

International Livestock Research Institute

Medium-Term Plan 2010-12

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International Livestock Research Institute

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MTP Overview

Introduction

Note: The 2010-12 MTP presents relatively few adjustments to research plans from the previous MTP. One main cross-cutting change in the ILRI research program in 2010 will be to accelerate efforts to align research activities to the livestock development challenges presented. In preparation for that, ILRI is conducting a center-commissioned external review in 2009 looking at research into sustainable intensification of smallholder crop-livestock systems to provide a review of past activities and advice on this future focal area. In order to better position itself for improved outcome and impact performance, ILRI is also conducting a center-commissioned external review on its current impact assessment activities and how these might be strengthened in future. Greater changes are anticipated in subsequent medium-term plans, once there is further clarity on the CGIAR strategy and results framework and the mega program / research portfolio of the Consortium.

The International Livestock Research Institute (ILRI) works at the crossroads of livestock and poverty. ILRI's global strategy is to focus research efforts on strengthening the role that livestock play in poverty reduction, livelihoods, and environmental sustainability (Figure 1). The strategy takes into account the new market opportunities being created for small-scale livestock producers by increasing local and global demand for high-quality livestock products (termed the Livestock Revolution) and the many pathways by which livestock has traditionally reduced poverty. Specific research programs address:

- the vulnerability of livestock producers to income loss when their livestock assets are lost to disease or inadequate forage and water as well as their vulnerability to zoonotic diseases;
- the challenge of sustainable intensification of smallholder livestock systems for increased productivity; and
- the potential for sustainable increases in income from expanding markets for safe, high-quality, and affordable livestock products.

ILRI is the only CGIAR centre devoted to livestock research. It works in Africa and Asia, with offices in East, Southern and West Africa, South and Southeast Asia, and China. ILRI partners strategically with others – national livestock research institutes and veterinary services, advanced research institutes and universities, community leaders, and the private sector – to generate and synthesize knowledge and approaches that can help poor people cope with economic and environmental vulnerability and take advantage of growing livestock opportunities. Through such partnerships, ILRI seeks to influence changes in culture and process as well as technologies which support innovation at all levels. ILRI provides leadership in the global research community on conserving and characterizing animal and plant genetic resources of importance to the livestock sector.

In addition to coordinating the CGIAR Systemwide Livestock Research program, which enables all centres to collaborate in research on a range of cross-cutting livestock problems, ILRI pursues its research agenda through four inter-related projects relating to the outcomes included in Figure 1:

Project 1. Targeting and Innovation. Where do we go and how do we get there? How livestock priorities are evolving, how innovation systems can improve livelihoods and reduce poverty, impact assessments, knowledge systems, gender analysis, and other tools.

Project 2. Improving Market Opportunities. What interventions will enhance smallholder

participation? Smallholder competitiveness in changing markets, changing demand and market institutions, measures to assure animal health for market access and trade.

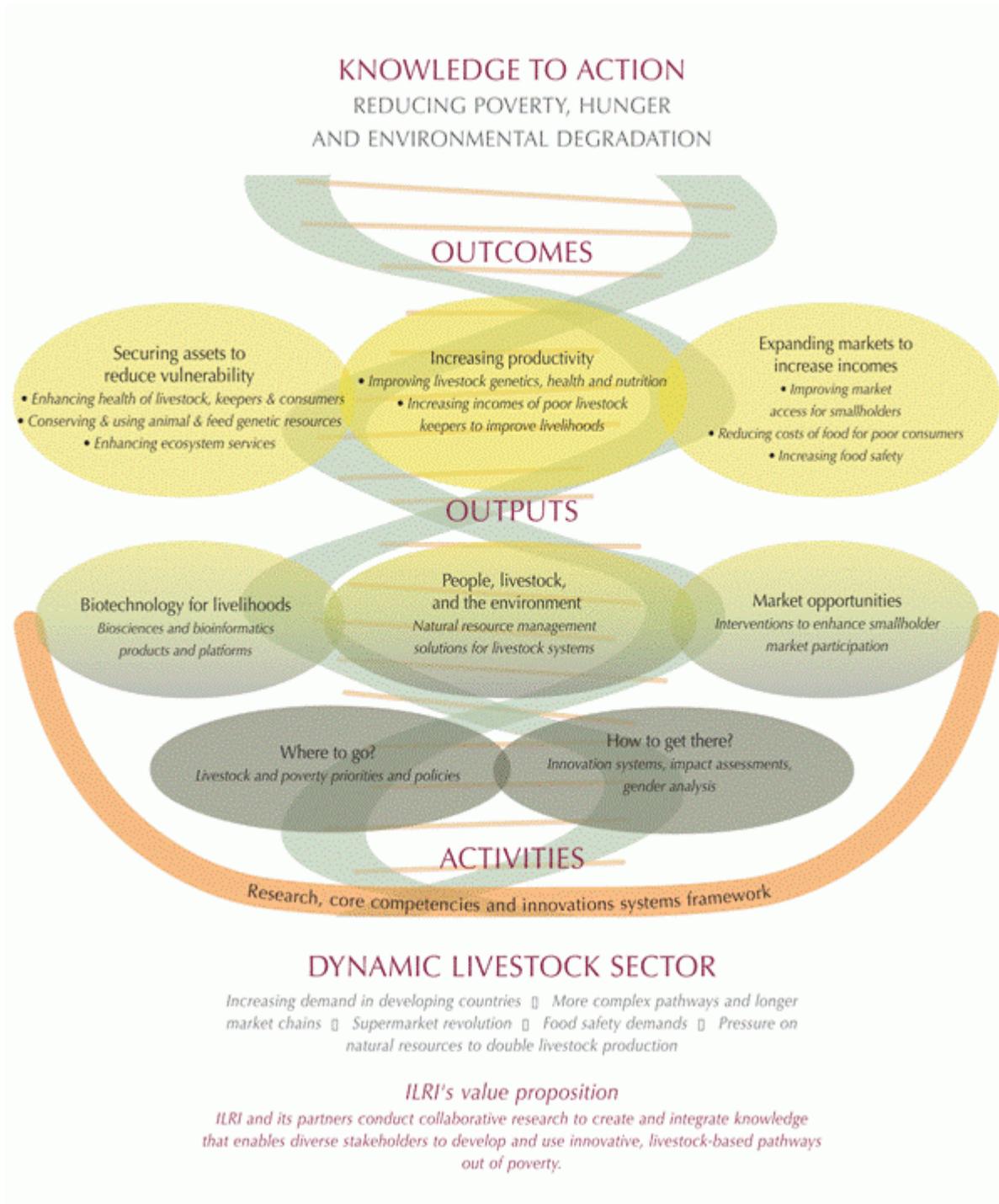
Project 3. Biotechnology. Biosciences and bioinformatics for animal health and genetics. Vaccine research, diagnostics, characterization of animal genetics, working models for livestock genetic resources.

Project 4. People, Livestock and the Environment. Developing environmentally-efficient production options for intensifying livestock systems, reducing vulnerability in pastoral and agropastoral systems, securing forage diversity for sustainable livestock feeding.

Within each theme, research is implemented in three operating projects that focus on research outcomes in the medium term (5–8 years). These operating projects are further elaborated under the Project Narratives section.

ILRI continues to implement important initiatives that were highlighted in that MTP: establishment of the Biosciences east and central Africa (BecA) platform, alignment with ICRAF in corporate and research support services, expanded human resource capacity development; and others.

Figure 1 Knowledge to action: Output–outcome-impact logic for livestock as a pathway out of poverty



Highlights of Project Portfolio

These are the major changes in ILRI's portfolio since the 2009-2011 MTP:

Global research for development challenges

- Outcome pathways elaborated for over-arching livestock research-development challenges linked to project outputs (see Box 1).
- Review of current research on sustainable intensification in smallholder systems and analysis of options for organizing research to maximize livestock development outcomes and impacts.
- Review of current impact assessment and analysis of methods, approaches and organization of ILRI impact assessment activities within complex research – development challenges.

Box 1 – Livestock Research - Development Challenges

Over-arching challenges:

- Sustainable **Intensification** of smallholder mixed crop-livestock systems – increasing productivity through better use of limited natural resources
- **Reducing Vulnerability** of livestock-dependent households in marginal systems subject to biophysical and socio-economic shocks

Specific challenges:

- **SPS and markets** – Improve the capacity of the poor to meet sanitary and phytosanitary (SPS) requirements through risk-based approaches, analysis of opportunities and value chain analysis with emphasis on local and regional trade.
- **Vaccines and Diagnostics** research and technology development to reduce the productivity, market access and asset impacts of tropical animal and zoonotic diseases.
- **Animal Genetic Resources** – Improved livestock breeds for the poor, either through better use of indigenous animal genetic resources or better cross-breeding programs.
- **Emerging Diseases** – Predict and prevent emerging diseases and understand the environmental, social, human and animal health determinants of infectious disease emergence and re-emergence and their impacts on the poor.
- **Climate change** – Prioritize and improve livestock-mediated adaptation.

Research Programs

Targeting and Innovation

- **Strengthening integration** of targeting and innovation research with markets, biotechnology and production systems.
- Work on livestock and climate change evolving from targeting of vulnerability – climate change impact hotspots to **livestock adaptation options** in priority target systems.
- Work on **Index-based livestock insurance** progressing from contract design to pilot testing with partners, including monitoring and evaluation.

Markets

- **Expanding role in evaluation and lesson learning** in dairy development projects in East Africa and South Asia.
- Strengthening of team on **livestock value-chains**
- **Evolving role** in avian influenza and zoonotic **emerging disease** research. Moving from risk assessment and response capacity of veterinary services to operational testing of control and mitigation options and research into factors for emergence of new diseases.
- **Increasing attention to role of livestock services** and input markets, including feeds and genetic services.

Biotechnology

- Continued research support to **ECF vaccine commercialization** to transfer improved vaccine production methods and technical support to quality assurance (outbreak investigations with molecular characterisation).
- Strengthening of cross project working groups on **flagship infectious diseases** (ECF, CBPP, RVF).
New project to develop and make available effective **tools to support sustainable breed improvement** of goats, chicken and pigs in Bangladesh, Pakistan, Sri Lanka and Vietnam.
- Greater investment in DNA sequencing and bioinformatics for **pathogen surveillance and discovery** and **landscape genomics**.
- Completion of the BecA hub facilities in 2009 and full use beginning in 2010.

People, Livestock and the Environment

- Speeding up **implementation of new project structure introduced in 2008**.

System-wide Livestock Program

- Focus on new multi-regional project on sustainable intensification of mixed smallholder livestock systems in southern, western and eastern Africa and South Asia.

ILRI and the CGIAR

Research and capacity building activities

As a facilitator of research-for-development activities, ILRI hosts some additional stand-alone capacity building activities that complement ILRI's own research program. These include:

- the regional network component of the BecA project (governed and managed by a regional steering committee and the BecA secretariat) and the
- non-research components of the IPMS project that support specific development and capacity-building activities
- spatial analysis training in Targeting and Innovation,
- training in participatory epidemiology to improve surveillance for infectious diseases in Markets and
- training on livestock genetic resource capacity in Biotechnology.

On development activities, the Market Opportunities project has some development activities within the IPMS (Improving the Productivity and Market Success) project and a research-into-use project using evidence from previous research on developing livestock value chains in north-east India. The Frontier research in Biotechnology is evolving work on livestock landscape genomics described on the previous page.

ILRI contributions to broader CGIAR initiatives

ILRI and the regional plans for collective action in Africa

ILRI supports the Regional Plans for Collective Action in Africa, a new Alliance-led process to catalyze the contributions of global agricultural research to regional agricultural research priorities. For eastern and southern Africa, ILRI in collaboration with ICRAF supports the coordination unit and actively engages in the research flagship projects.

System-wide and eco-regional programs

ILRI coordinates the CGIAR System-wide Livestock Program (SLP) and participates in 6 other system-wide programs (see Box 2 below). ILRI's participation in these programs is determined by the opportunities for livestock research to add value to the objectives of the program and its capacity to contribute. Livestock research could add value to some system-wide and eco-regional programs in which ILRI does not currently participate, but limitations in human resource capacity necessitate focus on a sub-set of programs.

System-wide Livestock Programme

The SLP is a multi-centre initiative that adds value to the outputs of individual CGIAR centres and their partners by creating and exploiting synergies in crop-livestock research to reduce poverty in areas where small-scale mixed crop-and-livestock production is widely practised. Details of the global activities of the SLP are presented separately, as an ILRI project narrative. Each participating centre in the SLP also highlights its contribution to SLP in its centre medium-term plan. Additional details are found in the SLP project narrative. Below are the highlights of ILRI's contribution to the SLP.

As a convener of the SLP, ILRI hosts and provides logistic and administrative support to the Program Coordination office, chairs the Livestock Programme Group and ensures that the required expertise in livestock is available for projects led by centres other than ILRI. ILRI research plays three major roles in the SLP. The first is in coordinating research on major drivers of change in crop-livestock systems. ILRI is leading the work on understanding drivers and anticipating and assessing changes (reported under the Targeting and Innovation Project). The second major area is providing livestock nutritional expertise so that important feed traits can be incorporated into the germplasm breeding and dissemination programs of CGIAR centres working on plants used as dual-purpose food-feed crops (reported under the People, Livestock and Environment Project). The major thrust has been on establishing methods for assessing, and indicators of, feed value of important crops so that these can be incorporated into crop breeding and seed systems. The third area in which ILRI contributes to the SLP is in coordinating research on innovative partnerships and strategies for mitigating feed scarcity in crop-livestock systems. Initial work has been conducted with public, private and NGO partners in India and Nigeria and is expected to expand in 2006/7 to scale-out lessons in these two countries and to extend studies to Ethiopia, Syria and Vietnam. This is reported under the Targeting and Innovation and People, Livestock and Environment themes.

Other system-wide and eco-regional programs

One of the 6 system-wide initiatives that ILRI contributes to is the Collective Action and Property Rights Initiative (CAPRI). An ILRI scientist serves on the steering committee and assists in CAPRI's PhD fellowship program. ILRI also has a research project funded under the CAPRI initiative.

Box 2. ILRI's participation in CGIAR system-wide and eco-regional programs

- Collective Action and Property Rights (CAPRI), led by IFPRI
 - Participatory Research and Gender Analysis (PRGA), led by CIAT
 - Rice-Wheat Consortium for the Indo-Gangetic Plains (RWC), led by CIMMYT
 - Strategic Initiative on Urban and Peri-urban Agriculture (Urban Harvest), led by CIP
 - System-wide Genetic Resources Programme (SGRP), led by Bioversity
 - System-wide Livestock Programme (SLP), led by ILRI
-

ILRI (People, Livestock and Environment Theme) has been working with members of the **Rice-Wheat Consortium (RWC)** for the Indo-Gangetic Plains since 2005 to describe and understand crop-livestock interactions in the rice-wheat systems of these plains. The research adopts a systems perspective to evaluate the contributions of crops, livestock and their interactions to the livelihoods of resource-poor families and to propose policy options and institutional and technical interventions to improve livelihoods and the management of the natural resources. This Theme also has a joint project with IWMI that includes the livestock component of water management in the Indo-Gangetic Plains.

ILRI (People, Livestock and Environment Theme) is working closely with other CGIAR centres as part of the **System-wide Genetic Resources Programme (SGRP)** in the areas of forage and livestock genetic resources. ILRI is applying the common CGIAR centre policy instruments and guidelines on genetic resources, biotechnology and intellectual property rights developed through the program. The SGRP plays a strategic role in coordinating collaborative action among centres on genetic resources management, research and capacity development. This program represents the system at international forums and contributes to global agendas and policy development. ILRI is involved in the system-wide upgrading of genebanks and activities on the collective action for the rehabilitation of global public goods in the CGIAR genetic resources system through the SGRP.

Challenge Program for Water and Food

ILRI is actively involved in bringing a livestock-water use dimension to the CPWF. Most of the ILRI contribution is in joint research projects with IWMI in the Nile Basin. There are also efforts to extend the methodologies and knowledge gained to projects in other river basins and to cross-basin comparisons. This work is reported under the People, Livestock and Environment Project.

Sub-Saharan Africa Challenge Program

The role of ILRI continues to be in providing strategic scientific advice and research inputs. ILRI has helped to identify science entry points, investment priorities and context-specific technical, policy and institutional options for reducing poverty at three of the program's pilot learning sites.

Center Financial Indicators

The Center has over the past years undertaken major efforts to reposition itself for future livestock research needs and a changing funding context. This has involved a significant draw down on reserves to invest in attracting key staff for the new areas of the research agenda: emerging diseases, food safety, value chains, and management of the biosciences platform. We have rationalized the physical infrastructure of the institute by devolving assets being underutilized, investing in the upgrading of strategic areas such as IT, establishing offices in Asia and Southern and West Africa and upgrading our laboratory facilities. We have also invested in strengthening the human resources management and managerial skills in ILRI.

These investments have placed ILRI in a strong position to respond to a rapidly growing and changing global livestock agenda. We see strong growth in demand for research into the growing demand for livestock products, particularly in Asia, the growing competition between human food, animal feed and biofuels, the growing environmental concerns associated with the worldwide expansion of livestock production, the world's nervousness about emerging zoonotic diseases, particularly Avian influenza, and the interaction of the above issues with international concerns about the impact of climate change on developing countries. Overall, there is a growing awareness of the importance of agriculture and agricultural research to feed the world and contribute to equitable and sustainable development across countries and we are confident that ILRI will be able to be a major contributor to this process and attract the expanded financial resources for livestock research that will be required.

ILRI has been able to attract a growing number of larger project grants from traditional donors and increasingly from new donors. We recognize that there is high uncertainty about a number of key factors influencing our financial outlook such as the short and medium term prospects for donor funding related to the global economic crisis and the uncertainties related to the reform process of the CGIAR. The critical challenge for ILRI is to successfully manage a growing portfolio of larger restricted projects in an efficient and effective manner. This involves enhancing our ability to attract and combine a range of disciplinary skills to design innovative science based solutions, to manage human and financial resources (particularly staff time and partnerships), to effectively monitor, evaluate and learn quickly to adjust to changing circumstances and needs.

After a spike in restricted expenses in 2009 due to the construction of the BecA Research platform funded by a grant from the Canadian government, the overall cost of the ILRI portfolio is expected to come down to \$46m in 2010. Given the high medium term uncertainty about future funding in the present context we are revising our expectations for 2011 and beyond downward vis a vis our earlier estimates. We seek to maintain the undesignated reserve levels at about US 9 million over the period to be used to manage our response should future funding become more problematic than presently foreseen.

Table 2. Program cost and funding sources

	2008	2009	2010	2011	2012
In US \$'000s	Actual	Estimated	Proposed	Planned	Planned
Program cost	42,308	56,651	46,287	50,402	51,988
Funding sources					
Unrestricted	13,770	14,503	14,014	14,845	13,361
Attributed	5,962	3,184	8,215	3,912	3,990
Restricted	24,049	39,769	24,056	22,967	23,815
Earned Income	3,883	3,081	2,948	3,757	3,832
Additional funds required*				8,678	10,822
Indicators					
Working capital liquidity	117	108	111		
Adequacy of reserves	90	79	81		

* Submitted and planned project proposals

Project Portfolio

ILRI-1: Targeting and Innovation

Project Overview and Rationale

The livestock sector in developing countries is changing rapidly due to demand and supply factors that strongly influence economic growth, poverty, and supply of livestock products. On the demand side, dietary changes induced mainly by income growth and urbanization, is changing market conditions for livestock products. Growing demand for bio-fuels is increasing competition between food, feed, and fuel. Climate change and degradation of natural resources put increased pressure on the ability of ecosystems to sustainably produce adequate livestock products to meet the rising demand. There are also diverse actors in the livestock sector, such as private agribusiness, producer organizations, non-governmental organizations, and philanthropy. Responses to a changing livestock context may marginalize poor people and degrade natural resources. Increasing demand and rising prices for livestock products may also provide new opportunities through price incentives and institutional innovations through public-private-NGO partnerships for using livestock in research strategies that support specific pathways from poverty.

ILRI's Targeting and Innovation Project analyses the complex interactions between livestock systems, poverty, and the environment. Its strong multi-disciplinary team conducts foresight studies on emerging livestock development challenges with uncertain future impacts and signals their importance for other ILRI Projects and policy makers. The rapidly growing demand for livestock products in developing countries and the importance of livestock in household asset portfolios provides great potential for using livestock to reduce poverty. The Project enhances the contribution of ILRI's research to poverty reduction by identifying, in collaboration with other ILRI Projects, specific pathways for sustainable poverty reduction and entry points where livestock research can play a role.

Research on **livestock systems evolution to set research priorities and influence the agenda** builds upon research characterizing livestock production systems and poverty to provide information and knowledge into trends and the future perspectives of livestock development in developing countries. Research addresses emerging challenges, such as livestock prices, climate change, demand for bio-fuels, pressure on land and water resources - and draws implications on the importance of these changes for future of livestock systems, poverty, and the environment. The research is undertaken at global, regional, community and household scales, in environments where livestock is a significant component of household livelihoods. Research outputs seek to guide priority setting, for example where to work and on what research issues, in the other ILRI research priorities and influence the livestock development agenda.

Research that identifies **strategies and options for enhancing the linkages between livestock, livelihoods, and poverty** builds upon research on spatial analysis of poverty and livestock, poverty mapping, and the role of livestock in pathways into and out of poverty. Research identifies the role of livestock in household and community strategies to enhance the competitiveness, income, and employment prospects of small livestock producers, reduce their vulnerability to shocks, and reduce the vulnerability of livestock to shocks such as disease or drought-induced feed shortages. Research outputs are aimed at identifying research strategies and priorities that provide rural households with specific pathways out of poverty and maximize the contribution of livestock research to poverty reduction. The issues that emerge from this research are used, in collaboration with other ILRI Projects, to inform the design of livestock based 1) policies and interventions to obtain higher value from livestock assets, and 2)

technologies that increase the productivity of livestock assets. Research on vulnerability informs strategies that reduce the vulnerability of rural households and livestock to health or environmental shocks, in part through innovative risk transfer instruments such as weather based livestock insurance. Best bet alternatives for potential livestock based pathways out for poverty are assessed through quantifying the direct effects on small livestock producers and the indirect on other poor people whose livelihoods depend on livestock through input, output or labour market linkages.

Innovation in livestock systems to strengthen the capacity to respond and ability to innovate in rapidly changing livestock contexts aims to strengthen the linkages between the outputs from ILRI's research outputs and development outcomes that improve the well being of livestock dependent poor people. Building on the characterization of livestock systems and evolving challenges and opportunities confronting poor people, the research works in collaboration with other ILRI Projects, to strengthen the capacity to innovate in specific livestock contexts through interventions that strengthen the links and networks between research and non-research actors and identifying policy and institutional changes that enable livestock innovation. The research focuses on two major livestock development challenges, livestock intensification and vulnerability of livestock keepers and livestock to shocks, emphasizing innovations in breeding and feeding strategies, livestock value chains, and risk coping and management instruments to address vulnerability in intensifying crop-livestock and pastoral systems. Research outputs inform project and policy design, monitoring and evaluation, learning, and best practices for scaling up promising interventions.

Alignment to CGIAR Priorities

Research activities on key drivers, trends, and future evolution of livestock systems and implications for poverty and the environment contribute to SP4B, SP4C, and SP5A. The work on livestock and opportunities for income growth and employment and the role of livestock in reducing vulnerability to shocks are applied in specific contexts such as conservation of indigenous livestock (animal genetic resources) in SP1C and demand driven growth opportunities from livestock in SP3B. The work on livestock, livelihoods, and vulnerability contributes to SP5D while innovation in livestock systems contributes to SP5B and SP5C.

Outputs Description

Changes from Previous MTP

There have been no changes in the structure of the Project since the last MTP. In terms of content, the work on climate change is moving from targeting livestock-vulnerability-climate change hot spots to identifying and evaluating livestock adaptation/mitigation options in priority target systems. The gender component of the poverty and livelihoods work has also been strengthened. Work on innovation in livestock systems, which was restructured in the last MTP period, is consolidating around innovation systems perspectives on delivery and dissemination of animal feeds, animal breeding, and animal health technologies.

Output 1: Strategies and priorities for research and development interventions to enhance the prospects for using livestock as an instrument for sustainably reducing poverty in the developing world

Description:

Research activities use analytical tools and methods, including Geographic Information Systems, trends analysis, spatial analysis, and scenario modelling to identify key issues and challenges and signal their importance to other ILRI projects and decision makers.

