Ika Darnhofer, Dr John Omiti, Mr Mengistu Buta, Mr Menale Kassie, Ms Miriam Steglic and Mr Solomon Desta.

We also owe the realisation of this work to the Assistants to the Programme Co-ordinator, namely Ms Letty Padolina, Ms Tehout Workalemahu and Ms Muluhiwot Getachew, in terms of co-ordinating the administrative management of the Programme, including budget development and monitoring. We also benefited greatly from the support of the various administrative assistants to the Livestock Policy Analysis Programme activities. They include Ms Tsehainesh Zewdu, Ms Almaz Zewdu, Ms Selamawit Dominique, Ms Azeb Bekele and Ms Woineshet Demissie. Finally, we would like to express our gratitude to the ILCA/ILRI management, Dr John Walsh, Dr Hank Fitzhugh and Dr Carlos Seré, whose vision and leadership as Directors General of ILCA and ILRI have helped provide a

supportive and enabling environment for undertaking research that resulted to these outputs during the 10 years under review.

We would like to dedicate this body of work to the many livestock farmers for whom we envision a better life through livestock research and to whom we look for inspiration. We hope that in our own little way we have been able to make a difference in their lives.

The authors

Introduction

The International Livestock Research Institute (ILRI) works at the crossroads of livestock and poverty, bringing high-quality science and capacity building activities to improve nutrition, food insecurity and protect the environment of smallholder livestock keepers and their communities around the world (ILRI 2002). In so doing, ILRI employs a variety of strategies and scientific methods that include production and development of technologies and strategies for efficient and sustainable use of resources, disease control measures and delivery mechanisms. The development of these technologies, strategies and measures is often complemented by socio-economic policy research involving the creation of conducive policy environment for their transfer and adoption, ensuring the active participation of smallholders in market activities and facilitating for efficient functioning of input and output markets. This task calls for creating the appropriate macro-economic policy environment at farm, market and trade levels to increasing production and efficiency of smallholder livestock producers.

This is so because inability of smallholders to benefit from technology transfer has often been due to policy and institutional factors rather than technical constraints, which requires policy intervention. Accordingly, there could be no doubt about the vital role livestock policy research and analysis plays in ILRI's quest to accomplish its global mandate and fulfil its objectives.

To this end, the role of policy analysis and research has long been recognised by ILRI, and implemented since the time the institution was known as the International Livestock Centre for Africa (ILCA). The overall goal of livestock policy programme is to increase smallholders' returns from investments in animal agriculture by providing them with essential information on government policies in the sector, and developing appropriate policy and institutional options that will help improve livestock productivity, asset accumulation, promote sustainable use of natural resources and building capacity of policy makers and analysts. In line with this, ILRI has implemented many major research projects constituting several components. The major areas of these undertakings could be broadly categorised as:

1. Global livestock policy issues including trends in livestock production, trade and consumption
2. Policies and institutions for improving sustainable livelihoods
3. Policies to improve the competitiveness of smallholder livestock systems, market access and trade
4. Policies for improving livestock technology adoption, nutrition and food security and
5. Policies for the sustainable delivery of animal health.

As of January 2003, ILRI's research programmes have been restructured and classified into five major themes, i.e.:

1. Targeting opportunities
2. Enabling innovations
3. Livestock market opportunities
4. Biotechnology and
5. People, livestock and the environment.

Clearly, these new research themes have room for policy research both within and between the themes and the relevant researches that used to involve substantial LPAP staff will now be undertaken under these themes. By the same token, it is crucial that future researches are built upon the achievements of LPAP and benefit from accumulated experience for more efficient use of research resources.

It is obvious that there is a wealth of knowledge, some of which has not yet been used, that was gained through the years. This paper reviews and documents the achievements of ILRI's policy analysis programme over a decade. It focuses on the major results gained, lessons learnt and puts forward recommendations. It covers the period from 1992—when the first policy research planning meeting was organised to set the relevant priorities of policy research for the then ILCA—to 2002/2003. The objective is to provide a comprehensive summary of ILRI's policy researches along with major findings in the area and recommended approaches for concerned groups. The objective is to provide a comprehensive summary of ILRI's

policy researches along with major findings in the area and recommended approaches for concerned groups. More specifically, it is intended for livestock researchers (including biological scientists both at ILRI and elsewhere), livestock policy makers and analysts in developing countries, the donor community, graduate students as well as scholars and researchers interested in ILRI's achievements in the respective areas.

In preparing this paper, it was necessary to review, cross check and sift through numerous publications on various categories and related topics. Care has also been taken in designing the presentation format to make it as much as readable and inspiring to colleagues engaged in researches in policy analysis and socio-economic aspects. It is also believed that the present attempt will be timely and contribute something worthy in filling up any possible gaps of information in regard with ILRI's accomplishment and contribution to research undertakings in the area.

The discussion in the following part is an overview of the birth and development of policy research at ILRI, followed by ILRI's comparative advantage and its research implementation methods in relation with the Livestock Policy Analysis Programme (LPAP).

Policy research at ILRI: Historical perspective

At the outset policy and economic research had been carried out under the Livestock Economics Division (LED) and continued under the same domain when LED was transformed into Socio-economic Sciences Division in 1993. In 1995, following the creation of ILRI, livestock policy analysis was incorporated as one component of Production Systems Research Programmes. But three years later, in 1998, the Production Systems Programme was abandoned and the livestock policy analysis assumed a new status and became an independent programme. However, it has passed through various stages involving many groups and their considerable efforts before it has reached its present position.

The birth of ILRI's Livestock Policy and Economic Research Programme can be traced back to March 1992, when thirty policy researchers drawn from the World Bank, the United Nations Economic Commission for Africa (UECA), national agricultural research systems (NARSs), the International Food Policy Research Institute (IFPRI) and representatives from universities in North America, Europe and Australia gathered to define the 1992–96 priorities for policy research for the then International Livestock Centre for Africa (ILCA, now ILRI). The workshop was attended by several scholars, one of whom was Dr Per Pinstrup-Andersen, the then Director General designate of IFPRI. It was indeed a momentous occasion in which several issues were explored, priorities set and the ground for important future initiatives laid. The huge benefit to be gained from increased livestock productivity both at household and national level, the potential of interventions, if adopted by farmers, to increasing livestock products, as well as the role of livestock policies in influencing the demand for adoption and impact of new technologies at various levels and degrees were among the key topics covered in the discussion. Furthermore, it facilitated the ground for forging important partnerships between (ILCA, now ILRI) and other stakeholders, one of which was the exemplary partnership formed between ILRI and IFPRI which is alive and thriving to this day.

After IFPRI was identified as the key partner for livestock policy research and ILCA's staff visited IFPRI in 1993 to initiate joint research proposals, IFPRI's staff visited ILRI at Addis Ababa, Ethiopia, in February 1995 and participated in a joint Food and Agriculture Organization of the United Nations (FAO)/ILRI round table on livestock development strategies for low-income countries. It was at this workshop that the idea for a 2020 vision project for livestock was first discussed and the technicalities for the partnership between ILRI and IFPRI finalised with the appointment of a joint staff. Since then there have been several joint initiatives taken up by the two institutions including the 1996 joint ILRI–IFPRI–Centre International de Recherche/Développement sur l'Élevage en zone Subhumide (CIRDES) workshop held on economic policies and technological options to revitalise the livestock sector in West Africa; and the 1997 joint project on policies for sustainable land management in the highlands of eastern Africa.

Following a system wide review of socio-economic and policy research, the Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR) requested that centres review their capacity and programmes in socio-economic and policy research. In response to this request and taking advantage of the newly formed ILRI, a Centre-Commissioned External Review (CCER) of ILRI's Livestock Policy Analysis Programme (LPAP) was organised in March 1996. The objective of the review was to '... assess whether the minimum capacity for desired collaborative research with IFPRI is in place'. The observations and recommendations of the review are published in the 1996 LPAP–CCER panel report. The panel believed that good policy analysis might offer greater potential returns than those available to other ILRI investments because returns in those areas are so closely dependent upon the policy environment itself. Furthermore, the panel reached consensus that improvements in the policy environment could substantially increase the social benefits of other ILRI researches, and endorsed the continuation and expansion of ILRI's policy research programme.

Another important landmark was the ILRI/IFPRI/African Highlands Initiative (AHI)/Soil, Water and Nutrient Management (SWNM) planning workshop on policy research for land management in the East African highlands, which was organised in Addis Ababa, in February 1997. It led to development of two

major proposals that were later funded by the Ministry of Foreign Affairs of Norway and the Swiss Development Corporation. The government of Italy and the United States Agency for International Development (USAID) provided complementary funding. In recognition of the accomplishments of the projects in building partnerships, the project won the 2000 ILRI Neville Clarke Award for Outstanding Teamwork and was nominated for the 2001 CGIAR Science Award for Outstanding Scientific Partnership. A proposal for the second phase of the project has been developed and submitted to Norway in 2003.

Still another notable achievement is ILRI's joint efforts with IFPRI and FAO to produce a comprehensive study on livestock trends: 'Livestock to 2020: The next food revolution'. This study revealed that, unlike the supply-led Green Revolution, a Livestock Revolution is taking place, which is driven by demand; hence the challenge for developing countries is to ensure that poor producers benefited from the expected dramatic increase in demand for livestock products and its resultant rise in farm income (Delgado et al. 1999).

ILRI's comparative advantage in policy research

One of the most frequently asked questions with regard to ILRI's success story has been the comparative advantage ILRI assumed for its policy researches. The 1996 CCER panel pointed out that ILRI has no comparative advantage in many areas of macro-economic and sectoral analysis *per se*. However, the panel noted that 'ILRI's main comparative advantage in policy analysis lies in its ability to tap synergies deriving from its institutional strength in livestock technology and production systems... ILRI's LPAP comparative advantage in policy analysis lies in its applied socio-economic research focused specifically on livestock-related issues for the purpose of generating empirical evidence vs. policy science or management research'.

The CCER panel also stressed that in the event that ILRI comes across any relevant findings in macro-economic or sectoral researches especially complementary to its own work, it should share these findings to other institutions specialising in these areas or undertake joint researches combining the practical knowledge and experience of the livestock sector and its existing structure and network with other institutions in macro and sectoral level. The panel also commended the ILRI/IFPRI co-operation and the exemplary working relationships forged between the two institutions (Delgado et al. 1999).

Indeed one of the attributive factors for LPAP's strengths in policy research has been its direct links with and access to the expertise of scientists in other programmes within ILRI including Systems Analysis and Impact Assessment, People, Livestock and Environment, Health, Genetics, Nutrition and Production–Consumption Systems projects—Market-Oriented Smallholder Dairy, and the West Africa and South-East Asia-based projects.

Furthermore, our experience has proven that it is important to maintain a reservoir of key resources that can develop linkages with partners and developed research proposals for funding.

Likewise, most of ILRI's policy researches have been conducted by economists who are also engaged in other projects and as a

result, bring in their first-hand experience, knowledge and relevant data to their policy analysis. Good examples in this regard are the policy analyses pertaining to smallholder dairy, animal health, technology adoption and livestock market access. The implications for this mode of operations are that the LPAP co-ordinator has had to manage a programme in which most of the contributors are non-staff members and involved in the programmes on part-time basis only. Still, the programme served as an example in efficient programme management in which unrestricted funding supports a small core staff capacity while the principal operational costs, including post-doctorals, are covered by project or programme restricted funding.

Research implementation at ILRI

The livestock policy research programme at ILRI has adopted the concept of partnership in implementing its research activities because of the dual advantage it offered. First, partnerships with collaborators in national programmes enabled the livestock policy programme to achieve its goal of strengthening the capacity of those partners to conduct livestock policy analyses. Secondly, through partnerships within and outside ILRI and LPAP the partners jointly tapped on resources available such as in macro-economic, trade and sectoral policies that are also consistent with ILRI's goals and objectives.

Global trend in research and development has been increasingly expanding to include international, national, regional and developed countries' research institutions as well as development and donor agencies (Ehui and Shapiro 1997). At the same time, making an impact on a global context with so many partners and stakeholders involved has required more focus and closer co-operation and co-ordination than ever. Likewise, following the international framework for action, policy research at ILRI has been organised and co-ordinated in such a way so as to work in close collaboration with scientists from other CGIAR centres, advanced research institutions (ARIs), NARSs and relevant development agencies (see Figure 1).

Since IFPRI has been identified as the key partner for livestock policy research in 1992 it has been the major collaborator in the livestock policy analysis programme. Several key projects were jointly developed and implemented particularly in areas of property rights, risk and livestock development, sustainable policy for land management in the eastern Africa highlands, economic policies and technological options to revitalise the livestock sector in West Africa and the livestock to 2020 vision.

The award-winning collaboration and partnership with IFPRI has attracted other potential partners such as FAO and AHI. This partnership has also built strong collaborative relationships with higher education institutions in North America and Europe. ILRI's list of active partners also comprises national institutions including research organisations, universities and local and

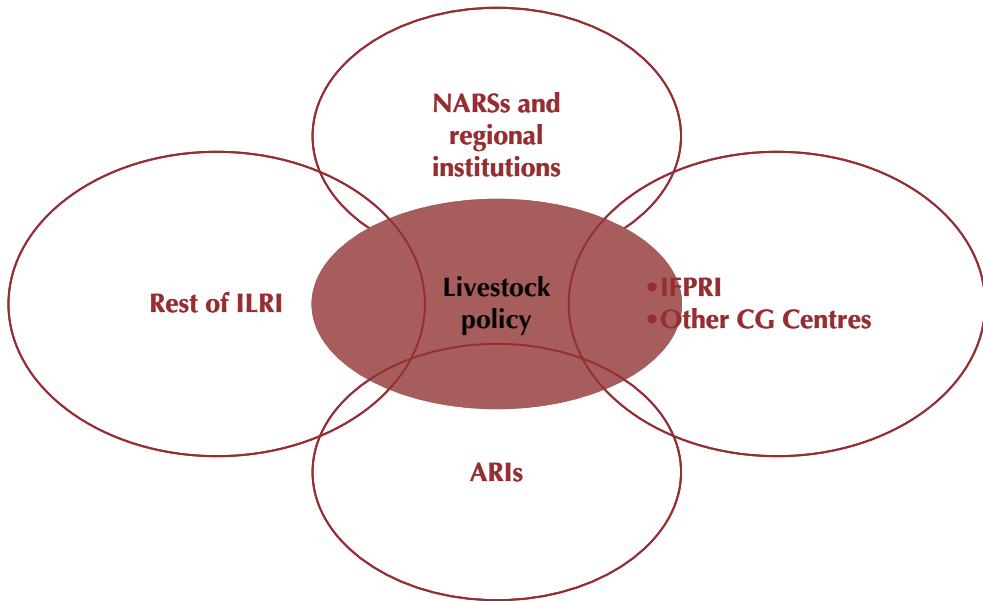


Figure 1. Livestock Policy Analysis Programme partnerships.

regional national government institutions such as ministries of agriculture. Often, several partnerships are built on single projects. The major areas covered in these programmes and projects include animal health, mountains, smallholder dairies, feeds and nutrition contained in the West Africa research-based programme. A case in point of these multiple partnerships is the project implementation of sustainable policies for land management in Ethiopia. This project, initiated jointly with IFPRI, has involved partners from the regional governments of Tigray, Amhara and Oromiya; researchers from the Ethiopian Agricultural Research Organization (EARO), Makelle University, Norway University of Agriculture and Purdue University, USA. Another similar example is the partnership in the implementation of a project in Uganda. As was indicated above, many of the LPAP staff were also contributing part of their time to fill in existing research needs in other programmes within ILRI. This tradition has resulted in strengthening the collaboration of fellow researchers and expansion of joint projects within the institute—at a time when such initiatives were badly needed.

Major themes of the livestock policy research

The first planning workshop that was conducted in 1992 to define the 1992–96 priorities for policy research for the then ILCA and grouped them under three major categories (Figure 2). They include: (1) trade and macro-economic policies; (2) technology policy, markets and institutions, and (3) resource management policy. Among the priority areas in trade and macro-economic policies are:

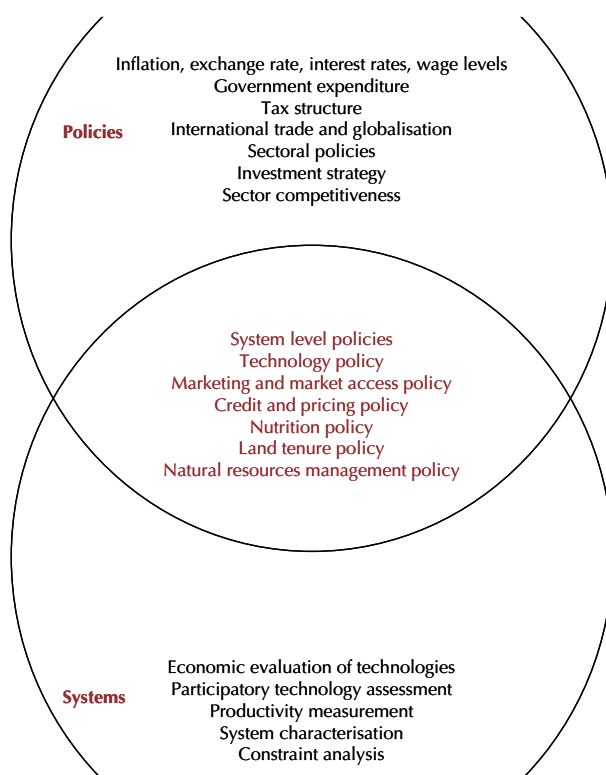


Figure 2. Policy and systems interactions.

