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and Partnership
Council

Strategic Review of Livestock in
the CGIAR (including ISPC
synthesis and commentary)

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ISPC SYNTHESIS AND COMMENTARY ON THE LIVESTOCK REPORT:

“A strategic overview of livestock research undertaken by the Consultative Group for International Agricultural Research (CGIAR)”

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Executive summary

The strategic think piece on livestock and its interactions with cropping, environment, nutrition and health was commissioned by the ISPC in mid-2013. The aim was to provide an analysis of livestock-related research across the Consortium Research Programs (CRPs) as a basis for providing advice to the Consortium and Fund Council on how best to enhance the CRP inter-linkages and coherence of the System’s agenda on livestock-related research issues which appear to varying extents in most CRPs. While there is only one CRP with Livestock in the title (CRP 3.7, Livestock and Fish), several other CRPs include research on issues of direct relevance to livestock in their portfolio, such as the cultivation of forages and the impact of livestock on water quality. Furthermore, the International Livestock Research Institute (ILRI) leads a component of CRP 4 (Agriculture for Nutrition and Health) and makes significant contributions to 8 CRPs.

The study highlights the balance that needs to be struck in framing livestock research issues - between meeting the growing demand for livestock products and the importance of livestock for economic growth and poverty reduction on the one hand, and the negative environmental and human health related issues associated with intensification of animal agriculture on the other. It concludes that livestock research needs to remain a priority for the CGIAR to address effectively the four high-level SLOs.

The authors observed that research related to livestock is important across the CRPs, in addition to the specific inputs from ILRI in 8 CRPs. However, the study highlights that the research agenda has been driven by opportunities rather than by a clear livestock strategy that would guide more coherent and optimally-linked agendas in the CRPs. Several areas where the livestock research agenda could be strengthened are identified. Examples are:

- Interface between livestock and climate, both mitigation and adaptation;
- better integration of feed research between CRPs including jointly funded research;
- addressing issues specific to livestock in policy research;
- addressing constraints related to animal health and feed service delivery; and
- institutional issues such as transactions in managing the CRP linkages.

The ISPC concurs with the analysis provided in this paper. The Council encourages the CGIAR partners, including ILRI and relevant CRP management teams, to draw from this

analysis in their preparation for the next phase of the CRPs so that they can capture better the synergies and complementarities for a more coherent livestock research agenda. The ISPC also agrees with the importance of planning carefully for linkages between the CRPs to avoid high transaction costs and to budget for joint research.

Introduction

The 15 CRP proposals were submitted for ex ante peer review in a sequential manner over a period of over two years (2010-2012). In the ISPC's appraisal of the CRP proposals it became apparent that the research outlined initially included a considerable proportion of on-going research brought together under the CRP umbrella. Furthermore, due to the sequential development of the CRPs, the proponents had not been able to consult with each other to shape an overall cohesive research agenda. The ISPC therefore undertook a series of strategic oversight analyses once the complete portfolio of the CRPs was available. Themes for these analyses were chosen on the basis of the cross-cutting nature of the topic. In 2012, the ISPC commissioned three strategic think pieces: on Theories of Change¹, Value chains and Seed systems².

In choosing these themes, the intent was to determine whether the efforts distributed across CRPs would result in impacts that are greater than the sum of the parts and whether the linkages between different kinds of CRPs are adequately framed. After discussion at its open meeting, the ISPC commissioned a third strategic think piece on livestock-related research in 2013.

For each theme the ISPC has commissioned an analysis of relevant content from each CRP proposal, of current literature on the topic, and expert knowledge of the author(s) to generate conclusions and recommendations on possible sharing of knowledge and opportunities for collaboration between CRPs. This ISPC strategic overview of key challenges common to a number of CRPs has been intended to help facilitate a process of transition towards a more coherent and better integrated portfolio of CGIAR research programs. This transition will also be encouraged by a second call of CRP proposals foreseen to be launched in 2014.

Scope of the study

For this study, 'livestock' was defined as including the monogastric, ruminant and poultry species that are relevant for developing country agriculture and are researched or could be researched by the CGIAR. The ISPC deliberately did not include fish in this analysis, because the research issues of animal nutrition, health (both animal and human), policies, breeding and environmental externalities are quite different for livestock compared to fish. Where livestock and fish come together most appropriately in the CGIAR is in looking at particular value chains in CRP3.7 where aquaculture is the focus in one value chain out of eight. Both livestock and fish also feature in human nutrition, which was not included in the focus of this study.

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http://www.sciencecouncil.cgiar.org/fileadmin/templates/ispc/Expert_advice/Advice_to_the_FC_CRPs_/CRPs_2012/cross-CRPs/19DecTheories_of_Change_FINAL.pdf

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http://www.sciencecouncil.cgiar.org/fileadmin/templates/ispc/Expert_advice/Advice_to_the_FC_CRPs_/CRPs_2012/cross-CRPs/19DecCross-CRP-Synthesis-Value_chains-Seed_systems_FINAL.pdf

Examples of issues which are relevant to more than one CRP include: responding to increasing demand for animal protein, livestock processing and marketing, the development of crop varieties with greater feed value, feed inputs into livestock value chains, intensification of crop-livestock systems, pastoral systems, environmental impacts of livestock production systems, and the effects of environmental shocks on animal production.

Although livestock research has a relatively smaller emphasis within the orientation of the majority of other CRPs, there are several intersection points where integration is important, including issues of policy and environmental sustainability. Examples include: crop breeding and the need to consider stover value in regions where such fodder has a monetary value; the use of manure as fertilizer/fuel is an important part of systems in some regions; and trade-offs between alternative uses of crop residues in conservation agriculture and for feed. The nature of the interactions is likely to depend on regional and agro-ecological differences that need to be considered when framing the research questions. It was suggested that a thorough analysis of these interactions could help to illustrate how individual CRPs might gain mutual benefit in terms of delivery of intermediate development outcomes by working together and linking jointly to other partners.

The consultants commissioned to undertake this study were asked to focus their analysis on three areas of importance: (i) the emerging issues related to livestock production and feed of relevance to agricultural development where the CGIAR has comparative advantage to engage in research; (ii) the apparent gaps in the CGIAR's research plans (relative to ensuring that the outputs of other CRPs can lead to relevant development outcomes) as reflected by the CRP proposals; and (iii) partnership opportunities including synergy across CRPs in livestock research. They were asked to explore the linkage from research on livestock to the CGIAR's System-level outcomes³ and trade-offs specific to livestock management. The consultants were asked to draw from existing analysis on pathways from livestock production to poverty reduction⁴, food security and nutrition and opportunities and threats related to livestock and natural resource sustainability.

Synthesis of key findings on emerging issues

- Sustainable intensification of livestock production is dependent on high quality feed, which has been in the research agenda of ILRI, CIAT and ICARDA in particular. Among the CRPs, feed issues are well documented in CRP3.7 on Livestock and Fish, and the Drylands and Humid tropics (systems) CRPs and in the (crop) commodity CRPs where use of both crops and their by-product is addressed. The study report highlights several issues related to CRP linkages, including between CRP3.7 and the systems CRPs on one hand and with the crop CRPs on the other hand. The latter are seen as essential so that the demands for crop CRP feed research can be better identified. The report also highlighted the potential benefits of funding joint research between CRPs and the opportunity to facilitate cross-CRP learning. Some gaps identified include research on the supply of high-protein feeds and work on developing seed systems and delivery. On the latter, the ISPC commissioned a generic think piece on seed systems in 2012 (see footnote 2) which provides useful guidance.

³ Poverty reduction; increased food security; improved nutrition and health; sustainable use of natural resources.

⁴ For instance, mapping done by ILRI

- The authors raise several policy issues that are specific to livestock and may be missed by the agricultural policy research done, for instance in CRP2 (on Policies, Institutions and Markets). These include the multi-functionality of livestock, which forces small-scale producers to be constantly engaging in trade-offs between uses and hence an inability to define clear production objectives; environmental externalities that may be exacerbated or mitigated by institutions and policies; and the higher risks and transaction costs in livestock value chains. Furthermore, policy objectives for livestock that correspond with the CGIAR SLOs have been shifting and the balance between them is likely to alter as countries develop and industrialize.

The report also suggests the potential opportunity which arises from being a part of the CRP portfolio, namely, to engage in a trans-regional analysis of selected case studies on value chains that will allow placing them in a global context, thus enabling extrapolation. It also noted that;

- Compared to crop agriculture, the research on climate change impacts and adaptation in the livestock sector is limited. The full range of potential impacts of climate change should be researched, including pest and disease vectors, disease occurrence, and the relation between coping and adaptation and the associated policy requirements.
- The authors foresee little impact from technology development unless the services for delivery of the knowledge and technologies function sustainably. Services related to feed and to animal health are notoriously weak. While there are several other organizations involved, a role for the CGIAR is proposed, particularly CRPs 3.7 and 4 (on human nutrition and health) and the systems CRPs, for instance in ensuring that services are in line with national livestock development strategies and providing business models for the services.
- The very limited attention given to animal genetic resources and breeding in the ILRI strategy and the CRPs is highlighted in the report. The authors argue that while livestock breeding would not be a high priority for the CGIAR, the private sector will not cover all issues of animal genetics resources adequately. They consider that the substance of the animal genetic resources research agenda in CRP 3.7 should be better developed, as a component of work on the intensification process.
- There is growth in the demand for small ruminants and they play a significant role in poverty reduction. While two value chain cases in CRP3.7 are likely to explore the constraints to marketing and resource management, CGIAR research could contribute more to exploiting the opportunities for progressive intensification of small ruminant systems in the developing regions.

The analysis highlights the lack of clear mechanisms for partnerships with the private sector and the lack of clarity regarding the outputs from such partnerships. The authors questioned why the CGIAR did not have greater involvement in exploring the relationships between smallholders and the private sector. Greater strategic dialogue between the Consortium and national and regional companies could be one way forward.

While the dynamics of rural development are not within the CGIAR's comparative advantage, linkages with non-CGIAR institutes dealing with those dynamics are considered necessary to keep the CRPs aware of the evolving issues.

The authors have analyzed the consequences that the programmatic approach through CRPs has had on the nature of CGIAR research, such as cross-Center research planning and collaboration. They highlight the large increase in transaction costs associated with research management, particularly through increased multi-, inter- and trans-disciplinarity, which requires outstanding management and organization. The authors also discuss the changes that the programmatic approach has had on livestock research, with the risk of fragmentation on one hand and opportunity for wider engagement of CGIAR in livestock issues on the other hand. The engagement of the only livestock Center, ILRI, in CRPs is seen as a matter of strategic choices.

In conclusion, the authors call for a 'strategic framework of livestock across the CRPs and Centers' to ensure that priorities are indeed being addressed. To achieve this they suggest that discussions are held with the key representatives of CRPs, to develop a 'roadmap' for the development of a strategic framework.