- Foresight studies in crop- livestock systems and implications for future livestock development, poverty, and the environment is being conducted with other CGIAR Centres to guide strategies and research priorities in the Systemwide Livestock Program. This output will also be used to set research priorities on feeding strategies in the People, Livestock, and Environment Project, livestock value chains, in the Markets Project, and animal breeding and conservation strategies in the Biotechnology Project The detailed analysis of specific trajectories and implications for food security and poverty in intensifying mixed cropping and pastoral systems will inform research issues and challenges relating to ILRI's global challenge on intensification of livestock systems and vulnerability to shocks in livestock systems.
- Assessing climate and land use changes and their impacts on poor people and the environment to inform the design of livestock based adaptation strategies and sustainable land management in systems where livestock is making a significant contribution to livelihoods. Climate change research activities are evolving to meet future needs of ILRI and its partners, focusing on targeting and assessment of climate change impacts on livestock and livelihoods, adaptation strategies, particularly on how livestock can contribute to protecting and enhancing food security and rural livelihoods in the face of a variable and changing climate, and what will work where, both for the short term (risk management options) and for the longer term (strengthening adaptive capacity, use of well-adapted livestock breeds, etc); and addressing the decision-making needs of livestock keepers and policy makers at all levels to respond effectively to climate change, in terms of providing and communicating appropriate information and evidence.
- Synthesizing knowledge on key livestock-poverty-environment issues to inform the livestock development agenda and help ILRI and its research and development partners address global livestock challenges. On-going synthesis work in this MTP looks at the nexus of climate change and livestock in the developing world.

Alignment to CGIAR Priorities : 3B: Increasing income from livestock; 4C: Improving water productivity; 5A: Improving science and technology policies and institutions;

Output 2: Strategies and options for enhancing the contribution of livestock in generation of income, employment, and risk management for setting research priorities, project design, and pilot testing in specific livestock contexts

Description:

Research questions and hypotheses that deliver this output are grounded in conceptual frameworks based on rural livelihoods and poverty traps, emphasizing asset-based approaches for identifying pathways out of poverty and addressing vulnerability. The applied research work combines spatial, quantitative, and qualitative methods to establish baseline conditions, identify intervention options, and evaluate the potential livelihood impacts of alternative interventions on target populations, emphasizing gender and equity dimensions. Current research activities focus on:

- Livestock and pro-poor growth to identify where and how intensification in livestock systems can lead to poverty reduction either directly via increased production and income of smallholder livestock keepers or indirectly through labour and service market linkages. A key aspect of this work involves enhancing positive—and avoiding negative-- impacts that intensification and commercialization could have on access to and control over livestock and related resources by vulnerable groups such as women or minorities. Current work in this area includes development of markets for cattle and goat in Southern Africa (together with Markets Theme) , and improving conservation and utilization of endemic ruminant livestock in West Africa (together with the Biotechnology, Markets, and People Livestock and Environment themes).

- Livestock, vulnerability, and risk management to identify strategies and options for coping with, mitigating, and managing risks in livestock systems. Livestock are a key asset for poor households, often acting as both a savings account and an insurance policy for when disaster strikes. Therefore protecting livestock and their productivity is vital to helping households stay on pathways out of poverty. In marginal environments where livestock-based livelihoods dominate, strategies for managing environmental risks are especially important. Current work in this area involves pilot testing index-based livestock insurance with partners from public and private sectors in arid Northern Kenya.
- Rigorous evaluation of the poverty impacts of livestock-related interventions in the field to generate knowledge on what works where and why. The results are used by policy makers and development organizations in the program design and implementation, and by researchers to design future innovations. Current work in this area includes an evaluation of a Government of Kenya-World Bank project designed to manage risk and drought in arid and semi-arid lands.

Alignment to CGIAR Priorities : 1C: Promoting conservation of indigenous livestock; 3B: Increasing income from livestock; 5D: Improving research and development options to reduce rural poverty and vulnerability;

Output 3: Pro-poor organizational, institutional and policy options for designing interventions aimed at stimulating and supporting innovation for sustainable intensification and addressing vulnerability in priority livestock systems

Description:

Research activities address how – the processes and mechanisms - the products from ILRI's and partners' research are used to generate development outcomes that benefit poor people whose livelihoods depend on livestock. The research uses quantitative and qualitative methods, including actor linkages, stakeholder, institutional, and gender analysis to identify linkages, policy, and institutional innovations that benefit poor people in specific livestock contexts. Current research activities focus on:

- Work in collaboration with the People, Livestock, and Environment Project in India, Nigeria, Vietnam, and Ethiopia, to improve access to feed through strengthening the capacity to innovate in response to increasing fodder scarcity driven by increasing competition between crops-livestock feed, and bio-fuels. Research outputs include institutional innovations for improving access to feed through collective action, property rights, and contracts that enhance linkages between feeds, livestock production, and markets. Another set of research outputs will develop the capacity of research and non-research actors to access and use knowledge on feeding strategies and options to address fodder scarcity.
- In collaboration with the Markets Project in the East Africa Dairy Development Project to identify appropriate incentives and institutional innovations that improve the coordination, functioning, and distribution of benefits, paying particular attention to gender dimensions, along specific livestock value chains. Research outputs will identify incentive structures that provide appropriate signals for collaboration between diverse research and non-research actors, research and development entry points for interventions to expand and enhance the distribution of benefits along livestock value chains.
- Policy and institutional analysis to identify environments that that enable innovation in specific contexts is embedded in all research activities.

Alignment to CGIAR Priorities : 5B: Making international and domestic markets work for the poor; 5C: Improving rural institutions and their governance; 6B: Free-standing training;

Impact Pathways by Output

Output 1: Strategies and priorities for research and development interventions to enhance the prospects for using livestock as an instrument for sustainably reducing poverty in the developing world

The project has three main user groups, and tailored impact pathways to reach each one. One of the main users our research results are other researchers, inside and outside ILRI, in order to set their research agendas. The major way we reach these groups is via collaborative research and dissemination of results in scientific fora. For example, foresight studies, undertaken in collaboration with other CGIAR centres with strong crop improvement and policy programs, is examining trends in key drivers, scenarios of future livestock development, and their implications for poor people and the environment in crop-livestock systems. The outputs will inform the SLP regional strategies, development outcomes, and priorities for the short to medium term.

To engage with policy makers at international and national scales, the project conducts targeted, often commissioned, analyses on key issues of policy relevance. This close communication between researchers and users of the output from design through implementation enhances the likelihood that the results will be used in crop improvement programs and policy dialogues that aim to influence the livestock agenda. For example, the output from the work on livestock and climate change is critical for development agencies implementing climate change adaptation strategies. The World Bank-commissioned evaluation of their Arid Lands resource Management Project is another example.

Finally, the project seeks to influence the design of development interventions, through both targeting and inclusion of specific technological or institutional innovations. This also involves engaging directly with end users, and often includes pilot implementation of interventions with rigorous monitoring and evaluation and impact assessment components. The work on risk management instruments, including Index Based Livestock Insurance, will be used by the World Bank, DFID, and the Government of Kenya to design insurance products and cost-effective mechanisms for delivering these products to poor people who are more likely to fall into chronic poverty when they lose their livestock assets in the event of droughts. The consortium of ILRI and partner research and development partners such as the World Bank, DFID, NGOs, and private insurance companies are testing the feasibility and implementing pilot index based livestock insurance products with poor livestock keepers in agro-pastoral and pastoral systems in Eastern Africa. The lessons learnt from work on this innovative risk management instrument will have significant implications for dealing with co-variate risks, such as climate change in a range of rain-fed based livestock systems in Africa, Asia, and Latin America.

Output 2: Strategies and options for enhancing the contribution of livestock in generation of income, employment, and risk management for setting research priorities, project design, and pilot testing in specific livestock contexts

The livelihood lens that is applied to work on sustainable use and conservation of indigenous animal genetic resources in West Africa will sharpen the poverty focus of animal breeding and conservation strategies and institutional arrangements for effective delivery of breeding services for poor people in the UNDP/GEF and African Development Bank supported Animal Genetic Resources Project in West Africa. The work on risk management instruments, including Index Based Livestock Insurance, will be used by the World Bank, DFID, and the Government of Kenya to design insurance products and cost-effective mechanisms for delivering these products to poor people who are more likely to fall into chronic poverty when they lose their livestock assets in the event of droughts. The consortium of ILRI and partner research and development partners such as the World Bank, DFID, NGOs, and private insurance companies are testing the feasibility and implementing pilot index based livestock insurance products with poor livestock keepers in agro-pastoral and pastoral systems in Eastern Africa. The lessons learnt from work on this innovative risk management instrument will have significant implications for dealing with co-variate risks, such as climate change in a range of rain-fed based livestock systems in Africa, Asia, and Latin

America.

The Strategic Analysis and Knowledge Support System (SAKSS) node for Eastern and Central Africa hosted by ILRI continues to be a key partner research, information and knowledge sharing in Eastern Africa. Through collaborative work with SAKSS, the outputs from complementary work, for example on vulnerability and risk management in pastoral and agro-pastoral areas in Eastern Africa, is used to influence important policy agenda such as the Comprehensive Africa Agriculture Development Program (CAADP).

Output 3: Pro-poor organizational, institutional and policy options for designing interventions aimed at stimulating and supporting innovation for sustainable intensification and addressing vulnerability in priority livestock systems

Understanding sources of innovation as well as the interactions and linkages among research and non-research actors in specific livestock contexts is a critical first step in identifying priorities and innovation response capacities that are relevant for poor people. For example, work on innovation in feeding systems will use the understanding of the different sources of innovation to correctly diagnose and set priorities that integrate poor people's perspectives as well as enhance the capacities of research and non-research partners to better respond to increasing fodder scarcity. Analysis of policy and institutional contexts will help decision makers and development agencies make necessary policy changes and investments in institutions that create an enabling environment for innovation in the livestock sector. Researchers and development agencies also use such the evidence base generated to advocate desired policy and institutional changes.

The Strategic Analysis and Knowledge Support System (SAKSS) node for Eastern and Central Africa hosted by ILRI continues to be a key partner research, information and knowledge sharing in Eastern Africa. Through collaborative work with SAKSS, the outputs from complementary work, for example on vulnerability and risk management in pastoral and agro-pastoral areas in Eastern Africa, is used to influence important policy agenda such as the Comprehensive Africa Agriculture Development Program (CAADP).

Regardless of the specific pathway, the Project systematically undertakes a number of activities to enhance the likelihood of translating its research outputs into outcomes, including early engagement and dialogue with clients and key stakeholders to get agreement on research issues, key questions, and outcomes and to clarify the roles and expectations of different partners. Formal and informal feedback sessions with research and development clients are also useful in ensuring relevance of research outputs. Interactions with ILRI's senior management, researchers in other ILRI Projects and their partners, key stakeholders such as the Science Council, and development agencies are critical in problem identification and providing strategic direction to priorities and strategies that ensure that outputs deliver development outcomes and impact. Collaboration with Innovations Works using tools such as outcome mapping and Challenge Dialogues helps foster stronger outcome orientation and learning around specific livestock issues.

International Public Goods

The project has three major strategies for developing international public goods. First, IPGs are created from synthesis of empirical information and results from case studies to generate policy relevant knowledge on livestock-poverty and their implication for sustainable development. In the MTP period, syntheses of livestock-climate change, livestock-environment, livestock-animal health, and livestock value chains issues will be used to provide context specific knowledge that can be used by a broad range of research and development partners to address important livestock issues within a broader poverty and livelihoods lens. Second, the Project is working with the Research Methods Group to apply statistical principles to empirical research, hypothesis testing, and social experimentation on livestock-poverty issues. The systematic use of statistical principles helps ensure that research from location specific research generates results and lessons that can

be generalized. These statistical approaches to social experimentation and learning will be applied in work on feeding strategies in the Fodder Innovations Project in India and Nigeria and livestock and livelihoods in Southern Africa and evaluation of an arid lands resource management project in Kenya. Third, the Project continues to invest in the development of decision support tools, methodologies, and analytical frameworks that have wide applicability.

Elaboration of Partners Roles

The Project has two generic types of partners, science partners and development partners. Science partners are mainly from NARS, local universities and autonomous research organizations, sub-regional research organizations, advanced research institutes, and other CGIAR Centres. They are primarily involved in the conceptualization, design, and implementation of research activities. The Project is also testing alternative approaches for collaboration with science partners. For example, together with Cornell University, we have developed collaborative research activities involving staff of both organizations,.

Development and policy partners, mainly from donor and development agencies, NGOs, national governments, sub-regional research organizations and regional economic communities use the research outputs from the Project in program and project design, strategy formulation, monitoring and evaluation, experimentation, and policy advocacy. These partners frequently initiate research studies and may be also be involved in the conceptualization of research activities. In many cases, the delivery of research outputs and the pathways from outputs to outcomes involve the close collaboration of science and development partners.

The delineation of partners' roles is based on complementary skills and expertise as well as differences in comparative advantage. The work on drivers of change in crop-livestock systems involves several CGIAR centres. The SLP and national research organizations are mainly clients for this work. The work on climate change has a much broader range of science, development, and policy partners because the Project itself does not engage in climate change modelling but relies on the work of other organizations to get climate projections for impact scenarios and adaptation strategies. For example, analytical and modelling work on climate change is undertaken with other CGIAR Centres, in a collaborative effort between the CGIAR and Earth System Science Partnership (ESSP) as well as with ARI's such as University of East Anglia, University of Edinburgh, Michigan State University and universities in developing countries. DFID and IDRC are using the results from the climate change work in setting their research agendas on climate change adaptation in Africa and advocacy on the impacts of climate change in the region. Some of the insights from the Project's work were also used in developing the CGIAR Climate Change Challenge Program.

The work on index based livestock insurance involve researchers from advanced research institutes such as Cornell and Wisconsin Universities who lead the development of conceptual frameworks, research questions, and key hypotheses on livestock and insurance markets. Researchers at ILRI and partner national research organizations provide leadership on empirical work to test hypotheses through fieldwork and household level studies. Development agencies such as the World Bank and DFID and the private sector provide important insights and feedback, ensuring that the research outputs are focused on delivering development outcomes. The development agencies and the private sector take the lead in designing interventions and implementing pilot projects, often seeking key inputs and advice from Project staff.. During the implementation phase, the Project focuses on monitoring and evaluation, particularly what is working or not working with a view to providing timely feedback that can be used to make adjustments during project implementation and learn lessons for scaling up and out to achieve broader development impacts.

Research on innovation in livestock systems involves collaboration with a range of science and development and policy partners. The work on innovations to respond to fodder scarcity is

conducted in collaboration with the United Nations University – Maastricht Economic and Social Research and Training Centre (UNU-MERIT), FAO-PPLPI, ICRISAT, IITA, national researchers, NGOs, and the private sector. The conceptual framework, developed by UNU-MERIT, FAO-PPLPI, and ILRI, to address fodder scarcity using innovation systems perspectives will be used in diagnostic studies on innovation response capacity and field research aiming to identify institutional innovations, and environments that enable innovations in animal feeds. NARS, NGOs, and the private sector in case study countries are taking leadership in implementing the field research activities while ILRI and its science partners are leading monitoring and learning activities that informs design, results-based management, and scaling up.

Logical Framework

	Outputs	Intended Users	Outcome	Impact
Output 1	Strategies and priorities for research and development interventions to enhance the prospects for using livestock as an instrument for sustainably reducing poverty in the developing world	ILRI Projects, CGIAR Centres, national and regional research organizations (ASARECA, CORAF, SADC, FARA), donors, (DFID, IDRC); development agencies (World Bank, UNEP)	<p>1) Characterization of livestock systems and livestock based climate change adaptation strategies and land management options used to guide priorities in other ILRI Projects, design interventions, and integrate livestock issues into the broader development agenda;</p> <p>2) SLP and researchers use research issues and implications to develop strategy and set research priorities for crop-livestock systems in developing countries;</p> <p>3) Challenge Program of Water and Food use hotspot analysis to identify priority study sites for development of research and investment plans on water, livestock, and crops;</p> <p>4) IDRC, researchers, and partners use future perspectives of emerging diseases to identify key issues, challenges, and priorities for intensifying livestock systems in Asia;</p> <p>5) IDRC and researchers</p>	Enhanced pro-poor orientation of the livestock research and development agenda and increased resource allocation to livestock research

	Outputs	Intended Users	Outcome	Impact
			<p>use climate change hotspots to identify priority areas and research issues for interventions;</p> <p>6) ASARECA programs, case study countries, research and development partners use adaptation strategies to design projects and influence climate change related policy dialogue.</p>	
<i>Target 2010: Other kinds of knowledge</i>	Scenarios of emerging infectious diseases and implications for intensification of livestock systems identified in Asia			
<i>Target 2011: Practices</i>	Climate change vulnerability hotspots in the Horn of Africa identified and characterised			
<i>Target 2011: Practices</i>	Climate change adaptation strategies and options identified for poor livestock dependent people in selected countries in East, West, and Southern Africa			
<i>Target 2012: Other kinds of knowledge</i>	Impacts of alternative methane mitigation options on climate and on livelihoods of the poor in specific livestock systems in Sub-Saharan Africa estimated			
Output 2	Strategies and options	ILRI Themes, policy	Targeted livestock	Improved livelihoods of

	Outputs	Intended Users	Outcome	Impact
	for enhancing the contribution of livestock in generation of income, employment, and risk management for setting research priorities, project design, and pilot testing in specific livestock contexts	makers, policy advisors, NGOs, and development agencies	interventions used to design pro-poor and vulnerability reducing livestock policies, programs, and projects and formulate effective poverty reduction and risk management strategies in two countries and one major regional initiative in Africa	poor people as a result on evidence based pro-poor strategies, policy, program, and project design
<i>Target 2010: Practices</i>	Index based livestock insurance products for pastoral and agro-pastoral systems piloted in Northern Kenya			
<i>Target 2010: Policy strategies</i>	Impact of the Arid Lands resource Management Projects evaluated in Northern Kenya			
<i>Target 2010: Policy strategies</i>	Impacts of conservation agriculture and other crop residue management technologies on livestock and livelihoods evaluated in South Asia			
<i>Target 2011: Practices</i>	Targeted risk management interventions for dealing with food security and vulnerability developed in the CAADP program			
<i>Target 2011: Policy strategies</i>	The role of endemic ruminant livestock in the livelihoods of the rural poor in West Africa characterized and implications for conservation and utilizations strategies identified			

	Outputs	Intended Users	Outcome	Impact
<i>Target 2012: Policy strategies</i>	Impact of commercialization of livestock production on women's access to and control over resources analyzed			
Output 3	Pro-poor organizational, institutional and policy options for designing interventions aimed at stimulating and supporting innovation for sustainable intensification and addressing vulnerability in priority livestock systems	ILRI Themes, Other CGIAR Centers, regional research organizations, development agencies	Analytical frameworks and decision support tools used to set investments priorities and target interventions by at least 2 major agricultural and rural development investment programs	Targeted investment priorities and interventions maximize the poverty impacts of research and development interventions
<i>Target 2010: Policy strategies</i>	Organizational, institutional and policy options for adapting and responding to feed scarcity in mixed crop-livestock systems in East and West Africa, Asia and Syria			
<i>Target 2010: Policy strategies</i>	Organizational, institutional and policy options to develop pro-poor and cost effective delivery mechanisms for improved breeding technologies			
<i>Target 2010: Policy strategies</i>	Pro-poor organizational, institutional and policy options for index based livestock insurance in Kenya and lessons drawn for agro-pastoral systems in East Africa			

	Outputs	Intended Users	Outcome	Impact
<i>Target 2011: Practices</i>	Strategies to improve innovation capacity in dairy and meat sectors in Ethiopia			
<i>Target 2012: Practices</i>	Strategies to strengthen capacity of pastoral communities to adapt to change and mitigate risk through greater participation in selected value chains identified and tested in India and Southern Africa			

ILRI-2: Improving Marketing Opportunities

Project Overview and Rationale

Livestock products have long been a pathway for income generation by the poor. Rapidly growing and changing livestock markets in the developing world provide real opportunities--but also significant challenges--to participation of the poor. Threats to smallholder farmers arise from the increasing integration and complexity of livestock product markets, increasing demand for food quality, safety and convenience, and at the producer level, constraints to smallholders' productivity and ability to produce high quality products due to lack of technology, inputs, resources and information. This Project addresses a range of inter-related issues around smallholder participation in markets, from productivity and access to inputs at the farm level, to the policies in animal trade and disease control at the international level.

Some consumer segments in developing countries, particularly in Asia, are clearly demonstrating higher demand for Western-style product quality and safety attributes, and markets now offer an increasingly integrated modern market chain that places value on food safety, high and uniform quality, and on increased production volumes to capture economies of scale in collection and processing. These higher end markets, part of the "supermarket revolution", will play an increasingly important role even in poor countries. However, due to demand for cheap products with traditional characteristics, markets for traditionally processed, or unprocessed informal products continue to predominate in most developing countries, even while demand for higher quality increases at the higher income end of the market. Because traditional and indigenous products are not easily supplied by larger-scale formal markets, or substituted for by imports, they create unique opportunities for small scale producers and market agents, many of whom are poor. The research program encompassed by the Project builds on those unique opportunities, whether in the form of raw milk, fresh pork, indigenous poultry, or range-fed, organically-raised small stock, and across a range of markets, from local to international. In both informal and formal market chains food safety is a concern from the point of view of both health and nutrition of producers, consumers and market actors and as a potential barrier for smallholders' access to higher end markets. This research program addresses the dualistic nature (traditional and modern) of livestock product markets and aims to help "bridge the gap", supporting the role of smallholders in the transition process, and aims to provide research support to assist these actors and processes to provide opportunities for the poor.

Because livestock market chains are long and complex, they provide multiple opportunities for the poor to participate through input and service supply, and in myriad ways in the marketing and processing of livestock products. ILRI thus assesses livestock value chains (including inputs and services supply) for pro-poor opportunities, then targets sectorally and regionally the best systems and components where the poor can benefit (with focus on dairy, small ruminants, pigs, and poultry).

Although research shows that many smallholder livestock products remain competitive with output from large-scale farms and with imports, there is considerable scope for helping the poor who might otherwise be left behind to join a market-driven pathway to improving their livelihoods through livestock, hence a focus on smallholder competitiveness. This requires not just improved output market linkages, but also support to increased farm productivity through access to improved technologies and appropriate and reliable livestock services and inputs – the "backward" linkages that support productivity.

Alignment to CGIAR Priorities

The Markets Project is completely aligned with System Priority 3b (CGSP 3b) “Income Increases from Livestock”. The project directly addresses the main concern of CGSP 3b that the rapid demand-led growth in livestock product consumption in developing countries presents opportunities, but that current policies, institutions, and structures unfairly favour large-scale livestock farming, and that poor livestock keepers may be driven out (CGIAR SP Dec. 2005, p. 46).

The three outputs of the Markets Project address the six bullet items in CGSP 3b under the “research on markets” component of Specific Goal 1 (CGIAR SP Dec. 2005 pp. 49-50) : (a) understanding how changing demand (including for food safety) can displace smallholders (Project Output 2), (b) assessing the relative competitive position of smallholders (Project Output 1), (c) evaluation of different forms of collective action to overcome transaction costs (Project Outputs 1 and 2), (d) linking livestock development to changes in trade (in this case SPS) agreements (Project Output 3), (e) coping with the impact of concentration of supply chains (such as supermarkets) on procurement from smallholders (Project Output 2), and (f) better linking rural production with expanding urban markets (Project Outputs 1 and 2).

In addition, the Project contributes to Specific Goal 2 to analyze the social impact of livestock development through research on how to minimize the exclusion of smallholders and how to enhance women’s income sources.

Finally, the Project directly addresses Specific Goals 1 and 2 of CGSP 5B, “Making International and Domestic Markets Work for the Poor” (CGIAR SP Dec. 2005 pp. 74-75): (a) understanding the impact of changing consumer preferences on poor producers (Project Output 2); (b) understanding risk sources for improved SPS standards (Project Output 3); and (c) options to help smallholders to adjust to new demands for food safety and quality (Project Outputs 1 and 2).

Outputs Description

Changes from Previous MTP

There are no major changes from the previous MTP. This project has three outputs that employ a set of multidisciplinary skills, particularly economics and veterinary epidemiology, to improve access to markets and service for smallholder livestock producers. Under Output 1, the project is increasingly engaged in developing improved mechanisms to sustainable delivery of feeds and animal genetics to smallholder producers, for example in the case of smallholder dairy in East Africa and South Asia. Under Output 2, new tools for empirical analysis of livestock value chains have been developed and are being adapted and disseminated. Under Output 3 which addresses animal health constraints to trade, new initiatives are being developed to understand the impacts and disease risks associated with alternative disease control standards in developing country trade.