1. the effects of structural adjustments/liberalisation on livestock production
2. the effects of and impediments to freer regional trade via economic integration and
3. structure of demand for animal products.

Technology policy, markets and institutions researches include several areas such as:

1. effects of price and non-price factors on technological change
2. political economy of technology generation and transfer
3. political economy of national decision making and
4. implications of consumption patterns for livestock policy

Resource management policy priority areas include:

1. effects of resource management institutions on resource use, and how changes in government policies affecting those institutions might advance environmental objectives in the different agro-ecological zones and
2. effects of credit, commodity pricing and selected macro-economic policies on resource use and the environment.

These research areas were proved to be sufficiently comprehensive to accommodate a wide range of research problems that are of interest to ILRI and its partners. In the course of time, new research areas were also identified and priorities were continuously revised in line with the changing priorities of the institution. For instance, when ILRI developed its 2010 strategy in 1999/2000, the prevailing socio-economic and policy activities were revisited and the following were identified as additional key areas:

1. reform of input and output markets that are serving smallholder livestock producers
2. participatory, institutional and policy research to improve the adoption of livestock technology and

3. policies to prevent negative effects of livestock production on human and environmental health.

These research areas formed the core focus of ILRI policy activities until December 2002, when ILRI restructured its programmes into five research themes and livestock policy analysis was further spread across the new themes.

For the purpose of this review, LPAP's published works are categorised into the following nine major themes:

1. Global trends in livestock consumption and production
2. Livestock technology strategies and policy
3. Policy factors affecting livestock technology adoption
4. Food security and nutrition, technology and gender issues
5. Livestock markets and pricing policies
6. International and regional trade
7. Policies for delivery of animal health services
8. Land tenure, property rights and institutions and
9. Policies to enhance the sustainability of mixed crop–livestock systems.

It is worth mentioning here that there are significant contributions that have not been documented in this review. For instance, ILRI economists and their collaborators have contributed important publications—both published and unpublished—that are not included in this review. Further, ILRI scientists including LPAP economists have frequently contributed to professional workshops and national, regional and international conferences, where their contribution may have been published as proceedings. Many students have also completed their research theses and dissertations at LPAP. Some of these works have not been published and thus not included here.

Global trends in livestock consumption and production

Taking advantage of IFPRI's global food model known as IMPACT (International Model for Policy Analysis of Agricultural Commodities and Trade), IFPRI, FAO and ILRI jointly conducted a major study on livestock to examine past and future trends in livestock consumption, production, and their impacts on prices, poverty, human health and technology (Delgado et al. 1999). This study, which has become very popular among stakeholders indicated that a revolution is taking place in the global agriculture, which would have profound implications for human health, livelihood and the environment. The study also revealed, based on empirical data, that population growth, urbanisation and income growth in developing countries are fuelling a massive increase in demand for food of animal origin. These changes in the dietary pattern of billions of people could significantly improve the well being of many poor people in rural areas. Therefore, governments and the industrial sector must be prepared for this continuing revolution by devising long-run policies and planning pertinent investments that will accommodate to the growing consumer demand, improve nutrition by creating direct income growth opportunities to those who need them most, and alleviate the stress on public health and the environment.

According to the study, unlike the supply-led Green Revolution, the Livestock Revolution is driven by demand, and from the early 1970s to the mid 1990s, the volume of meat consumed in developing countries grew almost three times as much as it did in the developed countries. The developing world's consumption grew at an even faster rate during the second half of this period than in the first, with Asia in the lead. At the same time the volume of meat and milk consumed in the developing countries increased by 175 million tonnes, which was more than twice the increase recorded in the developed countries, and over half as large as the increase in consumption of cereals made possible by the Green Revolution. Similarly, the market value of the increase in meat and milk consumption totalled approximately US\$ 155 billion, which was again more than

double the market value of increases in cereal consumption under the Green Revolution.

The issue of whether these consumption trends will continue in the future was examined through IFPRI's global food model, which included data for 37 countries and country groups and 18 commodities. The model's baseline scenario projects that consumption of meat and milk in developing countries will grow by 2.8 and 3.3% per year between the early 1990s and 2020. Correspondingly, the growth rates for the developed world will be 0.6 and 0.2% per year. By 2020, developing countries will consume 100 million tonnes more meat and 223 million tonnes more milk than they did in 1993, dwarfing developed countries' increases by only 18 million tonnes in both meat and milk.

Despite the prevailing potential for growing markets for livestock producers, there are still concerns that the smallholder producers might not be able to benefit from the Livestock Revolution unless specific policy actions are taken. With regard to this, the study has made the following recommendations:

- small-scale producers have to be linked vertically with processors and marketers of perishable products
- policy can help facilitate the incorporation of smallholders into commercial production by remedying distortions that promote artificial economies of scale, such as subsidies to large-scale credit and grazing and
- regulatory mechanisms for dealing with health and environmental problems arising from livestock production need to be developed.

The findings of this study, in addition to their relevance to ILRI's research and efforts to increase smallholders' market participation, had great influence on ILRI's 1999/2000 proposed strategy for 2010 on socio-economic and policy activities.

Livestock technology strategies and policy

There is substantial evidence demonstrating that major improvements in livestock productivity are possible if appropriate technologies can be generated and adopted by farmers. Cognizant of the fact that technologies help boost productivity in developing countries, socio-economic and policy research activities at ILCA/ILRI have particularly been concerned with the development of appropriate livestock technology strategy and policy. An important element of a successful research strategy is to ensure favourable social, economic and environmental impacts (ILCA 1992). This means that a successful livestock research strategy must be aimed at realising the potential of animal agriculture to contribute positively to the long-term sustainable development of agriculture, which contains elements of social, economic and environmental developments. Appropriate livestock technology development strategies should thus ensure adequate economic returns to livestock farmers, maintenance of natural resources, minimal adverse effects on the environment, optimal production with minimal external inputs, and satisfaction of human food and income needs, as well as of rural families' social needs (Fitzugh et al. 1992).

However, technology is only one necessary condition for agricultural development. Conducive policy is equally needed to realise the intended results in technical change and minimise possible negative consequences. When sound economic policies that support animal agriculture are not in place, investments in infrastructure will be low; incentives to farmers will be inadequate; supplies of production inputs and animal health services will be weak and effective marketing and credit facilities lacking. Hence, the close relationship and interaction that exists between technology and policy need to be better understood in order to bring about the desired impact on farmer's incomes and the environment.

Policy research could also improve information databases, and results of supply analysis help policy makers anticipate and

understand the probable consequences of alternative courses of action. Accordingly, policy research at ILRI has employed *ex ante* whole-farm modelling using mathematical programming, econometric adoption studies, policy analysis matrix (PAM) and other relevant methods to study the linkages between livestock technology and policy in developing countries.

Problems faced by farmers vary according to existing agro-ecological and socio-economic circumstances. Thus, description of the production system and analysis of critical production constraints are important instruments to inform scientists about the real problems farmers faced and the opportunities that exist within a farming system. Such system-description and constraint-analysis tasks would enable researchers to identify the different categories of farmers that could benefit from their research. As such, the livestock policy research has been involved in the characterisation and classification of farmers in an effort to improve the effectiveness of research results. In Niger, cluster analysis was used to classify crop–livestock producers in three villages into recommendation domains based on constraints and potentials using a combination of production and marketing variables (Williams 1994). Four recommendation domains were identified and separate analysis was used to profile the characteristics of the obtained groups. A combination of cluster and discriminate analysis was finally used to suggest appropriate research and policy interventions for each group.

ILRI policy research has also focused on assessing farmers' knowledge as an input to guide research planning. It was found that farmers' knowledge about the characteristics, adaptability and management needs of different species and breeds of domestic animals, and their preferences concerning these traits can be useful factors in designing breeding and conservation policies in several ways (Jabbar et al. 1999). First, it could help assess current stocks of different breeds held by farmers, the geographic distribution of those stocks, and the likely future trend in those stocks. Second, farmer preferences for different breeds, criteria used for selection of breed, value placed on homogeneity vs. diversity, the skills and information exchange mechanisms involved in the process of breed selection and management, and farmers' knowledge about the specific attributes of the different breeds under village conditions could all help to focus scientific research to particular traits, and

identify existing needs for extension and farmer education. Third, information about farmers' breeding practices and breed preferences could help to identify the potential market for existing or improved breeds. Fourth, farmers' knowledge can help determine the incentives that might be required by farmers for the conservation of threatened or endangered breeds.

The interdependencies between the social, economic and physical factors in determining the sustainability of an ecosystem has increased the need for and the importance of multidisciplinary research. Accordingly, policy research at ILRI has been conducted in close collaboration with biophysical scientists to develop a methodology that would enable to simultaneously assess the economic, social and environmental impacts of technology intervention packages for Vertisols (black heavy clay soils) at plot, household and watershed/community level in the highlands of Ethiopia (Jabbar et al. 2001b). In 1986, a consortium of national and international research centres funded by the Swiss Agency for Development and Cooperation worked together to develop a technology package for the Vertisols. Systems approach was used in the beginning to diagnose problems; but later, the discipline-based component technology research became the dominant characteristic tool of the project. Individual technologies were designed and tested on-farm with farmer participation, often separately, and their impacts were assessed using mostly bio-economic terms (e.g. yield and income).

The technology packages included a variety of mechanisms. Among these were the broadbed maker (BBM) plow, animal-drawn equipment used to draw excess water from the Vertisols during heavy rains. Early planting during heavy rains allows higher yielding crop varieties to take advantage of the longer growing period, and appropriate input and agronomic practices (Abiye and Jabbar 2001). To further improve the BBM package, the frame of the BBM was used as attachment of other implements to minimise tillage practices that reduce seed and fertiliser rates, labour and animal power requirements and reduce soil erosion (Abiye et al. 2002).

Consequently, the need for assessing the economic, social and environmental effects of several technology interventions simultaneously and at different levels (plot, household and watershed/community) became even more apparent. The

research methods have then been modified accordingly to adopt an integrated and holistic approach incorporating biophysical, economic and social dimensions of the ecosystem. Currently, an agro-ecosystem health approach to ecosystem analysis is being used as an integrative analytical framework. This evolution also meant a gradual shift from disciplinary to multidisciplinary and transdisciplinary approach to research (Jabbar et al. 2001a). Further modification of the BBM involved using it as the package for conservation tillage to save draft power and fertilisers and seeds, as all of these were required at above average rates to obtain a certain level of crop yield. Farmer participatory approaches were used to adapt these modifications, which also proved to be significantly more economical than the traditional tillage practices (Abiye et al. 2003).

While single component technology under the Vertisol package has been found to be economical, in reality, farmers might use various production and conservation technologies simultaneously. This use of combined technologies may have brought about competing demands on household resources, as well as both positive and negative impacts on the natural resources based on their interactions, and how and where in the farming system and the landscape they are used. Furthermore, the outcomes may depend on policies that affect land tenure rights, access to credit, and product and input prices. In order to assess the impact of policy and technology at a watershed level, a dynamic bio-economic model was used. The model has shown that without proper technological and policy intervention, soil nutrient balances, income and nutrition could not be substantially or sustainably improved in the highlands of Ethiopia.

Although cash incomes could raise from a very low base by more than 50% over a twelve-year planning period, average per hectare nutrient balances indicate significant nutrient mining and associated soil losses of about 31 t/ha. The adoption of an integrated package of new technologies (involving new high yielding crop varieties, agroforestry, use of animal manure and inorganic fertilisers, construction of a communal drain to reduce water logging and some limited land user rights), has resulted in the possibility of a two-and-a-half-fold increase in cash incomes on the average, and a 28% decline in aggregate erosion levels over a twelve year period given a population growth rate of 2.3%. Moreover, a minimum daily calorie intake of 2000 per

adult equivalent could be met from on-farm production and per hectare nutrient balances. Correspondingly, nitrogen and potassium could be reduced by 36 and 6%, respectively, which is still negative, whereas phosphorous balances are reversed to positive values.

However, these gains might be eroded by the constant need to meet increased nutritional demands arising both from increasing consumption levels and a more rapid population growth of over 2.8%. From a policy perspective, this reduction in nutrient contents in the face of higher reliance on the watershed for subsistence food requirements would imply an increasing need for a more secure land tenure policy than currently prevailing, including provision of credit to facilitate uptake of the new technology package, and a shift from the current livestock management strategy that emphasises use of livestock as a store of wealth to the one that encourages livestock keeping as a commercial activity. It would also imply a shift from a general approach to land management to a relatively more site-specific approach. The latter recognises the need for spatial and inter-temporal variability in input use based on land quality that would encompass an efficient nutrient management strategy (Okumu et al. 2000).

Policy factors affecting livestock technology adoption

Adoption of livestock technology

Determinants of technology adoption encompass characteristics of the technology, features of the farming system, market and policy environments as well as socio-economic characteristics of the decision-making unit (household, farmer). LPAP economists have published several adoption studies. The objective of such studies is to identify and determine the target group and farming systems or locations where technology diffusion and extension strategies could be implemented. These studies also provide essential feedbacks to biological scientists about what really works with their clients.

Shortage and low quality of feed, as a major constraint to livestock production, has prompted extensive studies on the determinants of adoption of feed technologies by smallholders. A study on alley farming, an agro-forestry system under which food crops are grown in alleys formed by hedgerows of leguminous trees and shrubs in West Africa, showed that land tenure security plays a significant role in the adoption and maintenance of the technology, the absence of which resulted in the discontinuation of alley farming (Lawry et al. 1994).

Ahmed et al. (2001) argued that the potential for adoption of improved forages in mixed crop–livestock systems should be high due to the high opportunity of exploiting the crop–livestock interactions and the potential of market-oriented livestock such as dairy. However, these systems are typically characterised by high population densities, resulting in land scarcity and low land productivity, and making competition with food crops unfavourable to the adoption of forages. Econometric analysis of panel data set from mixed crop–livestock systems of the highlands of Ethiopia showed that household resource endowment, especially land and labour, market integration and crop intensification are important factors that encourage adoption of vetch/oats forage technology.

In the upland areas of The Philippines ruminant livestock production is an important component of the farming systems. Since upland agriculture in The Philippines is beset by severe soil erosion, livestock production is a valuable source of income to complement crop production. However, scarcity and poor quality of livestock feed is a major constraint to improved livestock production in the area. Introducing planted forages in these systems can alleviate the feed problem and promote sustainability by improving soil quality and preventing runoff. Concomitantly, a study on the determinants of adoption of forages by smallholders in The Philippines uplands showed that adoption is conditioned by the dual-purpose role of the forages (Lapar and Ehui forthcoming). Similarly, econometric results showed that the level of education of the farmer, household income and access to credit explained adoption positively. The results imply that policies to increase access to credit and education may improve adoption. As a result, it is expected that adoption of forage species would be higher in upland areas with higher problems of soil erosion, and declining grazing areas.

In an attempt to improve upon the traditional methods used for the analysis of the determinants of technology adoption, LPAP scientists have incorporated geographic information system (GIS) to include spatially explicit variables into the analysis of the determinants of adoption of zero-grazing technology and planted fodder in Kenya (Staal et al. 2001b). This approach showed that uptake of zero-grazing technology is negatively affected by the number of adults in the household, distance to largest urban centre, and positively affected by cattle stocking density, average annual precipitation/evapotranspiration, and the presence of veterinary services. Similarly, years of farming experience, years of education, the presence of veterinary services, and average annual precipitation/evapotranspiration positively influence the adoption of planted fodder (Napier grass). Distance to largest urban centre decreased adoption of fodder.

Likewise, GIS has been used to develop spatial representation of recommendation domains of five multi-purpose trees (*Calliandra calothyrsus*, *Sasbania Sesban*, *Leucaena diversifolia*, *L. pallida* and *Chamaecystus palmensis*) in Ethiopia, Kenya and Uganda (Concheda et al. 2001). A combination of climatic, edaphic and topographic factors was used to select recommendation domains. Based on type of land cover/land use

and human and cattle population densities, suitable agro-ecological zones for each species has been defined. Results of such analysis can be useful in identifying priority areas where adoption process could be more successful.