ISPC commentary

The ISPC considers that this cross-CRP analysis has succeeded very well in synthesizing information and key issues related to livestock that are relevant to the CGIAR, considering that the scope of the issues is potentially very large. The ISPC endorses the authors' central argument that research related to livestock is one of the core areas in addressing the four System-level outcomes and that it can benefit from expertise that is spread across different CRPs. However, it is also clear that the totality of the research where the CGIAR has a strong comparative advantage is somewhat dispersed between the CRPs due to the way they were initially developed in a sequential rather than synchronized manner. This has left some important areas receiving less attention, as has been observed in the analysis.

It is clear that while the CRP commissioning process has allowed a broad reach in terms of livestock-related research, it has also led to fragmentation of the research agenda which still leaves the challenge of agreeing on an agenda that is larger than the sum of the parts. Even within the Livestock and Fish CRP there are potential disconnects between developing flagship programs on animal diseases, formerly a strong suit of the CGIAR, and the more production and food safety focus demanded by value chain research. Nearly all CRPs are thinking of the livestock dimension in their research; be it feed research or issues related to policy, climate change or systems intensification. Considering livestock-related research as a cross-cutting issue among CRPs and rearranging it, with adequate linkages among the CRPs, is therefore a task to be undertaken in the next phase of the evolution of the CGIAR portfolio.

It is also clear that the system CRPs are in a good place to synthesize feed research done in the commodity CRPs. In feed research legumes should not be ignored, as feed often determines the base price for legume seed. However, as with crop commodities in general, feed use requires specific consideration, as the desirable traits may be different from the desirable traits for human consumption. Animal type (e.g. ruminants, monogastrics) can also determine the aspects that are important in breeding for feed use. The use of crop residues for fodder is a secondary concern, but important within the farming systems. The livestock-crop-soil interface is also worthy of increased attention. As there are several institutions outside the CGIAR where animal feed is being researched, the CRPs need to forge those linkages as part of their feed research strategy and planning.

Policy is another area where more coherence and attention to livestock-specific issues is due. However, pragmatism is needed in approaching cross-cutting topics that involve the majority of CRPs because, as the study pointed out, the transactions in multiple cross-linkages can be large.

The paper clearly identified areas where more could be done⁵. The ISPC acknowledges, however, that linkages among the CRPs, while needed for generating synergies, also require specific funds. The further development of the CGIAR research portfolio in conjunction with the next funding phase of the CRPs, can offer an opportunity to forge such linkages and address gap areas. This strategic analysis can provide a useful basis to help the second round of CRP proposals and for looking at the portfolio as a whole. Assessment of the essential linkages needs to extend outside the CGIAR to consider partnership options.

The ISPC concurs with the conclusions that the CGIAR would benefit from a System-wide strategic framework for livestock research that is apart and beyond the ILRI strategy for 2013-22.

⁵ And further advice on aspects of biotechnology research in livestock, are expected to be included in the ISPC-commissioned study of *Biotechnology in the CGIAR*, to be published in 2014.

A STRATEGIC OVERVIEW OF LIVESTOCK RESEARCH UNDERTAKEN BY THE CONSULTATIVE GROUP FOR INTERNATIONAL AGRICULTURAL RESEARCH (CGIAR) CONSORTIUM

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LIST OF ABBREVIATIONS AND ACRONYMS

AfricaRice - a CGIAR Research Center

AGRA - Alliance for a Green Revolution in Africa

ARIs - Advanced Research Institutes

AR4D - Agricultural Research for Development

Biotech - Biotechnology

Bioversity International - a CGIAR Research Center

CAADP - Comprehensive Africa Agriculture Development Program

CB - Consortium Board (of the CGIAR)

CDB - Convention on Biological Diversity

CG - abbreviation of CGIAR

CGIAR - Consultative Group on International Agricultural Research

CIAT - International Center for Tropical Agriculture

CIFOR - Center for International Forestry Research

CIMMYT - International Maize and Wheat Improvement Center

CIP - International Potato Center

CO₂ - Carbon Dioxide

CRP - CGIAR Research Program

CRP1.1 CGIAR Consortium Research Program on integrated agricultural production systems for the poor and vulnerable in dry areas

CRP1.2 CGIAR Consortium Research Program on integrated systems for the humid tropics now called Humidtropics

CRP1.3 CGIAR Consortium Research Program on harnessing the development potential of aquatic agricultural systems for the poor and vulnerable

CRP2 CGIAR Consortium Research Program on policies, institutions, and markets to strengthen assets and agricultural incomes for the poor

CRP3 CGIAR Consortium Theme 3 on sustainable production systems for ensuring food security (with one program each on dryland cereals, grain legumes, livestock and fish, maize, rice, wheat, and roots, tubers and banana)

CRP4 CGIAR Consortium Research Program on agriculture for improved nutrition and health

CRP5 CGIAR Consortium Research Program on water, land and ecosystems: improved natural resources management for food security and livelihoods

CRP6 CGIAR Consortium Research Program on forests and trees: livelihoods, landscapes and governance

CRP7 CGIAR Consortium Research Program on climate change, agriculture and

food security

CSOs - Civil Society Organizations

FAO - Food and Agriculture Organization

FARA - Forum for Agricultural Research in Africa

GCARD - Global Conference on Agricultural Research for Development

GFAR - Global Forum on Agricultural Research

GMOs - Genetically Modified Food

GXE - Genotype-By-Environment

HYVs - High-Yielding Varieties

ICARDA -International Center for Agricultural Research in the Dry Areas

ICRAF - World Agroforestry Center

ICRISAT - International Crops Research Institute for the Semi-Arid Tropics

ICTs - Information and Communication Technologies

IEA - Independent Evaluation Arrangement

IFPRI - International Food Policy Research Institute

IITA - International Institute on Tropical Agriculture

ILCA – International Livestock Centre for Africa

ILRAD- International Laboratory for Research on Animal Disease

ILRI - International Livestock Research Institute

IMPACT - Integrated Modeling Platform for Animal and Crop Systems in the Tropics

INRM - Integrated Natural Resource Management

IPCC - Intergovernmental Panel on Climate Change

IP - Intellectual Property

IPG - International Public Goods

IPR - Intellectual Property Protection Issues

IRRI - International Rice Research Institute

ISPC - Independent Science and Partnerships Council

ITPGRFA - International Treaty on Genetic Resources for Food and Agriculture

IWMI - International Water Management Institute

MDGs - Millennium Development Goals

NAROs - National Agricultural Research Organizations

NARS - National Agricultural Research Systems

NGOs - Non-Government Organizations

NRM - Natural Resource Management

OP - Operations Plan

PES - Payments for Environmental Services

PRSP - Poverty Reduction Strategic Planning

R & D - Research & Development

REDD - Reduced Emissions from Deforestation and Forest Degradation

RLC - (FAO) Regional Office for Latin America and the Caribbean

RUPES - Rewards for, Use of and shared investment in Pro-poor Environmental Services

SLOs - System level outcomes

SRF - Strategy and Results Framework

SSA - Sub-Saharan Africa

UN - United Nations

UPOV - International Union for the Protection of New Varieties of Plants

WANA - West Asia and North Africa

WDR - World Development Report

WORLD FISH - a CGIAR Research Center

1. INTRODUCTION

1.1 BACKGROUND TO THE STRATEGIC OVERVIEW

The Independent Science and Partnership Council (ISPC) of the CGIAR Consortium commissions strategic overviews of selected themes, which are intended to foster greater coherence within the overall CGIAR research agenda. Livestock development research is considered by the ISPC to be a cross-cutting theme deserving scrutiny, and has been selected for a strategic overview. Traditionally this research has been led and largely undertaken by the one CGIAR Centre with a specific mandate for livestock research, namely the International Livestock Research Centre (ILRI) with its headquarters in Nairobi, Kenya. However, with the formation of the CGIAR Research Programmes (CRPs), designed to build and enhance partnerships between centres and disciplines and to be largely undertaken in the context of specified ecoregions, it appears that the idea of dominance of commodity research by any one Centre has changed significantly. The Consortium now has 15 CRPs addressing different aspects of agricultural research. They are subdivided in broad terms into three groupings. These are

- Systems (Drylands, Humid Tropics and Aquatic)
- Commodities (wheat; maize; rice; roots, tubers and bananas; grain legumes; dryland cereals; and livestock and fish)
- Natural resource management and policy (specifically these are: policies, institutions and markets; agriculture for improved nutrition and health; water, land and ecosystems; forestry, trees and agroforestry; and climate change agriculture and food security).

Within the portfolio of CRPs, there is only one which focusses in its entirety on livestock, and this (CRP 3.7 More Meat, Milk and Fish by and for the Poor) is led by ILRI. There are several other CRPs which have elements of livestock research in them, and indeed several of the 15 CGIAR Centres now work on issues relevant to the role of livestock in agricultural development and natural resource management in developing countries. But the process of CRP development was not one which clearly mapped out the major agricultural research challenges and allocated them, with accompanying adequate funding, to the relevant scientists or centres of expertise. Rather it was a somewhat opportunistic and to a degree competitive process, and while many global agricultural, including livestock, research priorities are now being addressed by the CGIAR and its partners, it remains unclear as to how well the elements in individual CRPs on livestock and forages amalgamate to address the major issues associated with livestock production and consumption in the developing world. This strategic overview is designed to open a discussion on this topic.

1.2 OBJECTIVES

1. Within the context of the CGIAR Consortium, evaluate the responsiveness of the CRPs and ILRI in addressing the major global livestock research demands associated with the CGIAR's four system level outcomes (SLOs), namely reducing rural poverty, improving food security, improving human nutrition and health, and ensuring the sustainable management of resources.
2. Assess the capacity and effectiveness of research and institutional linkages, both between the different CRPs and with other partners, to deliver impacts that are greater than the sum of the parts.
3. Based on the outputs of the strategic overview, make recommendations on the technical and operational opportunities for improving the relevance and effectiveness of the CGIAR's livestock research contributions.

1.3 METHODOLOGY

i. Literature review

The authors have undertaken a thorough review of different categories of literature. These include:

- The CRP proposals themselves, and revisions to them
- Associated process documents of the CGIAR consortium
- CGIAR-led and independent publications on livestock research drivers, priorities and approaches. A full bibliography is presented in Annex 2.

ii. Consultation

During the strategic overview the team has consulted with many CGIAR scientists, and some partners, the Director General of ILRI, and others outside the CGIAR, exploring current strengths and opportunities in the CRP portfolios.

iii. Strategic overview framework

The team developed a strategic framework to help articulate the link between drivers of livestock research and SLOs. This is presented below in section 3.