Output 1: Technical, institutional and policy options identified and promoted, that increase the ability of smallholder livestock producers to sustain and expand viable livestock enterprises

Description: Smallholder competitiveness in changing markets: The target of the first Output is to enhance competitiveness of poor producers through research on mechanisms that improve farmer access to the inputs, services, and knowledge products needed to increase productivity and profitability of their livestock activities, as well as improve their ability to capture better value for their marketed livestock products. Market-oriented production relies not only on ‘feeds, breeds, and drugs’, but also on information and knowledge regarding appropriate technologies and market

opportunities. Emphasis is placed on identifying technologies, institutions and policies that will sustainably support market-oriented production by smallholder farmers. The focus is farm-level, action-oriented, and recognizes the complex, multi-objective nature of poor farm households and the particular constraints that they face in gaining access to the relevant public services and private-sector markets. The work typically involves low-income livestock keepers, service and input suppliers, and development actors in smallholder settings, and buyers and integrators in mixed crop-livestock systems and intensifying peri-urban systems. There are two main areas of attention in this Output: a) institutions and strategies to support sustained uptake of improved production technologies, and b) contractual and organizational arrangements to support smallholder participation in markets. The focus systems are smallholder dairy systems in SSA and Asia, smallholder pig systems in SE Asia, and mixed crop-livestock systems that depend particularly on indigenous breeds in SSA. Work is continuing to identify opportunities for improving smallholder pig production and marketing systems in NE India and in Vietnam. A major Heifer International-led smallholder dairy development project in Eastern Africa initiated in 2008 is putting ILRI dairy knowledge into use through a business development services approach. In West Africa, projects are addressing emerging drug resistance for a major cattle disease and, in collaboration with ILRI's Biotechnology Project, examining the role of indigenous livestock for smallholder producers in several countries in that region. Value chain analysis of markets for input and services is being undertaken within the IPMS project in Ethiopia. New areas of emphasis within this Output address markets for inputs and services to smallholder producers, including animal health inputs in West Africa, and feed/fodder markets in India.

However even the most competitive small farms may not be viable if they cannot respond to the challenges of changing demand for food safety, quality, and standardisation. Design of better marketing institutions and strategies would allow smallholders to meet new requirements, hence a focus on changing demand structures that motivate the need for new institutions. These need to be implemented in the context of the continued dominance of the traditional, informal markets that resource poor producers and consumers chiefly rely on, so that bridging the gap between formal and informal markets, in terms of quality and safety, must be one objective.

Alignment to CGIAR Priorities: 3B: Increasing income from livestock; 5B: Making international and domestic markets work for the poor;

Output 2: Technical, organizational and policy options identified, evaluated and promoted for the improvement of market institutions that serve small-scale, poor and disadvantaged producers, market actors and consumers, in the context of rising demand for reliable quality, food safety and increased openness to trade

Description: Changing demand and market institutions: This Output addresses the drivers of change in livestock markets supplied by the poor, including potential changes in demand for better quality, increased safety, and higher levels of processing. It considers private sector and collective responses to new market opportunities and requirements, the impact of changes in industrial organization through the supply chain on small-scale producers, and the means for helping the latter and small-scale market agents to respond. It also assesses the impact of these changes on access by poor urban consumers to low cost livestock-source foods. The Output increasingly examines the actual safety characteristics of livestock products in alternative market channels, and applies a quantitative risk analysis approach to understand potential food safety – livelihood synergies or trade-offs to inform decision makers. The primary targets are institutional options for smallholder livestock producers and the supply chains that serve them. A secondary target is options for appropriate levels of food safety and enhanced risk mitigation strategies in local markets. Some of the work is action-oriented and includes pilot testing of technical and institutional options where appropriate, with development partners. The project incorporates the public health dimensions of food safety and risk analysis to complement the existing focus on market standards related to food safety. Some of the new work within this Output focuses on new

and innovative tools for diagnosing livestock value chains, and guiding development interventions within those.

Beyond these domestic markets, global procedures for control of animal disease face major challenges from changes in the global configuration of livestock production and consumption and from significant changes in technology options for disease control. The costs of compliance with these standards are often too high for small-scale operators in developing countries to meet, hence a focus on animal health for trade.

Alignment to CGIAR Priorities: 3B: Increasing income from livestock; 5B: Making international and domestic markets work for the poor;

Output 3: Strategies and policies identified and promoted for greater impact on poverty reduction through improved quality and safety of livestock commodities and products in national and international markets, through multi-disciplinary research in veterinary epidemiology, economics, and risk analysis

Description: Animal health for market access and trade: This Output addresses the animal-health related barriers to the access of poor and small stakeholders to local, national, regional, and/or international markets. Through the identification, development, and evaluation of animal disease control, surveillance, or livestock and livestock commodity certification methods, this operating project assists stakeholders to meet animal health and food safety standards restricting their access to various markets. This work draws attention to the high costs of compliance with existing SPS and other standards facing producers in developing countries who wish to sell into rising export markets. It also evaluates in selected cases the costs and benefits of alternative procedures for equivalent levels of animal disease control proposed for developing countries. Risk analysis from veterinary epidemiology is combined with analysis of the costs and benefits of different options and policies, including the implications for both direct and indirect impacts on the incomes of the poor. Such methods further provide the basis for improved pro-poor decision and policy-making through the assessment of cost-effective animal health alternatives and allowing stakeholders to more effectively respond to zoonotic and emerging diseases that potentially reduce market opportunities such as highly pathogenic avian influenza (HPAI) and Rift Valley fever. The increasing attention to emerging diseases is a result not only of immediate threats to human health from avian flu, but also the awareness of longer term strategies to mitigate ongoing risks of these “public bads”, that are tied to intensifying production and marketing systems. This area will be a key focus over the medium term, and is expected to grow. Furthermore, through applied research and capacity-building, the output disseminates innovative and more effective animal health and food safety solutions that contribute to an increase in market participation. The focus of partnership with lab-based organizations (such as ARIs) and policy and standard-setting organizations (such as OIE, FAO and CODEX) is to demonstrate interactions between the context and practical requirements of developing countries with the technical options available in different parts of the world.

Alignment to CGIAR Priorities: 5B: Making international and domestic markets work for the poor; 5C: Improving rural institutions and their governance;

Impact Pathways by Output

Output 1: Technical, institutional and policy options identified and promoted, that increase the ability of smallholder livestock producers to sustain and expand viable livestock enterprises

For all three Outputs in this Project, the strategy for pathways to convert our outputs into outcomes and impact is oriented towards three different deliverable types, meaning types of knowledge for target users. These deliverable types are policies, development solutions (technologies and strategies), and methodologies. A key unified strategy for delivering in each of these areas is working through partnerships; however those partnerships vary according to type of deliverable, and to the stage of delivery. The focus is on building national ownership of results, and engaging key decision-makers at policy, development and private investment levels early in the research, through national collaborators and joint projects. Particularly in research towards technical and institutional options, action research and pilot testing is conducted jointly with development partners, either public or non-governmental institutions or the private sector. Working with local and national partners to demonstrate potential for impact is essential for proving the relevance of research outputs, and for drawing the strategic lessons for applications in other setting and regions internationally.

- **Developmental outcomes and impact:** The partnership strategy for delivering these types of technology and institutional strategy impacts lies in working through Joint Research and Development Partnerships at national and local levels. The key to success is the effective linkage of researchers with investors and development agencies and implementers. These sorts of partnerships typically include government extension services and regulators, private-sector investors and service providers of both small and large scale, including business development service (BDS) providers, NGOs and producer associations. ILRI's role may be facilitating, catalysing or leading such partnerships, depending on need, as well as synthesizing and translating the lessons learned to generate global public goods. Such development Partnerships conduct: joint outcome mapping and regular monitoring and evaluation, joint R&D planning, field research to pilot test the technology and institutional strategies that emerge from research, joint communication development, inter-site exchanges, and short courses to improve skills to increase uptake. In such cases the ILRI research role is just one of several components, aimed toward better science-based targeting and application of development interventions, with a view toward learning lessons with international relevance. The Outcomes targeted by these technology and institutional strategy-related outputs is a) the sustained uptake of pro-poor institutional models and technologies, through improved capacity of development partners and b) demonstrated market innovations with international relevance. Depending on the type of issues addressed, Impacts will be in the form of improved welfare of resource-poor producers, market actors, and/or consumers.

- **Policy outcomes and impacts:** The partnership strategy for delivering at the policy level is to work with Advocacy Coalitions at international, regional and national levels, using policy-research outputs that have regional and global relevance. The key to the success of such coalitions is that partners pursue shared pro-poor goals but have different and complementary capacities. They are likely to include some policy partners and decision makers themselves, and feature credible researchers, global information networks, and research and development donors. A key element to success is to include pro-poor civil society organizations that have a particular interest in and specialized capacity for pro-poor policy advocacy. Global relevance is demonstrated in a) policy approaches tested locally and nationally that can be adapted to other countries and settings, and b) policy engagement strategies that can also be applied to other commodities, systems and issues elsewhere. The Outcomes targeted by these policy-related outputs are: a) changes in mind set among policy makers, accompanied by increased capacity to address wider range of sometimes complex pro-poor policy questions, followed by b) actual pro-poor shifts in public policy and investment interventions, either in the form of written or implemented policy. Depending on the type of policy addressed, Impacts will be in the form of improved welfare of

resource-poor producers, market actors, and or consumers.

- **Methodology outcomes and impacts:** The partnership strategy for delivering new or refined research methods and tools is to work through Multi Level Research Partnerships. The key to success in these cases: being a bridge between the international science community, ARIs, other IARC, and NARS. These partnerships typically include cutting-edge ARIs usually based in the North, IARCs with complementary skills and interests, and capable NARS institutions and individuals. Alternatively, as in the case of action research on methodology in surveillance and animal health delivery, appropriate partners include public sector service delivery organizations, non-governmental organizations and international agencies involved in program implementation. Again, there are a number of examples in this Project of these types of Partnerships, which are strongly aimed at research capacity building among our research partners that will in turn lead to positive development consequences, rather than direct welfare impacts on our primary target beneficiaries. The Outcome targeted by these methodology and skills -related outputs is a) the development and dissemination of improved research methods internationally, and b) increased research capacity nationally and regionally. Depending on the type of issues addressed, and rather more indirectly than in the above cases, Impacts will be in the form of improved capacity for sustained research on livestock marketing and related policy issues to improve welfare of resource-poor producers, market actors, and/or consumers.

The outcome and impact strategy for this Output (smallholder competitiveness) mirrors the three types of partnership strategies described above

Developmental outcomes and impact: For this particular Output, an important example is the East Africa Dairy Development project, a large scale four-year development project in Kenya, Uganda and Rwanda led by Heifer International. ILRI's role is guiding design, leading targeting of implementation to ensure benefits for the poor, and lesson learning from development interventions for wider strategies. The non-research partners work directly with producers and market agents, and so allow the scaling up of research outcomes for impact that is sustained due to their continued presence and role after donor project cessation. Other examples are seen in pig systems work in NE India in Nagaland.

Policy outcomes and impact: For this Output, an example also lies in the EADD project above, in which ILRI is leading the modelling of dairy policy impacts, and through the project's links to host governments, will be able to influence pro-poor policy, and the implementation of pro-poor dairy interventions of the development partners in three countries in that region. Another example lies in the Pig Competitiveness project in Vietnam where, through partnership with the national Centre for Agricultural Policy the key implementing partner, project outcomes will have influence on pig sector policies.

Methodology outcomes and impact: For this Output, some examples of these partnerships include the joint work with IFPRI and national partners that adapted integrated modelling approaches to address the complexity of contract farming/industrialization in pig systems in Vietnam, linked to Univ. of Queensland. ILRI is also working through a joint programme on zoonoses with a public health partner, the Swiss Tropical Institute, to develop One Health approaches to addressing the complex interactions of animal and public health mitigation efforts.

Output 2: Technical, organizational and policy options identified, evaluated and promoted for the improvement of market institutions that serve small-scale, poor and disadvantaged producers, market actors and consumers, in the context of rising demand for reliable quality, food safety and increased openness to trade

Developmental outcomes and impact: For this Output, an example lies in the dairy work in Assam, NE India, where having first led a diagnostic activity to guide the State Government's dairy development strategy, ILRI now is supporting local development partners in a new effort to introduce and scale up traditional milk market interventions based on a BDS model adapted from

East Africa. In all of these cases, outcome mapping or similar planning exercises help to manage the evolution of ILRI's role among other partners from leader in some cases, catalyst in others, to facilitator and supporter as R&D project matures. In all cases, the partnership with development partners in specific settings is used as an opportunity for ground-truthed lesson-learning about market and technology innovations for application in other international settings

Policy outcomes and impact: An important example of this type of Advocacy Coalition approach can be found in the work led by some of this Project's team members, on pro-poor policy change towards greater acceptance of small-scale milk marketing in East Africa. In 2009 the work continues at a regional level in East Africa, with ILRI now playing a smaller facilitating and capacity building role in support of an effort led by the East and Central Africa Program on Agricultural Policy Analysis (ECAPAPA, a network of ASARECA) aimed at applying the same policy lessons in Regional Policy Harmonization. Similarly, in the State of Assam in NE India, the same policy lessons are being adapted and applied, with ILRI supporting capacity of the Assam government to address traditional milk markets.

Methodology outcomes and impact: For this Output, an example lies in the work with national universities in East Africa and with Cornell University to develop adapted disease and food safety risk assessment approaches that address the data-poor and unregulated informal milk and meat markets in developing countries, which to date have never been developed.

Output 3: Strategies and policies identified and promoted for greater impact on poverty reduction through improved quality and safety of livestock commodities and products in national and international markets, through multi-disciplinary research in veterinary epidemiology, economics, and risk analysis

Developmental outcomes and impact: For this Output, a key area of developmental impact lies in work with government partners across West, East and Southern Africa on supporting decision making capacity in addressing risks from avian flu. In that work, Veterinarian Sans Frontier (Belgium) plays a key developmental role under ILRI scientific guidance.

Policy outcomes and impact: In the case of animal health policies as addressed by this Output, it is often essential to engage international organizations and standards setting organizations such as the Office International des Epizooties (OIE), highlighting equity and poverty alleviation issues through risk-based rather than rule-based approaches. ILRI is currently engaged in such coalitions to influence the animal health policies to better serve the needs of resource-poor producers and developing countries, though engagement with key Ad Hoc committees that draft OIE positions. We are also working with the Intergovernmental Bureau for Animal Resources of the African Union (AU-IBAR), to influence the uptake of more pro-poor approaches for complying with SPS issues in animal product trade.

Methodology outcomes and impact: A growing partnership is with the Royal Veterinary College in the UK, involving joint work on animal disease risk mapping and modelling for application to avian flu and other emerging diseases.

International Public Goods

The international public goods generated by this Project emanate from the basic approach applied throughout:

- a) Analyzing livestock value chains in their entirety (technical, institutional and policy elements)
- b) From that analysis, identifying sectors and regions with greatest opportunities for the poor to benefit from markets either as input suppliers, producers or market agents.
- c) Evaluating and demonstrating the transferability of policy approaches learned or innovations developed (e.g. dairy policy: East Africa to South Asia; policy approaches: East Africa dairy to Southeast Asia pigs)

d) Influencing the international agenda to embrace pro-poor market approaches that apply risk based systems with a variety of options for the poor to succeed.

The international public goods emanating from the research represent in all cases lessons for innovations in policies or institutional strategies that emanate from research in a specific site or context that have generic relevance in other sites, eco-regions and continents, and so have strategic international implications. They can be categorized in a manner related to the three types of outputs that are described above in the Impact Pathway discussion.

Because public policies play a key role in market regulation, infrastructure and performance, policy-related IPG's figure prominently in the work of the Markets Project. A key example is the work on policies to address small-scale informal milk markets that began in Kenya, described above, and associated with Output 2 in the Logframe. The policy-related IPG lessons from that work are a) the policy option itself, of formalising raw milk trade, and b) the analysis of the process of policy change emanating from research. Although the original work was Kenya-specific, interactions with stakeholders in other countries, some outside the region, demonstrated that policy-makers elsewhere could benefit from the lessons learned. As described above, the lesson is now being applied in other countries in E Africa and in NE India.

A key area of attention for the Markets Project is the application of risk-based approaches to understanding food safety and animal disease implication of livestock and livestock product markets. Such approaches are required to go beyond simple rule-based, "no-risk" policies, to understand potential tradeoffs in risk vs. livelihoods among various participants in market chains from consumers to livestock producers themselves. This work is generating IPGs in a number of areas, including methodology innovation to adapt the approach to developing country settings, new institutional and regulatory options to best balance risk and livelihoods, and in the future, new understanding of policies to allow poor countries to apply equivalent risk control measures to meet SPS standards in livestock exports (Output 3).

Finally, in the area of methodologies, the Project is for example developing the use of participatory techniques to better adapt epidemiological surveillance and research methodologies to the realities of developing countries and small-holder communities. These tools are also being developed as more sustainable methods for use by national governments to comply with SPS requirements and enhance access to markets. Another example relates to methodologies for addressing value chains that are currently being revised, the objective being to better identify leverage points (interventions that would have the highest impact) while ensuring good scientific rigour in the analysis (Output 2).

Elaboration of Partners Roles

The Markets Project is one of ILRI's most geographically diverse, and has staff based in several regions of SSA, in South Asia, and in several countries in Southeast Asia. Mirroring the variety of locations, the range of partners that the Project works with is similarly diverse, although it follows generally the types of partners and roles described above in the description of impact pathways. A key focus for this Project is building on the strengths of partners who offer development outcome platforms for generating strategic learning and IPGs.

South and Southeast Asia are areas of increasing attention for the Project, and the work there addresses all three Output areas in the Project portfolio. In Vietnam, an on-going project on improving the competitiveness of pig producers is being implemented jointly with the Institute of Policy and Strategy for Agricultural and Rural Development (IPSARD), Ministry of Agriculture and Rural Development, IFPRI and the University of Queensland. Oxfam GB and HK and a newly formed group, the Prosperity Initiative, play a critical role in supporting policy advocacy to increase likelihood of policy outcomes. Other Vietnamese partners who play roles either as

stakeholders or collaborators in this project are the Ministry of Agriculture and Rural Development and its relevant departments and institutes, and the Vietnam Animal Feed Association. In Cambodia, research on livestock market chains is led by the Center for Livestock and Agricultural Development (CeLAGriD) with support from Srah Takoun Farmer Association, Lok Farmer Association and Prash Punlear Slaughterhouse. Heifer Project International is a stakeholder in that project.

In Indonesia, ILRI is coordinating an Operational Research Project aimed at evaluating a suite of interventions against highly pathogenic avian influenza (AI) in backyard poultry production systems, including preventive mass vaccination and culling with compensation fully provided. Collaborators include the Ministry of Agriculture, FAO, John Snow Inc. and the Community-Based Avian Influenza Control Project, reflecting a range of public, international and private sector partners. ILRI is tasked with developing the study design as well as systems for monitoring and evaluating levels of uptake/coverage of interventions (i.e. process indicators) and their impact on AI incidence (impact indicators). The MoA, in collaboration with FAO, is responsible for implementing the vaccination campaigns and developing culling compensation systems. JSI Deliver provides logistical support for vaccines and equipment. CBAIC conducts community mobilization and tracks AI outbreaks in the target areas. In this MTP period, we expect this and related work to expand in Indonesia and other countries in SE Asia, given the strong demand for options to address Emerging Infectious Diseases in the region.

Another important node for partnership in research is found in India, where much of the research attention has been on smallholder dairy systems, but is now paying increasing attention to smallholder pig systems in NE India, and also plans to address small ruminant systems. A central part of this work is through the ILRI agreement on joint research with the Indian Council for Agricultural Research (ICAR). Key ICAR institutions that this Project are working with are NCAP, NDRI, and IVRI, addressing a range of issues from livestock value chains to breeding services, to livestock trade, to epidemiology and control of FMD among smallholders, with IVRI and the Ministry of Agriculture. Working collaborations also exist with collective and development agencies, such as the milk co-operative federation of Punjab and Hind Livestock Development Foundation in UP in a study which addressing smallholder compliance and food safety issues in livestock trade. In Assam, ILRI has been providing research support to the State Government of Assam Dairy Dept, to guide significant investment in dairy in that State for the next few years. Other local NGO partners in Assam play key roles in implementing and disseminating the research, thus contributing to joint learning and capacity building. In new efforts starting in 2009, FARMER, a local NGO, will play a lead role in implementing new dairy development efforts which will also include the private sector represented by Brihattar Guwahati Gopalak Sangstha (BGSS) a Dairy Producers cum Traders Association.

In a multi-country project focused mainly on SSA but including Indonesia, ILRI is collaborating with IFPRI and FAO on an action-oriented, multi-disciplinary research project on avian flu (HPAI) control and prevention strategies. The aim is to aid decision makers in developing pro-poor HPAI control and prevention strategies that are not only cost-effective and efficient, but also livelihood enhancing. The project is being implemented in Asian and African countries that have recently experienced HPAI outbreaks, including Ghana, Nigeria, and Indonesia, but also in Ethiopia and Kenya, countries in which there has been no outbreak of disease. The international research consortium, comprises risk analysts, veterinarians and social and economic scientists from ILRI, IFPRI, FAO, the Royal Veterinary College of the University of London; and the University of California, Berkeley. National partners include EIAR (Ethiopia), Bogor Agricultural University and Gadjah Mada University (Indonesia), and University of Ghana and University of Cape Coast (Ghana). RVC leads research on the epidemiology and risk elements of avian flu in close collaboration with ILRI, while IFPRI leads on assessing the socio-economic and livelihood impacts of the disease.

The Projects work in southern Africa continues to expand, building on a core project on market

participation of smallholder livestock producers funded by the EU that is being implemented jointly by ILRI and ICRISAT in collaboration with national partners in Mozambique, Zimbabwe and Namibia. The work includes diagnostic studies on constraints for smallholder participation in livestock markets using a value chain approach and identification and testing of alternative input delivery and output marketing systems for enhancing smallholder participation in markets. National partners include Agriculture Research Institute of Mozambique, an NGO and private sector partners; Department of Agricultural Research and Extension, Department of Livestock Development, Practical Action (an NGO) and private sectors partners in Zimbabwe, and Directorate of Agriculture Research and Training, Directorate of Extension and Engineering Services, Namibia national Farmers' Union, MeatCo (a private company) and DRFN (an NGO) in Namibia.

In West Africa, ILRI is leading a project on drug resistance that allies two German universities, two regional research centres (CIRDES and ITC), and national veterinary research agencies (Direction Nationale d'Élevage in Guinea, Laboratoire Central Vétérinaire de Bamako, Institut National de Recherche Agronomique de Bénin), veterinary services (Département de Services Vétérinaires de Sikasso in Mali Laboratoire Régional d'Élevage de Tenkodgo in Burkina Faso) and tsetse control projects (Tsetse and Trypanosomosis Control Unit in Ghana, Projet de Lutte contre la Mouche Tsétsé in Mali, Unité de Lutte contre la Trypanosomose in Burkina Faso) in five countries. This work looks at effectiveness of market-mediated supply of veterinary inputs, and mechanisms to support that.

Finally, a major geographical area of multiple and layered partnerships is in East Africa, addressing a range of topics. There is a wide variety of development partners, advocacy partners, government regulatory agencies, national research organizations, private sector collaborators, regional partners, and other international and advanced research institutes based locally or elsewhere. Key development partners continue to be both public (Min of Livestock and Fisheries Dev- Kenya, Kenya Dairy Board, Kenya Bureau of Standards), and non-governmental (Heifer International, SITE, Terra Nuova); they are instrumental in implementing research outcomes. Some large scale private sector players have contributed to understanding of market constraints and opportunities (Brookside Dairy), and many small scale individual entrepreneurs have contributed to pilot testing of market options for raw milk. Key research partners are found at both national level (KARI, NARO, Sokoine Univ. and Tanzania Bureau of Standards, Univ. of Nairobi, Ethiopian Ministry of Agriculture, Ethiopian Institute of Agricultural Research and Ethiopian Standards Authority among many others) and regionally (ASARECA, PAAP), and they contribute to research inputs, provide channels for capacity development, and help to scale up research approaches and outcomes. There are a number of links to other CGIAR centres and IARCs, including IFPRI in the area of smallholder industrialisation and competitiveness, and in IFPRI and Cornell providing methodological support in value chain and livelihood analysis in smallholder livestock systems. The Project is also linked to the Japan-based FASID in jointly analysing changes in dairy systems and technologies in several E African countries.