Adoption studies were also used to identify the determinants of adoption of improved livestock breeds in the Ethiopian highlands (Benin et al. 2003a). Adoption of improved livestock breeds in the Ethiopian highlands was found to be associated with an increase in proportion of irrigated area, access to the district town, household density and proportion of households obtaining credit from non- governmental organisations (NGOs), and where there has been land redistribution since 1991. These results, with the exception of the impact of access to district town, jointly suggest that the increasing pressure (population growth and diminishing land size and grazing areas) on already degraded grazing resources may be inducing farmers to replace part of their local stock with fewer improved breeds. The positive association between poor access to the district town and adoption of improved breeds is likely to be due to poorer households' access to NGO credit and extension programmes in remote areas. This raises the issue of sustainability (e.g. obtaining the necessary inputs and services) when such projects end. The same study found that adoption of stall-feeding where there has been land redistribution was associated with an increase in use of credit from NGOs.

Using an econometric technique similar to that employed in adoption studies, Benin et al. (2003b) examined the factors contributing to decline in ownership of various types of livestock and availability and quality of grazing lands in the northern Ethiopian highlands since 1991. Their paper also examines the factors contributing to changes in use of various feed resources. Increases in the extent of drought and population growth have contributed significantly to decline in ownership of livestock and availability and quality of grazing resources. However, better access to markets, credit and extension programmes have contributed to increases in ownership of livestock and use of feed resources. These results suggest that improving access to markets and extension programmes can enhance the role of livestock in improving food security and reducing poverty in mixed crop–livestock farming systems, as those that exist in the Ethiopian highlands. Easing the pressure on agricultural land by

providing non-farm opportunities and credit, extension and training programmes will be important.

Policy research at ILRI has also been involved in the assessment of technology adoption pathways and the analysis of the determinants of adoption of the BBM technology (Jabbar et al. 2001a; Jabbar et al. 2003). Regarding BBM, education and long distance to market and owning higher number of livestock affected adoption negatively, while skill training in BBM and owning larger cropland areas and larger areas under water logging problem increased adoption.

According to these studies, some of the most important determinants of technology adoption are apparently those related to the type of the technology and the characteristics of the system where adoption is studied. Examples that explain adoption of forage in the Ethiopian highlands are household resource endowment, especially land and labour, market integration and crop intensification, whereas these factors are not as relevant to the case of forage adoption in The Philippines since the technology does not compete for land.

Policies to promote animal draft cultivation

Technology strategies in sub-Saharan Africa (SSA) have not, in general, been cost effective since they overlook the biophysical conditions determining its technical feasibility as well as the socio-economic and policy factors determining its social acceptability and profitability (Ehui and Polson 1993). A good case in point is animal traction. SSA has the lowest level of mechanisation, including animal drawn draft power and use of tractors. Most tractor-based mechanisation schemes that were initiated in the 1960s and 1970s in Africa have had limited success because of high recurrent capital costs, insufficient divisibility of the technology, and lack of know-how in equipment handling and maintenance (Jansen 1993). Due to the exclusive emphasis given to mechanisation through tractorisation, animal traction initiatives were frequently hindered by government policies during the 1960s and 1970s. But eventually, following the failure of tractorisation, animal traction became politically acceptable in 1980s (Jansen 1993), and there has been renewed interest in research and extension activities with respect to animal traction (Jabbar 1993b).

Nevertheless, to date, animal traction is widely practised in the Ethiopian highlands, and is also common in the highlands of Kenya and Madagascar, but in limited use in other SSA countries (Jabbar 1993b). For example, in the semi-arid tropics of SSA, the use of animal traction is largely limited to small cash-cropping areas (Jansen 1993). Efforts to introduce animal draft power in the humid and subhumid zones have not been successful despite a substantial evidence that animal-driven implements comprise several benefits, including high yield and reduced labour requirements (Ehui and Polson 1993).

Such being the case, a review of the economic and ecological constraints to adopt animal traction in SSA showed that the use and profitability of a plow is largely a matter dependant upon a function of demographic, agro-climatic and market access factors. The transition from the hand hoe to the animal-drawn plow is only profitable at high intensities of farming (Ehui and Polson 1993). Hence, in areas of short fallow or grassy fallow stage, and where labour requirements for weeding and land preparation are high, the use of animal-drawn plow may be cost effective. Degree of use and profitability of animal-driven equipments will also be low in areas with light soil (arid zone), or areas prone to erosion (such as the humid zones). Since plowing requires high capacity, areas characterised by short growing season will not, naturally, favour the use of animal driven implements. Opportunity cost of labour for tending animals during off-farm season reduces the chance of using animal driven implements; and alternative uses of the animal (e.g. beef production) detract from oxen cultivation. The results imply that higher crop prices, combined with better market access (e.g. through improvement in rural infrastructure) and improved agricultural research and extension may encourage profitable use of animal-driven implements.

An evaluation of animal traction use in Niger showed that the potential gains from animal traction vary by region, and depend on a broad range of agro-ecological and economic factors (Williams 1997). Factors such as short growing season, low soil fertility and limited range of cultivable crops limit the use of animal traction. Even in better-endowed areas, realisation of potential benefits from animal traction will depend on using animal traction on a wide range of tillage operations (plowing, sowing, weeding), and on availability of sufficiently large area, and high value crops. Again, efficient credit and marketing

institutions and availability of low-priced equipment were also found to be necessary for adoption of animal traction.

A similar study on the use and profitability of animal traction in Niger and Nigeria showed that in western Nigeria, oxen traction is an attractive investment only when farmers grow cash crops and when sufficient capital is available (Jansen 1993). In northern Nigeria, however, the profitability of investments in oxen traction depends crucially on land availability. In the case of closed frontier, investments in animal traction ceased to be profitable under both conventional and commercial interest rates. Moreover, adoption depended on the potential impact of animal traction to justify the risk of the initial investment in equipment and animals.

Food security and nutrition, technology and gender issues

Perhaps, one of the fundamental questions that have often been debated on among economists working in the CGIAR is how the benefits of technological changes trickle down to poor households in a form of access to food of high nutritive value and better health. The question is especially relevant when technological change involves a cash crop such as dairy or meat, a commodity that is not consumed in large quantities by all members of the household or can possibly be substituted through the market for inexpensive staple foods. The debate emanates from a conception that the introduction of cash crop worsened the nutritional status of poor people, who could not eat cotton and were therefore more secure growing a subsistence crop (Pinstrup-Andersen 2000). The policy analysis work in this area, taking the case of market-oriented dairy, has shown this to be not necessarily true.

Nutrition and health impact

One major feature of the research undertaking on nutritional and health impacts of livestock and dairy technology is that it called for the partnership and participation of several national institutions in Ethiopia (for example, EARO and the Ethiopian Health and Nutrition Research Institute, EHNRI) and involved cross-programme linkages (e.g. the Mountains project). The work was carried out at Holetta, Ethiopia, where on-farm trial on dairy–draft technology was conducted in 1997. Seventy-five households who had been producing dairy from at least a pair of crossbred cows for the market for four years participated in the project and were studied for the nutritional impacts of market-oriented production.

The first set of analysis evaluated the nutritional and health status of women and children in households with and without crossbred cows (Shapiro et al. 2000). The overall level of malnutrition as determined by stunting, wasting and underweight in preschool children, and female adult

malnutrition as measured by body mass index, were all found to be lower in households with crossbred cows than in those with local breed cows. Furthermore, caloric and nutrient intake were also significantly higher in the crossbred cow group and hence households with crossbred cows had higher level of consumption of calorie, protein and other nutrients.

Further, the analysis is extended to investigate how increased milk production and household income of resource-poor smallholder farmers affect intra-household decision-making, as a result of adopting crossbred cows and improved feeding and management strategies (Jemal et al. 2000). One conclusion of interest is that women in households with crossbred cows maintain control over income allocated for food purchases, and make over 80% of household expenditure on food. It was also confirmed that this food-based intervention can have a significant positive impact on human nutrition and health status. However, it is not clear from these two studies whether the differences between the two groups, i.e. households with and without crossbred cows and dairy, can entirely be attributed to adoption of the technology or to some other inherent set of factors within the groups.

A further extension of this work has revealed that steady increases in income from adoption of market-oriented dairy in Ethiopia translate directly into increases in expenditure on purchased food, non-food and farm inputs (Ahmed et al. 2000; Ahmed et al. 2001; Ahmed et al. 2003). For example, an increase in income invariably leads to almost an equivalent percentage increase in expenditure on inputs, and over one-fifth of a percentage increase being in expenditure on non-food items.

It stands to reason that if the demand for goods manufactured in the area with low capital intensity is stimulated, it can potentially stimulate the growth in the whole rural economy, leading to multiple effects. The research also highlighted the important role of and functioning of input and output markets as important factors for success of the market-oriented interventions. The higher the level of input use per unit area, the more households tend to spend on inputs, food and non-food items as income increases. However, if there are no adequate markets to handle these transactions, households will be forced to rely on subsistence production.

Food security and marketed surplus effects of the market-oriented smallholder dairy production (MODP) technologies in peri-urban Ethiopia were examined (Tangka et al. 2002). Econometric estimation, using panel data, was used to evaluate the technology's effect on food consumption, calorie intake and food marketed surplus on a group of households using the new technology in contrast with a control group without this technology. The results obtained suggest that there is substantive and statistically significant improvements in food security and food marketed surplus with the improved cattle. The estimated regression results thus indicate the positive and significant effects MODP technologies have on food security and food production. These impacts are reflected mainly through the effects of incomes and wealth, measured by animal value and land area. Household income had a positive and significant effect on food consumption. Compared to the marginal propensity to spend on food, which was 0.034, the group with crossbred cattle (CBC) consumed on average, 30% more calories per adult equivalent per day than the group with locally bred cattle (LBC). The major difference in calorie intake between the CBC and LBC households (63%) was attributed to differences in the actual values of the explanatory variables, while the estimated parameter differences for the two groups accounted for only 37% of the difference.

The role of MODP technologies on calorie intake was reflected most significantly by the value of animals. Animal value had a significant and positive impact on calorie intake in both the combined and the CBC regressions. The large increase in animal values for the CBC households was calculated to simultaneously increase their caloric intake by 12.7% relative to the LBC households. The value of surplus food marketed quarterly by the CBC group was 82% higher than that by the LBC group. Seventy-six percent of the increase in the value of marketed surplus food for the CBC over the LBC groups was accounted for by the difference in household characteristics, while only 24% of the increase could be attributed to differences in the estimated parameters. To conclude, households that used the market-oriented dairy production technologies increased their income and animal values significantly as compared to households using traditional dairy production methods. The increased resources led to significantly higher food consumption, calorie intake and marketed surplus. Although intensified dairying improved the calorie intake level of the CBC households

throughout the year, there was no significant seasonal consumption smoothing in CBC households. The substantial increase in the marketed surplus has the potential to improve the dietary habit of non-dairy households (Tangka et al. 2002)

Nutrition, health and gender

Researchers recognised the important role of women in agricultural development in SSA in the face of population pressure and the interrelationship of this role to nutrition and health of the poor. One of the issues that received attention is the identification of policy options to ensure adequate opportunities for women to participate in the process of development. A study in Senegal (Mussa and Shapiro 1992) suggested that resource factors are likely to be less important than existing cultural barriers in determining women welfare. It appears to be necessary for governments to intervene through policy to enable women to gain greater access to new technologies.

Similarly, a review of gender roles and child nutrition in livestock production system in developing countries has also been conducted (Tangka et al. 2000). The review examined the applied literature on gender in relation with division of labour, access to resources and benefits from smallholder ruminant production systems, the effect of ruminant livestock production on nutritional status of children and presented two case studies on showing how gender analysis was included in smallholder ruminant livestock research projects. Judging from the demand for this publication, the review appears to be useful to our collaborators and partners in the national programmes as well as development practitioners and students in the field of development economics.

Taking into consideration the efficiency with which women farmers are operating, and with a bid to designing appropriate public policies to improve performance and livelihood of women farmers, LPAP research contributed to the debate in gender productivity. A recent paper (Ehui et al. 2003a) compared crop production efficiency differentials between male- and female-headed households in three districts (Ada, Akaki and Gimbichu) in East Shoa, Ethiopia. Using the Tornqvist-Theil index, and considering all the inputs and outputs in the crop production process, total factor productivity (TFP)

was measured. Result obtained from TFP analysis indicates that there is little evidence that gender difference *per se* accounts for productivity difference in crop production. Both land productivity and factor intensity were nearly the same for both male- and female-headed households. The results thus imply that the overall TFP gap is not due to productivity differences attributed to gender but can only arise due to:

1. differentials in access to the quality of human and physical resources and services and
2. differential control by women vs. men over the benefits from output.

The policy implication that follows is that increasing female farmers' access to education, extension services, credit, adequate amount of quality land and other resources and control over benefits improve their overall productivity and thus their livelihood.

Livestock markets and pricing policies

We have mentioned above how the nutrition and food security research at LPAP has responded to the misconception that the introduction of cash crops worsened the nutritional status of the poor who could not eat cotton and were therefore more secure growing a subsistence crop. This misperception is partly triggered by the apparent failure to recognise that the favourable effects on nutrition arise from the link between commercialisation (increased participation in the markets) and income rather than directly from the effect of technology on production (Binswanger and von Braun 1991). Without this link, as Pinstруп-Andersen (2000) stated, poor people and poor countries will remain in poverty while taking away an important option for escaping. This argument justified and served to initiate the LPAP works on livestock markets and pricing policies.

Broadly speaking, ILRI research in this area has focused on dairy markets, small ruminants, and macro-economic, trade and sectoral policies affecting livestock. The dairy marketing research has covered issues such as demand for dairy and dairy consumption, determinants of producer prices, policy reforms and price liberalisation and market development. Small ruminants marketing research, on the other hand, has focused on market potential and niches, determinants and patterns of small ruminants prices as well as spatial integration of markets.

Livestock pricing policies

Livestock pricing policies in SSA are important in four main respects. Firstly, many of the rural people in the sub-continent derive their livelihood from livestock production and their incomes are directly affected by changes in the prices they receive. Secondly, prices serve as signals of market efficiency and performance and policy outcomes. Thirdly, prices represent a cost to consumers who spend an important part of their income on livestock products. Finally, livestock pricing policies are important to governments because of their implications for producer incentives and for government revenue and expenditure.

We begin the review here by discussing two studies on livestock pricing policies. These two studies were largely motivated by the structural adjustment package of the World Bank that has been adopted by many African countries in the late 1980s and early 1990s. The first of these study evaluated, in a comparative cross-country context, the objectives and instrument of livestock pricing policy in five SSA countries and the effects of price interventions on output, consumption, trade and government revenues (Williams 1993). The study mainly aimed at:

1. comparing the objectives and instruments of livestock pricing policies in selected countries in SSA (Côte d'Ivoire, Mali, Nigeria, Sudan and Zimbabwe) and
2. estimating the effects of direct and indirect interventions on producer incentives, livestock output and consumer welfare.

The empirical results of this study showed that national livestock policies had numerous objectives and employed a variety of policy instruments including increased self-sufficiency in meat and milk, promotion of exports, stabilisation and control of inflation, generation of revenue for the government, improvement of nutrition and provision of employment opportunities.

The results of the study also indicated that, in comparison with real border prices, a certain degree of success was achieved in stabilising real domestic producer prices in the countries studied, and that since early 1980s, there has been a gradual shift away from taxation of producers. The analysis also reveals the importance of domestic inflation and exchange rates as key variables for livestock pricing policies, and highlights the need to address the macro-economic imbalances that cause exchange rate distortions and high domestic inflation at the same time. Since the time of these findings, market liberalisation policies spread through the sub-continent. And as a result, exchange rate distortions were largely removed and participation of African countries in World Trade Organization (WTO) and regional free trade agreements increased substantially. It is apparent that it is timely to identify macro-economic policies that contributed to growth in productivity of the livestock sector in SSA.

The second policy study analysed the implications of macro-economic, sectoral and trade policies for the livestock

sector in order to inform the policy debate on development especially in low-income countries (Williams et al. 1995). It described the economic and institutional factors that influence livestock sector growth and the options available to policy makers to improve performance, while reviewing the impact of past and present policies on the sector.

The paper focused on production of ruminant livestock in SSA, Asia and Latin America. Although particular references are made to West Asia and North Africa, and to poultry and pork farms, the study concluded that the broad range of policies affecting the livestock sector includes macro-economic, trade and sectoral policies. It also included public infrastructure, animal health services and investment in processing and marketing facilities. Because of their public good nature, services such as infrastructure, communications, research extension and training must be provided for the overall success of other economic reforms. Government policy should promote optimal use of domestic resources in livestock production as well as other agricultural commodities and products for both domestic consumption and export. This study is believed to provide an excellent analysis of policy and development, bringing together the insights of ILRI and IFPRI.