2. LIVESTOCK RESEARCH IN THE CGIAR; PAST AND PRESENT

Livestock research under the auspices of the CGIAR has been underway for almost 40 years, initiated through two then separate institutions, the International Livestock Centre for Africa (ILCA, based in Addis Ababa, Ethiopia) and the International Laboratory for Research on Animal Diseases (ILRAD, based in Nairobi, Kenya) in Africa and also the International Centre for Tropical Agriculture (CIAT) in Latin America (which had a livestock and forages programme during the 1970s). Livestock research has also been undertaken historically at IITA and ICARDA, and livestock forages work continues at ICRISAT. In the early days many of these institutions benefitted from regular substantial annual core investments from the World Bank, from several other funding organisations such as the Rockefeller Foundation (instrumental in the founding of ILRAD), and from international and bilateral donors. ILCA carved out a unique role in field-based systems research in many regions of Africa, while ILRAD specialised in lab-based biotechnology research on the development of vaccines against two vector-borne diseases of cattle, tsetse-transmitted trypanosomiasis and tick-transmitted theileriosis (known as East Coast fever). In 1995 these two institutions merged under the name of the International Livestock Research Institute (ILRI), while maintaining two separate campuses in Nairobi and Addis Ababa. The adolescent ILRI struggled for several years to integrate the widely differing science and institutional cultures of its parent institutions. The Second External and Program Monitoring Review (EPMR) comment that it displayed a “heterosis which was accompanied by identifiable traits of each parent, such that one Theme looks a little like ILRAD and one can see ILCA in other Themes⁴”. The review added that “since 1999, ILRI has been slowly metamorphosing into a new institution with a different mission and approach to that of its antecedents”. In 2002 ILRI emerged from this period heralding a revised strategy, which revitalised the institutional culture, introduced a new programming structure, but continued to struggle to obtain the funding necessary to sustain some of its traditional research; the 2006 EPMR commented “In the case of ILRI, major reductions in funding accompanied the latter days of ILRAD and ILCA and the ‘lost’ funds have been difficult to replace in real dollar terms, and the gap yawns wider when new funds are tied to specific projects or

⁴ http://www.sciencecouncil.cgiar.org/fileadmin/templates/ispc/documents/Publications/2d-Publications_Reviews_EPMRs/SC_EPMR-2_ILRI_Jan2008.pdf see page 11

programs. Coupled with these changes is refocusing of the international agenda around such foci as the Millennium Development Goals”.

The CG Consortium has had earlier initiatives to promote cross Centre collaboration, and focus on particular topic and eco-regions⁵. The System Wide and Ecoregional Programs⁶ (SWEPs) were established in 1994, and included the Systemwide Livestock Program⁷, which played a role in determining global livestock research priorities for the CGIAR, initiating its first set of funded research programmes in 1998. Next came the Challenge Programs⁸, which are being progressively integrated into the new CRPs. The introduction of the CRPs in 2010 elicited mixed emotions of excitement and fear among ILRI livestock scientists; the former responding to potential new funding opportunities, the latter from the apparent impending erosion of institutional leadership under a livestock banner.

The concept of CRPs has brought a new opportunity for a much broader engagement of the CG Consortium membership with the ever widening range of issues confronting the sustainable contributions of livestock to development and poverty reduction.

3. KEY DRIVERS OF GLOBAL LIVESTOCK RESEARCH FOR POVERTY REDUCTION, FOOD SECURITY AND NATURAL RESOURCE SUSTAINABILITY

To use a common cliché, the livestock development arena in both developed and developing countries is currently stuck between a rock and a hard place. The demand for meat and other livestock products is growing rapidly, and will continue to grow over the next three decades in most developing regions⁹. This opportunity has extraordinary potential as a development tool in processes of equitable economic growth and poverty reduction, and brings well documented nutritional benefits, particularly to children. But at the same time, animal agriculture and its intensification are cursed by many¹⁰, seen as contributing to the erosion of natural resources through land degradation, the decline and pollution of water resources, the emission of greenhouse gases¹¹, the erosion of biodiversity, and for introducing new human health threats, both direct and indirect^{12, 13}. Many of these issues were captured by FAO in the 2009 State of Food and Agriculture (SOFA) report entitled *Livestock in the Balance*¹⁴, and are discussed by Herrero et al. (2012). This is indeed the era for livestock research, but for livestock research which seizes the opportunity to rise to the occasion and seek an appropriate pathway forward which recognises the strengths and weaknesses of the sector, and engages effectively with a wide range of development partners.

The development of the CGIAR’s Strategy and Results Framework (SRF) in 2011 has been a key milestone in addressing the challenges and opportunities in agricultural research for development, and it provides the blueprint by which CRPs and Centres will make their impact. An important component of this strategic overview is to assess how well the large, multi-partner CRPs address major development challenges identified in the SRF. The four system-level outcomes (SLOs) of the SRF are:

⁵ CGIAR (2011)

⁶ CGIAR (2005)

⁷ CGIAR SLP (2013)

⁸ CGIAR Challenge Programs were the early precursors of the CRPs, and conceived in the late 1990s to build complementarities, synergies, and collective action among Research Centers. They introduced a new model for collaborative research. All Challenge Programs are being integrated and mainstreamed into appropriate CRPs. When all the CRPs are fully approved and are operational, the Challenge Programs will be fully mainstreamed.

⁹ LDIA Project (2013)

¹⁰ Wikipedia: Environmental impact of meat production (2013)

¹¹ Steinfeld *et al.* (2006)

¹² Grace *et al.* (2012)

¹³ Daszak *et al.* (2000)

¹⁴ FAO (2009)

1. **Reducing rural poverty (SLO1).** Agricultural growth through improved productivity, markets and incomes has been shown to be a particularly effective contributor to reducing poverty especially in the initial stages of development;
2. **Improving food security (SLO2).** Access to affordable food is a problem for millions of poor people in urban and rural communities and it requires increasing global and regional supply of key staples and containing potential price increases and price volatility;
3. **Improving nutrition and health (SLO3).** Poor populations suffer particularly from diets which are insufficient in micronutrients affecting health and development, particularly in women and children;
4. **Sustainable management of natural resources (SLO4).** Agriculture demands better management of natural resources to ensure both sustainable food production and provision of ecosystem services to the poor, particularly in light of climate change.

The SRF and its accompanying SLOs heralded a new era for the Consortium, bringing the aspirations and objectives of all Consortium Centres under a set of shared ideals and deliverables. However, Centres still appear to be developing their own institutional strategies, which relate to their scientific goals and priorities within their own commodity or sphere of influence, and their level of financial independence from CRP funding; nevertheless their performance will likely be measured increasingly by their sponsors and others on the basis of their contributions to the SLOs.

In analysing the responsiveness of the CGIAR's entire research programme in livestock across all CRPs to these outcomes, as part of this process we have tried to identify the key, internationally recognised drivers of livestock research, drawing on both long-standing approaches to livestock development in the developing world, and new thinking in this field. Below we provide below a synthesis of these drivers, and their interface with the CGIAR's SLOs. We also include interface with growth; in a recent ISPC analysis of the SLO impact pathways and inter-linkages growth is emphasised in several places.¹⁵

Higher level drivers	Specific drivers	SLO relevance ¹⁶
Economic growth	The livestock revolution ^{17, 18} increasing demand for livestock products, and demand for higher quality meat and milk products, particularly by urban consumers	SLO1, SLO2. The challenge is to generate evidence that pursuit of the SLOs does not need to involve trade-offs. How does appropriate smallholder-based development contribute to sustainable and
	Increasing prominence of supermarkets requiring higher quality products, with predictable supply, provenance, etc. ²⁰ . This is recognised to be difficult for smallholder participation ²¹ , while an opportunity for recognition and market expansion ^{22,23} .	
	Rapidly increasing share of pig and poultry meat in total meat production, supplied largely by the	

¹⁵

http://www.sciencecouncil.cgiar.org/fileadmin/templates/ispc/Expert_advice/Advice_to_the_CGIAR/ISPC_SLO_linkages_white_paper_final--15_June_2013.pdf

¹⁶ SLO1 = reducing rural poverty, SLO2 = improving food security, SLO3 = improving nutrition and health, SLO4 = sustainable management of natural resources

¹⁷ Delgado *et al.* (1999)

¹⁸ Sumberg and Thompson (2013)

	commercial sector ²⁴	equitable economic growth? ¹⁹
	The need for sustainability and environmental sensitivity; the high risk status of smallholder farmers in processes of intensification ^{25, 26}	
Population growth and urbanisation ²⁷	Contributes to the increased demand for livestock products ²⁸ , but also increased exposure to market risks (supply and price fluctuations)	SLO1, SLO2, SLO3
Climate change: balancing the research agenda of mitigating impacts of livestock on environment (greenhouse gases) and impact of climate change on livestock systems ^{29, 30, 31}	International concerns about the direct contribution of livestock to climate change (high methane emissions, and NO ₂ emissions through manure handling) ^{32, 33}	SLO4
	Concerns about climate change and increased occurrences of extreme weather events and their possible impacts on animal health and production ³⁴	SLO1, SLO3
	Concerns about the high carbon foot print of livestock-related deforestation and pasture degradation	SLO3
Feed-use efficiency in livestock systems	National concerns about rising imports of animal feeds (e.g. soy and grains), and of meat and milk products in many developing countries; a signal of poor competitiveness in domestic production due mainly to feed use inefficiency	Growth
	The growing understanding of the importance of feeds (grazing lands, forages, crop residues, fodder production) and feeding systems on intensification of ruminant livestock production The need for better use of underutilized feed resources (e.g. dual purpose crops) to reduce competition / trade-offs	SLO1, SLO2, Growth
Natural resource management	Rising competition for resources such as land and water: trade-offs between food, feed and bio-fuels ³⁵	SLO1, SLO3
	Continuing degradation of grazing lands (over-use of resources) and need to understand dynamics of	SLO1, SLO2, SLO3

²⁰ Reardon and Timmer (2005)

²¹ Elepu (2009)

²² Garnett et al., 2013

²³ Reardon et al. (2010)

²⁴ USDA FAS (2013)

¹⁹ Espey, 2013

²⁵ Thornton 2010

²⁶ McDermott et al. (2010)

²⁷ De Haan, 2013

²⁸ WHO (2013)

²⁹ Steinfeld et al. (2006)

³⁰ Gill et al. (2010)

³¹ Gerber et al. (2010)

³² Thornton and Herrero (2010)

³³ See Calvosa et al. (2009) for example <http://www.ifad.org/lrkm/factsheet/cc.pdf>

³⁴ See Thornton et al. (2009) <http://www.sciencedirect.com/science/article/pii/S0308521X09000584>