Logical Framework

	Outputs	Intended Users	Outcome	Impact
Output 1	Technical, institutional and policy options identified and promoted, that increase the ability of smallholder livestock producers to sustain and expand viable livestock enterprises	<p>Development practitioners and investors, private sector and collective livestock actors and producer associations, for the technical and institutional options.</p> <p>Policymakers and analysts for the policy options.</p> <p>Researchers in NARS, IARCs and ILRI for capacity and methodologies.</p>	<p>Pro-poor market-based strategies are applied by public and private-sector development actors and supported by policy makers</p> <p>Increased awareness and resources devoted to increasing the market orientation of smallholder livestock producers as a pathway out of poverty by decision makers and investors</p> <p>Increased activity in and capacity for research in pro-poor market development that links farmers to livestock input-output markets by research partners in target countries.</p>	<p>Increased productivity through uptake of best bet practices of smallholder livestock producers.</p> <p>Higher and less variable incomes from livestock production of vertically coordinated small-scale livestock producers, and indigenous livestock keepers.</p> <p>More reliable access to higher quality livestock services in target sites.</p> <p>Increased investment in households livelihood assets, including livestock assets</p>
<i>Target 2010: Practices</i>	Best practices for smallholder pig producer competitiveness and participation in markets identified and promoted in South East Asia (Vietnam)			
<i>Target 2010: Other kinds of knowledge</i>	The role of indigenous livestock in enhancing competitiveness and sustainability of smallholder producers evaluated in selected West African countries			

	Outputs	Intended Users	Outcome	Impact
<i>Target 2010: Policy strategies</i>	Case studies of role of feed and fodder markets in smallholder livestock production systems in East Africa and South Asia synthesized			
<i>Target 2010: Practices</i>	Strategies for containing and reversing trypanocide resistance, and implications for economic impact, identified and disseminated to stakeholders in West Africa			
<i>Target 2010: Policy strategies</i>	Institutional, organizational and technological determinants of commercial transformation of livestock producer smallholders in Ethiopia assessed and implications for poor livestock keepers identified			
<i>Target 2011: Policy strategies</i>	Lessons from case studies on input and services delivery for smallholder pig producers synthesized (Cambodia, Vietnam and South West China)			
<i>Target 2011: Practices</i>	Processes for enhancing commercial dairy orientation and profitability of smallholder cattle keepers in East Africa described			
<i>Target 2011: Policy strategies</i>	Lessons from the input markets and first-level output markets and their implications for the			

	Outputs	Intended Users	Outcome	Impact
	commercial transformation of livestock keepers in Ethiopia synthesized.			
Output 2	Technical, organizational and policy options identified, evaluated and promoted for the improvement of market institutions that serve small-scale, poor and disadvantaged producers, market actors and consumers, in the context of rising demand for reliable quality, food safety and increased openness to trade	<p>Policymakers and policy analysts, regulatory authorities, development investors, public and private sector traders of livestock products, producer associations, for the technical and organizational options, and the policy options to facilitate those.</p> <p>Business development services providers that work with livestock markets, including credit, certification, and disease control technology.</p> <p>Researchers in NARS, IARCs addressing livestock and agricultural market mechanisms, including the application of action research.</p>	<p>Increased use of technical and institutional options that improve market performance to benefit poor livestock value chain actors.</p> <p>Changes in policies that facilitate improved performance of traditional and formal markets serving smallholder producers.</p> <p>Policy makers and market participants aware of, and using, pro-poor risk-based approaches to food safety.</p>	<p>Improved livelihoods of small-scale producers and market-agents through greater participation in supply chains serving high-end urban markets</p> <p>Improved producer responsiveness to consumer demand for better food quality and safety, and lower prices for safe food to the urban poor</p> <p>Increase in the share of smallholder production going to higher priced markets in targeted countries leading to higher incomes</p> <p>Increased producer and market agent compliance with quality and safety requirements in urban high-value supply chains for livestock products leading to higher incomes</p> <p>Improved public health among poor livestock producers, market agents and consumers.</p>
<i>Target 2010: Capacity</i>	Results of case studies in Asia and Africa on methods			

	Outputs	Intended Users	Outcome	Impact
	for analysis of demand for quality and safety in animal products in the absence of official grades and standards documented, and national capacity for this analysis supported			
<i>Target 2010: Other kinds of knowledge</i>	Demand for quality and safety, and tradeoffs between food safety and economic welfare of poor people in South Asia and East Africa documented			
<i>Target 2010: Practices</i>	Value chain mapping and analysis applied to quality and innovation in the livestock value chains			
<i>Target 2010: Practices</i>	Combined value chain mapping and analysis with risk-based food safety approaches developed and demonstrated			
<i>Target 2010: Policy strategies</i>	Impacts of dairy policy changes in South Asia promoted			
<i>Target 2011: Other kinds of knowledge</i>	Demonstrated methods and approaches to analyse livestock commodity value chains in Asia, East and Southern Africa promoted			
<i>Target 2011: Policy strategies</i>	Value chain analyses and methods applied in policy design in target countries			
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Output 3	Strategies and policies	Policymakers and policy	Increased awareness	Increased and more stable

	Outputs	Intended Users	Outcome	Impact
	<p>identified and promoted for greater impact on poverty reduction through improved quality and safety of livestock commodities and products in national and international markets, through multi-disciplinary research in veterinary epidemiology, economics, and risk analysis</p>	<p>analysts, animal health and regulatory authorities, development investors, public and private sector traders of livestock products, for the technical and organizational options.</p> <p>Policymakers and policy advocacy partners (including regionally and internationally), and national and international animal health authorities for the policy options.</p> <p>Business development services providers working with livestock markets, including certification, disease control technologies and strategies.</p> <p>Researchers, including NARS and IARCs working in livestock market mechanism, including applying risk analysis, and trade impact implications.</p>	<p>among policy-makers, regulators and development agencies of the impact of and factors influencing smallholder capacity to comply with SPS guidelines and private sector sanitary and quality norms</p> <p>Improved procedures for livestock and livestock product exports that increase smallholder market participation, meet market demands and add value</p> <p>Health institutions in the target countries adopt risk-based and integrated approaches for surveillance, mitigation of disease impact, and promotion of health to enhance market access.</p>	<p>producer incomes through better access to high-value export supply chains for livestock products</p> <p>Increased compliance with animal health and safety regulations by small-scale producers and traders leading to increased and more stable producer incomes through better access to high-value domestic and export supply chains for live small ruminants and meat</p> <p>Increased private sector compliance with improved animal health and safety standards, including small scale market actors</p>
<i>Target 2010: Policy strategies</i>	Lessons learnt on the application of participatory approaches to disease surveillance in support of One Medicine approaches			
<i>Target 2010: Policy strategies</i>	Strategies for enhancing the capacities of national decision-makers to use epidemiologic, economic, systems and risk analysis to			

	Outputs	Intended Users	Outcome	Impact
	improve the performance of surveillance			
<i>Target 2010: Other kinds of knowledge</i>	A framework of integrated approaches and future scenarios developed for evaluating the evolving risks and impacts of selected zoonotic emerging infectious diseases			
<i>Target 2010: Policy strategies</i>	Lessons learnt in applying pro-poor strategies for compliance with SPS measures using innovative approaches to export certification			
<i>Target 2010: Practices</i>	Lessons learnt in disease mitigation and impact assessment of disease mitigation scenarios			
<i>Target 2011: Practices</i>	Wider application, capacity-building, and dissemination of integrated epidemiological-economic-livelihood framework for evaluating the risks and impacts of selected zoonotic emerging infectious diseases by stakeholders in selected developing country settings			
<i>Target 2011: Practices</i>	Pilot application of identified, best-bet, pro-poor approaches to SPS and food safety measures in selected settings, including monitoring and evaluation of poverty and trade impacts			

ILRI-3: Biotechnology

Project Overview and Rationale

The overall goals of this Project are to mitigate health threats to livestock so as to secure and multiply the assets of and alleviate poverty among smallholder farmers and pastoralists. This is achieved by applying modern molecular approaches to improve vaccines for disease prevention, to develop and use diagnostic tests for disease surveillance, food safety and market access and to characterize, conserve and utilize disease resistant livestock and those adapted to sub-optimal environmental conditions.

Since 2001, the ILRI Biotechnology Theme in collaboration with international partners has focused its vaccine research on developing an anti-schizont sub-unit vaccine for East Coast fever (ECF). Several candidate *Theileria parva* vaccine antigens that are the targets of cytotoxic T lymphocytes (CTLs) from cattle immune to ECF were identified. The next phase of the research focused on evaluating these parasite molecules in vaccine formulations and different vaccination systems were evaluated. However, none were found to efficiently induce CTLs, the desired immune response that correlates with immunity, and the lack of a robust vaccination system remains a bottleneck in vaccine development. This problem in CTL vaccine research is not limited to ECF and exists for several human diseases, notably HIV, malaria and cancer. Based on experience to date, the realistic expectation is that a CTL-based sub-unit vaccine is some years away as it will require strategic research in bovine CTL biology to develop an efficient vaccination regime. Hence, attention has shifted to an infection and treatment method of vaccination (ITM), which has been available for several years. Although effective, ITM has considerable drawbacks, most importantly a complicated and expensive production process of live parasites and the necessity for liquid nitrogen storage of the vaccine from point of production to point of use in the field. This live and potentially lethal vaccine has not been widely available. However, despite these limitations and due to the devastating impact of ECF there is an increasing demand for the ITM vaccine from livestock owners. Starting in 2007, ILRI has been engaged in a three year 'technology transfer' project, to apply a production protocol previously used by ILRI to manufacture the ITM vaccine. The process is designed to engage and train other producers of the ITM vaccine on a commercial-scale. Under the stewardship of AU-IBAR, ILRI is working with several entities including PANVAC (Pan-African Vaccine Centre of AU) and an international non-for-profit organization, the Global Alliance for Livestock Vaccines (GALVmed), to develop a dossier that will underpin the registration of the ITM vaccine. ILRI will also provide technological support for the deployment of the vaccine in eastern and southern Africa. During the medium term this will include an assessment of the immune responses generated by ITM vaccination in different cattle breeds, pathogen population studies and the cause of any vaccine failures should they occur. It is expected that these activities will have a positive impact in the immediate term in the control of ECF, while awaiting the development of a cheaper, safer and more practical next-generation vaccine.

The expertise generated by the long-standing ECF vaccine research effort has attracted collaborative projects on bovine tuberculosis (BTB), contagious bovine pleuropneumonia (CBPP) and tropical theileriosis, where ILRI works with several consortia conducting multifaceted research projects. The BTB and CBPP projects take advantage of ILRI's expertise in bovine immunology. In the MTP period, particular attention will be given to CBPP, due to its economic importance in Africa and lack of knowledge on the immuno-pathology of this disease. Similar to the ECF situation, the current CBPP vaccine is imperfect but the only available solution. The focus will be on understanding how the present vaccine works as a basis for developing an improved product. In addition, the availability of whole genome sequence data of several *Mycoplasma* species and advances in synthetic biology offer new approaches to dissect the biology of CBPP and for developing novel vaccines. Work will also continue on assessing candidate antigens from the tick vector of ECF, *Rhipicephalus appendiculatus*, for use as an ECF transmission blocking vaccine.

ILRI's role in the tropical theileriosis project is to identify antigens of *T. annulata* recognized by immune cells and is a logical extension of the previous work on ECF. A CCER held in 2008 recommended that the Operating Project should allocate its current projects into four programmes: ECF, CBPP, surveillance and discovery and development. The future directions and scope of other projects will be examined as part of a broader assessment of priorities in both vaccine and diagnostics research through partner consultations. This process will involve close collaboration with ILRI's Targeting and Innovations Project.

In diagnostics research, previous work was aimed at the development of assays for use by NARS for sero-surveillance and as epidemiological tools, in particular for tick-borne diseases and trypanosomiasis. The development of tests that can facilitate market access through the development and deployment of rapid diagnostic assays will be carried out if there is a demand for them, e.g., by the Markets Project. ILRI's work in African Swine fever (ASF) is aimed at identifying the extent of genetic diversity in East African isolates of the virus. Lack of knowledge of this diversity has constrained the application of diagnostic assays developed using viral isolates from other regions. Important aspects of the ASF project will use the new BL3 laboratory and the BecA-ILRI genomics platform. The need for better diagnostic tools for CBPP, in particular for the latent 'carrier' animal, is hampering efforts to control this disease. ILRI is taking a genomics-based approach to address this problem, which will also benefit from the facilities of the BecA-ILRI research platform. ILRI is also a collaborator in a major field project (the Infectious Diseases of East African Livestock – IDEAL – funded by the Wellcome Trust) in western Kenya aimed at establishing baseline information on diseases which affect calves for the first 12 months of life, the efficiency of diagnostic assays for these diseases and whether there is a correlation between disease susceptibility and genotype in these animals under smallholder management. The project will also yield a valuable biobank of samples linked to clinical, genetic and geospatial data. The field activities are due to end in late 2010 with laboratory activities and data analysis continuing until 2012.

Work on Animal Genetic Resources (AnGR) characterization seeks to map and characterize the diversity in livestock populations in developing countries. ILRI's role in livestock diversity is in developing the sampling, genotyping and analysis protocols and their optimization and application on strategically selected samples from different regions of the world. The goal is to provide a global overview of the distribution of livestock diversity, including hotspots of diversity. The tools are made available to National Agricultural Research and Extension Systems (NARES) and scientists for application at country level to fill the local/regional gaps with the global analyses providing an interpretation context. A large body of information has been generated and made available through various publications and information system (e.g. Domestic Animal Genetic Resources Information System - DAGRIS), the development of which will continue in the current MTP. Substantial progress has also been made in developing marker sets and analysis tools through FAO and ISAG (International society for Animal Genetics) for diversity assessment and systems for improved phenotype description with FAO. Attention in the medium term will shift to refinement and dissemination through training to facilitate broader application of these products and tools, especially in Africa and Asia. Work started in 2007 to complete the integration of DAGRIS with the complementary FAO DAD-IS (Domestic Animal Diversity Information System) database has now been completed as the two databases can now "cross-talk". The work on DAGRIS will continue to focus on facilitating national partners to record and curate their own data and to enhance access. This will provide an integrated, publicly-accessible system for measuring, documenting and evaluating genetic diversity, largely devolved to national partners as an important knowledge base to inform conservation and use. This will be an important source of research-based evidence for policy and decision making. Our focus has now shifted to functional analysis and phenotypic description of important livestock traits (e.g. disease resistance) for poor people facing high risks in marginal environments, including examination of likely implications of climate change. We will apply a two-pronged approach. One will be a landscape genomics approach to ask the questions: what genetics are where and how are they shaped by the characteristics of the 'landscape' in which they reside? This attempts to capture critical aspects of

the production system in which they occur – including the physical environment, disease pressure and human selection, interacting with market pressures and opportunities. Understanding this co-evolution will inform future conservation and use strategies and policies. A sub-component of this approach, combining genomics and infectious (human and livestock) disease burden has now started with the monitoring of an indigenous population of Western Kenyan zebu (in the IDEAL project referred to above). The research activities in this new initiative will generate a large amount of new information on livestock (initially cattle) genomes, their productivity traits and the environment. It will require integration of large datasets and complex multi-layer analysis and is an area where ILRI is uniquely placed to take a lead. Other research will continue to focus on lab-based discovery of genes that contribute to desired traits, e.g. disease resistance/tolerance. This work currently focuses on trypanotolerance in cattle and helminth parasite resistance in sheep and, depending on available resources, will begin to look at other high priority diseases, such as avian viral diseases (e.g. Avian Influenza, Newcastle disease) and Rift Valley fever. Broad-scale genetic diversity mapping and ILRI's gene discovery research capacity will underpin this activity. In addition to providing information on optimal genotypes for a given set of circumstances, this research will provide insights into mechanisms of gene function(s) that will have potential to contribute to vaccine and drug research for both livestock and humans.

Working models for livestock genetic improvement for smallholders in developing countries remains a critical need. At the same time, and in many cases because of this gap, introduction of inappropriate genotypes is a continuing problem. Even in situations where the value of specific germplasm has been demonstrated (e.g. dairy cattle crossbreds in medium potential areas), an absence of appropriate technologies for delivery and institutional structures that can assure sustainable supply of desired animals present a major constraint. Work in 'breeding strategies' will aim to identify appropriate genotypes for production systems in which smallholders predominate. In market led systems focusing on dairy production, we will undertake a synthesis of past successes and failures to learn lessons that can inform future strategies. This work will build on experiences of the market oriented smallholder dairy project in which ILRI has been involved for several years. Potential options for system improvements involving adaptation and tweaking the ways in which a range of 'off-the-shelf' technologies such artificial insemination, in vitro maturation of oocytes and fertilization and embryo transfer will be assessed and pilot-tested. A 'proof of concept' study involving a combination of technologies - ovum pick-up (OPU), in vitro fertilization with sexed semen, followed by embryo transfer ('SIFET') to produce replacement heifers of specific genotypes for smallholder dairy systems is on-going. The first set of activities has focused on optimizing the laboratory protocols to improve success rates with in vitro fertilization that will result into an economic number of embryos consistently being raised to term under conditions that simulate available infrastructures in developing countries. If successful, this technology could increase the proportion of female calves (or males depending on the system) and would provide an effective method for delivering first-cross (F1) replacement animals as well as speeding up multiplication and delivery of cattle breeds that have demonstrated promise elsewhere and would suit given production systems in sub Saharan Africa of South Asia. In addition, a combination of reproductive and genetic marker technologies would be innovatively used to initiate and fast-track synthetic multipurpose tropical cattle breed formation, where appropriate. It could also triple the rate of recovery from cattle losses following drought or other disasters. In the more marginal systems, analysis of the potential for community-based breeding approaches to deliver long-term (genetic) change using local breeds as base material, or to introduce genotypes which have proven successful in similar environments elsewhere, will be examined (e.g. through a GEF-funded project in West Africa and South Asia). The possibility for a multi-country, multi-breed, evaluation of promising dairy cattle breeds that have demonstrated promise elsewhere (e.g. the Brazilian Guzera, the Australian Friesian Sahiwal (AFS) and the Sudan's Butana cattle breeds in comparable systems in Africa) will be explored. It had been considered that gene discovery work would identify genomic regions (QTLs) responsible for disease resistance, and that these would subsequently be introgressed into livestock populations to increase or introduce the resistance attribute. Significant progress has been made in QTL identification for both trypanotolerance in cattle and helminth resistance in sheep. This work is

more advanced for trypanotolerance in cattle where several QTLs of relatively small effects have been identified. Although ongoing study of the mechanisms underlying these genomic regions is expected to reveal important insights into the biology of disease susceptibility, feasibility for application in breeding programs needs to be re-examined. Where a trait is controlled by many genes of small effects, technical and economic considerations make it less attractive to use DNA markers in breeding programs. This underscores the focus on adapting existing breeding technologies in the medium term. An analysis of the prospects and potential to use genetic information (including genetic markers) and/or conventional breeding approaches to select for disease resistance in developing countries will be undertaken, principally through simulation studies, during this MTP period. This work will facilitate the development of strategies/approaches for utilizing rapidly accumulating genotype (e.g. SNPs) information and incorporation of genetic selection in breeding programmes. Prospects for developing countries to benefit from the on-going SNP discovery projects around the world can be increased significantly if good quality phenotype data are available. In this connection, ILRI will, in the medium term, work towards the development of standard protocols for systematic recording and management of phenotype data on key livestock species.

Conserving adapted livestock breeds of poor countries need to be technically supported. The African and Asian indigenous livestock harbor unique genes for many important production and adaptive traits. Given the uncertainty associated with climate change and taking advantage of the emerging in-vitro-reproductive and animal tissue culture technologies, and that currently no cryo-banking programs exist in Africa, efforts must be made to avoid loss of unique germplasm. Supporting regions to develop gene banks, ILRI, together with the NARES, will identify opportunities for cryo-banking of flagship species (cattle/buffalos) at national and regional levels and facilitate the development of scoping studies to determine start-up pilot banking strategies and protocols, including agreements on benefit/material sharing arrangements.

Alignment to CGIAR Priorities

Characterization and improved utilization of AnGR will contribute to CGIAR System Priority 1 which aims at sustaining biodiversity for current and future generations and specifically to SP 1C which focuses on conservation of indigenous livestock. The gene discovery research is a special case of 1c and is in alignment with Priority 2d on 'Genetic enhancement of selected species to increase income generation by the poor', more specifically to goal 3 on 'smallholder livestock improvement for tolerance to biotic and abiotic stresses'. Research in this Project is also linked to System Priority 3, 'opportunities for high-value commodities and products', specifically to 3b, 'income increases from livestock', goal 1 of which is to reduce production risks through development of low cost vaccines and diagnostic tools and development of breeding strategies, which include breeding for adaptive attributes such as disease resistance. We see a clear link between priorities 1c, 2d and 3b. In many of the systems in which we are working, market forces are very important and influence decisions on breeding programs, requiring that market drivers be factored into both conservation and use programs.

In the 2010-2012 period, on-gong work in upgrading the physical laboratory infrastructure will be completed and the Biosciences eastern and central Africa (BecA) and ILRI shared research platform will become fully operational. The platform and the activities and partnerships it is catalyzing is increasing ILRI's reach and expanding the impact of ILRI's Biotechnology expertise - in areas such as immunology, molecular epidemiology and animal genetics – through collaborative projects involving NARS and ARIs.

Outputs Description

Changes from Previous MTP

There are some adjustments but no major changes from the previous MTP. An external review of

the vaccine and diagnostic research supported previous plans with specific suggestions on how to strengthen the links, for priority diseases, of laboratory and field research. This project has three outputs that apply biotechnological tools to protect the livestock assets of the poor. Under output 1, the project, in collaboration with partners is strengthening research to support the commercialization of the ECF vaccine. There will also be greater efforts to link field and laboratory research for CBPP and Rift Valley fever research. Under output 2, there will be more emphasis on the interaction between host and pathogen genomics with greater investments in sequencing and bioinformatics to allow for faster and broader pathogen surveillance and discovery linked to changing distributions of livestock breeds in different ecosystems. The focus on output 3 remains the same. Output 4 has been introduced as the BecA hub facilities will be completed in 2009 and full utilization will begin in 2010.

Output 1: New/improved vaccines and diagnostics (Africa and Asia) (3-5 years)

Description: The targets from this output are linked to SP 3b, 'increasing income from livestock'. The research is directed at securing livestock assets by reducing the effects of infectious diseases through improved vaccination regimes. The deployment of outputs from this work will rely heavily on the private sector for product manufacturing and distribution. A major outcome of the development of diagnostic assays is the field application of these in disease control programs and market access – as tools for ensuring food safety and disease-free status certification.

Alignment to CGIAR Priorities: 3B: Increasing income from livestock; 5B: Making international and domestic markets work for the poor;

Output 2: Phenotypic, neutral and functional genetic molecular diversity of AnGR characterized, quantified and mapped to inform livestock conservation and utilisation strategies (Global, 5 – 10 years)

Description: Linked to SP 1C, this output seeks to improve the understanding and documentation of the phenotypic and genetic diversity in indigenous livestock in developing countries and particularly to unravel mechanisms of tolerance to trypanosomiasis, including functions of the networks of genes involved in trypanotolerance. At the production system level, the work will seek to better understand the co-evolution of livestock in their environments, including identification of 'signatures' of selection under specific selection pressures.

Alignment to CGIAR Priorities: 1C: Promoting conservation of indigenous livestock; 2D: Genetically enhancing selected high-value species; 3B: Increasing income from livestock; 6A: New research;

Output 3: Livestock breeding and conservation programmes suitable for low-input systems established to enhance productivity and adaptation. (Sub Saharan Africa, South Asia and South East Asia, 3 – 5 years)

Description: This output is linked to SP 1c, 'conservation of livestock breeds', 2d, 'genetic enhancement of selected species to increased income generation by the poor' and 3b, 'income increases from livestock'. It focuses on enhancing the understanding of contexts in which specific genotypes are best suited and the adaptation or development of technologies to improve the delivery of appropriate genotypes to smallholders and to facilitate ex situ conservation of endangered breeds. Matching breeds with environments will be achieved through understanding of gene function and evolution, targeting the most promising breeds for different developing country settings.

Alignment to CGIAR Priorities : 1C: Promoting conservation of indigenous livestock; 2D: Genetically enhancing selected high-value species; 3B: Increasing income from livestock; 6B: Free-standing training;

Output 4: Knowledge and technologies in agricultural biosciences co-developed with partners at the Biosciences east and central Africa (BecA) Platform

Description: The Bioscience east and central Africa (BecA) hub provides a shared biosciences research platform, research-related services and capacity building opportunities to scientists in eastern and central Africa as well as a platform for research for continental and international partners. The hub provides sequencing, genotyping and oligo and proteomics services, bioinformatics support and labs for plant and animal sciences including a containment greenhouse and a biosafety level-3 pathogen lab. BecA hub scientists provide support in the design, implementation and analysis of research projects as well as a range of courses and hands-on training in biotechnologies and bioinformatics to meet the evolving needs of the African agricultural research community.