Dairy market analysis

The market analysis on the demand for and consumption of dairy products in West Africa was limited to a few studies that reveal some variations. These studies of the early 1990s were principally motivated by the excess demand for dairy in the region, particularly in Nigeria, where an increasing proportion of consumption of dairy products has been met by imports since the 1940s. During the oil boom of 1960s and 1970s, consumption of dairy products increased rapidly, but the domestic dairy production sector suffered due to deliberate government policy that promoted cheap imports. After the rapid devaluation of the local currency in the early 1980s, dairy products became dearer and import levels declined continuously. At the time the effect of these changes on dairy consumption and domestic dairy production sectors was not clearly known.

Jansen (1992), and Jabbar and di Domenico (1993) attempted to determine the current dairy consumption patterns of various segments of the population, and the factors shaping these patterns. The objectives were to help predict future demand patterns, particularly for domestic products and help devise production and marketing strategies to develop the domestic dairy sector in southern and northern Nigeria. These studies indicate that in both north and south Nigeria, the type of product consumed and the frequency of consumption differed markedly between ethnic groups and between urban and rural populations. In the south, per capita income of dairy consuming households did not differ significantly. Among the consumers, income elasticity of dairy consumption was higher for rural households in the southeast. In northern Nigeria, however, dairy product demand was found to be income inelastic, and larger households tend to consume relatively less dairy products per household member than the smaller households.

Perhaps the strongest and the most important conclusion derived from these studies was that the existing pricing structure, preference schemes and the resulting consumption patterns of the majority of consumers suggests increased support for the development of traditional production systems based on indigenous cattle. In view of the vast gap between the demand for and the production of milk in Nigeria, the concurrent development of indigenous dairy production systems and breeds might be the most appropriate approach to making a significant impact on dairy production in the country. A solid base of experience in intermediate-level milk production is necessary for the successful introduction of high-input modern production systems and imported genetic stock. Whether dairy development in Nigeria, since the time of the studies, has followed these guidelines remains an open question.

In East Africa, market research dates back to 1994 when the effects of market liberalisation on Kenyan peri-urban dairy were investigated using the policy analysis matrix (PAM) approaches (Staal and Shapiro 1994). In Kenya, public policy has clearly been successful in promoting dairy development. The integration of grade dairy cattle into the smallholder sub-sector can be attributed to the support activities under government policies. Until 1992, the Kenyan Dairy Board (KDB) officially controlled both dairy pricing and marketing policy.

During the early 1990s, input prices paid by producers increased at a higher rate than the KDB-controlled, farm-level prices. As a result, producers increasingly diverted sales to the informal market. Consequently, by early 1992, milk supply to Kenyan Cooperation Creameries (KCC) had fallen by 35% resulting in severe shortage of dairy products on the formal market. To stimulate supply, the Kenyan Government announced the liberalisation of dairy prices and the lifting of the KCC monopoly on processed milk sales to urban areas. Raw milk sales policy, however, did not change. The KCC subsequently raised its producer and retailer prices. The market response to price change was an immediate increase in supply of raw milk to the KCC and, consequently, of processed milk to retailers. The PAM results indicate that this policy reform removed about 20–30% of the negative policy effects of producer price controls. Disincentives to producers still existed. According to the study, the KCC continued to maintain its market power after the policy change. Furthermore, one year later, the dairy market showed little sign of entry by new market actors due to non-price factors such as market dominance and political power that can obstruct the positive effect of price policy liberalisation. The paper recommends that initiatives to encourage secondary processors and other markets need to be continued and strengthened.

Economic reforms in Kenya continue reducing the level of support and intervention within the livestock sector, specifically the public support for veterinary and artificial insemination (AI) services. Policy analysis of ILRI responded to these reforms by measuring the changes between 1990 and 1995 in milk marketing and service provision by the dairy farmer co-operative societies, which played a central role in meeting the needs of dairy production (Owango et al. 1998). Apparently, there were dramatic changes in milk market patterns, in ways unintended by policy reforms. Most notable has been the large increases in the role of the unregulated raw milk market. This helped increase real market prices paid to producers by up to 50%. Large increases were also observed in the provision of veterinary and AI services by the dairy co-operatives whose producer–client base and credit facilities may have enabled them to compete effectively with the independent private sector. Therefore, market liberalisation expanded the role of raw milk, and the participation of dairy farmers’ co-operative societies in milk marketing and the provision of input services with the increased attention to the potential of smallholder dairying. The

Kenyan dairy marketing model can be a lesson in dairy development for other countries, particularly Ethiopia, Uganda and Tanzania.

ILRI's policy analysis also examined the impact of public policy on dairy development in Ethiopia, as compared to that of Kenya (Staal 1995). Unlike Kenya, Ethiopia has not successfully developed a formal dairy system and some 88% of urban milk supply continues to pass through informal market channels (Staal 1995). The study attributes this to government policy that is directed generally towards exchange rates and agricultural markets and production, to the neglect of dairy production. The analysis revealed that domestic market milk prices were lower than export prices, indicating the potential failure in milk market. This market failure results mainly from a previously over-valued currency, which precluded dairy exports from official exchange rates. Recent currency reforms, however, have greatly improved the potential of dairy exports.¹ According to the comparative analysis, Kenyan and Ethiopian dairy policies show that, while Kenyan dairy is still more competitive, both countries have a comparative advantage with respect to world dairy markets due to low opportunity costs of domestic factors.

The comparative advantage and contrast between the Kenyan and Ethiopian dairy has once again been exploited in market research to illustrate the role of dairy co-operatives in reducing transaction costs in the search for ways to promote participation of large numbers of smallholder farmers in dairy activities. Staal et al. (1997) argued that first, in peri-urban areas of Africa dairy offers high potential as a smallholder diversifications activity. Second, the growth in smallholder dairying is limited by high transaction costs for both production and marketing. Third, differential levels of transaction costs across producers in what appears on the surface to be a single market (e.g. fluid milk in Addis Ababa at a point in time) explain why producers habitually accept widely different prices for a seemingly homogeneous item in the same location and time. Fourth, contracts between producers' and buyers' co-operatives play a central role in reducing transaction costs where market dairy activity is observed.

1. It is not clear from this study why a country such as Ethiopia, currently a milk and dairy importer, will strive for milk and dairy export. The immediate objective would seemingly be to close the import gap.

Still further, the analysis of the determinants—different levels of access to infrastructure and assets—explain why producers contemporaneously accept widely different prices for fluid milk. The study highlighted a number of policy implications based on the evidence of the study on transaction costs. First, because of the potentially important role of collective organisation in lowering transaction costs in dairy marketing, government actions would promote smallholder dairy development. This helps to provide an enabling environment of regulations, enforcement and infrastructure for well-managed co-operatives. Second, greater transparency of dairy marketing policies appears to be necessary to support smallholder dairy development.

Meanwhile, recent publications explain the impact of transaction costs and the choice of production techniques on the decision of farmers to sell fluid milk to co-operatives in the Ethiopian highlands (Holloway et al. 2000a; Holloway et al. 2000b). The results of the findings in these publications provide insights as to how market participation by smallholder producers could be further promoted. Locating groups to minimise the time required to sell milk increases the number of participating producers and the level of marketable surplus. Investment in infrastructure such as formation of the milk groups provides a less costly mechanism for increasing participation and furthering of the integration of traditional producers into agro-industrial systems. Although milk groups are an example of a simple agro-industrialisation innovation, they, however, appear to be a necessary first step in the process of developing more sophisticated co-operatives.

Adoption of cross-bred cows is an important variable influencing smallholders' entry into the emerging milk market. However, three aspects of milk marketing can lead to high transaction costs as barriers to entry. First, marketing decisions appear to be risky, as the product is perishable. Second, the weight of milk relative to its value in the market makes transportation cost an important variable as to whether to invest sufficient resources to enable participation. Third, in the context of marketing derivative products, the cost of processing and transforming the milk into butter and milk-products are substantial.

However, farmer co-operatives have been identified as potential catalysts to market participation. Analysis of data from the

Ethiopian highlands where farmers were organised in a dairy co-operative showed that male household heads and extension visitations affect crossbred cow adoption positively, while credit use and number of local breed cows currently milked affected adoption negatively (Holloway et al. 2000b). The same study showed that male household heads, extension visitation, and number of local breed cows currently milked affect milk output positively, while credit use affected milk output negatively. Distance to market affected milk sales negatively, while extension visitation affected milk sales positively.

This study also suggests that extension visitation is a potentially important catalyst for market expansion. Consequently, a number of important questions arise concerning the actual impacts of extension on participation, the number of extension-requesting households willing to pay for services if it was privatised, the corresponding demand schedule for extension services and the requisite conditions for the existence of a private market for the service.

A recent publication attempted to respond to these issues in the context of Ethiopian smallholder dairy producers (Holloway and Ehui 2001), and the results were interesting. For each unit increase in extension, the transaction cost is lowered by ETB² 0.62. Hence, extension is shown as a promising market entry catalyst. Further, the willingness to pay for one additional extension visit ranges from ETB 0.62 to ETB 6.77. The study estimated the marginal cost of each extension visit at ETB 2.14 based on the annual extension budget of the local administrative units and the estimated number of extension visits made during the year. The proportions in willingness to pay estimates show that some 65 households (39% of the participating households) would be glad to purchase extension services.

Reinforcing the findings of Holloway et al. (2000a), Holloway et al. (2000b) and Lapar et al. (2003b), Ehui et al. (2003a) found that households with higher education, larger number of cows, and greater non-farm income were positively associated with value of sales of dairy products. This suggests that income from sale of milk, butter and cheese can be increased through education and training, especially targeting females. Education and training help to improve the quality of dairy products, which can, in turn, attract better prices. The results further indicate that

2. ETB = Ethiopian Birr. In November 2003, US\$ 1 = ETB 8.75.

areas with greater population pressure are associated with lower sales of live animals, but greater sales of dairy products, suggesting the profitability of dairy production in densely populated areas.

Competitiveness of livestock systems

An important issue emerged from the Livestock Revolution study is that despite the potential growing markets for livestock producers, there are concerns that the smallholder producers might not benefit from the Livestock Revolution unless specific policy actions are taken (Delgado et al. 1999). The concern is generally common to many developing countries and increasingly with the rapidly increasing pace of economic liberalisation that may increase vulnerability of domestic markets to open competition. A recent paper addressed whether livestock production will remain competitive with the outside world in order to play a significant role in rural income diversification, and whether smallholders will remain competitive to stay in business and reap the benefits of the rapid demand growth for livestock products (Akter et al. forthcoming). Akter et al. (forthcoming) applied policy analysis matrix to assess the competitiveness of local, crossbred and exotic breeds of poultry and pig production in North and South Vietnam using data from a stratified sample of 2213 farms collected by IFPRI and ILRI in 1999.

Results show that productivity, average cost and economies of scale generally determined competitiveness of poultry and pig production from either breed. Poultry and egg production from cross and exotic breeds are generally competitive in the North, while egg production with local breeds is uncompetitive in the South, due to low productivity and high per unit cost. Economies of scale in poultry production exist in the North but are not so clear in the South. In Vietnam, domestic prices of both outputs and inputs are higher than the world prices due to protective policies. Under an alternative scenario of lower output prices and slower domestic demand, poultry breeds that are profitable under the existing situation would still remain competitive. Pig production under existing technologies and market conditions is highly competitive, especially with local and crossbreeds in the North and exotic breeds in the South. Currently, the producers in the South are apparently benefiting more due to market

conditions and policy that make input cost higher and output price lower in the North. There are economies of scale in pig production. Medium farms are more cost effective and small farms are least competitive. Small chicken farmers may not be in a position to compete in a more liberalised economic environment with low productive local breeds and higher per unit cost, so they may fail to reap the benefit of an expanded demand led market. Indeed they may be pushed out of the market, thus aggravating poverty and unemployment. So to avoid such a situation, active policy support in favour of small farmers may be provided so they can stay in business and grow sufficiently competitive. Such a policy may be the key to alleviate poverty of smallholders and let them participate in the market driven rural development process.

Live-animals market analysis

The trend in marketing live animals is generally poorly developed, and current knowledge on structure and performance is very limited especially in the Ethiopian highlands (Ayele et al. 2003). A 2000/01 survey of 38 and 131 livestock markets and traders, respectively, in the highlands of Amhara, Oromiya and Tigray regions showed that market agents (wholesalers, brokers and retailers) who are engaged in trade of all species of livestock, especially cattle and small ruminants, have increased significantly since 1991 (Benin et al. 2003c). In many of the markets, it was not known who was responsible for licensing, dealing with health issues or infrastructure development. Consequently, there were many unlicensed traders (and their numbers have increased substantially since 1991), irregular inspection facilities, and no stocking facilities (including fencing and feeding and water troughs). Similar to grain marketing, livestock marketing is characterised by small-scale businesses with very few assets and personalised trading (Jabbar and Benin 2003).

Examining the factors that affect market participation and sales by households, Ehui et al. (2003b) showed that physical capital (ownership of different species of livestock and landholding) and financial capital (crop income and non-farm income) are the main factors influencing market participation and sales, not the distance to markets and towns. These results suggest that constraints to production of livestock and livestock products

(e.g. capital to purchase animals, feed and processing equipment) may also be the main factors limiting market participation and sales. Since livestock are trekked to markets, ownership of pack animals (mules, donkeys, horses and camels) is critical in promoting market participation. Pack animals serve two purposes: transporting people to the market, and carrying commodities purchased from the market to home.

South-East Asia

A similar study was undertaken in a cross-section of smallholders in Northern Luzon, The Philippines, to investigate factors precipitating market entry where smallholders have to make decisions about participation (a discrete choice about whether to sell quantities of products) and supply (a continuous-valued choice about how much quantity to sell) (Lapar et al. 2003b). The model used in this study combines basic probit and Tobit models and is implemented using Bayesian methods, since it is believed to generate precise estimates of the inputs required in order to effect entry among the non-participants. Estimates of the total amounts of livestock inputs (from cattle, buffalo, pig and chicken) required to effect entry were obtained, and compared and contrasted with the alternative input requirements. This study examined the competing effects of transaction costs, labour mobility, capital formation (intellectual, financial and physical) and indebtedness on smallholders' market participation and selling decisions. The important role of policy in providing an enabling environment for improving the productivity of smallholder livestock production systems is suggested by the strong effect of animal numbers in the participation and selling decisions of farmers.

Technology and policy options that will enhance incentives to increase production will have a large, though indirect, impact on motivating market participation. Such options will provide a strong push to help mitigate the considerable input requirements for entry, which appear to be a major stumbling block for many smallholders to become market participants. It will be worthwhile exploring in further empirical work to understand what optimal combinations of these inputs will prove to be cost-effective, and provide an answer to the inevitable research question of identifying the constraints to households holding more than they do.

Social prescriptions that increase education will, however, divert smallholder attentions elsewhere, and this finding appears to stand in marked contrast to other studies (for example Holloway et al. 2000a) that find a strong participatory impact from education. Whether this difference stems from externalities arising from differences in off-farm employment opportunities; differences in risks associated with different commodities; or, perhaps, climatic variability, remains a potential research question. Other factors may explain differences in results attributable to existing infrastructure, especially the quality of roads, communication and transport systems.

The availability of alternative occupation opportunities, however, significantly affects the viability of social and economic prescriptions, and policymakers need to be cognizant of these results when targeting objectives for smallholders. In addition, capital stock variables, especially remittances, have a positive influence on market participation suggesting the importance of financial security in enabling smallholders to cope with risks and to meet their subsistence requirements. This also points to the more important and general issue of farmers' capacities to bear risks as critical determinants of market entry for this to be addressed through appropriate policy interventions that facilitate risk-bearing. Improving farm-specific skills through extension visitation appears to be important in precipitating entry, but not supply. Here, animal-productivity improving technologies are probably the most lucrative of all other options.

Another comprehensive study on the development of the livestock sector in Vietnam identifies barriers to livestock input and output markets for smallholders (Lapar et al. 2003a). Specifically, uncertain quality and high prices of animal feeds including raw materials for feed processing, variable quality and high cost of more productive animal breeds, and inefficient delivery of veterinary services and high cost of veterinary inputs were identified as the major constraints to livestock input markets. Constraints to reaching output markets include poor quality and unsafe meat and meat products, lack of a legal framework and standards, bottlenecks in the distribution channel, and limited access to information. In addition, the prevailing marketing system and channels for each type of commodity from farm to market have evolved into a multi-stage system that is characterised by high transaction costs, and lack of integration among the players in the various channels. The lack

of an organised marketing system for livestock in Vietnam disables producers to improve production activities. What is more, it perpetuates the low market power of producers relative to other players in the system, such as traders and wholesalers.

It is envisioned that the government could play a regulatory role in ensuring high standards and regulations to produce high quality, safe meat and meat products. Moreover, research into the development of alternative production models that are suitable to smallholder producers, at the same time catering for high quality and safe meat and meat products, would be important in engendering more smallholder participation in emerging markets for livestock. Collective action to take advantage of economies of scale in input procurement as well as output marketing could potentially be developed and tested for replication on a wider scale.