³⁵ Golub et al. (2012)

	rangeland ecology, including bush encroachment and role of invasive species	
	The need for a greater understanding of the roles and practicalities of Payment for Environmental Services in livestock systems ³⁶ , affecting biodiversity conservation, watershed protection and carbon sequestration	SLO1, SLO3
Natural resource management; effluent and pollution	Concerns about effluent pollution from intensive, concentrated livestock production systems (particularly near urban areas, divorced from feed production)	SLO3, SLO4
The water footprint of livestock ³⁷ : the need to strengthen water-use efficiency research in irrigated and rain fed systems	International concerns about the increasing competition for water (high water use requirements for livestock production)	SLO2, SLO3, Growth
Increasing animal and human health risks	The continuing need for appropriate, responsive and sustainable animal health delivery models	SLO1, SLO3
	The increasing risks and perceptions of emerging diseases in intensifying systems, with particular attention to zoonotic diseases in intensifying and urban systems ^{38, 39} ; The risks of food-borne disease as supply chains become longer and more complex	SLO3
	The need for greater understanding of the evolving roles of public and private standards at local, national and international levels in facilitating markets access and protecting human health ^{40, 41}	SLO1, SLO2, SLO3, SLO4, Growth
	Increasing concern about animal welfare in marketing of livestock and livestock commodities	
The continuing vulnerability of livestock-associated populations in pastoral and other dryland regions	Debates on viability of pastoralism exacerbated by climate change. Concerns to bridge relief and development. Interest in improving human services and livelihood diversification options for pastoralists. Interest in improving early warning and developing livestock insurance	SLO1, SLO2
	Understanding of the implications for equity of livelihood enhancement in arid and semi-arid environments ⁴²	SLO1
The inadequate recognition and balanced evidence-based	The need to address a wide range of livestock-associated issues and controversies in development and natural resource management policies at	SLO1, SLO2, SLO3, SLO4, Growth

³⁶ Silvestri *et al.* (2012)

³⁷ Mekonnen and Hoekstra (2012)

³⁸ Jones *et al.*, (2012)

³⁹ McDermott and Grace (2011)

⁴⁰ Perry *et al.*, (2005)

⁴¹ Perry and Dijkman, (2010)

⁴² Aklilu and Catley, 2010

articulation of the goods and bads of livestock and livestock commodities, and the adoption of such evidence in agricultural policies ⁴³	national and system levels	
The lack of progress on the use of gender-aware and socially inclusive approaches to livestock development	Increased recognition of key roles of small stock for women farmers and the extreme poor	SLO1, SLO2
Continued weaknesses in the links and contribution of research to development outcomes	Changes in the CGIAR modalities are recognised, and innovation systems are more widespread, but there remains a disconnect between certain areas of research and planned development outcomes.	SLO1, SLO2, SLO3, SLO4, Growth

4. LIVESTOCK RESEARCH ACROSS THE CG CONSORTIUM: SOME EMERGING ISSUES

We have reviewed and analysed the CRPs currently operational within the CG Consortium, and we present an analysis of each CRP in Annex 1. Building on that CRP by CRP assessment, we present here some emerging issues consideration and discussion exploring strengths and gaps in the current portfolio.

The dispersed livestock research agenda has undoubtedly changed the face of livestock research across the CG Consortium, and presents both new opportunities and new challenges. Overall it has probably raised the profile of the CG Consortium's livestock research portfolio, with identifiable components now spread more widely among CRPs and Centres. This devolution of responsibility and authority undoubtedly provides considerable opportunity for research into some of the more neglected areas by broadening the science and scientist base, and opening the door to new collaborations outside the CG Consortium. At the same time we noted from interviews a perception that it has challenged the leadership role of ILRI in livestock research, and this has arguably been exacerbated by the very generic institutional strategy which ILRI has recently published.

Broadly speaking, the CG Consortium livestock agenda across CRPs responds to many of the high level and specific drivers of livestock research which we have identified above, and has high relevance to the SLOs and growth. However, undoubtedly if one had had the opportunity to develop *a priori* a balanced livestock research framework which responds effectively to these drivers in different priority production systems and agro-ecologies, and with the appropriate resources and partnerships, the CG consortium portfolio of research would likely have had a different face.

4.1 LIVESTOCK FEEDS

Background

More and better quality feeds lead to higher feed-use efficiency and are a key ingredient of sustainable livestock intensification. Improved animal productivity, resulting from the availability of high quality feed, has many advantages: higher milk yields, faster growth rates and more off-spring result in higher income for

⁴³ Herrero *et al.* (2009)

smallholders and a reduced environmental footprint per unit animal product. More and higher quality feed, however, comes at a cost in terms of land, water and labour, and these need to be carefully balanced. So far much of the increased demand for meat has been achieved by increasing pig and poultry production mostly by the commercial sector⁴⁴. This trend has driven the rapidly increasing demand for and trade of feed grains and soybean (as a protein source) but has also led to environmental concerns about effluent pollution and resource use for feed grain production.

Analysing trends and predicting feed use in ruminant livestock feeding in developing countries to 2030 the World Bank (2012) predicted a reduction in the use of crop residues, an increase in the use of crop by-products such as oil cakes and concentrates, an increase in the area of planted forages, and a sharp increase in feed procurement rather than own production. Identifying priority areas for investment they highlighted technological research (on feed-food crops, better ration formulation, processing and storage, and forage seed production), institutional issues (such as access to land and water, improved governance, capacity building, access to markets, inputs, services and information), policy concerns (such as dumping of meat and milk from developed countries, regional tariff barriers and lack of investment in infrastructure), and the inclination of smallholders to increase animal numbers in response to market demand with dire environmental consequences. A major conclusion of the report was the need for sustainable livestock intensification which in turn requires more and better feeds.

Feed research suppliers in the CGIAR

Research on livestock feeds in the CGIAR is fragmented (Annex 1). This is partly related to the wide variety of plants that constitute feeds including forages (grasses and legumes, and including pastures), fodder crops (e.g. oats, barley, maize, and sorghum), crop residues (straw, stubble, haulms, stover), crop prunings (e.g. leaves of maize), feed grains and RTBs (e.g. barley, maize, soybean, cassava) and crop by-products (e.g. oilseed cake, rice bran).

The CG Centres with an emphasis on feed research are:

CIAT: Forages (grasses, legumes and fodder trees/shrubs) for humid and sub-humid tropics

ILRI: Forages for highland tropics, quality aspects of crop residues

ICARDA: Forages for drylands, particularly in small ruminant systems

Different feed research suppliers have expertise in a range of technical areas such as breeding, agronomy, nutritive value and feeding systems. Historical development of expertise means that each supplier has particular strengths (e.g. CIAT – breeding *Brachiaria* hybrids) and expertise in particular livestock systems and ecosystems.

Feed research localities in CRPs

CRP 3.7: The majority of feeds research is conducted within CRP 3.7, which is led by ILRI and brings together the expertise of ILRI, CIAT and ICARDA. It focuses its research on intensification of selected livestock value chains in a limited set of countries where there is high potential for intensification of small-scale livestock production. In these value chains, CRP 3.7 conducts feeds research including: (i) producing more and better feeds, (ii) making better use of the available feeds, (iii) processing of feeds, (iv) marketing of feeds, and (v) understanding the implications of different feeding systems on labour allocation and time use, and income generation potential, especially by women. The value chain approach provides a simple framework and focus for feeds research that addresses the key objective of sustainable intensification of livestock production. The limited range of locations and environments where this research is carried out limits the scalability of concrete

⁴⁴ Delgado, 2005

feed options but provides an opportunity to develop approaches and methodologies that can be applied elsewhere. Individual value chains will be led by different CG Centres. For example, ICARDA is leading the small ruminant value chain in Ethiopia, and CIAT is leading the dual-purpose cattle value chain in Nicaragua. This concurs with the particular expertise of these Centres. The value chain approach employed by CRP 3.7 tends to lead to a lower emphasis on interactions with crops and other farm activities, and environmental aspects of feed production and use, and these need to be addressed in other CRPs. A supporting activity of CRP 3.7 is the building of a platform for the evaluation of feed quality for breeding programs of the various crop CRPs.

CRP 1.1 and 1.2: CRPs 1.1 (led by ICARDA) and 1.2 (led by IITA) conduct research on feeds in a systems context. ILRI is a major partner in both CRPs, and CIAT is a major partner in CRP 1.2. The systems approach naturally leads to a focus on the interactions between feeds / livestock and food (and tree) crops, and livestock and the environment, and addresses issues such as the trade-off between the uses of crop residues for animal feeds vs. soil conservation. CRP 1.1 divides its target environment into those with more favourable conditions (with a research focus on intensification and diversification and thus an overlap with CRP 3.7) and those with less favourable conditions for improving agricultural productivity (with a research focus on reducing vulnerabilities). Similarly, the geographic scope of CRP 1.2 overlaps with several of the value chains in CRP 3.7. For both Systems CRPs feeds research is part of a wider agenda on a step-wise intensification process and, while being acknowledged as an important component of farming systems, has not been outlined in detail.

CRP 3.1, 3.2, 3.3, 3.4, 3.5 and 3.6: Crops and their by-products provide a substantial part of the livestock feeds. Pig and poultry production systems are almost entirely dependent on grains and oilseed crops. Dairy production relies heavily on concentrate feeds. The value of crop residues of some dryland grains and legumes can make up 50% of the total value of the crop, making them truly dual-purpose crops. Some crops such as sorghum and maize are purposely grown for fodder only in some regions. Crops with a particularly high 'feed' value include: Barley (mostly for grain), soybean, maize, sorghum, cassava and other dryland grains and legumes. While these uses are well described in the CRP proposals, there are few research outputs that relate directly to feeds. Most crop CRPs engage in feeds research in two ways. Firstly, they include traits for improved feed quality of crop residues in their breeding programs based on the finding that this is possible without compromising grain yield⁴⁵. Secondly, they engage in research on sustainable intensification of farming systems in regions in which their crop dominates (e.g. rice-based systems). Almost invariably, these are mixed crop-livestock farming systems and livestock and feeds are an important livelihood component of these farming systems. This research overlaps partially with the systems CRPs, and not all of the feed-related research is linked to the 'feed research suppliers' identified above. ILRI is not a listed partner in any of the crop CRPs, however, there is limited collaboration with some CRPs. ILRI collaborates with CRP 3.3 GRISP on rice straw quality through the CSISA project in Bangladesh, and CRP 3.2 MAIZE has contracted ILRI to collaborate on feed quality aspects of maize.

Linkages between CRPs on Feeds

There are several linkages on feed research between CRP 3.7 and System and Crop CRPs. CRP 3.7 is listed as a collaborator on feed quality aspects of crop residues in most crop CRPs. It is also listed as a collaborator in the system CRPs 1.1 and 1.2 on intensification of crop-livestock systems, fodder / forage production, environmental dimension of fodder production, biomass use for feed and the environment. CRP 1.1 lists collaboration on understanding the trade-offs in biomass uses with CRP 1.2, and CRPs 1.1 and 1.2 will provide feedback to crop CRPs on needs for crop characteristics (e.g. requests for dual-purpose crops, fodder crops).

Discussion

⁴⁵ Sharma *et al.* (2010)

The emphasis on feed research in a value chain context in CRP 3.7 and in a systems-oriented approach in CRPs 1.1 and 1.2 potentially cover both the need for intensification and the systems and environmental foci needed for a comprehensive feeds research strategy. Much, however, depends on the effectiveness of partnerships and communication among the 'feed research suppliers' and the various CRPs engaged in feed-related research. System CRPs and CRP 3.7 need to provide feedback to Crop CRPs on the need for quality and quantity aspects of crop residues, dual-purpose and fodder crops. This requires a more formal mechanism for discussing the feed needs in different value chains, livestock systems and environments than was envisaged in the CRP proposals.