The targets from this output are being developed in close partnerships and consultations with a wide range of partners from the north and the south. Research outputs will be co-developed with African NARS, universities, NGOs and others. Major outcomes will be in the enhancement of individual and institutional capacities and the application of new biotechnology tools in agricultural research leading to the development of efficient crop and livestock improvement strategies.

Alignment to CGIAR Priorities : 3B: Increasing income from livestock; 6B: Free-standing training;

Impact Pathways by Output

Output 1: New/improved vaccines and diagnostics (Africa and Asia) (3-5 years)

The strategy to translate outputs to outcomes and eventually to impact involves working with consortia of strategic international collaborators (including advanced research institutes, the private sector, and non-governmental organizations (NGOs)) and national partners. The aim is to ensure that the best practices, at both the technical and institutional levels, can be applied to a range of diseases under different settings. For example, the ITM work will facilitate the African Union's Inter-Africa Bureau on Animal Resources (AU-IBAR) efforts to develop, with the Departments of Veterinary Services (DVS), a regulatory framework for the deployment of the vaccine in relevant countries. The strategy to realize commercialization involves early engagement of relevant stakeholders in the product development continuum. Demand for the vaccine has been established through the sale of previously manufactured vaccine, and expressed interest by the private sector in the production and distribution of the vaccine, and national assessments conducted in close collaboration with AU-IBAR and DVSs. ILRI and GALVmed have produced a dossier to facilitate registration and the production of the vaccine by the private sector or other public sector entities. ILRI has the expertise and facilities to assist countries wishing to deploy ITM to assess the suitability of the current parasite components in the vaccine, and to determine if new components should be incorporated. Discussions with current and potential distributors of the vaccine will ensure that research aimed at improvements of the vaccine will be practical, and will reduce the cost or otherwise increase the use of the vaccine.

Output 2: Phenotypic, neutral and functional genetic molecular diversity of AnGR characterized, quantified and mapped to inform livestock conservation and utilisation strategies (Global, 5 – 10 years)

Similar to the strategy for vaccines research, the approach here involves early engagement of key stakeholders, from national program scientists who facilitate on the ground activities – sampling and analysis - to the FAO which provides intergovernmental mechanism for effecting policy change. Collaboration with international agencies such IAEA/FAO Joint Division in AnGR has also

been instrumental in providing training for a large number of NARS scientists from Asia who have spent time at the ILRI labs using standard protocols to analyze samples from their own countries. The Project has had extensive collaboration with the FAO AnGR group over many years, for example in the development of sampling strategy, short list of candidate microsatellite markers for molecular diversity assessment, conceptualization of activities in economic valuation of animal genetic resources and development of on-farm phenotypic characterization protocols. ILRI scientists have also participated in the initial planning and subsequently reporting of the global assessment of the state of animal genetic resources, the State of the World's AnGR (SoW-AnGR). ILRI's key role has been in development of characterization approaches, targeting, information management, and catalyzing action by national systems primarily through partnerships in research processes, capacity building programs and sharing of knowledge through various avenues. SOW-AnGR, the Convention on Biological Diversity and other international mechanisms have been used to get the global issues known while active partnerships with international organizations (e.g. IAEA) and ARIs (e.g. SLU) help to facilitate broader regional and national reach of activities. This process and the international partnerships it has engendered have helped improve the understanding of the AnGR issues in different regions of the world, and to identify gaps in policy and opportunities for sustainable use, especially at the national level. ILRI's strategic role in AnGR work and the global engagement we have pursued has provided opportunities to influence important players – including national governments and donor agencies.

Output 3: Livestock breeding and conservation programmes suitable for low-input systems established to enhance productivity and adaptation. (Sub Saharan Africa, South Asia and South East Asia, 3 – 5 years)

Although ILRI's involvement in breeding strategies is recent, we have built on the partnership network developed over the years through AnGR characterization work. The strategy identify relevant partners and engage them starting from problem identification through to the design of interventions and their implementation. Most of this work will involve NGOs, farmers and farmer associations. Working directly with them will ensure that resulting, promising breeding models are picked up early and adoption process starts in the course of project implementation. For example the approach for SIFET (use of sexed semen, in vitro fertilization and embryo transfer) to deliver crossbreds for smallholder systems will involve national universities with expertise and some experience in reproductive technologies, private sector entities involved in delivery of breeding services and farmers representing the end users of the technology.

Output 4: Knowledge and technologies in agricultural biosciences co-developed with partners at the Biosciences east and central Africa (BecA) Platform

The BecA hub, based at ILRI, provides a shared bioscience infrastructure and support platform for research projects conducted by regional researchers and ILRI and other CGIAR researchers linked in research partnerships to other public and private researchers and research organizations. The core competencies of the BecA hub have been planned and discussed in the context of NEPAD's African Bioscience Initiative (ABI), Comprehensive African Agricultural Development Program (CAADP) and the priorities of sub-regional organizations. A major component of the outcome-impact strategy of the BecA hub is to improve the capacity of research partners in Africa to conduct research and to improve their planning and implementation of research to respond to evolving opportunities and challenges. In addition to the infrastructure and research support provided, the hub team will convene groups around priority agricultural bioscience challenges and how to meet these. This will include the formation of public-private consortia to plan, implement and inform research linked to product development and dissemination to speed-up and improve the contribution of research to production development and application for impact.

International Public Goods

ILRI's biotechnology research is designed to address issues of regional and global relevance and to generate public goods that have international application. The international public goods

expected out of this research include: technologies/products (vaccines, diagnostics) that are applicable across multiple countries/regions, methods/approaches (breeding strategies, diversity assessment protocols, antigen identification protocols, institutional arrangements that work in delivering certain types of technologies and generic lessons learnt in engaging certain types of institutions), tools (e.g. databases such as DAGRIS and training resources such as AGTR as prototype tools that regions/countries can adapt and apply to manage AnGR information), knowledge/information (e.g. the characteristics, distribution and status of specific indigenous AnGR contained in the DAGRIS, genome sequences). Examples include:

- ILRI's involvement in the ITM vaccine production and deployment is part of a unique activity – delivering a thermolabile, infective inoculum in regions of severely limited infrastructure. This also will inform the prospects of other, similar approaches, e.g. malaria, where the possibility of using attenuated or irradiated parasites to immunize humans is the subject of serious research.
- Gene discovery work examining cattle-trypanosome interactions is revealing fundamental aspects of the inflammatory response and this understanding of mechanisms of resistance is already seeing direct application in human health and in other disease models. For example, results from this work have catalyzed a pilot project in human health in a hospital in Manchester (UK) which involves routine monitoring of patients for cholesterol, focusing in links to patient ability to handle infections.
- The concept of BecA as a generic shared research platform and lessons learnt in its implementation will inform similar efforts elsewhere – e.g. NEPAD's African Biosciences initiatives in southern Africa, West Africa and North Africa.
- In the area of AnGR, diversity assessment protocols as well as results which provide quantitative data on extent of diversity and identify diversity hotspots for different livestock species are global public goods already being widely used in many parts of the world.
- The training resource on AnGR is, based on survey evidence to date, a highly demanded tool in developing regions and both the CD and web-based versions are already in use for graduate teaching in many countries. The tool is empowering university trainers to deliver more (developing country) context-relevant teaching of AnGR courses.

Deliberate engagement with NARS as partners/collaborators and as scholars is considered an effective means for knowledge dissemination and for facilitating the translation of results into outcomes. The research teams are supported by an institute Intellectual Property Unit that ensures that proactive defensive patenting and appropriate contracts with collaborators are used to manage IPGs, ensuring that these become available for, and accessible to, those who need them.

Elaboration of Partners Roles

The principal partners involved in the ECF ITM vaccine research include GALVmed (ILRI and GALVmed have collaborated on developing a registration dossier, which will serve as a basis for product registration, technology transfer and an improved production protocol). The *T. annulata* project is funded by the Wellcome Trust and is led by the University of Edinburgh (which provides MHC constructs and T cell lines for identification of *T. annulata* antigens). The bovine tuberculosis research is part of a Wellcome Trust-funded project being undertaken in collaboration with Imperial College London, VLA Weybridge and the Onderstepoort Veterinary Institute (is coordinated by Imperial College; VLA provides training, reagents and intellectual input; OVI provides BL3 facilities for infection of cattle with virulent *M. bovis* and comparative analysis of immune responses and pathology). Tick vaccine research is funded by WOTRO, USDA and The Swiss Centre for Tropical Agriculture (ZIL) and is being done in collaboration with the Swiss Tropical Institute (STI), USDA-ARS-ADRU Pullman and the University of Wageningen (STI is assisting with immunological analysis, immuno-histochemistry and private sector linkages for

evaluation of transmission blocking vaccines; USDA-ARS is collaborating on identification of novel antigens for use in tick-pathogen combination vaccines and the University of Wageningen is expressing candidate antigens using baculovirus). The University of Edinburgh leads immunological and epidemiological analyses in a collaborative Wellcome Trust funded CBPP project.

Work on development of improved diagnostic tests, evaluation of viral prevalence and molecular diversity of African Swine fever and Rift Valley fever in East and Central Africa by the National Institute for Agriculture and Food Research and Technology of Spain (INIA) involves collaboration with the viral diagnostics unit, CISA-INIA, at Valdeolmos, Madrid (CISA provides staff expertise, diagnostic reagents and BSL3 laboratory for viral culture and in vivo infections of swine and experimental animals). Validation and registration of the test will be carried out in partnership with the Kenyan Department of Veterinary Services and the Kenya Medical Research Institute. These organisations are making available both facilities and biological material from recent outbreaks of these diseases in Kenya. Validation of a candidate trypanosome ELISA is being conducted with the Foundation for Innovative Diagnostics (assessing the diagnostic potential of several trypanosome antigens by ELISA). The CBPP diagnostic research is funded by GTZ and IAEA, and is being undertaken in collaboration with Tierärztliche Hochschule Hannover (identification of diagnostic antigens), the University of Bern (pathogenicity studies) and the Federal Research Institute for Animal Health in Jena (validation of diagnostic antigens), with additional components funded by SIDA and undertaken in collaboration with SLU and Uppsala University in Sweden (bioinformatics of Mycoplasma genomes). IDEAL is a collaborative Wellcome Trust-funded project led by the University of Edinburgh (who are performing epidemiological analyses) and includes the University of Pretoria (who are undertaking clinical and diagnostics aspects).

The main partners in the AnGR research have been: national governments who provide access to samples; national scientists who lead the sampling and are involved in the on-farm phenotypic characterization, genotyping/sequencing and data analysis. One example is the CAAS-ILRI Joint Laboratory hosted by Institute of Animal Science (IAS) of Chinese Academy of Agricultural Sciences (CAAS), which facilitates access to samples, research facility and national funding for work on phenotypic and genetic characterization of AnGR in China and other countries in the region. The Project has collaborated with FAO in developing diversity assessment protocols and in the conduct of the State of the World's (SoW) report on AnGR. For example, ILRI led the preparation and presentation of a key paper at the FAO-convened high-level International Conference on Animal Genetic Resources (Interlaken, Switzerland, September 2007) at which SoW report was presented and issues and global priorities for AnGR R & D discussed and agreed upon by the FAO member states. IAEA/FAO Joint Division has partnered with ILRI in providing hands-on training for a large number of NARS scientists from Asia who, in this process, have analyzed samples of their (national) priority breeds at the ILRI labs. ARIs, especially universities in the North have played important roles in the gene discovery work. In the case of trypanotolerance research, a consortium comprising ILRI, Universities of Liverpool and Manchester (data management and analysis) and the Roslin Institute (expression analysis) has been developed and is funded by the Wellcome Trust. This has strengthened the capacity of all partners through regular exchange of personnel and development of novel means of electronic data exchange. These partnerships are continuously revised as the work evolves. For example, the Rural Development Administration (RDA) joined recently the consortium contributing its extensive experience in in vitro/in vivo control of gene expression in mammals. A similar relationship through University of Nottingham has enhanced research on helminth resistance. Partnerships with Hebrew University of Jerusalem and University Iowa have enhanced our gene mapping and genome scanning capacity, and new partnership with the University of Edinburgh, through a Wellcome Trust funded project, has led to the initiation of activities on landscape genomics.

The development and pilot-testing of breeding strategies will involve close partnership with national governments (providing in-kind contribution in terms of local logistical support and access

to government ranches/farms as initial locations of nucleus breeding flocks/herds and farmers in the pilot community-based projects in the GEF-funded project (in The Gambia, Guinea, Senegal and Mali). The regional office based at International Trypanotolerance Centre (ITC) based in The Gambia will be an important link in this activity (providing animals for nucleus and intellectual input). The GEF-funded project in Asia (in Bangladesh, Pakistan, Sri Lanka and Vietnam) on goats, chicken and pigs, the outcome of which would be “enhanced conservation & management of these livestock’s genetic diversity using Decision-Support Tools”. The outputs of the animal genetic resources research components will include support tools developed for assessing of genetic diversity and sustainable breeding program options for the 3 species assessed and the appropriate ones pilot tested. A similar partnership between ILRI and Austria’s BOKU University of Natural Resources and Applied Life Sciences and ICARDA involves farmer participatory breeding of cattle (with NARS in Uganda) and sheep (with NARS in Ethiopia). BOKU provides intellectual inputs (the research design, student supervision, and contribution to study design, analysis and publication of results), while Makerere University and the Uganda National Animal Breeding and Genetic Resources and Data Base provide local logistical and technical and field research supervisory support. ILRI works in collaboration with the Swedish University of Agricultural Sciences (SLU) to “train trainers” in developing countries, and to update an electronic training resource (Animal Genetics Training Resource) in a project focusing on capacity building for sustainable use of AnGR. SLU provides intellectual inputs in terms of subject matter content and as resource persons in group training courses. Through a new collaboration with FAO, ASARECA and SADC, SLU will provide intellectual input in an assessment study of the existing structural, institutional frameworks and policy environments frameworks in the Eastern Africa region, the results of which will be used to inform the design of new and sustainable cattle and meat goat breeding programs.

Logical Framework

	Outputs	Intended Users	Outcome	Impact
Output 1	New/improved vaccines and diagnostics (Africa and Asia) (3-5 years)	Livestock farmers; Departments of veterinary services; Private sector , NARs and ARI researchers	New/adapted vaccines or diagnostics are in use leading to reduced mortality and improved livestock productivity ITM vaccine registered and the manufacture is being done by public and/or private sector entities in a sustainable way Veterinary Departments are using data on efficacy of an adapted CBPP vaccine to support its field delivery Veterinary Departments are using data on efficacy of an adapted CBPP vaccine to support its field delivery Researchers and private sector manufacturers are using data on efficacy of CBPP diagnostic antigens to ascertain the prospects of a new diagnostic assay for the disease International researchers are using these data to better understand the immunological response to T.annulata infection and to ascertain the prospects for better vaccines. Private sector manufacturer using data and antigens to ascertain the prospects for an anti-tick vaccine to reduce the incidence of tick-borne diseases Researchers and private	Livestock assets of the poor secured through reduction in effects of East Coast fever Livestock assets of the poor secured through reduction in effects of contagious bovine pleuropneumonia Livestock assets of the poor secured through reduction in the effects of African swine fever. Livestock assets of the poor secured through reduction in the effects of infectious diseases.

	Outputs	Intended Users	Outcome	Impact
			sector manufacturers are using data to ascertain the prospects of a new diagnostic assay for African Swine fever Researchers using data to better understand the immunological response to BCG vaccination and to assess the prospects for a better vaccine against bovine tuberculosis. Researchers and policy makers using data to prioritise the diseases in this and similar regions and to determine the need for better diagnostic assays and procedures for these diseases.	
<i>Target 2010: Other kinds of knowledge</i>	Knowledge of the efficacy of African Swine fever molecules to detect infected animals documented			
<i>Target 2010: Other kinds of knowledge</i>	Knowledge of the differences in the immune responses and pathology in Bos indicus and Bos taurus cattle following M. bovis infection documented			
<i>Target 2010: Other kinds of knowledge</i>	Evaluation of arbovirus diversity and frequency in host and vectors carried out in selected areas of Kenya			
<i>Target 2011: Other kinds of knowledge</i>	Knowledge of the infectious diseases acquired by calves in western Kenya documented			

	Outputs	Intended Users	Outcome	Impact
<i>Target 2012: Other kinds of knowledge</i>	Knowledge of the efficacy of a tick / parasite combination vaccine, based on recombinant antigens of R.appendiculatus and T. parva, established under field conditions			
<i>Target 2012: Other kinds of knowledge</i>	Establishment of a generic platform for rapid identification of known and unknown pathogens, pathogen diversity and host/vector/pathogen co-occurrence			
Output 2	Phenotypic, neutral and functional genetic molecular diversity of AnGR characterized, quantified and mapped to inform livestock conservation and utilisation strategies (Global, 5 – 10 years)	NARES; ARIs; policy makers; livestock keepers; FAO, Global Environment Facility; NGOs; private sector (breeding companies and breed societies)	Use of livestock diversity information to guide conservation and utilisation programs Policy makers, livestock keepers and researchers using DAGRIS data to inform decision making on conservation and use of AnGR Researchers are using more efficient molecular tools for genome mapping (disease resistance) and biodiversity studies in sheep A range of stakeholders using AnGR diversity data as evidence for decision-making on conservation and utilisation of AnGR diversity Researchers and technology developers are using data on molecular mechanisms to inform design of projects for novel therapeutics or	Diversity in livestock assets of the poor secured and livelihoods improved with conservation and improved use of promising breeds/traits. Diversity in livestock assets of the poor secured through informed use of its components

	Outputs	Intended Users	Outcome	Impact
			<p>new lines of vaccine research Policy-makers, researchers and livestock keepers making informed decision on conservation and utilisations of AnGR based on information in publicly accessible databases Researchers are making informed decisions regarding selection for disease resistance in field populations Researchers and technology developers using information on mechanism of pathology and role of gene polymorphisms in response to infectious disease to design new research Researchers and policy makers make informed decisions on conservation and use of AnGR based on improved understanding of diversity in systems context Researchers use the geo-referenced bio-bank to inform further research and to support decision making on conservation and use of AnGR diversity Researchers and technology developers use data on mechanism of pathology and role of gene polymorphisms in response to infectious disease to inform new research leads</p>	
<i>Target 2010: Other kinds of knowledge</i>	Development of country level DAGRIS completed and the tool handed over to			

	Outputs	Intended Users	Outcome	Impact
	appropriate stakeholders to manage			
<i>Target 2010: Other kinds of knowledge</i>	Regions of the cattle genome which have responded to selection by disease identified in African indigenous cattle through genome- wide screening			
<i>Target 2010: Other kinds of knowledge</i>	Biological role and function of genes involved in trypanotolerance evaluated in broad stress response and documented			
<i>Target 2011: Other kinds of knowledge</i>	Domestic Animal Genetic Resources Information systems linking livestock productivity, diversity (breeds, molecular), agro-ecosystem, environmental and socio economics parameters information developed (DAGRIS 2)			
<i>Target 2011: Other kinds of knowledge</i>	A geo-referenced Biobank for livestock and pathogen genetic studies developed			
<i>Target 2011: Other kinds of knowledge</i>	A knock-out system for the study of gene expression (in vitro/vivo) for trypanosomosis developed in mice (2009), and in cattle (2010)			
<i>Target 2011: Materials</i>	Transgenic mice stably carrying exogenous APOL1 born and the process of evaluation for resistance to trypanosomes begun			

	Outputs	Intended Users	Outcome	Impact
<i>Target 2012: Materials</i>	Biobank populated with diverse livestock pathogen and vector material - samples carry rich meta-data which is continually enhanced by analysis by collaborators, partners and users			
<i>Target 2012: Materials</i>	Transgenic cattle carrying exogenous APOL1 born and the process of evaluation for resistance to trypanosomes, safety and public acceptance begun			
Output 3	Livestock breeding and conservation programmes suitable for low-input systems established to enhance productivity and adaptation. (Sub Saharan Africa, South Asia and South East Asia, 3 – 5 years)	NARES, ARIs; policy makers; livestock keepers; FAO, Global Environment Facility; NGOs; private sector (breeding companies and breed societies)	Greater use of more appropriate indigenous breeds for enhanced health, productivity and profitability under specified local conditions. Policy-makers and extension personnel give better recommendations concerning breeds and breeding policies based on better understanding of constraints to breed improvement programs. Prospective private or public sector investors in production and dissemination of germplasm through these technologies have data on which to make Go / No-go decision on whether to scale up promising delivery approaches Government,	Livestock diversity secured, and livelihoods of the poor sustainably improved. Livelihoods improved. AnGR conserved. Advisors equipped with improved knowledge and tools. Diversity of livestock preserved for an uncertain future. An insurance policy for future generations.

	Outputs	Intended Users	Outcome	Impact
			<p>NGO, CBO and farmers using new material from the training resource to inform decisions on AnGR conservation and use</p> <p>Researchers, development agents and livestock keepers using the resulting data to inform decisions on alternative delivery options under certain situations</p> <p>Researchers, policy makers and other development agencies better able to design breeding programs at community level using lessons learnt and tested tools.</p> <p>Livestock keepers/breeders using information from breed evaluation studies to make informed choices among a wider range of breeds/genotypes</p> <p>National livestock breeding/conservation programs using ex situ gene banking protocols to establish low cost cryogenic stores of semen, embryos and tissues for future livestock development.</p> <p>Development agencies & livestock keepers using the information to decide on options that will work under specific circumstances</p>	
<i>Target 2010: Other kinds of knowledge</i>	Outcomes of Community Based Breeding Program projects documented and disseminated			

	Outputs	Intended Users	Outcome	Impact
<i>Target 2010: Practices</i>	Realistic/ appropriate livestock recording system in place and being used in Kenya as a pilot test for East and Central Africa region			
<i>Target 2010: Other kinds of knowledge</i>	Constraints and incentives to dairy cattle breeding services and demand for different breeds and breeding services identified and documented			
<i>Target 2011: Materials</i>	Animal recording and evaluation system for use in multiple environments and countries designed and made available within ECA.			
<i>Target 2011: Other kinds of knowledge</i>	Production and delivery systems for improved animal genetics and favourable dairy calves sex-ratio (95F:5M) pilot tested on farm			
<i>Target 2011: Other kinds of knowledge</i>	A phenotypic and genetic diversity platform for livestock breeds in developing countries, and systems for storage, querying and retrieval of such information developed (i.e. a one-stop-Animal Genetics Resource Centre for indigenous livestock breeds in developing countries in place)			
<i>Target 2011: Policy strategies</i>	Alternative breeding options for smallholder systems in			

	Outputs	Intended Users	Outcome	Impact
	West Africa assessed			
<i>Target 2012: Policy strategies</i>	Gene banking strategy and protocols for ex-situ gene bank(s) for domestic livestock in Africa developed and made available for use through partner organisation(s)			
<i>Target 2012: Materials</i>	Decision support tools for assessing of genetic diversity developed and tested in 4 Asian countries			
<i>Target 2012: Policy strategies</i>	Sustainable breeding program options for the 5 species (cattle, sheep, goat, chicken and pigs) assessed and the appropriate ones piloted in 4 Asian and 4 African countries			
<i>Target 2012: Other kinds of knowledge</i>	Based on existing populations, development of adapted and productive dairy cattle for smallholder systems in Africa/the tropics initiated			
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Output 4	Knowledge and technologies in agricultural biosciences co-developed with partners at the Biosciences east and central Africa (BecA) Platform	Researchers (NARS, Universities, ARIs), NGOs	Researchers apply bioscience technologies and tools to conduct research of importance to African agriculture	African livelihoods improved through improved food security, better health and higher incomes.
<i>Target 2010: Other kinds of knowledge</i>	Identification of basic and applied bioscience research			

	Outputs	Intended Users	Outcome	Impact
	needs to inform the development of priority agricultural bioscience research projects			
<i>Target 2010: Capacity</i>	Capacities of regional partners developed in molecular diagnostics and bioinformatics for genomic discovery and diagnostic studies			
<i>Target 2010: Capacity</i>	Capacities of regional partners developed in the application of molecular markers for breeding research			

ILRI-4: People, Livestock and the Environment

Project Overview and Rationale

Increased demand for livestock products in the developing world, as a result of population, economic growth and urbanization, present new challenges and opportunities for small-scale livestock farmers, herders and landless people. Meeting a doubling in demand for livestock products—and doing so using the same resource base and in environmentally sustainable ways that do not exclude poor people—will be challenging. This project addresses the “sustainably improving productivity” pathway out of poverty as described in ILRI’s strategy through conducting research on productivity enhancement (especially feeds) taking advantage of improved feeding strategies, food feed crops and forages as well as livelihood vulnerability reducing strategies and balancing these with environmental challenges. Research is directed towards the productivity and environmental management dimensions of increasing income from livestock through better market participation (SP3B and SP4) and environmental challenges in the context of reducing vulnerability of pastoral systems (SP4), while forage diversity which underpins these areas, contributes to SP1A.