Small ruminants

Since the mid-1970s, researchers at ILCA have recognised the importance of meat and milk from small ruminants both for subsistence and as potential sources of additional income for resource-poor smallholders in SSA. Their small body size, high reproductive rate and rapid growth make it easy to integrate sheep and goats into production systems. It is, thus, not surprising that several studies have emerged from the policy programme examining the role of markets in increasing small ruminant production, identifying market niches, analysing price patterns and price determinants in small ruminants markets in selected countries across the sub-continent. The centre has conducted numerous marketing and consumption studies in Nigeria, Ethiopia and Niger.

In the humid zone of Nigeria, where livestock production is limited by the prevalence of the trypanosomiasis, supply–demand imbalances have important implications for markets, prices and increased production potential of small ruminants. These phenomena motivated an analysis of the role of market in increasing small ruminant production in southern Nigeria (Jabbar 1993a; Jabbar 1995).

The analysis showed that excess demand for small ruminants, particularly at festival times, is usually augmented by supplies from the northern part of the country. Subsistence-oriented

southern producers sell animals throughout the year mainly for various cash needs. However, prices are generally higher at festival times, but on a yearly basis variability is insignificant. So, production technologies that contribute to year-round increase in supply may be of better value for small-scale subsistence-oriented producers, while commercial production may be geared to the peak festival-time markets. Technology needs of the subsistence production system may include disease control measures that contribute to increasing the flock size. This type of analysis, common in LPAP works, is an attempt on its part to lead technology development and dissemination to respond to farmers' needs and the market opportunities offered to them.

A related study analysed economic demand for specific breeds of small ruminants, price differential and factors influencing price in southern Nigeria (Jabbar 1998). As there are significant differences between species and breeds purchased for various purposes, e.g. rearing, trading and ceremonies, there are equally significant price differentials. In order to target specific markets to maximise their benefits, producers could use the results on buyer preferences for specific breeds and species for specific purposes.

Intra-annual sheep price patterns and factors underlying price variations in the central highlands of Ethiopia have been analysed by Andargachew and Brokken (1993). The objective of their study was to determine the effects of certain animal and market characteristics on price, and the patterns of sheep prices in relation to seasons. Considerable weekly price variations were evident in redistribution, intermediate and terminal markets that are identified by buyer's purpose. Animal characteristics (weight, age, condition, sex and colour) as well as buyer's purpose for buying and buying seasons were important in explaining variation in price among animals. Producers may, as in Nigeria, target marketing opportunities in order to gain from co-ordinating fattening, breeding and marketing operations.

Through price signals and differentials, the small ruminant markets in Nigeria and Ethiopia translate consumer preferences into producer breeding strategies. This serves as a market mechanism for biodiversity of sheep breeds within the farming system to respond to specific niches of market demand. Does the market mechanism always guarantee biodiversity or

conservation? Jabbar et al. (1998) used the case of Muturu, a West African shorthorn breed, to illustrate the relationship between farmer preferences and market values of cattle breeds in west and central Africa.

An analysis of cattle market prices in the derived savannah area of south-western Nigeria found small, but significant, price differential by breed. Even though the breed is known for its superior abilities to resist diseases, particularly trypanosomosis, and is productive under high humidity, heat stress, water restriction and poor quality feed, the Muturu was rated the least for its marketability, market value and mobility. For producers, the perceived limited marketability, low market value, and the need for mobility to market are important components of the returns to raising Muturu. Farmers' preferences against this breed imply that there is very little scope for conservation of the Muturu in the derived savannah areas of southern Nigeria. Accordingly, the Muturu could be interbred to extinction in 2–3 decades. The point is that market may not always lead to biodiversity conservation. Other strategies are important to ensure conservation of breeds at risk of extinction.

Two additional studies have dealt with markets and price variability of large number of categories of livestock in Niger. The first was an analysis of the degree of spatial integration of livestock markets (Fafchamps and Gavian 1996). As the droughts of 1973 and 1984 have amply demonstrated, the livestock industry in the Sahel is vulnerable to local pasture availability and weather shocks. By allocating livestock more efficiently over space, market integration should favour a better use of scarce pasture resources. Indeed, to the extent that producers react to local pasture availability by selling or buying animal, price differentials between regions should signal difference in returns to livestock. Spatial arbitrage is therefore expected to reduce excessive pressure on the environment by helping livestock move out of stress areas. Studying the geographical integration of livestock markets should shed lights on the optimal and sustainable use of one of the Sahel's most critical natural resources—pasture.

The analysis shows that livestock markets in Niger are poorly integrated. Prices are seldom integrated, suggesting that large price differentials occasionally persist between adjacent areas for longer time. The results suggest that there is a room for

improving the functioning of livestock markets in Niger. How market efficiency can be improved, however, cannot be assessed on the basis of price series alone and further research is needed. The authors expected that a more positive attitude by government authorities with involvement in infrastructure could significantly improve the efficiency of livestock markets.

Using the same data, the authors followed the above study by an analysis of determinants of livestock prices (Fafchamps and Gavian 1997). This analysis shows that livestock prices in Niger respond to droughts and pasture availability. Livestock prices are also exposed to aggregate shifts in export revenues and meat demand that affect Niger and its southern neighbour, Nigeria. These shifts add an important element of risk to the livelihood of Sahelian farmers and pastoralists. Famine early warning systems should keep an eye not only on weather shocks but also on macro-economic conditions and other factors affecting the livestock economy.

Input markets: Credit

Many economists suggest that improved livestock in semi-arid and subhumid tropical SSA and Asia should be obtained through intensifying production from the integrated crop–livestock systems via adoption of improved crop and livestock technology.

Credit is one instrument to encourage adoption of new technology by alleviating the cash constraint, rendering necessary inputs inaccessible to poor farmers. Many countries have successfully experienced some means of advancing loans to crop farmers but few managed with livestock. The project on the role of credit in the uptake of livestock technology in SSA was initiated in 1993. It was intended to measure the impact of credit use on productivity of livestock farming operations, to assess the relative efficiency between credit constrained farmers and non-credit constrained farmers, and to compare terms of informal livestock loans with crop loans. The research project was motivated by the low rate of adoption of agricultural and livestock technologies due to problems of high risk associated with the technologies, poor extension services and binding liquidity constraints. The need to determine the extent to which credit limits livestock productivity and technology uptake arises

from the importance of livestock in smallholder, mixed farming systems. The project was implemented in Uganda, Ethiopia, Nigeria and Kenya.

The results from the studies conducted were consistent in many respects with those from the extensive literature on smallholder farmers credit programme in the crop sector in developing countries. For example, many smallholder credit programmes rely entirely on central governments or donors for funds rather than savings. Also, some policies and practices pursued by banks screened many smallholder producers out of formal credit markets, and many banks had inflexible loan terms and structures and persistent problems with loan recovery.

A comparative study attempted to determine the impact of credit on milk output on smallholder dairy in Ethiopia and Kenya (Freeman et al. 1998). No consistent relationship was discovered between farmers' credit constraint conditions, i.e. whether the farmer considered himself as credit constrained or non-credit constrained. The number of crossbred milking cows in the dairy herd explained most of the variation in milk output per farm. Because credit is likely to facilitate investment in crossbred cows, the study concluded that it has substantial impacts on smallholder dairy farms, especially if it is targeted to credit constrained farmers.

An on-going research recognised that advancing credit for smallholders to encourage technology adoption is a complex policy issue. Among the interrelated issues that may affect the policy success are amount and form of credit, the interest charged, targeting of specific farmer groups based on their level of wealth, targeting of specific activities and repayment schemes. The study examines how these factors affect the credit-induced technology adoption. Obviously, more research in this area is needed to help policymakers design an effective and sustainable livestock credit policy. Many experiences can be learned from successes around the globe, e.g. the Grameen Bank in Bangladesh.

Credit has played a significant role in the adoption of improved technologies under the Green Revolution. It is generally perceived that supply of credit to the livestock sector is very limited, and that access to credit by smallholders is even more limited. Based on analysis of credit supply in Ethiopia, Kenya, Uganda and Nigeria, it is shown that public credit institutions do

not have sufficient funds to meet the demand for livestock credit and cannot mobilise savings from their clients, or other commercial sources for one reason or another (Jabbar et al. 2002). Also due to the application of inappropriate screening procedures and criteria to determine credit worthiness, available credit does not reach those who need it the most and with whom it could have the greatest impact.

The analysis of demand based on borrowing and non-borrowing sample households using improved dairy technology shows that not all borrowers borrowed due to actual liquidity constraint. Some borrowers and some non-borrowers had liquidity constraint but did not have access to adequate credit. Logistic regression analysis shows that sex and education of the household head, training in dairy, prevalence of outstanding loan and the number of improved cattle on the farm had significant influence on both borrowing and liquidity status of a household, though the degree and direction of influence were not always the same in each study country. Based on the findings it is suggested that combining public and commercial finance could solve the problem of inadequate credit supply, while inventory finance to community level input suppliers and service providers might help in getting credit to worthy and needy smallholders at lower cost than providing credit to smallholders directly (Jabbar et al. 2002).

International and regional trade

Globalisation is transforming domestic and international agricultural markets in developing and high-income countries through increasing trade and enhanced exchange of technology and capital. Trade liberalisation, as one of the key drivers of the globalisation process, affects supply and consumer prices, triggering changes in production specialisation patterns and generating second-round effects through consumption, income, investment, factor prices and employment. Other events that shape the globalisation process, like urbanisation and rising incomes, are rapidly strengthening domestic demand for livestock products and are expected to dramatically affect agricultural production, agro-industries and food consumption, bringing increasingly stringent food safety and quality standards. These events are likely to lead to profound changes in the structure and performance of livestock industries in developing countries, not only by providing opportunities for accelerated economic growth and poverty alleviation but also by introducing risks for the poor and smallholder producers. Given the role of trade and globalisation forces in shaping livestock production and markets, ILRI's research in this area has been expanding in recent years and is expected to have an increasing importance in the near future.

Three studies on livestock trade have been reviewed in more detail. The first of these analyses the potential role of China as a major importer of agricultural products aiming specifically at the livestock sector. It also presents a detailed analysis of productivity growth in China's pig and poultry production along with projections of China's likely meat trade in the year 2010 (Nin Pratt et al. 2002; Nin Pratt et al. (forthcoming)). The study uses a global general equilibrium model which allows the authors to explore the sensitivity of trade and production projections to macro-economic uncertainty as well as uncertainty in livestock productivity growth rates. The analyses show that China's net trade position is very sensitive to both of these factors. With high livestock productivity growth and a slow-down in the rest of the economy, China could be a substantial competitor in livestock export markets by 2010. On the other hand, slow productivity growth in livestock

production, coupled with a rapidly growing macro-economy could transform China into a major market for future meat exports.

The second study examines the implications of multilateral trade liberalisation for Vietnam's livestock sector and its consequences in terms of poverty alleviation (Nin Pratt et al. 2003b). A number of developing countries consider their livestock production sectors to be particularly vulnerable to global trade liberalisation, especially because of the dominance of smallholder systems. The argument is that agricultural trade liberalisation will give undue advantage to large-scale commercial livestock systems at the expense of smallholder production systems, adding to the adjustment pressures on smallholder producers for whom income from livestock production is vital in helping them avoid poverty. The study evaluates the impact of trade liberalisation on Vietnam's smallholder livestock producers and the potential contribution of the livestock sector to poverty alleviation in anticipation of Vietnam's accession to the WTO. The impact of trade liberalisation on Vietnam's livestock production tends to be small but, in general, a more open Vietnamese economy would result in a deterioration of the trade balance of livestock products. In spite of this, trade liberalisation would benefit poor livestock producers by increasing livestock prices relative to production costs, feed costs in particular, and by increasing non-agricultural income.

The third study focuses on sanitary measures to protect human and animal health that also act as non-tariff barriers to trade (Nin Pratt et al. 2003a). As is generally the case, livestock importers adopt hygiene and health standards that are higher than those of developing countries. Exports of live animals from Ethiopian Somali region to the Middle East face major constraints and costs on complying with standards required by importers.

A ban on livestock exports from the Horn of Africa imposed by Saudi Arabian authorities in 1998 and 2000 has had a major impact on this livestock dependent economy. The study considers economic relationships in the Somali region as a model, building a social accounting matrix that includes factors such as the main production activities, rural and urban households categorised by wealth, as well as the main economic flows within the region on the one hand, and between the

region, and the rest of the world on the other. A CGE model is used to simulate the reduction of live animal exports from the region. Results show that the overall cost to the Somali economy of a ban that lasted 16 months was US\$ 21.8 million, and that it could reach up to US\$ 36 million with the assumption of constrained factor mobility in the region. The total estimated loss in value added for the region was US\$ 195 million, almost equivalent to the total value added that is produced in a normal year.

In the short-run, middle income and better-off households deal successfully with the negative effects of the ban by increasing home consumption and/or increasing sales of livestock products. Poor pastoralists with limited production capacity, however, experience welfare losses because increased consumption of their own production is not sufficient to compensate for the income losses. In the medium-run, reduced livestock supply and reduced income in pastoralist activity is higher than in the short-run, and household consumption strategies are not sufficient to avoid welfare losses even for better-off pastoralists.

The study also evaluates the certification of exported live animals, granted Rift Valley fever (RVF) free zone, as is the case of Ethiopia, as one possibility to handle the problem and comply with international sanitary regulations. The benefit–cost analysis employed derives costs and benefits from the CGE simulations, and future outbreaks of the disease are simulated using a Monte Carlo approach. It also examines different alternatives (export tax, sales tax and increased transaction costs) to charge producers for the equivalent amount of the cost of the programme. The study concludes that implementing an animal health programme in the Somali region is economically feasible and would benefit poor producers. It also suggests that increasing taxes on livestock sales offers the best prospect as the way to fund the health certification plan. This option has the less negative impact on exports and welfare, resulting in the higher benefit for the poor given that it implies a transfer from middle and better-off producers to poor producers.

Policies for delivery of animal health services

A good deal of policy research over the last decade has been devoted to economics of disease control, particularly on trypanosomiasis which results in an estimated annual loss of US\$ 1.6–5 billion (Falconi et al. 2001), as such disease represents a major source of loss of productivity and farmers' incomes. However, other diseases of economic importance have also been evaluated as the result of the methodologies and approaches developed. The research extended beyond economics of the disease and its control to issues of delivery and privatisation of veterinary services as well as property rights and local institutions. As we will see, there are important lessons that can be learnt from the experience of ILRI in working with communities in diseases control.

The economics of trypanotolerance

The early research on trypanotolerance was driven by the demand for policy information. The exploitation of genetic resistance to the disease using African trypanotolerant breeds of cattle was given an increasing attention in a bid to reducing the effects of the disease (Itty et al. 1995). A great deal of information on the health and productivity of these cattle has been accumulated through research conducted at contrasting monitoring sites of the African Trypanotolerant Livestock Network (ATLN) since the late 1980s. In some of these sites, trypanotolerant cattle were introduced from regions of origin.

Several publications addressed the question about the circumstances under which trypanotolerant cattle enterprises can be economically viable in regions of origin and areas of introduction (Itty and Swallow 1994; Itty et al. 1995; Itty 1996). Village cattle enterprises in four countries in West Africa (The Gambia, Côte d'Ivoire, Togo and Zaire) were analysed. These studies concluded that trypanotolerant cattle represent a solution to the problem of producing cattle in regions of Africa affected by trypanosomiasis. Expansion of trypanotolerant cattle

systems cannot, however, be recommended without a comparison with other tsetse and trypanosomiasis control strategies. In sites where cattle were to be introduced (Togo and Zaire), for instance, the level of costs need to be kept low because the benefits were limited to production of beef and breeding stock.

In contrast to the case of village cattle production using trypanotolerant breeds, other research considered the productivity of cattle herds raised under local management with a systematic regime of drug therapy, as the case in the Ghibe valley of south-western Ethiopia (Itty et al. 1995). As this work was completed during the time of expectations of devaluation of the Ethiopian currency and the privatisation of provision of veterinary services, the analysis had to focus on these two policy issues. The results indicated that economic returns increased considerably with higher costs of foreign exchange because of the resulting higher shadow prices for milk and meat. However, with high market price for trypanocidal drugs, the internal rate of return on investment for the cattle owner would decrease from an average of 25% to its worst-case scenario of 20%.

The policy research paper presented at an annual conference on the Ethiopian economy, Mussa and Gavian (1994) raised several policy issues regarding privatisation of animal health services in Ethiopia. The paper, based on economic theory, argued that vaccination against contagious diseases and vector control are public goods since the benefits extend to the whole economy, while curative services (diagnosis and treatment) of non-transmittable diseases are primarily private goods. Preventive services work better when managed by the state while privatisation could be encouraged for curative services.