There are several critical linkages that are needed to ensure effective feeds research. The linkage between feeds research in CRP 3.7 value chains and the systems-oriented research in CRPs 1.1 and 1.2 is critical for avoiding duplication and maximising the complementarities of the two research approaches. Also, feed-related research conducted as part of sustainable intensification of farming systems in Crop CRPs is in danger of being conducted in isolation and without linkage to either CRP 3.7 or CRPs 1.1 and 1.2. There is an urgent need to investigate options for facilitating linkages and cross-CRP learning on feed research across CRPs.

Feed research gaps

In reviewing feed research across CRP proposals a number of issues have been identified that warrant consideration in future feed research planning:

- Protein – an emerging feed gap. The demand for plant-based high-protein feed ingredients such as soybean is increasing rapidly with the rising demand for pork, poultry and milk in developing countries. Increasingly, aquaculture producers are also looking towards plant-based protein sources for feeding fish (cf. CRP 3.7 proposal). This provides both an opportunity for smallholder farmers to produce such protein feeds for sale in domestic markets and a constraint for small-scale livestock producers who will need access to high protein feeds for more intensive animal production. This warrants a more substantial research focus on soybean, other high protein grain legumes and other plant-based protein sources for animal feeds.
- The need for a feedback and discussion mechanism on feed gaps identified by CRPs 1.1, 1.2 and 3.7 to the Crop CRPs breeding programs to ensure that needed forage and fodder crops, dual-purpose varieties, and varieties with higher-quality crop residue are available for livestock intensification. This goes well beyond the scope of the CRP 3.7 platform on quality aspects of crop residues.
- The need to investigate options for coordination and facilitation of linkages and cross-CRP learning on feed research between CRP 3.7 value chain research, CRPs 1.1, 1.2 and Crop CRPs systems-oriented research.
- The need to allocate specific budgets for joint feed research activities between CRPs. In many instances, collaboration with another CRP has been highlighted (e.g. most Crop CRP mention collaboration with CRP 3.7 on quality aspects of crop residues) but there are no clear funding arrangements that facilitate this joint research. There was only one case where funding was clearly allocated for joint research, another pointed to pre-CRP project funding that facilitated limited collaboration, and no funds were allocated in several other cases. This situation does not encourage effective collaboration and needs to be rectified in future proposals.
- Development of seed systems. This is an area identified by The World Bank (2012) report quoted in the introduction but received relatively little attention in CRP 3.7. Recently, seed delivery was highlighted as a serious constraint to generating impacts in a recent ISPC commissioned strategic overview on seed systems (CGIAR ISPC 2012⁴⁶) which recommended a series of areas for attention.

⁴⁶ CGIAR ISPC 2012. Strategic overview of CGIAR Research programs Part II. Value chains and Seed systems. ISPC, Rome, December 2012. Accessed on 21 Aug 2013:

The low emphasis on seed delivery was appropriate initially as seed only becomes a serious constraint as demand increases during the scaling out phase of development. Facilitating the formation of seed supply systems, however, needs to go hand in hand with increases in demand for seed of specific varieties and this takes considerable time to develop. It is thus appropriate to initiate research into ways of facilitating seed systems as soon as promising new varieties are identified in the current feed research.

4.2 LIVESTOCK POLICY

Agricultural policy issues, which are assumed to include livestock policy issues, are formally contained in CRP 2 (Policies, Institutions, and Markets to Strengthen Food Security and Incomes for the Rural Poor), but there is now broader coverage across the CRPs of policy issues, in particular ensuring that policy is informed by research findings. CRP 7 in particular contains policy work under its Theme 4: Integration for Decision-Making.

Through CRP 2 and policy work under other CRPs, the CGIAR brings distinguished expertise to bear on agricultural policy. Nevertheless, we feel this work risks missing out some specific questions of livestock-related policy. We summarise these under four headings:

Multifunctionality of livestock: the livestock kept by poor people in developing countries (and many in more traditional production systems who might not be regarded as poor) serve multiple functions⁴⁷: direct consumption of livestock products, sale of livestock products and live animals for sale, inputs to crop production, a savings/insurance/consumption-smoothing function, and a social function (establishing and maintaining social bonds through loans, gifts, marriage payments etc.). This not only means that small-scale livestock producers are constantly engaging in trade-offs between multiple uses, it also means that livestock production may be refractory to research agendas, in the biophysical or social sciences, that assume clearly identifiable production objectives.

Environmental externalities: more so than with crop-production (though this is not to minimise the important externalities associated with fertiliser use, or with certain crop-processing technologies), livestock production involves very strong environmental externalities, including overgrazing, nitrogen emissions from manure, and greenhouse gas emissions⁴⁸. Research on these issues, and making findings available to policy-makers, have been carried out by and under the auspices of FAO since the mid-90s: a strong strand in this is that potential externalities of livestock production are exacerbated or mitigated by institutions and policies, and are thus a policy issue.

High transaction costs in livestock value chains: Value chains for livestock products and livestock on the hoof involve, as a generalisation, higher degrees of risk and transaction costs than those for crop commodities and may produce an (apparent) tendency to oligopoly and dominance of middlemen. Relevant factors include:

- For livestock and meat; livestock's nature as both capital and commodity, constant trade-offs by producers between different uses, (in some systems) scattered supply, high skill requirements for dealing with live animals, high perishability of meat, cost of dealing with veterinary regulations⁴⁹;
- For milk; perishability, bulkiness, quality variations, high entry and exit costs of processing⁵⁰.

http://www.sciencecouncil.cgiar.org/fileadmin/templates/ispc/Expert_advice/Advice_to_the_FC_CRPs/_CRPs_2012/cross-CRPs/19DecCross-CRP-Synthesis-Value_chains-Seed_systems_FINAL.pdf

⁴⁷ Kitalyi *et al.* (2005)

⁴⁸ Gerber *et al.* (2010)

⁴⁹ Little (1995)

⁵⁰ Jaffee (1995)

The World Bank (2009) has adopted a similar analysis based on the necessity, and difficulty, of livestock-based value chains providing: uniformity of product, reliability of timing of supply, reliability of the origins of supply (traceability), and compliance with sanitary standards.

Multiple and shifting policy objectives for livestock: FAO (2009) proposes a fourfold schema for government (and donor) policy objectives for livestock, which is in fact close to the CGIAR's SLOs:

- Livelihoods
- Food security (and prosperity more generally)
- Food safety and human health
- Environment (see above)

However, the FAO analysis stresses much more that the balance between these objectives tends to shift as countries develop and industrialise. Such shifts to some extent distinguish livestock policy from policy in other branches of agriculture.

4.3 LIVESTOCK VALUE CHAINS

ILRI made a strategic choice to introduce greater focus to its livestock research programme, driven in part by the call for better defined outcomes and greater impact, and CRP 3.7 exemplifies this change in approach, which the strategic overview team endorses. However, it does raise some questions. A major gap and opportunity identified in this CRP is the area of post-harvest losses in each of the commodities. This includes the areas of storage, transportation, marketing and processing, seeking options for the different value chains, and exploring targeting for optimal distribution and nutritional impact. This is a substantial component of a value chain analysis, and the underlying hypothesis of broadening the range of impacts to a wider range of stakeholders than just producers. A further gap is the need for an understanding of consumer preferences, including the willingness to pay component.

A further comment on the context of these selected value chains. The CRP states that its paired country-distinct case studies “will allow comparisons and cross-system learning that will support the development of strategic lessons, methodologies and technologies of wide applicability, and the delivery of strong international public good knowledge outputs”. As discussed in the comments on CRP 3.7 (Annex 1), perhaps the most significant area in which this CRP could draw on its comparative advantage in the CG Consortium is to take these selected case studies up to a higher level, and engaging in a transregional analysis which would help to put the selected value chains in a wider global context, giving a better understanding of the extrapolation potential of the results obtained from this limited cluster.

An additional question is on the choice of value chains, and other candidates for the future might include indigenous poultry and beef, but the counter to this is the need to retain focus, comparative advantage and credibility, and not be enticed into trying to be all things to all people.

4.4 THE LIVESTOCK/ENVIRONMENT/CLIMATE CHANGE INTERFACE

The impacts of livestock on the environment, and ways to mitigate these both through technological innovation and through policy/institutional issues, have been a major feature of policy-related discussion of livestock development since the mid-90s, particularly in work carried out by or sponsored by FAO. Environmental impacts discussed included overgrazing, eutrophication of water associated with nitrogen run-off, and industrial pollution from tanneries. In 2006 *Livestock's Long Shadow* took a more pessimistic tone about the possibility of mitigation and added the emission of greenhouse gases to the list of environmental impacts, with high estimates for global emissions (18% of anthropogenic greenhouse gases and 37% of

anthropogenic methane) which have been much repeated in climate policy literature and the media. *Livestock's Long Shadow* controversially advocated intensification as a means of reducing emissions per unit of economic output.

At the same time, there has been an increase in research interest on the potential impacts of climate change on livestock. These, summarised by Thornton *et al.* (2009), include quantity and quality of feeds, heat stress, water, and changing patterns of disease. The latter, also reviewed by Baylis and Githeko (2006) are seen as suffering “intrinsic problems of predictability”. Another potential pathway for impact has been climate change effects on rangeland composition. At the same time, Jones and Thornton (2009) demonstrate for Africa, and at a broad geographic scale, that “transition zones can be identified where the increased probabilities of failed seasons may induce shifts from cropping to livestock”, although the policy and information needed to effect this transition are not discussed. There has also been a specialist literature on pastoralist adaptation to climate change, drawing on existing strategies to cope with climate variability.

The above work on impacts and adaptation has only represented a small fraction of the work that has been done on climate change and crop agriculture. There is a pressing need for livestock-specific work on the full range of potential impacts of climate change on livestock. This includes the effects on pests and disease vectors, and the threats these might pose to different systems. A major gap identified in CRP 7 is exploration of the impacts of climate change scenarios on changes in disease occurrence and impact (particularly vector-borne diseases, but also those which are water-borne and temperature sensitive, of both plants and animals). There is also a need for work on adaptation that carefully considers the complex relation between coping and adaptation, and the necessary policy environment of adaptation.

It was noted that CCAFS has developed a memorandum of understanding with the AGA policy group in FAO, which is seen as very constructive, as FAO seeks to explore sustainable livestock sector development as part of the Global Agenda of Action. This constructive partnership highlights the absence or weakness of other partnerships between FAO and CRP 3.7, the system CRPs and ILRI

4.5 THE CONTINUED CONSTRAINTS IN ANIMAL HEALTH AND FEEDS SERVICE DELIVERY

The CGIAR is engaged in developing a variety of technologies and innovations which are designed to be used by the poorer livestock keepers of the developing world. While much has been discussed and written on theories of change and impact pathways, without functional and sustainable services for the delivery of such knowledge, innovations and technologies in the areas of animal health and feed resources, little impact will be felt. For feed, as livestock systems intensify, farmers will need access to good quality forage and fodder seeds, different fodders, compound concentrate feeds, knowledge on how to mix and combine feeds suitable for different phases of production, and many other feed-related products and services. The concept of prioritisation tools such as Techfit⁵¹ which assess in a practical manner different feed options is seen as a most valuable approach.