There are three outputs which are summarized below, and which relate to the priority Livestock Research-Development Challenges (as described above). It is important to note that the largely technical and biophysical research focus of this project, needs to be considered and conducted in relation to broader and at times more dominant issues, which may be addressed in conjunction with the research of others within or outside of ILRI.

Research that aims to provide environmentally **efficient production options for intensifying livestock systems** builds upon research to mitigate livestock feed scarcity, increase productivity in crop livestock systems, together with research on livestock water productivity (SP4c). Information and material from forage diversity work is also an input into the feed production options explored here. Whilst in many developing countries, smallholders in mixed crop livestock systems currently provide most livestock products, the future challenge will be to address their role in changing market circumstances, whilst managing environmental goods and services in ways that ensure sustainable production of feed to address livestock productivity and competitiveness. The research is conducted against a background of many rapidly evolving challenges such as biofuel competition for biomass, rapidly fluctuating/rising prices of feeds and livestock products and impacts of climate change. Research outputs are aimed at informing users about strategies for enhancing livestock productivity through feed options, appropriate feed and natural resource management options in relation to their requirements for water and land, and towards the end of the MTP period, the research will provide information that can guide choices about intensifying livestock production in crop livestock systems in relation to public “bads” and goods and the related incentives for producers.

Research to address **reducing vulnerability of livestock-based livelihoods, ecosystem goods and services in pastoral and agropastoral systems** builds upon research on sustaining lands and livelihoods together with research on livestock water productivity (SP4c). Human population growth and climate change are major drivers undermining the resilience of livestock based livelihoods in arid environments, which deepen the vulnerability of livestock keepers and impact on the availability of the ecosystem services on which they depend. Research here focuses on ensuring that the risk, vulnerability, resilience and sustainability dimensions are addressed with increasing emphasis on the potential of such systems to provide a range of environmental goods and services as opposed to livestock productivity per se. A key issue is the ability to respond to a number of variables that operate at different spatial and temporal scales. Research will provide information on the biophysical potential and the environmental impacts (incl. sustainability) of potential vulnerability reducing adaptation and mitigation options, such as

increased market orientation, livestock insurances, improved animal feed strategies and livelihood diversification such as payment for ecosystem services that can guide decision makers.

Securing forage diversity for future livelihoods builds on the forage genebank work as in previous MTPs and provides inputs to the other two research areas. ILRI's role in characterization and diversity assessment is closely linked to activities in the above two areas, making better use of the diverse forage resources available as part of improved feeding strategies for sustainable livestock production systems. Given the changing nature of livestock systems we can anticipate that the role for forage species will also change. There will be new demands to feed animals to respond to market opportunities, as well as opportunities for both forages per se as well as the genes within forage species to address changing ecosystem needs and mitigate land degradation, often resulting from climate change. In order to meet such demands, many of which cannot at present be precisely predicted, and to ensure that the diversity contained within many thousands of forage species is not lost, there is a need to conserve, manage and document the diversity of forages. This activity is part of a coordinated effort on improving the efficiency and effectiveness of management of forage diversity under the System-wide Genetic Resources Programme (SGRP). Making better use of these valuable resources remains a priority for ILRI and in line with ILRI's role as a knowledge institution, increased focus will be given to knowledge management and sharing about forage diversity. ILRI's role will be more of an information portal, engaging with others who also generate information, to provide a coordinated approach to sharing knowledge on forage diversity across the CGIAR and with other partners.

Alignment to CGIAR Priorities

Research to develop environmentally efficient production options for intensifying crop livestock systems directly addresses SP3B in the context of providing options for management of the intensification of livestock production to improve the balance between productivity and economic growth, environmental sustainability and social equity. Aspects of this research also address SP4, notably in relation to water productivity for intensifying systems (SP4C) and sustainable agroecological intensification (SP4D). Feeds research which includes working with crop centres and the SLP on food-feed crops addresses SP2D.

Research aimed at reducing the vulnerability of livestock based livelihoods in pastoral lands addresses SP4D (especially in low potential areas) and, with the inclusion of our earlier work on livestock-water productivity, SP4C. The focus is on assessing the environmental dimensions of diverse livestock based strategies to improve the adaptive capacity of livestock keepers and the rangeland systems on which they depend.

Forage diversity work is at the core of SP1, with the allocation in line with SP1 on crop biodiversity. Research to enhance the availability and use of Napier grass in East Africa contributes to SP3B.

Outputs Description

Changes from Previous MTP

There are no major changes from the previous MTP. This project has three outputs, focused around the central issues of improving productivity through feeds in intensifying crop livestock systems while optimizing use of land and water; improved adaptive capacity for pastoral systems and forage diversity. This output configuration provides an integrated research portfolio around two key dynamic livestock challenges – intensifying crop livestock systems and reducing vulnerability in pastoral systems. ILRI will continue to refine the agenda and strengthen its staff capacity and partnerships to address this during this MTP period.

Output 1: Environmentally efficient production options for intensifying crop-livestock systems are available

Description: Activities to address this output include macro level studies together with the Targeting and Innovation Project to assess the water and land requirements for feed production, targeting the increasing demand for livestock products and feed in intensifying crop livestock systems in SSA and South Asia. Initially assembled data sets will be used, together with case study information on land and water productivity for livestock to develop a conceptual framework and a predictive tool for assessing livestock feed requirements in relation to land and water potential, including where appropriate, in watersheds and irrigated systems (large or small scale) or using waste water for fodder production (with IWMI). Such studies will help to sharpen the focus of research to address more specific feed options which will also take account of resource use needs. As crop livestock systems become more closely linked to markets and begin to intensify, new feed related aspects need to be considered such as options for transporting feed (already happening for example in parts of south Asia, Sudan), processing and transporting feed with small scale entrepreneurs potentially increasing interaction with the private sector. The interaction of feed aspects with improved access to better breeds and veterinary care also needs to be factored in. Approaches for assessing feeding strategies in relation to productivity and environmental needs based on increasingly dynamic situations (feed prices, competing biomass demands, livestock product prices) will also be developed. These studies link closely to value chain assessments led by ILRI's Market Project which will help target implementation points and the sequence of interventions. The feed research will continue to include and build upon research that relates to inclusion of feed traits in crop breeding implemented in collaboration with crop centres and the SLP. Feed research will be increasingly placed in the context of innovation system approaches in collaboration with the Targeting and Innovation Project and especially using the research in the fodder innovations work in Ethiopia, Syria and Vietnam (in the SLP context). The third area of research applicable here concerns the environmental impacts of intensifying livestock production and addressing how such impacts may best be mitigated. This is an area for which ILRI continues to develop new partnerships and seeks to increase its capacity, meaning the research portfolio will continue to evolve.

Research to address this output builds on our capacity in food-feed crop research, fodder market analysis and optimization of crop residue based diets by supplementation and feed processing implemented closely with CGIAR crop centres, the SLP, NARS partners, feed manufacturer as well as the network of collaborators engaged in livestock-water research, notably in the Nile Basin and especially with the CPWF.

Alignment to CGIAR Priorities: 2D: Genetically enhancing selected high-value species; 3B: Increasing income from livestock; 4C: Improving water productivity; 4D: Promoting sustainable agro-ecological intensification in low- and high-potential areas;

Output 2: Approaches that contribute to reducing the vulnerability of livestock-based livelihoods, and enhancing ecosystem goods and services in pastoral and agropastoral systems are available

Description: An initial activity to address this output is to synthesize the past methods and approaches from research on vulnerability of livestock production systems and sustainable land use, mainly in East and West Africa to provide a tool box of options that can be used in changing pastoral systems. Research dimensions here focus on providing the environmental assessment to complement other research in relation to different risk mitigation and adaptation options. In this respect, for pastoral systems, social based risk mitigation options (for example index based livestock insurance), as studied by the Targeting and Innovation Project have the potential to impact on the environment in diverse ways, and providing information on such potential environmental impacts can be important to help appropriate decisions. Adaptive options for agro-

pastoral systems include improved feeding strategies while integrating livestock and crop production, greater market participation, with again the need to provide assessments that enable the environmental impacts of such to be evaluated in collaboration with the Markets Project as well as Biotechnology (in relation to the use and conservation of animal genotypes, impact of animal health opportunities) and with ILRI's forage diversity work.

Severe biophysical constraints limit the options to increase animal production in the arid zone. In pastoral systems with limited livestock production potential, an important livelihood strategy may be to manage livestock to achieve sustainable stewardship of natural resources, as this might offer non market and market oriented opportunities, such as earnings from tourism and payments for ecosystem services. In this respect, building expertise in ILRI in environmental impact assessment of different options and how these may be measured and valued will be important. Management of water resources is crucial for dry land pastoral systems and here ILRI will build on its expertise in livestock water productivity, considering especially the hotspots around watering points/reservoirs where there are opportunities for improved management for better environmental, human and animal health. Our research, together with the Targeting and Innovation Project also includes studies of institutional arrangements that impact on natural resource management in pastoral systems. Key partners are both in research and development, bringing together advanced research institutes with developing country national programmes and universities. Development partners and aid agencies as well as development funding agencies will partner in using the research results to generate outcomes.

We have strong partnerships with IWMI and the Challenge Program on Water and Food (CPWF) that combine expertise and a growing inventory of intervention options to reduce vulnerability of pastoralists and agro-pastoralists that depend on small reservoirs and other natural and human developed water resources. Opportunities exist to link to other initiatives, research programs and institutions in dry land areas of Africa in ways that will maximize the reach of this output while avoiding duplication of investment in research and development.

Alignment to CGIAR Priorities : 4C: Improving water productivity; 4D: Promoting sustainable agro-ecological intensification in low- and high-potential areas;

Output 3: Forage germplasm secured and available as part of a rational global system of genetic resources conservation and sustainable use

Description: This output addresses the international responsibility of conserving the more than 18,000 forage accessions as a global public good, as well as making the information on this material available and accessible so that it can contribute to changing global demands for feeds and natural resource management as well as provide the potential to discover and use genes for mitigating biotic and abiotic stresses. This context determines the focus of activities – on conserving and understanding the diversity of the forage germplasm, and sharing the knowledge about this – all of which is implemented in the context of the system-wide efforts convened by SGRP. Conservation of diversity includes using efficient and effective best practices for germplasm management, health, regeneration and safety back up of the collection in relation to stratification approaches to make sure that the most used material is readily available whilst ensuring all accessions are safely conserved. Diversity assessment aims to evaluate collections of species identified as important for use in changing livestock systems to meet current and future demands, especially through assembling information generated by others. Participation in development and subsequent use of a global crop registry and on line ordering system through a collaborative project of the SGRP ensures information and forage material are readily accessible in the public domain.

Within ILRI, this project provides a service function in providing forage germplasm and therefore contributes to the other two outputs in the project on feed-related issues, with the Targeting and

Innovation Project on impact and with IPMS project and the Improving Market Opportunities Project on delivery of improved germplasm for livestock market systems.

Alignment to CGIAR Priorities: 1B: Promoting conservation and characterization of underutilized plant genetic resources; 3B: Increasing income from livestock;

Impact Pathways by Output

Output 1: Environmentally efficient production options for intensifying crop-livestock systems are available

Intensifying crop-livestock systems, especially in South Asia and sub-Saharan Africa, are requiring more and better livestock feed supplies as well as improved livestock management options to mitigate environmental degradation. The Project's previous work has provided a sound platform that enables crop breeders (CGIAR and NARS) to evaluate crop residue quality, and strategies to engage with the seed sector once dual purpose varieties are identified. However, broader approach is now needed to provide NGOs, development agents and small scale entrepreneurs with appropriate tools to rapidly determine suitable feeding strategies to cope with increasing feed demand using combinations of food-feed crops, forages, purchased supplements and compound feeds together with innovative strategies for biomass management in relation to competing demands for soil health and energy. The research portfolio is designed to provide this information as well as relating such options to the land and water requirements and, in the longer term, the potential environmental impacts. This at times means that we need to cultivate "buy in" from non-livestock partners who have important decision making roles. Making choices about where to promote intensification of crop livestock systems, and using what resources from within and outside the system has the potential to make a tremendous contribution to the livelihoods of the millions of farmers currently engaged in such systems and who are going to face significant transitions in the coming decades. Such choices will also be important for minimizing the environmental impact of intensification in smallholder systems. Research that provides tools for assessing appropriate feeding strategies using the range of available resources combined with innovation research to understand how these feed based research outputs can be scaled out and up is being conducted with grassroots research and development organizations working with ILRI's Targeting and Innovation Project in collaboration with SLP partners in West Asia, North Africa, South and Southeast Asia and sub-Saharan Africa, including the ILRI-led project on Improving the Productivity and Market Success of Ethiopian Farmers (IPMS).

Multidimensional crop improvement aims at routine inclusion of crop residue fodder traits into crop improvement and cultivar release criteria and decisions. ILRI builds capacity for international and national improvement institutions to phenotype such traits quickly and cheaply by training in feed analysis using Near Infrared Spectroscopy (NIRS), giving access to a wide range of NIRS equations and by assistance in setting up NIRS techniques for example for cultivar release agents. Feed manufacturers are linked to crop improvement and cultivar release agents to improve their information of and access to crop residues/by products from improved cultivars.

Output 2: Approaches that contribute to reducing the vulnerability of livestock-based livelihoods, and enhancing ecosystem goods and services in pastoral and agropastoral systems are available

By providing tools and methods that help researchers and development agents who are engaged with pastoral systems to design appropriate livestock management strategies that balance livelihood, environmental and equity dimensions we anticipate that their efforts will impact positively on pastoral livelihoods and the environment on which they depend. Development and emergency relief agents who engage in social risk mitigation schemes (drought relief, insurance, re stocking after drought, etc) also need access to information on the environmental implications of different approaches so that they can make informed decisions that will not damage or destroy the ecosystem goods and services that support these vulnerable communities. The arena of

payment for ecosystem services is vast, and the project aims to provide strategic information on livestock based options in relation to management of ecosystem services (especially water) and how these can be measured by those who are engaged in higher level development and implementation of such schemes. Similarly, where increased opportunities exist for pastoralists to participate in livestock markets, information on approaches that balance productivity with land and water use is an important input for decision makers who may influence where this is promoted – ultimately impacting on the livelihoods of such pastoral communities. A number of capacity building initiatives are planned including working with universities in Tanzania and Kenya, and with UNEP together with advanced research institutes to develop elements of curricula and country development plans especially focused on ecosystem services, poverty and livestock livelihood studies. In West Africa capacity strengthening will include GIS training and communication approaches in relation to information for pastoralists on market access.

Output 3: Forage germplasm secured and available as part of a rational global system of genetic resources conservation and sustainable use

The forage diversity for which ILRI has a global responsibility is saved, studied and used to help sustain smallholder farming systems. This ensures that the ILRI maintained material continues to be managed according to international genebank standards, that high quality planting material is available for distribution on request, and that an appropriate duplicate collection is established for safekeeping. The project will continue to collate, package and share knowledge with national systems in genebank management, forage seed production, germplasm health and characterization to improve capacity of users to better select from among the range of diversity available. Through the SGRP, we are also contributing to inter-centre projects on documenting best practices for germplasm management, developing a global forage registry and on-line ordering of germplasm to support partners access to knowledge on forage diversity. The project is taking advantage of the range of new web-based knowledge sharing tools to reach a wide audience, while continuing to provide information in hard copy for those without internet access. As part of the overall capacity strengthening activities of ILRI, the project provides face to face learning opportunities for technicians and researchers in forage seed production, forage characterization, germplasm health diagnostics (linked to BecA) and genebank management as well as facilities and support for graduate research in these areas.

International Public Goods

ILRI's Targeting and Innovation Project is helping the People, Livestock and the Environment project to identify where systems are intensifying most rapidly and to make macro-level feed and resource based assessments that will help ensure these studies have wide relevance. For intensifying crop-livestock systems where over 600 million smallholders produce much of the developing country meat and milk, transitions in the coming decades are going to be significant. These will entail new market opportunities with implications for resource management to improve productivity and environmental services, set in the context of rising prices for both animal products, food and feed as well as increasing competition for biomass and improved access to better breeds and animal health. Our research aims to target key issues in such transitioning systems and aims to provide assessment tools (eg to assess and manage trade offs) and practical options that will be applicable in such systems in different world regions. Working in a number of environments in both SSA and S Asia increases the robustness of the approaches and information generated here.

Close collaboration with ILRI's Targeting and Innovation Project is also important for identifying hotspots for work on reducing vulnerability of pastoral systems. Here we consider not only the biophysical information, but how to target approaches according to other dimensions – market access, institutions, etc. This means that the environmental information generated will be useful to development agencies and policy makers in other regions with similar characteristics. One of the major tasks is to synthesize approaches and methods for addressing livelihood issues in

pastoral lands – this will have wide applicability for researchers and development agents engaged in pastoral systems.

The ILRI-maintained forage germplasm and related information are IPGs freely available for all users. ILRI has ensured the IPG in-trust status of its forage collections and related information by signing in 2006 an agreement with the Governing Body of the International Treaty on Plant Genetic Resources for Food and Agriculture. Access to this material supports current forage development while also providing a source of diversity for addressing diverse challenges in the future. Ensuring the forage collection is a part of a global crop registry through collating the information on the diversity and adaptive traits is another IPG dimension to this work.

Elaboration of Partners Roles

ILRI's Targeting and Innovation Project is helping the People, Livestock and the Environment project to identify where systems are intensifying most rapidly and to make macro-level feed and resource based assessments that will help ensure these studies have wide relevance. For intensifying crop-livestock systems where over 600 million smallholders produce much of the developing country meat and milk, transitions in the coming decades are going to be significant. These will entail new market opportunities with implications for resource management to improve productivity and environmental services, set in the context of rising prices for both animal products, food and feed as well as increasing competition for biomass and improved access to better breeds and animal health. Our research aims to target key issues in such transitioning systems and aims to provide assessment tools (eg to assess and manage trade offs) and practical options that will be applicable in such systems in different world regions. Working in a number of environments in both SSA and S Asia increases the robustness of the approaches and information generated here.

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Elaboration of partner roles

Given the prominent roles of livestock in so many agricultural production and marketing systems, our research necessitates working with diverse groups of partners in many ways. Included here are approaches that build upon platforms such as challenge programs (e.g., Challenge Program on Water and Food) and system-wide programs (e.g. crop-livestock work with the System-wide Livestock Program; forage genetic resource research with the System-wide Program on Genetic Resources). All these platforms provide opportunities for locally relevant research results to be shared and integrated into the global agenda. At another level, communities of practice bring together diverse stakeholders with complementary areas of expertise; examples from our research include the interface of livestock and water scientists, and crop breeders and animal

nutritionists. We will increasingly explore linking up with key environmental partners as our agenda evolves. Locally and regionally, we typically implement projects working with national researchers and their development partners and provide individual and group training to help strengthen the capacity of these partners to conduct effective mission-oriented livestock research.

Key partners in increasing productivity through improved feed supply through multidimensional crop improvement are CGIAR centers whose global mandate covers the key crops in crop livestock systems such as CIMMYT, CIP, ICRISAT, IITA and IRRI – often partnered in the context of the SLP. Basic research questions such as exploitable genetic variability in food-feed traits, relations between crop residue and primary traits and appropriate conventional and molecular breeding techniques for further genetic enhancement towards food - feed traits are addressed within these partnerships. Increasing the availability of new food-feed type cultivars are addressed in collaboration with national crop improvement institutions that are mandated to release new cultivars for example the National Research Center for Sorghum in India and private seed industry. Densification and fortification of feeds and feed components are researched in collaboration with private industry for example Miracle Feed and Fodder Pvt and Rusni distillery in India as well as pertinent NARES institutes (for example under the Indian Council for Agricultural Research (ICAR) umbrella in India and the Ethiopian Institute for Agricultural Research (EIAR) umbrella in Ethiopia). The International Water Management Institute (IWMI) together with national collaborators (ASARECA, EIAR (Ethiopia), Agricultural Economics and Policy Research Centre (Sudan) and the Department of Animal Science, Makerere University (Uganda)) have been key partners for research on optimizing water input in feed production in intensifying systems.

We anticipate that the CPWF Phase 2 will likely be the primary vehicle for extending our collaborative research on livestock and water in relation to both intensifying and pastoral systems to other partners across the developing world during the period of this MTP especially in the Nile, Volta, Limpopo and Indo-Gangetic river basins. We are exploring options to partner strategically with those engaged in assessing and evaluating at different scales and in different systems, the environmental dimensions of livestock productivity. These include Wageningen Institute for Animal Sciences, the Swiss College of Agriculture, KU-LIFE and FAO.

Research that provides tools for assessing appropriate feeding strategies combined with innovation research is being conducted with grassroots research and development organizations including collaboration with SLP partners in West Asia, North Africa, South and Southeast Asia and sub-Saharan Africa, and the ILRI-led project on Improving the Productivity and Market Success of Ethiopian Farmers (IPMS); IFAD is an important development partner for this research area.

The strengths of our research partners addressing issues related to vulnerability in pastoral systems from those focusing on developing theories and framework on vulnerability and sustainability (Harvard University, US; University of Louvain, Belgium), statistical tools (University of Hohenheim, Germany; Michigan State University, US), ecological (Colorado State University, US; University of Witwatersrand, South Africa) and anthropology and pastoral livelihood (University College of London, UK; University of Wisconsin, US). The involvement of NARS such as the University of Nairobi, Kenya; University of Dar es Salaam, Tanzania, Institut National de Recherches Agronomiques du Niger (INRAN), Niger and Institut d'Economie Rural (IER), Mali through capacity building ensures that the research outputs are sustainable, up scaled and relevant to the local environment. In addition to IWMI (as mentioned above), ICRISAT is a key CGIAR partner working in the drylands. A number of key development partners are dealing with pastoral issues and will apply our results. These include UNDP drylands development centre, World Initiative for Sustainable Pastoralism (WISP), Aid agencies (such as the Red Cross, World Food Program), development funders (World Bank, African Development Bank).

Activities aimed at securing forage diversity for future livelihoods area are fully integrated into the SGRP. This includes collaboration through collective action for improving genetic resources curation within the system and developing a common approach to the management of information

on the forage collections, working closely with CIAT, ICARDA and Bioversity. Other more global approaches such as the crop registry involve not only partners within the CGIAR but other major forage research institutions, including CSIRO and USDA as well as other regional and NARS partners working on forage diversity. Regional activities with support from ASARECA on using germplasm to mitigate the effects of smut and stunt disease in Napier bring together a coalition of partners from KARI, Kenya, NALIRRO, Uganda and NCPP, Tanzania, who are working on determining the spread and severity of the disease, together with Rothamsted Research, UK which is providing expertise in use of molecular tools for disease diagnosis, while ILRI provides the coordination and capacity building with support in M&E provided by ILRI Innovation Works.