Even if public goods such as preventive service work better when managed by the state, the question of willingness on the part of the community to the provision of local public good remains unanswered. Swallow and Woudyalew (1994) investigated whether local communities are willing to contribute in terms of money and/or labour for trypanosomiasis control programmes that used baited targets to kill tsetse flies in south-western Ethiopia. When asked contingent valuation questions about the maximum amounts of money and/or labour that they would be willing to contribute to the control programme, 59% of the households surveyed volunteered both

money and labour and only 3% volunteered neither. Willingness to contribute money was related to the gender of the household head, the number of cattle held by the household and the participation of the household in a monitoring exercise being conducted by the research organisation. Willingness to contribute labour was related negatively to off-farm employment status of the head of the household, and positively to the information available to the respondent about the programme. Apart from direct applicability of these results to increase local involvement of the affected population in the control programme, the study stressed that the methodology used here, when integrated into participatory research approach, can generate practical results for evaluating the prospects for local participation in the provision of public goods.

Disease control and biotechnology

Recently, the policy analysis of disease control took a new angle by examining the potential benefits to research on maintaining resistance to trypanosomiasis in tolerant and susceptible animals of two research thrusts: historically field-based and biotechnology-based (Falconi et al. 2001). This was motivated by the interest in understanding and exploiting the inherited resistance to trypanosomiasis of some livestock species and the opportunity for exploiting the emerging biotechnology to speed up the slow but steady progress made through field-based research. The issue here is prioritisation and research resource allocation. Such analysis is critical under conditions such as that of increasingly tight research budgets, pressures to demonstrate relevance, cost-effectiveness and impacts of particular research thrusts. The analysis concluded that overall priority should be given to the biotechnology option since resource devoted to field-based research on trypanotolerance generate significantly low potential benefits on aggregate than do those from biotechnology research. However, the relevance of biotechnology research and, most importantly, the likelihood that farmers will actually adopt outputs of that research and realise the potential gains that hinges on close link with field-based work.

Rapid gains in genetic resistance to trypanosomiasis in cattle population of affected areas of Africa is expected from identifying 'marker-assisted selection' of target genes and

‘marker-assisted introgression’ coupled with AI. This complexity of the research product, together with its cost, raises the question about the means of delivering this technological product. To answer the question, the authors considered alternative arrangements of property rights. The paper compares the research impacts under two regimes of ownership rights, and delivery of research outputs. These are the complete private ownership vs. the complete public ownership. Under any scenario, institutional capacity to manage the implications of intellectual property rights for research activities is crucial to the distribution of gains of biotechnological research on trypanotolerance. The authors suggested that further research is needed to consistently identify and track the impacts of alternative intellectual property rights regimes, their implications for delivery options, and thereby their effects on the levels and distribution of research benefits.

Lessons in service delivery: The extension services in focus

It is necessary that agricultural extension systems be efficient and effective for technology diffusion to end-users. Agricultural extension systems across Africa are under great pressure to become more efficient and effective. Although there are sufficient proposals to what African governments should do in order to achieve these goals, those addressing how they might do so are rare. Are there any lessons that we can draw from ILRI’s involvement in the interventions to control trypanosomiasis that may contribute to increasing the efficiency and efficacy of national extension systems in SSA?

The analysis of the outcome of the multi-year, farmer-centred intervention to control trypanosomosis carried out by ILRI in South-West Ethiopia offered an important guidance to the specific factors and processes that likely influence development and diffusion of agricultural technologies in given circumstances (Omamo et al. 2002). While not conceived as such at the time, this intervention emerges, in retrospect, as a real-world experiment in decentralised private provision of a traditional public extension activity. The nature of the control technology and several biophysical and socio-economic characteristics of the region selected for control, and that of participating farmers suggest insights into a range of issues that arise when analysts

and decision makers take the question of how to reform agricultural extension services in Africa.

The significance of ILRI's experience is summarised as follows:

1. ILRI succeeded in overriding a set of inherently indivisible physical and institutional obstacles to growth
2. ILRI's most important interventions focused on the institutional constraints. Specifically, its effort to raise awareness among farmers, help set up treatment centres, and organise treatment of sick animals produced a crucial combination of effects: learning effects, co-ordination effects and adaptive expectations. These effects led to an increase in the rate of adoption and sufficient use to overcome the inherent lumpiness of tsetse control
3. ILRI's role led to an 'organised articulation of demand' that resolved co-ordination problems typically involved in 'market creation'.

The primary lesson for extension reforms emerging from ILRI's experience is that it is the demand-driven nature of an agricultural extension system that matters the most, i.e. the demand for new information, which itself derives from demands for such goods and services as improved inputs and credit.

Other diseases

The policy work on health has not been restricted to trypanosomiasis. The economic loss due to ovine fasciolosis in the Ethiopian highlands was estimated and opportunities for reducing these losses were explored (Ngategize et al. 1993). The study indicates that the returns from anthelmintic use to control fasciolosis are potentially high since the infrastructure already exists. Returns from endoparasitic control of fasciolosis in the Ethiopian highlands were estimated to be as high as 215%, and nutritional supplementation has the additional effect of reducing endoparasitism. Based on the results from this study, the authors justified control of this disease.

The policy work has not been limited to Africa, either. With ILRI's global mandate, LPAP researchers extended their effort to South-East Asia. In recent work, social welfare of adoption of

herd health control programmes on smallholder dairy farms in central Thailand were estimated and the implications of heavy public policy support to the Thai dairy sector were analysed (Hall and Ehui 2000). In this study, the main concern is the impact that the adoption of herd health control programmes has on the exogenous, policy-induced distortions that benefit the Thai farmers. Results of the study indicate that dairy farmers of central Thailand have incentives to adopt herd health measures and that, following adoption of such programmes, there is a reduction in the degree of social inefficiency resulting from public policy supporting dairy farming. Following a reduction in the incidence of bovine disease on adopters' farms, the study predicts that there would be an increase in private profits due to the increase in farm revenues exceeding the increase in veterinary input costs.

On-going research on disease control and delivery of animal health service at LPAP includes a collaborative project with the Agricultural Research Centre for International Development (CIRAD) on sustainable delivery of animal health services and appropriate decision making for control of contagious bovine pleuropneumonia (CBPP). CBPP is a major respiratory disease of cattle prevalent in most of African countries and widespread in several regions of Ethiopia. Its economic importance is mainly due to high mortality, production losses and costly and inefficient control strategies. Its control is expected to substantially improve productivity of cattle. A cost-benefit analysis of CBPP control strategies at herd level in traditional livestock farming systems of Ethiopia reveals that antibiotic treatment, as local practices prove, is the most cost-effective compared to other treatments such as vaccination, vaccinations and antibiotics, and multiple vaccinations. The study was implemented in close collaboration with local research and other stakeholders, mainly constituting the Ethiopian Ministry of Agriculture, EARO, National Animal Health Research Centre, National Veterinary Institute, Faculty of Veterinary Medicine and University of Claude Bernard Lyon I, the National Institute of Agronomic Research (INRA), the National Centre for Scientific Research (CNRS), the French Food Safety Agency (AFSSA) and the National Veterinary School of Lyon in France.

With the recent emergence of diseases of trade where imports from certain host countries are restricted, policy work on diseases is expected to focus on the analysis of the welfare

impact of these on trade and the smallholder producers. This focus necessitates a closer integration of research in economics of disease control and market, and regional and international trade research. Trade globalisation and the emerging stringent health and environmental regulations in importing countries can substantially affect smallholder producers' market participation and the level of benefits or losses resulting from the evolving Livestock Revolution.

Land tenure, property rights and institutions

Property institutions and land tenure rights³ have been studied extensively mainly due to two reasons. Firstly, land is the primary and critical factor of production in agrarian societies. Secondly, ILRI has the objective of developing technologies and promoting policies that expand the production of livestock while at the same time conserving the natural resources. This is evident in a review in 1994 of 18 studies on land tenure systems and related issues in Africa conducted by ILRI staff and their collaborators (see Swallow 1994b).

Early analysis

The majority of the earlier studies have been concerned with several questions:

1. How do property institutions affect the use and management of resources?
2. How do property institutions act as obstacles or create opportunities for the adoption of new technologies and expansion of agricultural production?
3. How does the structure of government affect property institutions?
4. How do changes in economic and technical conditions affect resource use and property institutions?

A great deal of research on property institutions in West Africa has focused on evaluating the effects of property institutions on adoption of feed production technologies. Examples are the studies on adoption of fodder banks, alley farming and a study of the processes by which livestock owners obtain feed resources when they begin to adopt dairy production. Other studies

3. Property is defined here as a stream of benefits that is generated by a resource or other assets while property institutions are the rights, rules, conventions and norms that govern the relationships between people and those benefit streams.

focused on farming systems in the Sahel and examined the relationship between property rights and the management of manure (Toulmin 1992; Gavian 1993; Gavian and Fafchamps 1994).

Several studies have focused on theoretical analysis of the prospects for internal governance of common property regimes of natural pastures. The results of the analysis suggest that a group of livestock owners can effectively manage common property rangelands without formal organisations or institutions if the group is relatively small, if entry into the group is relatively slow or difficult and if the members of the group do not discount the future too heavily (Swallow and Bromley 1994). The types of institutions that can be implemented to regulate the use of rangelands depend upon the structure of governance. That is, a common property regime can only be effective if its institutions are compatible with the structure of governance. In many cases, it is more appropriate for African governments to define and enforce boundaries between groups, then help to establish conditions in which internal group dynamics yield efficient resource management outcomes (Swallow and Bromley 1995).

Changing property institutions

A considerable attention has been given in the literature to the relevance of and the debate around the issue of property institutions, land tenure and agricultural productivity in Africa and in line with this, the policy work of ILRI. For Ethiopia in particular the change in the structure of government in 1991 has created an environment in which property institutions can change rapidly. This environment provided an opportunity to evaluate the effects of different types of property institutions. The evaluation focuses on use and productivity as well as efficiency of land resource, and on how property institutions change in response to external and internal pressures.

The studies by Omiti et al. (1999) and Omiti et al. (2000) on changes in land-use practices reveal some changes. The resurfacing of rural factor markets following the agrarian de-collectivisation in Ethiopia provides some grounds of optimism that freeing-up of the land markets will bring with it more sustainable land use practices. This optimism is due to the observed changes in adoption of soil conservation, tree planting,

adoption of crop rotation and fallow practices, and increased use of organic and inorganic fertilisers associated with the new land policy. There also has been a reduction of the imperfections in rural factor markets. Selling, hiring, renting and exchanging of agricultural land, farm labour and animal traction are increasing. These changes were expected to influence agricultural production in many ways; particularly reforms of rural factor markets are encouraged and accorded appropriate policy support.

The opportunity to study the rapid changes in property rights institutions of the Ethiopian case was seized by another research project. The project on land tenure institutions and agricultural productivity in Ethiopia was initiated in late 1993 to identify factors influencing the evolution of land tenure institutions, to determine the effect of land tenure on investment, productivity and efficiency in crop–livestock systems in the Ethiopian highlands, and to assess the impact of land tenure on household access to feed resources.

ILRI researchers used the project output frequently to contribute to the continuing policy debate on land tenure systems and land policy in Ethiopia. For instance, a paper discussing the issue of access to land by private commercial investors (Gavian and Gemechu 1994) was presented at the second workshop of land tenure project in 1994. Another paper on land tenure and farming practices in the highlands of Ethiopia (Gavian and Amare 1996) was presented to the annual conference of the Agricultural Economics Society of Ethiopia in 1996. A third paper presented evidence on ways farmers in one region of the Ethiopian highlands are gaining access to land. The strategies for cultivating and maintaining that resource was presented in 1996 at the sub-regional workshop on Land Tenure Issues in Natural Resource Management organised by the United Nations Economic Commission for Africa (Gavian 1996).

Another output of the project dealt with the relative efficiency of alternative land-tenure contracts. Gavian and Ehui (1999) argued that the production efficiency of alternative land-tenure contracts was measured using the concept of interspatial total factor productivity. The paper tested the hypothesis that land under varying configurations of property rights will be farmed at different levels of production efficiency. The analysis indicated that although the informally contracted lands were farmed

10–16% less efficiently, farmers of such lands actually apply inputs more intensively. However, no empirical basis was found to support the hypothesis that land tenure is a constraint to agricultural productivity.

A recent paper that re-examined the technical efficiency of the alternative land tenure contracts has employed the production frontier model to explain differences in technical efficiency of crop production in the mixed crop–livestock system of the Ethiopian highlands (Ahmed et al. 2002). The paper identified significant differences in technical efficiency between plots owner cultivated or rented on the one hand and those sharecropped, borrowed or given as a gift on the other. This difference was attributed to the level of restrictions imposed on the tenant in the sharecropping and borrowing agreements. These agreements involve factor exchanges and labour and traction supply by the tenant. The findings suggest that technical inefficiency may arise because of the distortions in other markets (labour, credit) interacting with land market.

Examining the evolution since 1991 in land rental markets of the highlands of northern Ethiopia, Benin et al. (2003d) showed that changes in the production environment and natural resource endowments, changes in human capital, access to credit, commercialisation of cereal production, and tenure security are the major forces contributing to the changes in land rental arrangements. Reduction in production risk, through increased availability of moisture or reduced degradation of soil, has reduced the need for risk-pooling arrangements associated with sharecropping in favour of fixed-rent leases. Furthermore, increasing commercialisation of cereals has caused an increase in use of land rental arrangements in general, while an increase in access to credit has caused an increase in use of fixed-rent leases. These results suggest that land tenure arrangements are indeed dynamic and do evolve in response to technological change, market development, population pressure and agricultural commercialisation.

Examining other factors that affect changes in crop yield, Benin et al. (2003d) showed further that increase in use of alternative land rental arrangements has had a positive impact on changes in average cereal yields. This is consistent with the theory that land rentals allow land to be used by farmers who are more capable to earn the highest return from it through mobility of

scarce factors of production. The paper suggests that land tenure arrangements have evolved in a manner that eliminates Marshallian inefficiencies associated with share tenancy.

A related issue is how tenure security influences investment in land improvement and productivity. An application of the double hurdle statistical analysis to data from the Tigray Region of Ethiopia reveals different causal factors for soil conservation adoption vs. intensity of use (Berhanu and Swinton 2001). Farmers' reasons for adopting soil conservation measures vary sharply between stone terraces and soil bunds. Long-term investments in stone terraces were associated with secure land tenure, labour availability, proximity to the farmstead and learning opportunities via the existence of local food-for-work projects. By contrast, short-term investments in soil bunds were strongly linked to insecure land tenure and the absence of local food-for-work projects.

Public conservation campaigns on private plots reduced adoption of both stone terraces and soil bunds. Whereas capacity factors largely influenced the adoption decision, expected returns carried more influence for the intensity of stone terrace adoption (measured as metres of terrace per hectare). More stone terracing was built where fertile but erosion-prone silty soils in higher rainfall areas offered valuable yield benefits. Intensity of terracing was also greater in remote villages where limited off-farm employment opportunities reduced construction costs. These results highlight the importance of the right kind of public interventions. Direct public involvement in constructing soil conservation structures on private lands appears to undermine incentives for private conservation investments. When done on public lands, however, public conservation activities may be exemplary in encouraging private soil conservation. Secure land tenure rights clearly reinforce private incentives to make long-term investments in soil conservation.

In Ethiopia, particularly in the Amhara Region, one source of tenure insecurity is the frequent land redistribution, which has been ongoing since 1974 in an attempt to equalise land holdings and quality across households. However, its short- and long-term effects may have mixed impacts on farmers' land management and productivity. Expectations of future land redistribution may undermine farmers' incentive to invest in

land improvements and soil fertility, since farmers' ability to reap the benefits of such investments is undermined. Redistribution might, however, improve access to land of households that have relative surpluses of other important factors of production, such as labour, oxen or cash to purchase inputs, particularly in the context of prohibited land sales and restricted lease markets that exist in Ethiopia. Thus, land redistribution may increase intensity of land management and use of purchased inputs, which may in turn increase productivity.

Benin (2003) and Benin and Pender (2001) found that crop yields in the Amhara Region were significantly higher particularly in villages where the last major land redistribution took place in 1997/98. Benin (2003) also found that plots on which households felt more secure (i.e. expecting to operate the plot for the next five years) were associated with higher crop yield, suggesting that security of tenure may be associated with other yield-enhancing management practices. Together, these results suggest that improving tenure security can bring about substantial increment in crop productivity.

However, the positive impact associated with the last land redistribution exercise should not be interpreted as justification for continuing it. Although, the exercise increased productive capacity per unit area of land, by improving access to land of households with excess capacity, the long-term (insecurity) effects, which were not adequately studied, may outweigh the positive short-term effects. Thus, more sustainable ways of improving access to land will be important. It should be noted that the Amhara regional government has adopted a land use policy that stops future land redistribution. It will therefore be necessary to educate farmers on the implications of such a policy in order to build up their confidence and increase their sense of tenure security.

Property rights in pastoral and agro-pastoral systems

The importance of the relationship between property rights, risk, technology and productivity in SSA was reflected in the workshop held by ILRI and IFPRI researchers in 1994. The workshop catered to plan collaborative research on property rights and to summarise the results of studies previously

conducted by ILCA and others. It also attempted to identify priorities for future research, and to consider and evaluate specific proposals for future research areas of complementarities and/or overlaps with other past or current projects (Swallow 1994a). It can be argued that subsequent work on property rights at ILRI was built on this workshop, e.g. resource use and property rights under risk.