Animal health services are notoriously weak in most countries of Africa, and many in Asia. Despite the presence of numerous case studies, cameos and even larger scale examples of functional service delivery meeting demands of the CGIAR's target beneficiaries, policy and institutional research by the CGIAR of delivery systems in developing countries is virtually absent. There are of course other players in this field, notably the Food and Agricultural Organisation of the United Nations (FAO) and the OIE (World Organisation for Animal Health) who are active in different ways. FAO has made considerable progress in building on its emergency service responses to livestock diseases such as highly pathogenic avian influenza by broadening the capacity to respond to other diseases, where donor agreements have allowed, and on building sustainable indigenous capacities in the field and the laboratories. However the challenge they have faced has been to bridge the gap

⁵¹ Duncan (2012)

between widening these emergency response portfolios, and also considering the long term support to health services for endemic and neglected diseases⁵². Similarly OIE has developed and refined a process of evaluating veterinary services on a country by country basis with the aim of setting standards for service quality⁵³. Valuable as this initiative is, it centres primarily on compliance with OIE's standards for the control of notifiable diseases affecting trade in livestock and livestock products, and pays lesser attention to the demands of a given country vis-à-vis broader animal health services to its livestock development strategy and the needs of the different sectors. Animal health services in many developing countries with growing livestock economies have to deal with a wide range of different types and qualities of service to their vastly differing clientele in contrasting development trajectories⁵⁴. We are of the opinion that the CGIAR could have an important role to fill in this arena. This could be placed initially under the current value chain activities of CRP 3.7, and the zoonotic and emerging disease control aspects of CRP 4. There is also the potential to consider this in the systems CRPs of 1.1, 1.2 and 1.3. Areas of particular importance include ensuring that services are in line with the national livestock development strategies and human and animal health priorities of the countries concerned, and to address the need for service provision at community level in settings where these are not available. The use of Community Animal Health Workers (CAHWs) is regarded, in some regions, and particularly in remote areas under-served by more conventional delivery systems, as promising and upscalable⁵⁵. In some other areas experience has been negative, except in the delivery of vaccination. The important issues are the development of business models which are both financially sustainable and include proper oversight, and the regulatory environment, including relations with the veterinary profession.

4.6 ILRI'S UNIQUE RESOURCE IN BIOTECHNOLOGY: BIOSCIENCES EASTERN AND CENTRAL AFRICA (BECA)

The Biosciences Eastern and Central Africa (Beca) Hub⁵⁶ is a facility embedded within ILRI designed to promote, foster and accelerate the contributions of the biosciences to Africa's agricultural development. The Hub's shared platform with ILRI gives it a unique status. It benefits from the global research network and trusted administrative support which ILRI and the broader CGIAR provide; and it benefits from the direct engagement with, and service to, the agricultural and bioscience development aspirations of the African Union (AU) and its constituent membership. Curiously, there is little if any mention of BecA in most of the CRPs, including in CRP 3.7. The facility is currently used by ILRI, CIP and IITA, and is independently supported in part by sponsors keen to develop biosciences capacity in Africa, and have the facility as a laboratory environment accessible by African researchers on crops, livestock and indeed all fields of biotechnology. It is an excellent facility which has the potential to contribute to the SLOs of food security and human health, and the cross-cutting objective of capacity building.

4.7 ANIMAL GENETIC RESOURCE CONSERVATION AND USE

Curiously, while genetic resource conservation and use is central to the CGIAR crop centres, in which it demonstrates the unique comparative advantage of the CGIAR, livestock genetic resource conservation and use are not explicit to the CGIAR livestock agenda, not even in ILRI, although ILRI does hold the valuable forage crop gene bank at its facility in Addis Ababa. ILRI has historically undertaken limited research on genetic characterisation and conservation, but has been part of a call for greater attention to this issue⁵⁷. The crop centres generally restrict their breeding activities to crops and cropping systems that are not covered by the

⁵² FAO (2009)

⁵³ OIE (2013)

⁵⁴ Perry *et al.* (2011)

⁵⁵ See Leyland and Catley, 2002 http://www.eldis.org/fulltext/cape_new/Leyland_and_Catley_OIE_Tunis.pdf

⁵⁶ <http://hub.africabiosciences.org/>

⁵⁷ See for example Okeyo 2011: <http://www.slideshare.net/ILRI/animal-genetic-resources-characterization-and-conservation-research-in-africa-an-overview>

private sector. Is livestock breeding adequately covered by the private sector? Almost certainly not, but it is unclear as to whether livestock breeding would be a high priority given the 4 SLOs. However, it is the subject of mandates given to national and international research communities under an international agreement, the Interlaken Declaration and Global Plan of Action for Animal Genetic Resources⁵⁸. Under this agreement the need to promote the development of knowledge, in particular through research, leading to improved sustainable use, development and conservation of animal genetic resources was recognised, and the international research community was urged to provide scientific guidance for strategic decisions under conditions of imperfect information. Animal genetic resource conservation is also a topic of interest to NGOs, who also promote concepts of “Livestock Keepers’ Rights⁵⁹” to conserve indigenous breeds.

Within the current CRPs, it is perhaps not surprising that it is only in 3.7 where livestock genetics is mentioned, and here there appear to be aspirations to seek broader cross CG dialogue and collaboration. CRP 3.7 writes: *“The CRP will provide a platform for working in a coordinated manner, building a team of geneticists across Centers with a broader range of expertise. Complementary skills and talents, as well as experience in different environments, are expected to translate into a greater ability to address the most limiting constraints consequently leading to higher chances of achieving impact. This newly forged Animal Breeding and Genetics group will also raise the profile of work in this area in the CG system through consolidated views and propositions.”*

Elsewhere in the 3.7 proposal, it was written: *“Other genomic studies, such as the characterization of genetic diversity (to complement phenotypic characterizations, and to inform conservation strategies) or the identification of genes for important traits such as disease resistance (with potential applications to breed improvement and / or the creation of new animal health products), also have strong relevance to developing country livestock systems. However, as the potential outcomes from such studies are longer term and difficult to predict they play a complementary (rather than central) role to the overall research portfolio presented here”.*

These rather general comments leave the authors of this strategic overview wondering about the substance of animal genetic resource characterisation, conservation and use in the CRP portfolios; livestock genetics comes under the technology development component 1.2, and the set of seven research questions and seven activities comes over more as a shopping list than as a well thought out research agenda. Clearly the agenda of CRP 3.7 is very full, but arguably this important aspect of the intensification process merits greater specificity.

4.8 THE STRATEGIC INTENSIFICATION OF SMALL RUMINANT SYSTEMS

Over the last 20 years much of the developing world has seen a dramatic change in the contributions made by small stock to processes of poverty reduction. This has particularly centred on poultry in most regions of the world, and on pork, particularly in Asia but also in other countries of Africa and Latin America. This has been in three ways: firstly the opportunistic intensification of smallholder systems to take advantage of growing market opportunities; secondly the employment opportunities in large scale poultry and pig production, processing and marketing; and thirdly the nutritional benefits accrued from the increased proportion of animal protein in diets. While a similar demand growth has apparently occurred in small ruminants, this has been less obvious, less well articulated, and less exploited.

Sheep and goats play a critical role in the livelihoods of small scale producers, traders and processor in many dryland, marginal and high altitude regions of the developing world. The livelihood contributions comprise both a safety net as assets which reduce vulnerability in difficult seasons or other crises, and provide income

⁵⁸ <http://ftp.fao.org/docrep/fao/010/a1404e/a1404e00.pdf>

⁵⁹ See <http://www.pastoralpeoples.org/themes/livestock-keepers-rights/>

through local market opportunities. There is substantial evidence that these markets are indeed growing (see for example Aw Hassan *et al.* (2010); Iñiguez (2011); Peacock and Sherman (2010)). CRP 3.7 is exploring intensifying small ruminant value chains in two countries, Ethiopia and Mali. The authors see this as a highly relevant case study which is well placed to explore the many constraints to improved marketing, as well as the natural resource management issues associated with goats. However, given the documented evidence of the livelihood roles and of increasing market opportunities, the team questions as to whether the prospects for progressive intensification of small ruminant systems in other regions and settings in Africa, Asia and the Andean region of Latin America are being adequately exploited.

4.9 ENGAGEMENT WITH THE PRIVATE SECTOR

In many CRPs there is talk of engagement with the private sector, but the mechanisms for this, and the expected outputs are not clearly presented. There are some notable success stories of private sector engagements with smallholder agriculture through contract farming and vertically integrated companies involving outgrowers. Such mechanisms have the advantage of bringing together service needs (such as breeding, feeds and health) for both small, medium and even larger producers, as well as introducing the standards needed for Good Agricultural Practice (GAP) and Hazard Analysis and Critical Control Points (HAACP) for accessing and sustaining new urban, regional or niche markets. In the livestock field this is probably best represented by Farmers Choice in Kenya⁶⁰ and Zambeef in Zambia⁶¹. While it is understood that CRP 3.7 is exploring partnership with Fresh Cuts⁶² in Uganda, which is an excellent initiative, the authors question why there is not greater strategic dialogue between the CG Consortium and companies such as these to explore the strengths, weaknesses and modalities of smallholder partnerships with industry. New institutional models for sustainable smallholder intensification are urgently needed, and although we suspect that the CG does not currently have a credible voice in this dialogue, we believe that it should, and such a strategic dialogue is long overdue.

One area where there has been engagement with the private sectors has been ILRI's partnership with private insurance companies in the quest for index-based livestock insurance⁶³. Takaful Insurance of Africa has recently launched a pilot project providing satellite data-based livestock insurance cover for pastoral livestock herders in the drought-prone drylands of northern Kenya's Wajir County. The Takaful Livestock cover will provide livestock keepers in the county with covers against livestock deaths resulting from shortage of fodder due to prolonged dry weather. Those who subscribe to this insurance policy will receive payments if the forage available for their insured cattle, camels, sheep or goats falls below a given threshold, with assessment of the state of vegetative cover in the county determined by satellite data.