Logical Framework

	Outputs	Intended Users	Outcome	Impact
Output 1	Environmentally efficient production options for intensifying crop-livestock systems are available	Investors, development agents, researchers, NGOs, private sector, planners and policy makers	1) More refined choices are made on targeting evaluation of feed based productivity efforts in relation to new livestock market opportunities; 2) Appropriate feeding strategies that are pro poor are implemented; 3) Investment choices made based on assessments of trade offs of environmental public bads and goods	Sustainable feed options enhance livestock production so as to promote the transition of smallholder crop livestock farmers to improved livelihoods through market participation without environmental damage
<i>Target 2010: Other kinds of knowledge</i>	Quantitative and qualitative feed supply-demand gap and surplus analysis for selected areas within Sub-Saharan Africa and South Asia compiled and options for feed movements from surplus to deficit regions explored			
<i>Target 2010: Other kinds of knowledge</i>	Evaluation of livestock-water-land productivity at different levels (for example farm, watershed, district, state, nation, region) available for crop livestock systems in selected systems of SSA and the Indo -Gangetic plains			
<i>Target 2010: Other kinds of knowledge</i>	Conceptual framework to integrate land-livestock-water productivity data within farming systems is available for selected crop			

	Outputs	Intended Users	Outcome	Impact
	livestock systems in east Africa			
<i>Target 2010: Other kinds of knowledge</i>	Water productivities associated with major classes of feed resources assessed for selected areas within sub Saharan Africa			
<i>Target 2011: Other kinds of knowledge</i>	Predictive tool for optimizing livestock productivity and land and water use relations available for West and East Africa and South Asia			
<i>Target 2011: Other kinds of knowledge</i>	Options available for developing feeding strategies to assist smallholder producers in moving toward feeding for competitive livestock product markets			
<i>Target 2011: Practices</i>	Cropping, feeding, and water use options that optimize income from meat and milk, resource usage and environmental aspects are tested and made available			
<i>Target 2011: Practices</i>	Options for feed and livestock management in intensifying crop-livestock systems with positive and negative environmental implications are identified for SSA and SA			
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Output 2	Approaches that contribute to reducing	Researchers, development agents and policy makers	1) Approaches are used that enable implementation	Reduced vulnerability and improved livelihoods in

	Outputs	Intended Users	Outcome	Impact
	the vulnerability of livestock-based livelihoods, and enhancing ecosystem goods and services in pastoral and agropastoral systems are available		of best practices to support pastoral systems development; 2) Choices about risk management options for pastoral systems are informed by integration of environmental considerations; 3) Informed choices made regarding testing of environmental management options as part of diversification and risk management strategies for pastoral systems; 4) Informed choices made regarding testing of environmentally friendly options to promote pastoral participation in market opportunities.	pastoral systems through better management of risk and improved adaptive capacity
<i>Target 2010: Other kinds of knowledge</i>	Synthesis of livestock, water and forage based options to reduce vulnerability in pastoral and agro-pastoral areas to evaluate their potential to mitigate vulnerability in SSA			
<i>Target 2010: Other kinds of knowledge</i>	Assessment of the interaction between climate change and vegetation on pastoral systems to inform development of coping and adaptation strategies to climate change			
<i>Target 2010: Other kinds of knowledge</i>	Synthesis of knowledge on how more effective water use and more secure access to water may enhance livestock production and			

	Outputs	Intended Users	Outcome	Impact
	reduce livelihood vulnerability in pastoral and agro-pastoral systems			
<i>Target 2010: Capacity</i>	Synthesis of organizational, institutional and policy options to enhance the adaptive capacity of communities to respond to change through better natural resource management and payment of ecosystem services (eg land leasing, consolation, water programs) in pastoral and agro-pastoral lands to allow assessment of optimal options under specific conditions			
<i>Target 2011: Other kinds of knowledge</i>	Assessment of the impact of various management options for indigenous livestock on land use and natural resources in selected countries in West Africa			
<i>Target 2011: Practices</i>	Assessment of environmental implications of different social based risk mitigation strategies for selected pastoral systems of SSA			
<i>Target 2011: Capacity</i>	Synthesize lessons and options to enhance adaptive capacity of pastoral and agro-pastoral households in West Africa to environmental and policy change through market and non-market options			

	Outputs	Intended Users	Outcome	Impact
<i>Target 2011: Capacity</i>	The capacity of pastoral and agro-pastoral households to manage and conserve natural resources that support endemic livestock breeds in selected countries of West Africa is strengthened			
Output 3	Forage germplasm secured and available as part of a rational global system of genetic resources conservation and sustainable use	Development agents, community based organizations and Researchers	1) Forage germplasm can be accessed and used; 2) Informed choices are made about selection of forage germplasm for specific farming systems and other purposes	Forage diversity safe, healthy and available to contribute to new demands from changing livestock systems
<i>Target 2010: Other kinds of knowledge</i>	Preliminary demand and impact assessment to reassess priority forage species to target future research completed			
<i>Target 2010: Practices</i>	Best practices for germplasm health, viability testing, drying, storage, regeneration and characterization for forage germplasm being applied			
<i>Target 2010: Other kinds of knowledge</i>	Phenotypic and trait diversity for tolerance to smut and stunt disease described for Napier germplasm in East Africa			
<i>Target 2011: Other kinds of knowledge</i>	ILRI genebank upgraded to full international standards based on a comprehensive risk assessment			
<i>Target 2011: Other kinds of</i>	Diversity and gap analysis			

	Outputs	Intended Users	Outcome	Impact
<i>knowledge</i>	completed for global forage collection using information in crop registry			

ILRI-5: Systemwide Livestock Program

Project Overview and Rationale

As agriculture in the developing world intensifies in response to the increasing demand for food, integrated production of crop and livestock becomes an important livelihood strategy. Integrated crop-livestock production allows for an efficient use of resources in small-scale farms because it provides a means to use labor effectively and the byproducts of one activity are key inputs for the other. This is critical given natural resource limitations as well as greater climatic uncertainties. At the same time, demographic growth, urbanization and rising incomes are leading to a rapidly expanding demand for livestock products in developing countries, with the majority of the expected growth in production occurring in small scale crop-livestock farms. This trend, commonly referred to as “the livestock revolution”, provides opportunities for crop-livestock producers to generate income and improve their overall household livelihood, but also increases the pressure on their natural resources due to the need for producing livestock feed. Studies indicate that large-scale intensive industrial systems, which are also increasing in response to market demand, have a considerable impact on the environment, in particular through pollution of water and air and emission of gases to the atmosphere. Over recent years, the increasing demand for fuel has led to important changes in the objectives of agricultural production worldwide, in particular due to the growing industry of bio-fuels. Scientific knowledge, especially in the areas of genomics, has opened new avenues for technological change, while at the same time development and research systems have become more aware of the need for a better understanding of the innovation process.

These dynamic changes in agriculture in relation to poverty, markets, scientific progress, environmental impact and industrial uses of crops call for appropriate policies, institutional support and technologies that increase farm productivity, enable crop-livestock producers to reap fully the benefits of participating in livestock markets and prevent the negative impact of agriculture on the environment. Such options are much more easily attained when International Centers and their partners combine in a research consortium approach to share organizational resources and to facilitate the cross-fertilization of ideas and experiences from one geographic area to another. This is the *raison d'être* of the CGIAR Systemwide Livestock Programme (SLP). The Programme builds upon the expertise and investments of twelve CGIAR centers (CIAT, CIMMYT, CIP, ICARDA, ICRAF, ICRISAT, IFPRI, IITA, ILRI, IRRI, IWMI and WARDA) on food crops, natural resource management, policy, institutional analysis and livestock to create synergies and leverage the resources within the system to address the global research needs of small-scale crop-livestock farmers in a coherent and integrated manner. The SLP thus serves as a platform for networking and coordination and as a springboard for high priority and broadly cross-cutting research projects. Beyond its research programme, the SLP also serves as a system-wide focus for information and knowledge exchange on crop-livestock systems through its website <http://www.vslp.org> and joint publications.

The proposed MTP for 2009-2011 for the SLP maintains the Programme's original focus on creating and exploiting synergies in crop-livestock research and addressing feed and related natural resource management, policy and institutional issues. However, the balance of the project portfolio is evolving as the Programme seeks to understand better how livestock systems are changing in response to population growth, urbanization, livestock market economies and other external factors. There is an increased emphasis on land- and water-based solutions for the sustainable (ecological) intensification of small-scale farms, including initiatives addressing bio-fuels, and their impact on livelihoods through improving food security and income opportunities.

Over the past year, there have been some delays in the implementation of SLP activities due to the departure of the SLP coordinator in mid 2007. It has taken some time to recruit a new

coordinator, who will be in post in September 2008. An interim SLP coordinator has been in place during this interim period and has supported the development of two strategic SLP studies implemented by cross-centre interdisciplinary teams. The first is on developing an analytical framework and assessing drivers of change in key crop-livestock systems. The second is on the tradeoffs between food, feed and fuels in smallholder systems. These studies will inform SLP priorities and research programmes over the medium term from late 2008 – early 2009. The programme has three major outputs, as highlighted in the following paragraphs, which may be modified based on the results of these on-going studies and discussions of how their implications will be implemented by the SLP and SLP members.

Research priorities derived from a dynamic understanding of drivers of change in crop-livestock systems continues with ILRI playing a leading role and the substantial involvement of CIMMYT, CIAT, CIP, IFPRI, IWMI, ICRISAT, IITA, IRRI and their partners. Recognising the rapid transitions and challenges anticipated for crop-livestock systems, this research seeks to better understand the drivers of change and their likely impacts, for priority crop-livestock systems. The knowledge gained will serve to define and refine the research entry points and priorities set for the second and third years of this medium term. The research includes specific studies on strategic issues related to biofuel production and its trade-offs and the impact of the biofuel industry on small scale crop-livestock systems. Research led by ICRISAT, in partnership with ILRI, analyzing the potential role of sorghum in the bio-fuel industry will continue.

Identifying technological, policy and institutional options for improving crop-livestock systems is addressed by research on staple crop improvement, institutional innovations for fodder and trade-offs in natural resource management. The research conducted by CIMMYT, ICARDA, ICRISAT, IITA, ILRI and their partners on improvement of staple crops as entry-point for improving feed supply in mixed farming systems has developed new approaches for genetic enhancement and dual purpose cultivars, especially in millet, sorghum, maize, and legume crops. As these results are expanded to crops such as rice and cassava through initiatives involving IRRI, WARDA, CIAT, ILRI and their partners, there is the need to address broader issues on the impact of these approaches and technologies on systems productivity, sustainability and livelihoods and the requirements for their effective use in innovation systems (included in the third output below) involving national and international research crop breeding programmes, seed releasing agencies and both private and public seed systems. During the previous MTP, this research was expanded to address the tradeoffs and synergies between the need for livestock feed and resource conservation following two lines of work. First, in systems characterized by low soil fertility, soil and animals compete for the nutrients contained in crop residues. In these systems CIAT, CIMMYT, ICRISAT, IITA, ILRI and their partners conduct research to assess the tradeoffs and synergies among animals, crops and soil in order to maximize the efficiency of nutrient use and to improve livelihoods. In the current MTP, complementary research will assess the trade-offs and the impact of the competition between food, feed and energy, including biofuels. Second, in systems where water is the main constraint, the SLP will support work, led by IWMI with inputs from ILRI and ICRISAT and their partners, to minimize the competition for water between livestock and other uses and to maximize, at the farm and watershed level, the productivity of water in relation to feed and drinking needs of animals. During this MTP, these areas of research on trade-offs and improving the efficiency of utilization of natural resources will be further strengthened drawing on the strategic frameworks developed in 2008 - 2009. The research led by ILRI and ICRISAT to address institutional and policy options to reduce vulnerability of more extensive systems - pastoral and agro-pastoral in Kenya and Niger will be concluded.

Making available information on options for improvement of priority crop-livestock systems involving the poor recognizes that the development and successful adoption and use of feed technologies by smallholders require the synergies from a wide range of existing and new partnerships and delivery systems. Within the SLP, and with the support of DFID and IFAD, ILRI, ICRISAT, IITA, CIAT, ICARDA, ICRAF and their partners are conducting research aimed at enhancing the capacity of networks of organizations involved in rural development to respond to

the needs for feed of small scale, poor farmers. Learning lessons about how diverse service providers (technologies, information services) can interact better to address the needs of the poor is central to this research. These lessons will be shared internationally and options will be sought for their application in a broader international context. As this research will be reaching completion before the end of this medium term, the SLP will increase its efforts to better inform policy and decision makers in the development and research domains to increase institutional capacity to meet the needs for information, technology and services of poor crop-livestock producers.

Alignment to CGIAR Priorities

As a whole, the SLP focuses on ways to reduce poverty in areas where small-scale crop-livestock production sustains the livelihoods of rural people. In doing so the SLP contributes to the CGIAR System Priority 3, “reducing rural poverty through diversification and emerging opportunities for high value commodities and products”, specifically priority 3b (income increases from livestock).

The systems approaches to research on the production and utilization of food-feed crops applied in SLP contribute through the better definition of selection criteria to the CGIAR System Priority 2, “producing more and better food at lower costs through genetic improvements”, and more specifically priority 2a (maintaining and enhancing yields and yield potential of food staples).

Research on livestock feed and natural resource use aims at developing approaches to increase productivity and farm income through the sustainable use of land, water and soil nutrients. In doing so it contributes to the CGIAR System Priority 4, “poverty alleviation and sustainable management of water, land and forest resources”, specifically priorities 4c (improving water productivity) and 4d (sustainable agro-ecological intensification in low- and high-potential areas).

By understanding how private, public and civil institutions can interact better to develop effective feed innovation systems the SLP supports the CGIAR System Priority 5, “Improving policies and facilitating institutional innovation to support sustainable reduction of poverty and hunger”, specifically priority 5d (improving research and development options to reduce rural poverty and vulnerability). The increased focus of the Programme to better inform policy decision makers in the research and development systems contributes directly to Priority area 5 “Improving policies and facilitating institutional innovation to support sustainable reduction of poverty and hunger”, specifically priority 5d (improving research and development options to reduce rural poverty and vulnerability).

Outputs Description

Changes from Previous MTP

The focus of the SLP for this medium term continues to be on drawing together synergies from different centres to address diverse challenges of crop-livestock systems. However, recognizing the rapid changes in such systems, the initial part of the period will focus on improving understanding of how livestock systems are changing in response to different drivers, and using such evaluation to identify priority entry points for research. There is an increasing emphasis on seeking solutions that address the need for sustainable management of natural resources (land and water) to facilitate the intensification of crop livestock systems including initiatives addressing bio-fuels, and their impact on livelihoods through improving food security and income opportunities. The project has three outputs, addressing the drivers of change (and providing context for future research), identification of technological, policy and institutional options to address the challenges of these changing systems, and the context of information synthesis and dissemination aspects.

Output 1: Research priorities derived from a dynamic understanding of drivers of change in crop-livestock systems

Description: This research uses spatial and temporal modeling and geographical information systems that integrate data on demography, socio-economics, agro-ecologies and livestock and crop markets to analyze the dynamic evolution of crop-livestock systems in order to anticipate their development and research needs. Initial steps include the development of an analytical framework to facilitate evaluation of the drivers of change, and their likely impacts. This will then be built upon to identify research entry points which in turn will influence the future direction of the SLP research activities. The trade-offs in biomass use for crop, livestock and soil had already begun to feature in the SLP activities, including the demand for biomass for bio-fuel is a new dimension here and will be addressed through a strategic study of the impact of the bio-fuel industry on crop livestock systems. Both the drivers of change research, and the bio-fuel assessment will feature case studies as one dimension of their evaluation. Specific research on the use of sweet sorghum for bio-fuel and livestock feed with ICRISAT and ILRI will be implemented.

Building on the comparative advantage of the skills and data sets in different centres, ILRI plays a leading role in the research on drivers of change together with the substantial involvement of CIMMYT, IFPRI, IWMI, ICRISAT and their partners. CIMMYT, together with CIAT, CIP, ICRISAT, IFPRI, IITA IWMI, IRRI, ILRI project 1 and partners have a significant role in the bio-fuel studies.

Alignment to CGIAR Priorities : 3B: Increasing income from livestock; 4C: Improving water productivity; 4D: Promoting sustainable agro-ecological intensification in low- and high-potential areas; 5D: Improving research and development options to reduce rural poverty and vulnerability;

Output 2: Technological, policy and institutional options for improving crop-livestock systems produced from research findings

Description: Building upon previous research on specific aspects of food-feed crops, studies are underway to address the tradeoffs and synergies between the need for livestock feed and resource conservation. This includes research to identify options that enhance synergies and reduce negative trade offs between livestock and conservation agriculture, facilitated through projects in the Indo Gangetic Plains, West Africa and Central America. Specific options and recommendations arising from this research will be articulated during this MTP period.

Research to identify entry points to improve synergies of water use in crop-livestock systems will be based initially on research in Ethiopia and Zimbabwe, firstly providing information to develop datasets which relate the water and land requirements of feed production and then building upon these to develop a conceptual framework. This research aims at developing generic strategies and models of broad relevance and applicability to increase the productivity and sustainability of crop-livestock systems.

One further aspect of technological, policy and institutional studies for natural resource management includes determining options that contribute to reducing the vulnerability of more extensive systems. The research led by ILRI and ICRISAT to address institutional and policy options to reduce vulnerability of pastoral and agro-pastoral societies in Kenya and Niger will be concluded with the documentation of options for policy makers.

Research on trade offs and synergies between livestock and conservation agriculture is being conducted by CIAT, CIMMYT, ICRISAT, IITA, ILRI and their partners. Research funded by BMZ and implemented by IWMI, ICRISAT, ILRI and partners addresses livestock water productivity in crop-livestock systems. ILRI, ICRISAT and partners in Kenya and Niger are focused on the evaluation of options to reduce vulnerability in extensive systems.

Alignment to CGIAR Priorities: 3B: Increasing income from livestock; 4C: Improving water productivity; 4D: Promoting sustainable agro-ecological intensification in low- and high-potential areas; 5D: Improving research and development options to reduce rural poverty and vulnerability;

Output 3: Information on options for improvement of priority crop-livestock systems involving the poor developed and made available to key decision makers

Description: Research conducted to enhance the capacity of organizations to respond to diverse feed needs for crop livestock farmers will conclude during this MTP period, with the results from a number of countries will be drawn together to synthesis options for feed innovations to better inform policy and decision makers in the development and research domains to increase institutional capacity to meet the needs for information, technology and services of poor crop-livestock producers. Research here also seeks to build upon work conducted by the centres on food feed crops and forages to address the policy and institutional dimensions that are needed for effective dissemination of such technological options, in particular in the context of innovation systems involving national and international research crop breeding programmes, seed releasing agencies and both private and public seed systems. The lessons learnt and being further refined in India and Nigeria, will be tested and adapted in Ethiopia, Syria and Vietnam to understand how providers of technologies, information and services, including the private and official sectors and civil organizations, can interact better to address the needs of the poor. Recommendations arising from research on such options in Nigeria, India, Ethiopia, Vietnam and Syria will be articulated.

Research on fodder innovations is conducted with the support of DFID and IFAD, through research led by ILRI, together with ICRISAT, IITA, CIAT, ICARDA, ICRAF and their partners.

Alignment to CGIAR Priorities: 2D: Genetically enhancing selected high-value species; 3B: Increasing income from livestock; 5D: Improving research and development options to reduce rural poverty and vulnerability;

Impact Pathways by Output

Output 1: Research priorities derived from a dynamic understanding of drivers of change in crop-livestock systems

By applying consortia-based approaches to create and exploit synergies in crop-livestock research, the immediate impact of the SLP is a CGIAR system partnership that is more effective in supporting the MDGs through international agriculture science. In this consortia based approach, SLP plays a critical role in the development of frameworks and models that can be applied by the partners to set priorities and assess interventions. This supports better targeted research and development investments and thus enhances the likelihood of these efforts having positive impacts on poverty alleviation and enhanced sustainability.

Output 2: Technological, policy and institutional options for improving crop-livestock systems produced from research findings

Working in a multi-disciplinary mode involving agro-forestry, crop, livestock, social and systems-analysis scientists, the SLP partners develop approaches to assess the role and value of crops, fodder trees and forages as feed resources. These approaches are applied in current crop breeding programmes in international and national research organizations to select cultivars with superior value in traits of economic importance as feed. At later stages in the research-development continuum, seed systems provide the mechanism to make the superior dual-purpose cultivars available to end users and beneficiaries. Potential tradeoffs among feed traits, food yields and the need for soil conservation in sustainable agricultural strategies are analyzed and used to develop tools to aid decision making. Strategies are developed to produce food, feed and energy through the sustainable use of land, water and soil nutrients. These strategies are translated into tools

usable by national research and development partners as well as by policy/decision makers.

Output 3: Information on options for improvement of priority crop-livestock systems involving the poor developed and made available to key decision makers

The principles that underlie the functioning of successful feed innovation systems are understood by analyzing the ways in which networks of institutions involved in the use of feed technologies operate. These networks include associations of farmers and local communities, extension services, official and private enterprises involved in production and dissemination of seed, feed and related inputs, non-government organizations and policy/decision makers. As the principles that govern feed innovation systems are understood, opportunities to enhance the capacity of these networks are identified. It is hypothesized that the enhanced institutional capacity results in the provision of high quality feed-related services to poor crop-livestock producers and landless livestock keepers. The overall outcome of this research is international and national research systems, networks of service providers, development actors and policy makers that are better informed and more able and interact better to address the needs of small scale poor crop-livestock producers and their landless counterparts. This enhanced capacity of research and development systems is the mechanism that mediates scaling up and out the impact on poverty alleviation, food security and sustainable development.

Lessons learned and knowledge generated with the SLP and other programmes are shared in a number of formats, both web- and print-based. The Programme website serves both as a mechanism to share research results, and as a system-wide source of information and knowledge on crop-livestock systems.

International Public Goods

The generic research approach followed by the SLP partners to ensure the delivery of IPGs includes specific actions at various levels in the research process: 1) The Programme conducts research on problems of broad relevance that prevail beyond national boundaries and regions; 2) The research partners use approaches and methods that allow for the results obtained to be of generic applicability. These methods generally involve trans-country and trans-regional analysis as well as synthesis of the problems investigated; 3) Research partners and stakeholders have specific roles determined by their complementary competencies ensuring multi-disciplinary inputs in the research activities. Generally, partners are located in several countries across geographical regions covering the spectrum of the conditions that define the research problem; 4) The results and outputs of the SLP are placed in the public domain making the research findings available to the international scientific and development communities; 5) Users of SLP outputs are targeted in countries, production systems and a diversity of market access situations covering a broad spectrum of conditions that determine the nature of the problem investigated

Elaboration of Partners Roles

In 2007, WARDA joined CIAT, CIMMYT, CIP, ICARDA, ICRAF, ICRISAT, IFPRI, IITA, ILRI, IRRI and IWMI as a member of the SLP. The function of the twelve centers is three-fold. First, they collectively develop a global strategy and identify priorities for the Programme in a coherent manner across the CGIAR system. Second, they provide scientific inputs in their core areas of expertise in the development and implementation of specific research activities. Third, they provide supervision to research activities and serve as a bridge for the Programme to link with other SWPs, CPs, NARS and research organizations in developed countries. In addition to these functions, ILRI hosts the Programme, provides logistic and technical support to its Coordination office and acts as its legal representative to establish letters of agreement with partners and donors.

All SLP projects are required to have a strong participation of NARS. These institutions, including decision makers, are key collaborators as they know best the realities of the countries where the activities are implemented and they are also the main target and elements of the change sought by the Programme. National institutions from Bangladesh, China, Ghana, Ethiopia, India, Kenya, Mexico, Nicaragua, Niger, Nigeria, Syria, Tanzania, Thailand, Vietnam and Zimbabwe participate in the current MTP. They link either through other CGIAR Programmes (for example RWC through CIMMYT and other partners, and the SSA-CP through IITA and ILRI) or directly with Centers for project design and implementation. The RWC plays a key role in activities in the Indo-Gangetic Plains, while the SSA-CP are involved in work in Northern Nigeria and Southern Niger. There are linkages with the Water and Food CP through collaboration with IWMI.

SLP strives to involve more research organizations from developed countries in its projects: Hohenheim University (Germany) participates in a project on dual-purpose maize; the Royal Veterinary and Agricultural University (Denmark) participates in a project on livestock and soil conservation in West Africa; ETH contributes to research on the trade-offs between using legumes for soil enhancing or as animal feed resources in Central America; and, the University of Wisconsin (USA) participates in research to reduce vulnerability to droughts in agro-pastoral and pastoral systems in East and West Africa. These organizations ensure that the best of frontier science plays an important role in the Programme's projects.