A project entitled 'Property rights, risk and livestock development' was initiated in 1996 and ended in 1999, as a collaborative venture between ILRI, IFPRI and the Göttingen Research Institute for Rural Development. The goal of the project was to support appropriate reforms of property institutions and land policies in the semi-arid areas of SSA. The project objectives include:

- better understanding of how environmental risk affects the use and management of resources under alternative property rights regimes
- identifying circumstances under which different pathways of land use and property rights change and
- identifying how policy and other external interventions can assist communities to achieve desirable pathways and mitigate negative impacts of undesirable pathways.

LPAP published a summary of this research as a working paper (ILRI 2000).

ILRI's property rights research further focused on the semi-arid area in southern Ethiopia—the Borana rangelands. The area is characterised by extensive livestock production system, and it is a valuable source of livestock both for draft power and for export. Despite the region's high ecological potential *vis-à-vis* livestock production, the success of development effort remains limited due to the pressure of privatisation of crop production and grazing on the rangelands. The trends are hypothetically attributed to various factors, including demographic and market forces. The semi-arid nature of the area creates a concern about the potential capacity of the area to support a fully privatised system on a sustainable basis.

A recently completed study in the area focuses on the effects of environmental risk; market variables and population pressure on

land use and property rights, and seeks to identify pathways for development (Kamara 2001). The theoretical basis of the study is developed mainly from property rights theory, focusing on efficiency and interest group theory of institutional change. The empirical results largely conform to the principal hypotheses about the driving forces of institutional change in Borana.

Community level co-operation in resource management is determined by demographic factors, heterogeneity in wealth, off-farm income and social capital variables. Rainfall variability affects stock densities only in areas of high rainfall variability. Market variables do not crucially determine stock densities or community level co-operation, but affect land allocation to crops. Population and non-co-operation further induce a change in land use. Changes in property rights are explained by policy variables such as the ban on wildfire, the creation of peasant associations, sedentarisation programmes and development interventions.

The study infers that the Borana system is in transition, with evidence of departure from traditional pastoralism to a semi-sedentary system with increasing reliance on crops and private grazing. There is a marked potential for market improvement in Borana without adversely affecting the stability of the system. The study further highlights the need for a re-animation of a traditional authority in resource management and the relevance of programmes that reduce heterogeneity among the Borana pastoralists. The study concludes that the agro-ecological diversity of the Borana rangelands calls for selective policies that support a mixture of crop–livestock integration and extensive livestock production as necessary, rather than a ‘one policy fits all’ approaches.

Collective action

A growing interest in the potentialities of local collective action for the development of poor countries is caused by the limitations and failure of both the market and the state. The literature, emphasising this potential, covers a wide range of situations. The most outstanding of these include those involving the creation of a local public good, those entailing appropriation problems in the presence of ecological externalities (most notably in the case of common property resources), and those

concerned with the emergence of voluntary mechanisms for the provision of credit and insurance. Within ILRI's focus, economists encounter many situations such as the case of rangeland management, disease control and even natural resource management at community level.

The analysis of the aspects of individual adoption of a technology that produces mixed public-private goods and public goods with indivisibilities is the other dimension in property right research at ILRI. In one publication, the case of public good problem of watershed development in the Ethiopian highlands—Ginchi—was presented in a simple game-theoretical model to study the logic of voluntary contributions to an indivisible public good; namely a central drainage channel (Gaspart et al. 1998). This approach emphasised the difference between the problem under attention and the classical representation of public good provision, i.e. the Prisoner's Dilemma, which emphasises the joint role of leadership and private interests as key determinants of individual contributions, thereby illustrating the game-theoretical model and providing well-founded guidelines for similar collective actions.

The most striking result of the study is that there is indeed a clear positive relationship between the magnitude of personal stakes and the amounts of effort spent on building the site. In other words, in the equilibrium selection process, a social norm of the kind 'from each according to his expected gains' seems to have been at work to favour co-ordination of individual efforts. Even though it concerns only five households, leadership appears as the most statistically significant explanatory factor, and only a narrow interpretation can trace its impact back to purely self-interested motives of a material nature.

Another study in this area focused on 'pour-on' application to control trypanosomosis in cattle (Swallow et al. 2000). Farmers who treat their cattle with pour-on obtain private benefits. Animals that receive these treatments carry fewer ticks, and may receive fewer bites from tsetse and other biting flies. Private treatment of animals with the pour-on also generates local public benefits; namely suppression of the numbers of tsetse and other biting and nuisance flies in the local area. Thus, the public good benefits of the treatment will depend upon the strength of the local institutions governing pour-on use, and how neighbours are expected to respond to changes in others'

behaviour. The study developed and applied a model of household demand for pour-ons that considers the private and local benefits that they generate. The study concluded that *kebeles* (the lowest administrative units in Ethiopia) and other similar local government administrations are important focus of co-operation. Even though these units were not formally involved in the control programme, co-operation is costly, and factors increasing the costs or risks of co-operation will reduce the likelihood of successful co-operation. The pilot tsetse-control trial in south-western Ethiopia was changed in two ways because of the insights obtained from this study. First, two new treatment centres were opened in low co-operation areas. Second, the dates when pour-on treatments will be given are now announced at least a month in advance. These lessons will extend to other locations where this approach to pour-on delivery and use is attempted.

Similar to pour-on treatment, a technology that produces a mixed public–private good, ILRI’s research on property rights investigated the determinants of collective action and its effectiveness in managing community natural resources (see Benin and Pender 2002; Berhanu et al. forthcoming). The importance of these studies is that management of community woodlots is similar to that of communal grazing land and primary source of livestock feed in many areas. Thus, successful management of common resources is important for sustainable land management through reducing the risk of deforestation and use of manure as a source of fuel. The studies suggest that collective actions may be more beneficial and more effective when managed at a more local unit, i.e. village-level rather than at higher municipal level. They also suggest that collective actions are more productive when the role of external organisations is more demand-driven, and when the actions are promoted in intermediate population density communities that are more remote from markets. In higher population densities and areas closer to markets, private-oriented approaches are likely to be more effective.

Intellectual property rights

Besides the extensive focus of ILRI’s research on property rights on land and its property institutions, intellectual property rights is now re-emerging as a new type of property rights. While the

research work focused on understanding and use of property rights institutions for better and sustainable use of natural resources, ILRI as well as other research institutions are required to develop rules and legal apparatus to protect the use of the products—the technology and knowledge generated from its research. In reviewing the impact of research on maintaining resistance to trypanosomes, it has been pointed out that the research impact of biotechnology depends on whether the ownership rights, and delivery of research output are completely private or public. Intellectual property rights are likely to influence both levels and distribution of research benefits. With the emerging revolutions in science, biotechnology and genomics and globalisation, ILRI will increasingly deal with issues of property rights.

Policies to enhance the sustainability of mixed crop–livestock systems

Environmental and natural resources degradation threatens both the economic prospects of future generations and the livelihood of current users. The cumulative effect of the operations of many smallholders is the primary contributor to the serious degradation of natural resources in developing countries. In SSA, increasing soil erosion reduces the capacity of many countries to produce food, and jeopardises the benefits from water resource development. Deforestation threatens biological diversity, and contributes to alteration of the global climate.

With growth in household income, the demand for livestock products is expected to grow, and livestock numbers are likely to grow as well. Much of the increase in livestock production is expected to come from developing countries, and mixed production systems will play an increasing role (Staal et al. 2001a). Appropriate policies are required to ensure that smallholders benefit from the increased demand for livestock products. It must be noted that the increase in production by smallholders should not come at the expense of environmental and natural resource degradation.

Ruminant livestock may have a net positive effect on the environment, particularly in the mixed crop–livestock systems. In such systems, good opportunities can clearly be made available through the contribution of intensive livestock production to soil fertility. Sustained intensification cannot fully take place without the resource enhancing and stabilising role of livestock (Fresco and Steinfeld 1997).

However, there could be some aspects of environmental harm that are caused by livestock and are not easily managed without reducing production levels. Appropriate measures are needed to internalise those costs in order to improve overall social and environmental welfare (Staal et al. 2001a). Beyond this, the key to capturing the potential benefit of livestock to the environment and natural resources base will depend on promoting the role of integrated crop–livestock production.

Changes in economic policies, property regimes and incentives to producers may be needed to solve the problems of resource and environmental degradation, to promote sustainable resource use by large and small enterprises and households, and to channel economic and demographic growth into activities that raise income and promote sustainable use of natural resources. Government policies and property rights arrangements have much to do with the use of natural resources in SSA. Existing land and tree tenure arrangements often discourage tree planting and encourage deforestation.

Policies to promote the evolution and productivity of production systems

Four stages are defined in the process of animal agricultural intensification system (McIntire 1992). In the first stage, at low population density and abundance of land, crop and livestock production activities are extensive and specialised, with few interactions between cultivators and pastoralists. In the second stage, agriculture intensifies due to population growth and changes in market. There are more crop–livestock interactions with crop farmers using more animal power and manure, and with pastoralists using more crop residues for feed. Higher competition for land between cultivators and pastoralists also sets in. In the third stage, as population pressure increases further, cropland expands, while fallows and natural pasture contract. Further intensification increases the demand for more crop inputs in livestock production and for more livestock inputs in crop production. Increasing impediments to obtaining inputs in markets or through contracts promote closer integration of crop and livestock activities or mixed farms. Such impediments create economic incentives to provide inputs directly on farm, thus encouraging crop–livestock integration. In the fourth stage, if markets and exogenous technologies accompany further population growth, purchased inputs can replace crop–livestock integration, thereby developing specialised enterprises.

The evolution of production systems has been a focus of research for LPAP scientists in the first half of the 1990s. One such study was conducted in humid West Africa (Jabbar 1993b). Results indicated that cattle rearing in humid West Africa was nearly impossible in the past owing to the prevalence of trypanosomiasis. However, with increases in population

pressure, jungle clearance, crop cultivation and tsetse control measures, the challenge has been reduced. As a result, there has been an influx of cattle owners who used to visit the zone only for dry season grazing and return to the safer subhumid/semi-arid zone in the wet season. An increasing number of cattle owners have begun to settle in the humid zone by adapting mixed crop–livestock farming.

It has also been observed that there is a tendency among some local crop farmers to adopt livestock gradually in the farming system. Consequently, new farming systems are evolving in the zone. Results imply that research and development strategies should be aimed at supporting, accelerating, and helping to direct the natural forces of intensification of agriculture and the evolution and maturation of mixed crop–livestock farming systems. This is believed to make agriculture more productive, and sustainable, while at the same time improving the socio-economic conditions of the people. Such a strategy should adopt a resource management approach with land as the most critical resource. Possible research issues in this endeavour include determination of the environmental impact of animals; role and potential of manure in system sustainability and productivity; role of legumes (forage, crop and trees) in soil fertility, weed management, crop productivity and feed supply; and potential use of animals for traction with an efficient use of crop residue as livestock feed in the system.

Based on 66 randomly selected cattle owners, an assessment of the process and extent of sedentarisation in the derived savannah zone of south-western Nigeria indicated an ongoing process of sedentarisation (Jabbar et al. 1995). Herd sizes were larger among recent settlers; but with longer duration of settlement and with cattle herders' involvement in crop production, the herds became less mobile between seasons, and herd size decreased and the proportion of farms with mixed zebu/trypanotolerant cattle herds increased. Some indigenous crop growers became mixed crop–livestock farmers by purchasing cattle.

Results of a similar study in the derived savannah of south-western Nigeria showed that at the current stage of evolution, as a crop farmer adds livestock to his business, there is a small gain at the beginning, followed by an increasing rate of substitution between crop and livestock (Okuruwa et al. 1996). As a

livestock keeper engages in crop production, there is a decreasing rate of substitution between livestock and crop, because crop production is more intensive than livestock production. If increased population pressure and cropping intensity severely limit access to grazing land, farm and herd sizes will become smaller. Then the degree of integration between crop and livestock will increase significantly.

Research results on the breed portfolio of settled farmers in southern Nigeria showed that farmers' breed portfolios are the outcomes of dynamic processes that vary both across farmers within and across micro-environments within an agro-ecological zone (Jabbar et al. 1994). Percentage of zebu animals in the herds of recently settled Fulani agro-pastoralists was inversely related to the length of time they have been settled. Farmers also consider a variety of characteristics of different breeds, and that their breed preferences are based on a composite of those characteristics. Breed preferences are then put into practice through a variety of actions. Overtime, the breed portfolio of the herd will change to reflect modified breed preferences.

In urban areas where transport costs of inputs and products are lower than in rural areas, specialised animal production such as milk or small ruminants or poultry production develop. These intensive production systems that are developing around cities represent what is called peri-urban livestock system. A study on the peri-urban livestock systems showed that the principal constraints to its development in SSA are technical, institutional, infrastructural and policy related (Ehui et al. 1995). Feed, animal health, genotype and livestock management are major technical constraints. In the policy area, despite substantial improvements in sector and macro policies, there is room for significant improvement in sectoral policies that affect dairying at all levels in the dairy system, all the way from production to consumption. The principal constraints of an institutional and infrastructural nature include inefficient support services as well as underdeveloped roads and markets. The potential for increasing peri-urban livestock production is directly related to the ability to intensify feed production and feeding strategies. Intensifying feeding requires higher levels of input either produced on-farm or purchased from the market.

In farming systems where food crops are grown in alleys formed by hedgerows of trees and shrubs, preferably legumes, the hedgerows are periodically pruned, and the pruning is applied as mulch for improving soil fertility, controlling erosion and increasing yields (Jabbar et al. 1992). Whether it is profitable to use part of the foliage as feed rather than as mulch depends mainly on crop response to mulching and animal response to feeding tree foliage. An economic analysis of on-farm agronomy and animal response trials in southern Nigeria showed that, at low crop yield level, and low crop response to mulching, feeding small ruminants with part of the foliage was profitable (Jabbar et al. 1992). Using 50% of the first season foliage as mulch and feeding the rest gave the highest total return from crop and animal. At higher yield levels, and high crop response to mulching, feeding animals was not profitable or only marginally profitable, at current prices.

A similar study by Reynolds and Jabbar (1994) showed that the major benefit from supplementing the diet of free roaming small ruminants in West Africa with the foliage of leguminous trees (*Leucaena* and *Gliricidia*) was an increase in survival, and the forage is best directed at late pregnant and lactating females. In East Africa, crossbred dairy cows show a significant response in milk production to supplementation with *Leucaena*.

Another angle of system evolution is the shift to intensification. Agricultural intensification involving greater crop–livestock interactions and integration is emerging as a promising strategy for improving agricultural production and productivity in much of SSA. In West Africa, where this process is at various stages of evolution, 559 farm households from the Sudan savannah (SS) and northern Guinea savannah (NGS) zones were studied to examine the factors affecting production efficiency (Okike et al. forthcoming). The farms in each zone were divided into four socio-economic domains using combination of population density and market access as criteria. The study tested the hypothesis that production efficiency of farms varied according to level of intensification, agro-ecological condition, population density and market access. Estimation of stochastic frontier production function indicated the need to include ecological and socio-economic variables in both the production function and the accompanying inefficiency equation; failure in such models may suffer from omitted variables bias. The results showed that inefficiency effects of a stochastic nature existed

among the sample farms and average efficiency was 76% (68% in the SS and 86% in the NGS zones). Further, increased resource use associated with agricultural intensification was not always accompanied by an increase in production efficiency. While agricultural intensification based on high external input strategies yields higher marginal returns in the NGS, a similar strategy is not critical to success in the SS given current use levels and the biophysical endowments of the latter ecological zone. These results lead to the conclusion that while agricultural intensification and efficient production in the NGS still benefit from high external input use strategies, the same strategy is not critical for achieving similar results in the SS, given current levels of resource application in the latter ecology. Increasing agricultural productivity, even within the framework of the ranges provided by this study will depend on how seriously extension services are taken and how their programmes are carried out. Going by recent studies in West Africa on the performance of extension systems, a lot still needs to be done if extension systems are to be the preferred route of reaching farmers with new technologies including information.

System evolution studies also conducted comparative sectoral analysis to derive the lessons learned from the progress made under similar agro-ecological systems in other countries. For example, due to the similarities of the highland agro-ecological conditions of Kenya and Ethiopia, the development of the dairy sector in Ethiopia would benefit substantially from experience of neighbouring Kenya. In this regard, the development of the dairy sector in Ethiopia over the last 50 years was revisited (Ahmed et al. 2003). In particular, the study presented an overview of the dairy sector in Ethiopia; identified key phases in the development of the sector and examined the trends in production and consumption, policy changes and development emphasis during each phase; provided evidence on the potential impact of improved dairy cattle and examines the factors that increase smallholder participation in market-oriented dairying; and identified key policy and technology issues to be considered in designing appropriate policy and development strategies. The paper also draws evidence from neighbouring countries in order to help understand dairy development strategies in Ethiopia.