4.10 CROSS-CRP LINKAGES

Linkages between CRPs are relevant to many aspects of the CG overall research programme. These are:

- Ensuring there are no gaps, and that the combined and integrated CRP research agendas are complete, relevant and if possible integrated from an outcome perspective
- Ensuring that there is no duplication of effort, although some overlaps can be healthy; most importantly the boundaries between certain CRPs should be well defined and articulated
- Ensuring effectiveness and efficiency in the overall CG Consortium research programme

⁶⁰ Farmer's Choice Limited (2013)

⁶¹ Zambeef Products PLC (2009)

⁶² Fresh Cuts Limited (2013)

⁶³ ILRI (2013)

The 15 CRPs have been developed as independent multi-institutional collaborative research proposals, and most of them are constructed around a problem solving agenda. They have all broadly speaking followed a designated format under the guidance of the Consortium and the ISPC, but there is some variation in the style and presentation. The interface between CRPs appears to be largely centred on the availability of limited resources, and the consequent need for cross CRP partnership to achieve the anticipated outputs. As mentioned earlier, it is not purposefully based on a strategic overview of research needs across the range of CG expertise.

In considering the balance of livestock research across the CG, and the role of ILRI, the authors of this analysis see the three Systems CRPs (in which ILRI is a partner in two out of three) as a critical point of synthesis of emerging livestock-associated issues from all the commodity CRPs, particularly in the geographical regions in which they are operative. While the team sees progressive interface between CRPs with respect to drylands, it is of the opinion that a functional interface with the humid tropics CRP is yet to be fully achieved, lessening the impacts of commodity CRP outputs and deliverables in this priority systems context. CRP 1.2 is very strongly driven by an elaborately-defined interdisciplinary intellectual agenda around intensification, driven by resource pressures, and takes the form of integration at the farm level of tree, crop and livestock components; there are grounds for concern that the high level of abstraction tends to imply a single unilinear model of integration.

The team also notes that the systems-oriented research of many Crop CRPs, which includes feed and livestock research, is somewhat isolated from the 'main-stream' feed and livestock research of CRP 3.7 and CRPs 1.1 and 1.2.

4.11 OTHER PARTNERSHIPS

The initiation of the CRPs, supported by the SRF of the Consortium has moved the Centres from being commodity and system driven research institutions towards them playing a more direct and integrated role in sustainable rural development, food security and poverty reduction. This is a major and very valuable step, bringing together a cohesive CG approach to integrating agriculture, development and natural resource management. However, it is not the end of the road. Inevitably many of the CRPs still centre their endpoints on the rural smallholder. Indeed, curiously the unit of analysis in CRP 1.2 appears to be the smallholder. The broader systems CRPs will need to be paying attention both to the dynamics of smallholder enterprises, and to the interface between them and medium and larger scale livestock enterprises and markets.

The next step is arguably the broader consideration of agriculture as one of many opportunities in rural development, food security and poverty reduction, within the context of alternative employment options, alternative food production options, and other partners in the development arena. While this is moving to the margins of the CGs comparative advantage, key linkages with NGOs, and with socio-economic research capacity within non-CG research institutes, both northern and southern, will be critical in keeping the Systems CRPs in tune with the dynamics of rural development.

4.12 INSTITUTIONAL ISSUES

The adoption of CRPs as the centre stone of research management appears to be having a significant impact on the interdisciplinary and trans-disciplinary nature of CGIAR research. Operations have moved from coordination of commodity and thematic research by the 15 Centres to leadership of 15 CRPs by scientists scattered through the different centres. This has had various positive impacts such as cross-centre research planning, collaboration and cross-fertilization among CG Centres, but undoubtedly the largest impact has been a substantial increase in the transaction costs of research management. So a key question is does the time consuming transdisciplinarity bring added value outcomes and impacts that were not there before?

Roles and responsibilities

Multidisciplinary and interdisciplinary research is complicated and time consuming. There are clearly trade-offs between the relative simplicity and more obvious focus offered by sets of “monoculture” disciplinary scientists and groups interacting with their counterparts in government and national institutions, perhaps oblivious of the externalities implicit in their relatively narrow research findings, and the complexity of multidisciplinary teams grappling with the broader implications of innovations for a much wider set of stakeholders. The former is more manageable, but with a narrow impact, the latter requires outstanding management and organisation, but has the potential for initiating real change, and understanding the processes by which change occurs. It would appear that the CGIAR Consortium has moved precipitously to the latter *modus operandi*, but not necessarily with the required managerial tools required.

But the main challenge has arguably been gaining a common understanding of the ground rules of CRPs, and the interface between them, among the CGIAR scientists themselves, who almost unanimously complain about the amount of time spent discussing the logistics of CRP operations at the expense of the science itself.

The seats of power: Centres or CRPs?

While not seen as unduly disruptive, but raising the question about efficiency of resource use in livestock research across the CG Consortium, the emergence of CRP leaders who are junior to the Centre Directorates as powerbrokers within the broader Consortium presents, at least theoretically, additional managerial complexities. Some Centre Directorates maintain traditional leadership and management structures that appear to complicate the new leadership and management responsibilities of CRPs, raising the question as to whether the CG reform has gone far enough. There appears to be a difference between Centres, and those Centres with broader funding sources, and therefore less reliant on the CRPs, appear more reluctant to move away from the traditional Centre culture.

Ownership of the CGIAR livestock agenda: the role of ILRI

ILRI as an institute has been subjected to a period of dramatic change. It has entered a period of existence without unrestricted core funds, resulting in several of its historical flagship research areas having to undergo a period of transition to new modalities of funding. This has not been easy. Understandably this transition may see circumstances under which CRP funds are used to substitute unrestricted core, but this is unlikely to be sustainable. While it negotiated strongly for lead roles in four CRPs, it emerged with leadership roles in two, with an ILRI scientist as Director of just one (Livestock and Fish (CRP 3.7), and another ILRI scientist as Leader of a component of a second (the Agriculture-Associated Diseases component of Agriculture for Nutrition and Health, CRP 4). While these do cover some of the research areas on which ILRI was engaged before the birth of CRPs, these two research portfolios do not adequately represent the wide range of issues which ILRI espouses. This causes disquiet in some corners. The Livestock and Fish CRP cleverly confronts the commercialisation and intensification processes of smallholder livestock systems, in an “experiment” on understanding and supporting selected value chains, while other areas of livestock’s role, such as on livelihood issues, poultry enterprises, etc. now appear to be missing from ILRI’s agenda. In reality many of them are not. ILRI is currently engaged in 7 of the 15 CRPs, and so many other issues are dealt with by ILRI or other CGIAR scientists under other CRPs. For example ILRI plays a leadership role under CRP 1.1 on the drylands of Eastern and Central Africa, an ILRI scientist leads the Systems Analysis and Synthesis Research Theme of CRP 1.2 on the humid tropics, and an ILRI scientist leads one of the four Themes of CRP 7 (Climate Change, Agriculture and Food Security). It was noted that each of these roles appear to go beyond just the livestock dimension.

Apart from the challenges this transition presents for ILRI in funding research endeavours which do not fit under the two funded areas led by the Institute, some see the change as having given rise to a fragmentation of the global livestock agenda. While this is understandable from an institutional perspective, it is interesting to note that other scientists see this as a major opportunity to widen the engagement of the CGIAR in livestock research issues, and indeed to offer greater breadth to the range of research partnerships through new, or

newly discovered networks of scientist. The concern about fragmentation even raises concern that Centres should be careful not to over-commit to CRPs, based on a feeling that Centres risk reducing their impact in the longer term, and as such their very survival.

It is important to document that ILRI had to make strategic choices as to its engagement with different CRPs. It is easy for us to say that ILRI should be more engaged with for example say the crop centres to investigate dual purpose crops, or the role of livestock in certain aquatic systems in the Ganges river basin or the flood plains of the Zambezi, but choices were made in the same manner as buying shares, based on total available unrestricted core funds plus 5%. It took, for example, active decisions not to engage with CRP 1.3 and CRP 6, for example, and despite the importance of greater understanding of water use and efficiency in livestock production and product processing, it receives under US\$ 200,000 annually from CRP 5, Water, Lands and Ecosystems.

The ILRI and CGIAR Strategy on livestock research

The authors of this analysis probed on many occasions with different scientists as to the whereabouts of the CGIAR livestock strategy. Should there be a Consortium wide strategy for such a cross-cutting agenda as livestock? We consider that indeed there should be, in order that the wide and varied components of livestock research, covering everything from health and production to environmental impacts and livestock-specific policy issues are identified and clearly articulated, and the comparative advantage of the Consortium and its key partners is clearly highlighted. Such a strategy does not exist. Should the ILRI strategy, recently released, play this role?

The current ILRI strategy is dramatically different from the previous one. It is for a period of 10 years (2013 – 2022), and according to the Director General is purposely not an operational document. It sets out three strategic objectives. These are tabulated below, along with “metrics” of what each objective is expected to achieve:

Strategic objective	Metrics
1 ILRI and its partners develop, test, adapt and promote science-based practices that—being sustainable and scalable—achieve <i>better lives through livestock</i>	Over a 5–10-year time period, livestock-related real income for 2.8 million people is increased by 30%, the supply of safe animal-source foods in ILRI’s target sites/countries ¹ is increased 30%, and greenhouse gas emissions per unit of livestock product produced are reduced. Simultaneously, in partnership with others, these results are scaled to tens of millions more people
2 ILRI and its partners provide compelling scientific evidence in ways that persuade decision-makers—from farms to boardrooms and parliaments—that smarter policies and bigger livestock investments can deliver significant socioeconomic, health and environmental dividends to both poor nations and households	Within a 10–15-year time frame, the share of agricultural budget investments in livestock in ILRI’s target countries are brought at least 20% closer to livestock’s contribution to agricultural GDP. Increased investor contributions to the livestock sector should drive greater representation of livestock commodities in development efforts. Metrics to assess underpinning changes in attitudes and behaviour are defined once ILRI has taken pilot studies to scale in target countries
3 ILRI and its partners work to increase capacity among ILRI’s key stakeholders and the institute itself so that they can make better use of livestock science and investments for better lives through livestock	ILRI has not previously articulated capacity development at this level or covering such a diversity of engagement, spanning both institutions and individuals from farmers to local and global decision-makers. ILRI will conduct a baseline assessment before specifying the exact metrics for this third strategic objective; the baseline will specify the number of individuals and key institutions to have

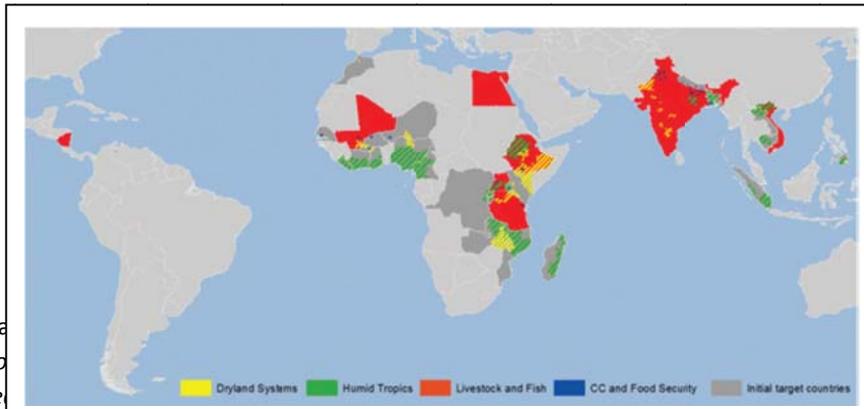
		developed greater capacity to make greater use of livestock research results—be it for better productivity on farms, improved environmental management or more strategic use of development resources
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The strategic objectives are supplemented by five performance areas are considered essential for ILRI to achieve its objectives. These are termed *critical success factors* and identified as:

- 1) getting the science right
- 2) influencing practice, policy and choices of decision-makers to achieve impact
- 3) growing capacity
- 4) securing sustainable and appropriate funding
- 5) ensuring that ILRI is fit-for-purpose.