Logical Framework

	Outputs	Intended Users	Outcome	Impact
Output 1	Research priorities derived from a dynamic understanding of drivers of change in crop-livestock systems	Researchers, research managers, CGIAR-SC, policy/decision makers and development actors	Enhanced capacity and effectiveness of the CGIAR, its partners and relevant development agencies to target and address the needs of large numbers of poor, small-scale crop-livestock producers	Greater returns to investments and impact of research and development efforts targeted to poor, small-scale crop-livestock producers
<i>Target 2010: Other kinds of knowledge</i>	Assessment of the impact of the bio-fuel industry on small scale crop-livestock systems in developing countries (CIMMYT, CIAT, CIP, ICRISAT, IFPRI, IITA IWMI, IRRI, ILRI project 1 and partners).			
<i>Target 2011: Other kinds of knowledge</i>	Synthesis document describing options for ecological intensification of priority crop-livestock systems (SLP member centres and their partners)			
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Output 2	Technological, policy and institutional options for improving crop-livestock systems produced from research findings	Researchers, research managers, providers of services for small holder crop-livestock producers and development actors	Better equipped research and development systems to meet the needs of small scale crop-livestock producers	Increased crop-livestock productivity in equitable and sustainable ways
<i>Target 2010: Policy strategies</i>	Institutional, organizational and policy options to address fodder scarcity in diverse contexts developed and disseminated, with			

	Outputs	Intended Users	Outcome	Impact
	focus on East and West Africa, South and SE Asia and Syria			
<i>Target 2010: Other kinds of knowledge</i>	Conceptual framework to integrate land-livestock-water productivity data within farming systems is available for selected crop livestock systems in east Africa (IWMI, ICRISAT, ILRI Project 4 and partners)			
<i>Target 2011: Policy strategies</i>	Recommendations on technological, policy and institutional options for ecological intensification of priority crop-livestock systems available from case studies in target sub-regions (SLP member centres and their partners)			
<hr/>				
Output 3	Information on options for improvement of priority crop-livestock systems involving the poor developed and made available to key decision makers	Policy and decision makers in research and development systems	Key decision makers support policies and institutional changes to enhance sustainable intensification of smallholder systems	More effective poverty reduction strategies and programs
<i>Target 2010: Other kinds of knowledge</i>	Options for feed innovations in crop-livestock systems in three countries documented and made available (ILRI Projects 1 and 4, CIAT, ICARDA, ICRISAT, IITA)			
<i>Target 2010: Capacity</i>	Cross-country (India, Nigeria, Ethiopia, Syria, Vietnam) synthesis of			

	Outputs	Intended Users	Outcome	Impact
	options to enhance the capacity of providers of feed related services and technologies for small scale crop-livestock producers (CIAT, ICARDA, ICRAF, ICRISAT, IITA and ILRI Projects 1 and 4 and partners)			
<i>Target 2011: Unassigned</i>	Synthesis document describing options for ecological intensification of priority crop-livestock systems (SLP member centres and their partners)			

Annexes

Implementation of EPMR/CPER Recommendations

Recommendation	Center's Response	Implementation		
<i>As listed in the EPMR report</i>	<i>Accepted or not accepted</i>	<i>Milestones</i>	<i>Progress Achieved</i>	<i>Target Date of Completion</i>
<p>Considering the competitive operating environment, the substantial assets of ILRI and the naturally long horizon for measuring results in livestock research, ILRI should expand its planning horizon to complement the MTP. The Panel recommends a planning cycle in which strategic vision and goals with ten year horizons yield strategic five-year business plans, operationalised annually</p>	<p>Agreed – ILRI currently has a strategic vision and goals that were developed in 2002 and reviewed in 2005 prior to its 2nd EPMR. The 10-year strategy will be reviewed prior to each subsequent EPMR. ILRI has begun developing 5-year implementation plans that bring together research, resource mobilization, staffing, partnership planning and communications and linking these to annual workplans and performance management. The 5-year horizon is appropriate for planning how research outputs lead to development outcomes</p>	<p>Develop 5-year rolling ILRI and theme implementation plans (linked with 3-year MTP) that are built on 5-year operating project implementation plans for each ILRI output.</p> <p>Strategic review process with the Board every three years (before and between EPMR)</p>	<p>5-year OP Implementation Plans at Annual Planning Meeting linked to 2008-10 MTP (process refined in 2007 and fully operational in 2008). Strategy review document (Business Plan) developed and discussed with staff at the March 2008 Annual Planning Meeting and with ILRI Board in April 2008. Follow-up proposal for developing a Balanced Scorecard awaiting participation of the new Director of Finance and Administration.</p>	<p>June 2008 - ILRI, Theme and OP implementation plans linked to 2009-11 MTP. Next Strategy review at the November 2008 Board meeting. Comment: focus of 2008 Board discussion was on strategic implementation issues. Given the CGIAR change process, the broader strategic review will be postponed until late 2010.</p>
<p>The ambition of global impact requires a more geographically distributed allocation of a critical</p>	<p>Agreed - ILRI accepts this recommendation, recognizing the major programmatic,</p>	<p>Develop strategic and Implementation Plans for regions, in consultation with</p>	<p>Discussions on regional ILRI issues at Nov and March MC meetings (W. Africa, Southern Africa & Asia)</p>	<p>November 2007 - Global and regional plans discussed by the Board of Trustees</p>

Recommendation	Center's Response	Implementation		
<i>As listed in the EPMR report</i>	<i>Accepted or not accepted</i>	<i>Milestones</i>	<i>Progress Achieved</i>	<i>Target Date of Completion</i>
<p>mass of resources. Projects with global outcomes can beneficially be managed from locations other than east Africa. The Panel therefore recommends that ILRI redefine its physical location strategy (using CGIAR Centres wherever possible) and its modus operandi for each region. The Board should assess progress in three years through external review</p>	<p>partnership and financial challenges this acceptance implies. We see an expansion in geographic scope as an evolutionary process in which the Board and management will develop a plan to engage with key partners in different regions and through that mechanism develop strategies and resource mobilization opportunities. Our approach will be to focus on key global livestock issues backed up by a global knowledge management and communications strategy that takes account of the context, needs and opportunities in different regions</p>	<p>stakeholders, linked to ILRI's global plan - Asia (South, Southeast, China) - East Africa - West Africa - Southern Africa These plans will highlight areas of regional emphasis from the global plan and specificities for management, partnerships, resource mobilization, partnerships, communication and capacity building.</p> <p>Implementation of plan from late 2007 reviewed by a CCER on ILRI global reach in November 2009</p>	<p>Further Strategic discussions at Feb 2007 MC retreat and Annual Planning Meeting in March 2007.</p> <p>A review document of ILRI regional plans and activities, including draft regional implementation plans have been developed (for W. Africa, E. Africa, Southern Africa and Asia – South & Southeast Asia and China) and discussed at the October MC meeting. The ILRI Board will discuss a review of ILRI global reach at its April and November 2009 meetings.</p>	<p>Implementation to be reviewed by a CCER in 2010.</p>
<p>Noting that the BecA network will offer ILRI and its partners opportunities to study a range of diseases, the panel recommends that ILRI maintains a clear focus in vaccine research, and that before ILRI enters any new disease for developing a vaccine or diagnostic, it clearly defines its role and that of</p>	<p>Agreed – In vaccine and diagnostic research we plan to follow two approaches, one when ILRI plays the leadership role (such as for East Coast fever) and one in which ILRI contributes a specific component to a larger initiative led by others. In vaccine projects that ILRI plans to lead, we</p>	<p>In consultation with public and private partners, develop a Vaccine and Diagnostic Plan - Principles and criteria for prioritization - Vaccine Operating Project Implementation Plan - Vaccine Network developed with research partners</p>	<p>Vaccine Operating Project Implementation Plan developed and adopted.</p> <p>Draft Business Plan for a Vaccine Network developed but with little progress. Issues paper for the Board to define Vaccines, Genetics & Genomics CCER. Review initially delayed to accommodate availability of the desired CCER panel chair but has been completed in September 2008. Review</p>	<p>October 2007 - Vaccine and Diagnostic Plan developed</p> <p>2nd half of 2008 – CCER review of vaccines, diagnostics and genomics work at ILRI</p>

Recommendation	Center's Response	Implementation		
<i>As listed in the EPMR report</i>	<i>Accepted or not accepted</i>	<i>Milestones</i>	<i>Progress Achieved</i>	<i>Target Date of Completion</i>
its partners, and evaluates the viability of any new technology	will carefully consider our comparative advantage, research capacity and financial resources before committing to lead the project. When ILRI is requested to participate in vaccine projects led by NARS or ARI partners, we would agree to provide specific research inputs if we have the capacity and financial resources are made available	<ul style="list-style-type: none"> - Develop ILRI role of vaccines and diagnostics in BecA - Show linkages with other ILRI Themes CCER review of vaccines, diagnostics and genomics work in late 2007 or early 2008	recommendations and management response will be discussed at the November 2008 Board meeting. Plan for implementing CCER recommendation on new vaccines and diagnostics being developed with view to what ILRI does, what partners do and progress milestones.	Target dates to be specified in a detailed implementation plan. Funding success will be a critical criterion in milestone determination.
As pastoralists are an ancient and continuing component of the livestock sector, and as they are increasingly marginalized by agricultural development, the Panel recommends that People, Livestock and the Environment Theme research related to transhumant livestock keeping be oriented to pro-pastoral policies globally and that knowledge developed to date be published in a global context as a priority	Partially agreed – Strengthening ILRI's global contribution by publishing methods and practices for pro-poor pastoral research for development is a logical next step. This contribution to global fora will build initially on research results from studies in East and West Africa, that have provided important insights such as sustainability, diversification and vulnerability issues for pastoral communities. ILRI's contribution to global pastoral issues will focus on pastoral systems in the tropical	Global pastoral issues articulated and clarified in the 2009-11 MTP. Establish links to pastoral partners globally, including ICARDA and ICRISAT. Field activities would be focused in Africa and South Asia CCER in 2010 to review implementation of pastoral activities	Discussions of pastoral vulnerability and sustainability activities at Annual Planning Meeting 2007 and 2008. The PLE research programme has been re-organized from 5 to 3 Operating Projects and the pastoral work re-focussed into one of the Operating Projects. A new Leader of this group is being recruited and will be on board early 2009 so implementation will be delayed. (Jan de Leeuw began March 1st 2009.)	June 2008 - Clearer articulation of global pastoral issues and how implemented in 2009-11 MTP 2010 or 2011 – CCER to review implementation progress.

Recommendation	Center's Response	Implementation		
<i>As listed in the EPMR report</i>	<i>Accepted or not accepted</i>	<i>Milestones</i>	<i>Progress Achieved</i>	<i>Target Date of Completion</i>
	zones, as others have comparative advantage in pastoral systems of temperate zones			
<p>In view of the imminent new capacity for plant biosciences in BecA, the Panel recommends that ILRI maximize use of the facility for the forage genebank activities while also increasing research collaborations, particularly with the CGIAR Centers, that enhance the use of the germplasm</p>	<p>Agreed –Our plans for interactions between the forage genebank and BecA would focus on the identification and selection of traits for key abiotic and biotic stresses for a few selected forages. Broad-scale molecular characterization of forages is unlikely to be a priority. We see opportunities for other Centres to use the grass germplasm in the ILRI collection to look for genes of interest to their breeding programs. A critical short-term focus will be to work with CIAT and ICARDA to increase the efficiency of global forage genetic resources in the areas of genebank management and strategic utilization of conserved materials</p>	<p>Discussions with SGRP on how ILRI's activities in forage genetic resources can be better linked to those of other centres</p> <p>Activities to link conservation and use</p> <ul style="list-style-type: none"> - Make the ILRI collection more accessible by bar coding, stratifying the collection by function and making information more available to genomic and field users - One major project using genebank materials 	<p>ASARECA project on disease-resistant napier grass</p> <p>Initial discussions with CIAT and ICARDA in 2007</p> <p>Slow progress in harmonizing genebank functions with CIAT and ICARDA. Discussions will continue as part of SGRP and CGIAR reform processes. Molecular capacity at BecA will be completed late 2009 and together with renovations to genebank labs will be able to support increased research in this area as demanded.</p>	<p>Discussion document to SGRP in January 2008</p> <p>Internal review of ILRI genebank improvements annually in 2007 and 2008 with a final review linked to overall review of GPG 2 project in mid 2009).</p>
<p>The Panel views the People, Livestock and the Environment Theme as broad and uneven. To remedy this, the Panel recommends that OP2 be</p>	<p>Partially agreed – ILRI recognizes the need for greater focus and coherence within the People, Livestock and Environment Theme. We</p>	<p>Strategic alignment of the PLE Theme in 2007 with process documented in the MTP 2009-11</p>	<p>PLE Theme discussions at Annual Planning Meeting 2007 and re-organization of the Theme presented at the APM 2008. New plans reflected in the 2009-11 MTP. Recruitment for Operating Project Leader underway.</p>	<p>June 2008 – articulation of revised framework for PLE in 2009-11 MTP</p> <p>Implementation of re-aligned zoonotic</p>

Recommendation	Center's Response	Implementation		
<i>As listed in the EPMR report</i>	<i>Accepted or not accepted</i>	<i>Milestones</i>	<i>Progress Achieved</i>	<i>Target Date of Completion</i>
<p>focused on pastoralists and INRM and a refocused OP3 be transferred to the Markets Theme</p>	<p>see the coherence coming from a focus on two main issues, sustainability of land and water resources in livestock production systems and the intensification of crop-livestock systems given the need for greater production from limited land and water. These issues will be considered and implemented through a number of strategic realignments of the theme portfolio over the next 18 months. Research on zoonotic diseases of importance to the poor is a priority for ILRI. We will review how to structure this between the People, Livestock and Environment and the Market Themes.</p>	<p>Re-alignment of zoonoses research discussed and implemented by the end of 2007</p>	<p>CCER on intensification of crop-livestock systems planned for 2009</p> <p>Discussions on zoonotic research alignment between PLE and Markets Theme held and implementation achieved in late 2007</p>	<p>research by December 2007.</p>
<p>Following success of ILRI facilitating the creation of a large regional initiative (BecA), the Panel recommends that ILRI look at how it can generate adequately resourced, high impact initiatives for each Theme</p>	<p>Agreed - ILRI will continue to improve its resource mobilization by strengthening the current strategy and how it is implemented. A selected number of livestock issues of global concern to which ILRI research can make a contribution have been identified as priorities</p>	<p>Improved Resource mobilization efforts</p> <ul style="list-style-type: none"> - Recruitment of Resource mobilization officer - Briefs on big global livestock issues for investors and partners developed - Revised Resource Mobilization plan with targets 	<p>Resource mobilization officer recruited</p> <p>Big livestock issues briefs (Development Challenges documents) developed as fund raising tools.</p> <p>There has been a significant increase in restricted funding from larger and longer term projects in 2007 and 2008.</p>	<p>Resource mobilization officer in place first half of 2007</p> <p>Review of implementation and success with Board annually 2007-9.</p>

Recommendation	Center's Response	Implementation		
<i>As listed in the EPMR report</i>	<i>Accepted or not accepted</i>	<i>Milestones</i>	<i>Progress Achieved</i>	<i>Target Date of Completion</i>
	for concerted resource mobilization efforts			
<p>Given the risks to ILRI of being perceived as conducting development activities, the Panel recommends that the IPMS project be managed, budgeted and reported in two parts with research allocated to respective Themes and project management done by the DDG's office, and that ILRI decline management roles in future development projects</p>	<p>Partially agreed – To have impact, ILRI research needs to actively engage with development projects and partners. We agree it is critical that ILRI constantly assess its research for development role. We also agree that in the management of large research – development projects, ILRI concentrates on its research role and partners with others who have expertise in development activities. ILRI believes it is important to manage the IPMS project as one entity. However, ILRI agrees to better link the research components and their reporting to its research programme</p>	<p>Improved research performance within the IPMS</p> <ul style="list-style-type: none"> - Research theme engagement - Specific expert support <p>Guidelines for ILRI role in larger research for development projects developed and applied to decisions on individual projects</p>	<p>Inputs from Science Advisor and staff recruitment</p> <p>Link with development partners for large research-development projects (e.g. GEF AnGR West Africa)</p> <p>Guidelines for ILRI's role in large research – development projects were developed and approved in June 2008 for implementation.</p>	<p>Annual review of IPMS 2007-9 to assess research component</p> <p>Guidelines for ILRI's role in large research – development projects approved by ILRI MC in December 2007.</p>
<p>In the interests of continuing to improve the quality of its research output, the Panel recommends that ILRI immediately and systematically invest in increasing its Internet capacity for research</p>	<p>Agreed - ILRI is committed to expand its internet capacity with increased expenditures in 2007. ILRI and ICRAF are establishing a common ICT unit which should improve our capacity for strategic</p>	<p>MC to develop a plan for ICT improvement for Board approval guided by an internally commissioned review</p> <p>Review of external internet connections with a view to improving</p>	<p>Information on broadband service provision from ICT ICER discussed at 2007 MC retreat.</p> <p>Tender process for bandwidth service provision was completed May 2008; upgrades to be implemented in July.</p> <p>Optic fibre gateway expected in early 2010</p> <p>The joint ILRI and ICRAF ICT Unit was</p>	<p>Board approval of ICT development plan in April 2007</p> <p>Internal review of ICT performance to support bioinformatics conducted in mid-2008</p>

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purposes	investment. Currently we are undertaking an internally commissioned review on ICT to advise on practical approaches and the investment required to increase internet capacity, taking into account regulatory and infrastructure conditions.	access to the bioinformatics hub. Review internal network to ensure efficient access to the bioinformatics hub. Implant an ICT specialist in Bioinformatics group to ensure requirements are clearly defined and implemented	created in July 2007 and an ICT Linux Specialist recruited and seconded to Bioinformatics in September 2007. A review of the internal network design is being carried out and improved access to the biometrics hub to be implemented in 2008. Increased bandwidth will be purchased as possible with expectation of much decreased costs and faster speeds in 2010. Separate high performance computing network for bioinformatics and other data-intensive activities being developed as needs and clients differ from the ILRI-ICRAF corporate network.	Implementation of research computing network in progress. Target date – end 2009.
As a critical component of ILRI's systems approach, the Panel recommends that ILRI management charge the research themes to conduct ex post impact studies on selected programs using methodologies developed by the new Innovation and Impact Unit, and using external inputs where needed	Agreed - ILRI will take steps to strengthen its ex-post impact assessment capacity. These will include the participation of scientists who carried out the research, methodological support from impact assessment specialists in ILRI's Innovation and Impact Unit and review by outside experts to ensure objectivity	Establishment of innovation and Impact Unit Inclusion of plans for impact assessment in research projects and specific ex-post studies developed and implemented by Themes	ILRI-wide Innovation initiative (called Innovation Works) established in 2007 and fully operational; all ILRI impact studies available at: www.ilri.org/InnovationWorks Impact Assessment Task Force formed in March 2008 and agreed on objectives and how the task force will operate. Impact assessment CCER terms of reference developed and team leader hired; assessment will be carried out in 2009; it will advise on scope, nature and responsibilities for IA work in ILRI and with partners and inform task force's development of an ILRI IA strategy 2009-13	June 2007 - Innovation and impact unit plans incorporated in 2008-10 MTP June 2008 – impact assessment plans in 2009-11 MTP IA CCER presented to Board in November 2009.
As part of ILRI's contribution to strengthening capacity, the Panel recommends that ILRI make this	Agreed - ILRI has recently recruited a senior Capacity Strengthening Manager and is finalizing a	New CaSt Manager and team to develop a Capacity Strengthening implementation plan taking into account	Capacity Strengthening (CaSt) Manager recruited and a CaSt strategy and implementation plan developed and reviewed by Management and Board in 2007.	CaSt strategy and implementation plan developed and reviewed in November 2007

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activity explicit and measurable in research program design and report results for Boardh training and follow up activities	capacity strengthening strategy for the institute. Procedures will be put in place so that capacity strengthening contributions are explicitly recognized in its program planning, implementation and reporting	recent CCER recommendations Establish procedures for incorporating capacity building into research programmes and documenting capacity building activities	CIM expert on monitoring and evaluation under recruitment. New New IRS position for Nairobi started January 2009.	Procedures for capacity building in research programmes included in 2009-11 MTP and reviewed annually by CaSt team and Management Committee.
The panel recommends that ILRI provide new members of the board with a thorough orientation to the financial issues and trends that shape ILRI's budget, strategy, and capacity as well as to the processes that support the board's responsibilities for financial stewardship and oversight	Agreed- An orientation program is being developed and a financial briefing session was presented to the Board prior to its November 2006 meeting. This program will be updated to reflect the changing environment and the changes within ILRI's priorities and structure as well as the evolving requirements of the Finance & Audit committee of the Board	Board Financial orientation programme developed, revised and presented All Board members receive orientation during their first year of tenure	Orientation Nov 2006 Board meeting. The Board financial orientation is updated twice a year before every Board meeting and shared with every new Board members	Orientation programme documents prepared November 2006
The Panel recommends that ILRI management and the board chair redefine the responsibilities and scope of work of the Board Secretary and improve ILRI's practices with respect to meeting preparation	Agreed - A detailed checklist on Board meeting preparation and the conduct of Board affairs throughout the year is being developed by the Secretary and the Board Chair and will be implemented by ILRI management and Board	Review TORs for Board Secretary Checklist of Board meeting preparation with deadlines developed and implemented by November 2007 Board meeting	CCER on corporate governance conducted in 2007. CCER recommendations on Board committee structure, nomination and leadership succession, performance assessment and policies adopted by the Board in April 2008 and are being implemented.	Implementation of EPMR and subsequent CCER recommendations will be finalized in 2008.

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		CCER on Board governance		
The panel recommends that the board increase the quality of its board recruitment process by developing a multi-year strategy for the recruitment of new board members, which supports the global mandate of ILRI and provides it with a board that is a sustained asset to the accomplishment of its work	Agreed - The ILRI Board of Trustees will finalize a Board of Trustees Development Strategy which includes the recruitment of Board members based upon complementary skills to ensure continuity in providing oversight to the business of ILRI	Board of Trustees Development strategy including Board recruitment plan	Board Development Strategy including a multi-year recruitment strategy approved in 2006 New Board member appointed with specific financial and audit expertise Process on hold waiting for outcome of CGAIR Change Management process.	November 2006 November 2007
ILRI having identified the weaknesses in key management proficiencies, the Panel recommends that the DG and DDG institute comprehensive training and development opportunities for all managers and hold themselves and managers responsible for improvements in performance	Agreed – ILRI, with external consultants, has reviewed its human resource management and individual manager skills. Follow-up actions identified as part of this review have been agreed. These will be implemented in the next 12 months and their effect monitored and reviewed as part of a continuous management improvement program	Follow-up management actions 1. Training of staff and coaching of managers 2. Recruitment of a learning and development officer in HR 3. Systematic follow-up of issues noted in staff and manager training 4. Survey by learning and development officer of improved management performance	Performance Management training in late 2006 and First level Development Programme learning and development programme in 2007 (90 staff trained) Recruitment of learning & development officer in February 2007; Coaching with individual managers in mid 2007; Recruitment of a HR Director in February 2008; Participation of managers in the CGAIR G&D Leadership course.	March 2007 – training of managers December 2007 – manager coaching Performance management system assesses the performance of managers. Also reviewed as part of staff survey in 2009.
The Panel recommends that as part of overall improvements to the HR function, ILRI develop a staffing plan which is	Agreed – This recommendation will be implemented as part of the business planning and globalization of	Development of a staff plan as part of the 5-year ILRI, Theme and OP implementation plans taking into account	See recommendation 1. Targets postponed for one year because of delayed recruitment of HR Director	Plan to be agreed by MC by end of 2009 and provided as an input into the globalization of ILRI CCER in 2010.

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cognizant of geography, anticipated disciplinary expertise and gender, and is consistent with the ILRI priorities	ILRI's activities (response to recommendations 1 and 2)	research requirements, regional locations and gender (relative to Board-approved G&D goals)		
The Panel recommends that ILRI undertake a comprehensive reassessment of its current sites in Kenya and Ethiopia, exploring all options with respect to the management and disposition of its properties	Agreed – Within its evolving global strategy, a comprehensive review of ILRI properties and assets in Kenya and Ethiopia will be conducted with a view to assessing their relevance and increasing their effectiveness and efficiency	Internal review of ILRI properties in East Africa as to their relevance to ILRI's present and future mission to be prepared by MC and discussed and approved by the Board	1) Following a review of the functioning of the Debre Zeit station and a dialogue with the Government of Ethiopia, ILRI handed over the facility to the Government of Ethiopia. 2) A Board document was developed and discussed in March 2008 outlining the efficient utilization of ILRI facilities.	Review presented to and approved by the ILRI Board in April 2008.
The Panel recommends that ILRI continue to improve its financial management through adoption of a new investment strategy, a more comprehensive resource mobilization plan, and more efficient grants management	Agreed – An investment policy was approved at the November 2006 Board meeting. In line with recommendation 7, ILRI agrees that it needs to increase its skills and experience in resource mobilization and enhance coordination of resource mobilization activities within the institute. We also concur that, as far as possible, restricted fund raising should focus on large and medium-size and longer-term grants and should also attempt to recover staff costs and overhead to the largest	Investment strategy developed and approved by the Board Resource Mobilization Officer recruited and updating of the ILRI resource mobilization plan New grants management system	1) Investment strategy approved by the Board. 2) Resource mobilization officer recruited. 3) Review of implementation begun in April 2007 and on-going since (see under recommendation 7); April 2008 – New Grants System –in place. To be integrated into a broader project management system.	November 2006 April 2007 – Recruitment; December 2007 - Resource mobilization plan revised. Project cycle management improvements to be implemented by early 2010.

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	extent possible			