According to the study, the dairy sector in Ethiopia has passed through three phases or turning points, following changes in the

economic and political policy in the country. In the most recent phase, characterised by the transition towards market-oriented economy, the dairy sector appears to be moving towards a take-off stage. Liberalised markets and private sector investment and promotion of smallholder dairy are the main features of this phase. Milk production during the 1990s expanded at an annual rate of 3.0% compared to 1.63–1.66% during the preceding three decades. However, most of the growth in milk production (60%) was due to the increase in herd size. Only one-quarter was due to productivity per animal resulting from technological change. This is not surprising since dairy production in the country is principally dependent on indigenous zebu breeds. Therefore, integration of crossbred cattle to the sector is imperative for dairy development in the country. This can be achieved in two ways: (1) through promotion of large private investment, which at the end will introduce new technology in the sector such as improved genotypes, feed and processing, and (2) as smallholders will likely continue dominating the sector, the government should also promote integration of crossbred cattle into the smallholder sector through improving their access to improved cattle breeds, AI service, veterinary service and credit. Similarly, the government should also take the lead in building infrastructure and providing technical service to smallholders. Severe shortages, low quality and seasonal unavailability of feed remain the major constraints to livestock production in Ethiopia. These constraints need to be addressed and technological change be promoted to increase milk production.

There are several lessons to be learned from the Kenyan experience. There is a need to focus interventions more coherently. Development interventions should be aimed at addressing both technological gaps and marketing problems. If the appropriate producer price incentives are in place and input markets are allowed to operate freely, dairy production may respond positively. This has been demonstrated in the Kenyan dairy development that has to some extent similar agro-ecology and production systems. Milk groups and co-operatives increase the participation of smallholder in fluid milk markets in the Ethiopian highlands. Milk groups are a simple example of an agro-industrial innovation, but they are only a necessary first step in the process of developing more sophisticated co-operative organisations and well-functioning dairy markets. The survival of the milk groups that supply inputs and process

and market dairy products will depend on their continued ability to capture value-added dairy processing and return that value-added benefits to their members. Evidence from Kenya emphasises the importance of milk collection organisations in improving access to market and expanding productive bases (Staal 1995). Also there is a need to stimulate consumption of dairy products in the country as low demand for dairy produce can potentially discourage production in the long run.

Economics of organic fertiliser

One area of research where ILCA's socio-economics division and LPAP scientists worked on was the role of animal manure in maintaining soil fertility. In the semi-arid West Africa, animal manure is an integral component of soil fertility management practices. Soils in the region are deficient in nutrients, particularly in phosphorus and nitrogen (Williams et al. 1995). The use of inorganic fertiliser is limited in the region due to low rural incomes, high cost of fertiliser, inappropriate public policies and infrastructural constraints. Research on the role of manure showed that manure increases yields of crops and forages. It augments soil organic matter content, raises soil Ph, improves nutrient exchange and water holding capacity of soil and, when sufficient amount is supplied on a continuous basis, permits stable intensified crop production (Williams et al. 1995). However, despite the vital role of manure for crop production, availability of the input in sufficient quantity remains a critical problem.

A similar study in Niger confirms that aggregate livestock population and species composition is a key factor that may effectively limit the amount of manure available for crop production. Hence, external inputs in the form of inorganic fertiliser are needed to augment the available manure to sustain crop production, even considering the role of fallow, and the possibility of increased manure collection (Williams et al. 1995). Since the gap between the current use of inorganic fertiliser and the amount needed to supplement available manure is wide, appropriate public policies are needed to alleviate the constraints of increased use of inorganic fertilisers.

Policies for sustainable land management

In collaboration with IFPRI scientists, the project on 'Policies for sustainable land management in the highlands of eastern Africa' was initiated in 1997. In the Ethiopian highlands, the interrelated problems of soil erosion, soil nutrient depletion, deforestation and limited soil moisture appear to be the most critical land management problems, resulting in substantial costs in the region. The proximate causes of these problems include rugged topography, thin soils, and low and uncertain rainfall. Moreover, farmers' practices regarding land management, including land use, crop choice, adoption of soil and water conservation measures, soil fertility management practices, grazing practices, use of agricultural inputs etc. have contributed to the problem. Farmers' practices are conditioned by many socio-economic and institutional factors, the most important of which are population pressure, poverty, land tenure, local market development, local institutional and organisational development, and farmers' perceptions and attitudes.

Many of these socio-economic and institutional factors affecting land management are influenced by many government policies and programmes, particularly policies affecting distribution and leasing of land, agricultural research and extension, input marketing, credit, irrigation development, road and other infrastructure development, development of farmers organisations and local institutions, and soil and water conservation programmes.

However, since the underlying causes depend upon many site-specific factors that vary greatly across the diverse circumstances of the region, no 'one-size-fits-all' policy, institutional or technology strategy is likely to suffice to generate sustainable development. While common elements of successful strategies such as security and macro-economic stability do exist, the appropriate portfolio of investment in physical, human, natural and social capital will likely be different in different circumstances.

The appropriate strategy for sustainable development is, therefore, likely to depend on the 'pathways of development'⁴ that are feasible in a given location. Such development pathways

4. Development pathways represent common patterns of change in economic livelihood strategies.

are largely determined by three factors that influence comparative advantage: agricultural potential, market access and population pressure. Results of the analysis of data from the Ethiopian highlands showed that population growth has a negative impact on resource conditions and human welfare (Pender et al 2001). Increase in population pressure results in reduced soil fertility, deterioration in resource and welfare conditions and reduced ownership of livestock. However, improved market access contributed to improvements in soil fertility and conservation, resource and human welfare conditions, ownership of livestock and use of animal health services. These results imply that better market access, credit, and extension programmes can provide win–win development strategies to reduce land degradation and poverty. It was also shown that community resource management might contribute to sustainable use of woodlots and grazing lands (Benin and Pender 2002; Berhanu et al. forthcoming).

The overall findings of the project on policies for sustainable land management are summarised in a recent paper prepared for the plenary session on Environmental Stewardship of the 25th International Conference of Agricultural Economists.⁵ The paper combined the experience from East Africa with similar research in West Africa. In this paper, Ehui and Pender (2003) argued that no one strategy for sustainable development would work for SSA. The key is to identify and implement effective policies and strategies for different circumstances in the region. Essential to such strategies will be investment in an appropriate portfolio of physical, human, natural and social capital. The appropriate portfolio of such investments will differ from one place to another depending upon differences in potential comparative advantage, which determine the private and social profitability of different investments.

In the East African highlands, great potential exists for increasing agricultural production, reducing poverty and land degradation in the high potential areas with good market access. Central Kenya stands out as an example of successful development, offering promise of similar development in areas of similar comparative advantages. However, the highlands of Central Kenya have a number of advantages that are not present to the same extent in these other areas. These include a

5. Other findings at the regional level in Ethiopia were summarised in Benin et al. (2003f), and Berhanu and Swinton (2003).

well-developed infrastructure and market institutions, farmers' access to credit through coffee and tea co-operatives, a strong commercial orientation of farmers, presence of a merchant class with considerable international experience, and development of long-term relationships with buyers in international markets. Realisation of the potential in other regions can be facilitated by public investments to help reduce transportation costs, develop market institutions, increase farmer access to information and technical assistance about market opportunities and appropriate technologies, develop agricultural inputs and credit markets, promote development of the non-farm economy, and increase sustainable use of degraded and uncultivated lands. In addition to direct investments (e.g. investments in infrastructure, education and other public goods), policies that can help promote private investments in these areas include continued avoidance of over-valued exchange rates, establishment of grades and standards for grains and other commodities, establishing a legal framework for a warehouse receipts system to promote the availability of marketing credit, reduction of taxes on imported vehicles and spare parts, and providing secure property rights for private use of degraded and unused lands.

In highland regions with good agricultural potential but low market access, high value perennial crops such as coffee are important. Agricultural research and extension will continue to be important to provide technologies that increase productivity and reduce susceptibility of these crops. Where there is a comparative advantage in perennial cash crop production in land scarce environments, increasing productivity in food production will be critical to avoid subsistence food requirements from displacing cash crop production. Demand for purchased inputs such as fertiliser for cash crops may be limited in such areas (as in south-western Ethiopia), but there may be potential to increase productivity by using inputs in food crop production. In this case, earnings from cash crop production can finance increased food productivity in order to free up land for more cash crop production. In this situation, it is important not to over promote food production, since this may simply lead to local surpluses that may not benefit farmers. In areas where the comparative advantage is in cereal production, greater emphasis on production enhancement can be more beneficial. But improvement in infrastructure and marketing systems will also be critical to realise the potential of these commodities. Improvement in livestock production can be a successful

strategy by promoting more crop as well as livestock production, higher income, and reduced soil nutrient depletion, as seen in Uganda.

In the low potential areas of the highlands, there exist profitable investments that can increase agricultural production, income and reduce land degradation. Intensive food production using high levels of fertilisers and improved seeds is risky and not likely profitable in such areas without significant investment in water management. Soil and water conservation measures can provide high returns in such environments by conserving scarce soil moisture and enabling greater use of inputs. Other profitable land management practices include reduced tillage, reduced burning and composting. As found in northern Ethiopia, the comparative advantage of the low potential highlands is likely for more livestock production and tree planting than for intensive cereal production. Livestock development in this environment offers a potential win-win strategy capable of increasing productivity and incomes, and of reducing land degradation. Realising the potential of improved livestock and crop production and tree planting in these areas will require improved institutions for managing communal lands. Other opportunities include investment in education, market institutions such as marketing co-operatives, and development of the non-farm economy. Despite all of these opportunities, such areas are likely in the near term to remain dependent upon safety nets such as food-for-work programmes or other employment guarantee schemes to prevent famine when farmers' incomes are decimated by droughts. In the long run, the risk of famine can only be eliminated by overall development of the economy, providing a more guaranteed source of employment and income.

Within the humid zone in West Africa, since the greatest potential is for root and tree crops, providing disease-resistant varieties of those crops that respond well to small amounts of purchased inputs will be needed. In addition, investments in roads and markets should have a high priority. The humid zone also offers high potential for meat production through disease resistant breeds, such as the N'Dama, and improving health delivery systems and digestibility of the plentiful biomass in the zone. In the subhumid zone, because crop-livestock systems are more common, introducing disease resistant animal breeds and improving health infrastructure are the key elements.

Since livestock production is important in the semi-arid zone, policy strategies should focus on extension, education and credit in livestock fattening programmes. Milk production and improved marketing and health facilities should also be facilitated. In the arid zone, providing drought-resistant crop varieties and improving property rights to pastures and water resources should be emphasised.

In general, the empirical evidence reviewed confirms that different strategies are needed in different development domains of SSA. Nevertheless, some elements will be common to all successful strategies, including assurance of peace and security, a stable macro-economic environment, provision of incentives through functional markets, development of market institutions for those that do not function, and public and private investment in an appropriate mix of physical, human, natural and social capital. The differences in strategies across these domains mainly reflect differences in the mix of those investments as influenced by different comparative advantages.

Conclusion

This report reviews the activities and achievements of ILRI in socio-economics and policy research that has been conducted partially under the auspices of the Livestock Policy Analysis Programme during the period 1992–2002. It was started in 1992 when a formal planning workshop identified research themes of the socio-economics and policy research to be conducted at the then International Livestock Centre for Africa (ILCA). In 1995 when ILRI was officially formed following the merger of ILCA and ILRAD (International Livestock Research for Animal Diseases), a programme was created that carried through the activities of the ILCA socio-economics and policy research. Since ILRI and its forebears (ILCA and ILRAD) have always been particularly concerned with livestock technology development and its diffusion, it is natural that policy research is integrated in these activities as the key component and instrument for ensuring their successful implementation. An understanding of the policy environment within which technologies are likely to be successfully adopted and scaled up is crucial in the technology development and delivery pathway. Is the technology appropriate to the needs and resources of the target beneficiaries? Will the technology be successfully adopted by a large number of target beneficiaries over a wide range of conditions? What are the incentives for enhancing the successful and sustainable adoption of these technologies? Policy research provides useful answers to these questions.

There are other ‘big picture’ issues that motivate the need for policy research in a science institute like ILRI. Livestock production does not happen in a vacuum; it is constantly vulnerable to the impacts of the changing technological, economic, political and institutional environment. For example, appropriate economic policies are crucial for the development of sustainable livestock production systems and practices that benefit the poor in developing countries. Distortions in the capital market reinforce inefficient economies while poor infrastructure and inappropriate marketing of livestock products constrain smallholders’ adoption of new technologies and hamper competition with large-scale producers. Inadequate property rights, marketing and pricing policies encourage

overgrazing. The interaction between livestock policies, institutions and farm-level factors affects the adoption of new technologies and the participation of smallholders in markets. Therefore a coherent and transparent livestock policy framework is essential to provide clear information to stakeholders and increase the effectiveness and efficiency of their decisions regarding sustainable livestock production.

The multi-disciplinary nature of various ILRI programmes over the past ten years has made socio-economic and policy analysis an integral component of many research projects that have been implemented by other programmes outside of LPAP. The body of works cited in this review, thus, may not have captured all of them as this has focused largely on the outputs from LPAP research. On the other hand, this review has contributed to bringing out the many important and timely answers to relevant policy questions that may have been previously ignored, and other issues that could be usefully addressed in future researches. Overall the livestock policy analysis programme has been both dynamic and responsive to the needs of its target audience as well as to the changes within the institute. This is evident in the evolutionary development of research practices at the institute and the particular research works executed within each of its programme areas. In commensuration with the readjustment in ILRI, LPAP has also been committed to respond to issues in all aspects where livestock are involved.

Since the planning workshop of 1992, LPAP has made substantial contribution to the development of existing knowledge in studies of livestock-related issues such as economics of disease control, property rights, marketing and price policies and systems of livestock production. It has also addressed global issues such as the Livestock Revolution conducted jointly with IFPRI and FAO (Delgado et al. 1999). The majority of LPAP's research papers reviewed here have been published in refereed journals or contained as chapters in edited books. Similarly, an equally large amount of research outputs have also come out as publications in the Socio-economic and Policy Research Working Paper series before subsequent publication in other refereed outlets and other forms. Some of the research outputs have also been published in proceedings of national, regional and international workshops and conferences. LPAP also has published policy briefs, which provide non-technical summaries of contemporary research findings and

their relevant policy implications. Many methodological contributions were also evident in the reviewed papers. In addition, authors focused on implications of the research results to derive relevant policy implications and recommendations. LPAP scientists also consistently marketed their research results and recommendations to policy makers, scientists in other disciplines and institutions through various ways and forms. An example of the project-based workshops is the international conference under the theme of 'Policies for sustainable land management in the East African highlands' which was convened in 2002 to bring together researchers, policy makers, development practitioners, donors and other stakeholders to review, discuss and synthesise the findings and policy implications of the research on sustainable land management in the East African highlands (see Benin et al. 2003). More than 110 participants including three ministers from Ethiopia and Uganda attended the conference.

The programme, undoubtedly, has also made enormous contributions to the existing corpus of economics literature on livestock in general and on Africa in particular. Due to the substantial research output, policy research in ILRI has been taking the lead in research for technology development by exploring, identifying and evaluating target needs, problems, as well as trends and intervention options, all of which necessarily require strong cross-programme linkages and collaboration.

To our knowledge, no effort has been made yet to evaluate the impact of ILRI socio-economics and policy research to end users. This would be an important research area for future work. We recognise, however, that it is not an easy task to demonstrate the concrete impact of social science research as its output is mostly knowledge that cannot be physically quantified nor delivered directly to farmers or intended beneficiaries. The impact of social science research can be usefully assessed indirectly through the actions of the receivers of its outputs. For example, rigorous analysis of policy issues resulting in policy options that are effectively communicated to the appropriate policymakers and/or decision-makers will have impact when policy changes will have been implemented. Through policy dialogues, knowledge from research could influence policy debates, leading to behavioural and attitudinal changes that could eventually, albeit indirectly, contribute to the well being of the target beneficiaries through actions taken by scientists,

policy makers and extension programme officers. Thus, by making this relevant knowledge available and accessible to intermediate and final users, there is higher likelihood of creating the conditions that will eventually lead to the desired impact. This review is a step in the right direction, and by making this body of knowledge in this compilation available and accessible to as many end users as possible, it is envisioned that it could have an influence in policy discussions about livestock related policy issues. This also highlights the complementary role of socio-economics and policy research to the 'hard' science at the other end of the spectrum of ILRI research. The close integration of these two branches could help ensure that ILRI will have useful and meaningful impact in its ultimate mission of alleviating poverty through livestock research.

The details of the work summarised in this report and various other documents related to livestock policy research can be found in an accompanying CD ROM: *ILRI Socio-economics and Policy Research on disc, Version I*.

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