Absent from the Strategy document is how these critical success factors (or principles) will be achieved, and how the as yet unidentified activities will reap the metrics aspired to. While the Strategy document says that “for each critical success factor a multi-year operational plan sets out ILRI’s specific objectives and actions”, in reality this operational plan is not presented. We understand informally from its interviews that this process is still underway. An “Operational Business Plan” is apparently under development, which will be circulated to relevant ILRI staff in September and presented to the ILRI Board at its next meeting in November.

So how were the metrics developed without an operational research plan? This is explained in Appendix 2 of the Strategic Plan. Each of the CRPs in which ILRI is engaged has identified areas of operation, termed target regions. The Figure below show information on four CRPs in which ILRI is engaged, namely (i) Dryland Systems, (ii) Humid Tropics, (iii) Livestock and Fish, and (iv) Climate Change, Agriculture and Food Security. It also shows the target regions where ILRI has initially planned to operate. ILRI’s activities in research program on Agriculture, Nutrition and Health are mostly co-located with the Livestock and Fish programme, while those in the program on Water, Land and Ecosystems are likely to be co-located with activities of the systems research programmes. The program on Policy, Institutions and Markets focuses mainly on regional and global level analyses. This mapping exercise yielded target regions within an initial set of 28 target countries.



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an initial ballpark figure, positive impacts on at least a hundred thousand people per target country can be envisioned. Through its combined efforts in all the research programs, ILRI therefore aims to reach 2.8 million people. Their livestock-related income will be increased by 30%, there will be a 30% increase in the supply of safe animal source foods, and greenhouse gas emissions would simultaneously be reduced per unit of product”.

ILRI has taken a bold move to try and provide indicative target indicators of change; these will clearly need careful revision once the Operational Business Plan is developed and approved, in order to enhance the credibility of its arguments.

The question remains as to whether the ILRI Strategy, supplemented by an Operational Business Plan, will provide the overall Consortium Strategy for livestock research. We consider that while perhaps it should, this will take much more than is currently planned; at present the ILRI Strategy hardly mentions the CRPs, and yet clearly the different CRPs have a significant role to play in contributing to a Consortium wide livestock strategy. To ensure true integration and multidisciplinary engagement, this would require a process of active engagement of other CRPs, and representation from key Centres such as CIAT, ICARDA, IITA, IWMI and some of the crop centres, among others.

5. CONCLUSIONS

5.1 Livestock research by the CG Consortium remains a priority area for reducing rural poverty, improving food security, improving nutrition and health and contributing to sustainable management of natural resources, outcomes which constitute the System Level Outcomes of the CG's Strategy and Results Framework.

5.2 Livestock research is multifaceted and transdisciplinary, and benefits from the wide range of expertise offered by the CG Consortium under the 15 CRPs, and by their partners outside the CG Consortium.

5.3 There are many research questions specific to livestock: bio-physical, socio-economic, methodological and policy-related, that are being addressed in different CRPs. However, there are also many that are not receiving the attention they deserve. This is due in part to the opportunistic way in which the CRPs were created, without the development of a needs framework. It is also due to the multifunctionality of livestock and multiple production objectives of small-scale livestock keepers.

5.4 The flagship livestock CRP 3.7 is well placed to tackle the central driver of smallholder intensification in four important value chains distributed in Africa, Asia and Latin America. The CRP reflects ILRI's attempt to become smarter in bringing together the species, value chains and regions in which livestock really will make a difference to the poor. The major gaps and opportunities identified in this CRP are in the area of post-harvest losses in each of the commodities, and in undertaking a transregional analysis which would help to put the selected value chains in a wider global context, giving a better understanding of the extrapolation potential of the results obtained from this limited cluster. Key to the success of the CRP concept for livestock is good cross-CRP dialogue and collaboration. While CRP 3.7 has built strong partnerships with several other CRPs, and with national, regional and northern partners, the challenge will be to engage effectively with the broader natural resource management, climate, water and policy CRPs to ensure that it does indeed contribute to all four SLOs.

5.5 CRP 4 effectively brings the human health implications of the intensification process to the fore, as well as adding a broader global perspective of zoonotic and emerging diseases to the CG Consortium agenda.

5.6 Systems CRPs. Livestock issues are being considered in two of the three systems CRPs (1.1 and 1.2). The methodological approach and geographical focus of 1.3 also offer potential for the inclusion of livestock in the strengthening of community resilience, improvements in markets and productivity, improvement of service institutions and support of livestock policies, particularly in Bangladesh, Cambodia and Zambia.

5.7 CRP 1.1 considers the specific roles of livestock in vulnerability reduction and progressive crop-livestock integration under suitable circumstances, and has what appears to be a functional interface with CRP 3.7 (exploring small ruminant value chains) and CRP 7 (exploring payment for environmental services). Areas which may be under-represented in drylands livestock research include rangeland ecology dynamics, the role of women in market access, and land rights, conflict and broader policy issues, including the voice and representation of dryland dwellers.

5.8 CRP 1.2 should provide the vision and broad conceptual framework with which all commodity CRPs should be able to identify and interface. The authors of this analysis consider it to have its own independent research outputs which did not appear to be easily compatible with the outputs of the commodity CRPs. It also appeared to have the smallholder farmer as the main unit of analysis, potentially limiting exploration of system evolution.

5.9 CRP 2 brings together policy analysis activities across the whole span of food security and agriculture issues. However, it does not capture some of the important specificities of livestock-related policy issues, especially the multiple and shifting objectives of governments in respect to livestock development, the problems of livestock service delivery, and the systemic issues of risk and high transaction costs in livestock product value chains.

5.10 Feed research is situated to varying degrees in many CRPs, which is related to the wide variety of forages and crops that constitute livestock feeds. This fragmentation poses considerable challenges for facilitating cross-CRP learning and collaboration, which has not been sufficiently addressed. There is an urgent need to develop a more formal mechanism for discussing and addressing feed needs in the different value chains, livestock systems and target environments, and encourage the various 'feed suppliers' to conduct research that addresses these needs (e.g. develop new fodder crops for identified needs).

5.11 The systems-oriented research of many Crop CRPs, which includes feed and livestock research, is somewhat isolated from the 'main-stream' feed and livestock research of CRP 3.7 and CRPs 1.1 and 1.2. Several critical linkages need to be forged to ensure effective collaboration and joint research on feed (and livestock) research among CRPs. These include links between CRP 3.7 value chains, the systems-oriented research in CRPs 1.1 and 1.2, and the livestock-related systems research in Crop CRPs. In the CRP proposals, many linkages were identified but few were funded, or were partially funded through existing projects. Apart from discussing options on how to collaborate more effectively, there is a need to specifically allocate budgets for collaborative research activities to encourage these cross-CRP linkages⁶⁴.

5.12 CRP 7 represents the CG Consortium's initiative to research climate change in an agricultural context, including both adaptation and mitigation strategies. Livestock-specific issues are under-emphasised, including disease risk, possible change in rangeland composition, developments in estimating and managing livestock contributions to greenhouse gas emissions, and win-win scenarios in adaptation and mitigation in livestock systems.

5.13 Other research gaps. We conclude that there are some additional research gaps, discussed above in section 4. These include the need for greater capacity in epidemiology and impact assessment, in animal health service delivery models, options and policies, and in the role of the private sector in the intensification of smallholder systems. In addition there is a strong need for partnership with NGOs and socio-economic research capacity within non-CG research institutes both northern and southern in order to keep the systems CRPs and commodity CRPs in tune with the dynamics of rural development.

5.14 The CG livestock research agenda and ILRI's strategy. The concept note developed for this strategic overview states "The cross-CRP analysis on livestock interactions needs to be set in the context of the new strategy of the CGIAR's livestock centre (ILRI) on one hand and the global needs and capability for livestock

⁶⁴ This poses an interesting conundrum. CRPs were created as a way to improve collaboration among CG Centres. This conclusion implies that this has not been fully successful – at least for feeds - and more collaboration among CRPs is still needed. The systems-oriented research conducted by Crop CRPs is definitely an issue.

research on the other hand". ILRI's new strategy, in its current form, does not provide the strategic Consortium-wide leadership necessary to form the blueprint for a CGIAR approach to livestock research. It is very generic, it takes a Centre-based approach, and does not articulate adequately the roles of other CRPs and Centres. It appears that the emerging Operational Business Plan might provide greater clarification, but without wider consultation with other CRP leaders and Centres, which we understand is not currently planned in the process, the emerging product is unlikely to meet the needs of the CG Consortium as a whole.

5.15 The need for a strategic framework of livestock research across CRPs and Centres. As noted in the introduction to this strategic overview, the process of CRP development was not one which clearly mapped out the major agricultural research challenges and allocated them, with accompanying adequate funding, to the relevant scientists or centres of expertise. Rather it was a somewhat opportunistic and to a degree competitive process. There is therefore an urgent need to develop a strategic framework for livestock research across the CG Consortium in order to ensure that priority issues are being addressed, that they are being addressed in the Centres and CRPs holding the scientific capacity and comparative advantage, and that funding gaps can be identified and clearly articulated.

6. RECOMMENDATIONS

We have analysed the livestock research portfolio in the CG Consortium, identified some issues for consideration and discussion, and drawn some conclusions. It is all too easy for us to build on this and make a set of recommendations as to where gaps should be filled, which areas of research should be intensified, how new partnerships should be developed, etc. But the limitations to that pathway are firstly that we are looking in from the outside, and arguably lack the detailed understanding of those embedded in the system, and secondly that each of such recommendations would have a price tag, over which we have no control. As such we opt to avoid making specific recommendations on thematic changes in the CRPs, our thoughts on this can be drawn from the conclusions; rather we choose to make recommendations of principle and of feasible actions.

6.1 **CG Consortium-wide livestock research framework development.** It is recommended that ILRI or ISPC convene a dialogue with key representatives of each CRP (such as Director, CRP focal point, etc.) and key Centres to consider the issues raised and the conclusions presented in this analysis, to undertake a gap analysis, and to develop a roadmap for the elaboration of a CG Consortium-wide livestock research framework.

As part of this process, it is recommended that the following issues and areas be given particular attention:

- Research on climate change impacts on livestock, and the prospects for adaptation
- Research that more explicitly and critically examines the question of greenhouse gas emissions from livestock, and the prospects for mitigation
- Research on policy related to livestock as a development tool, that is able to operate across the CRPs, and across the themes within CRP2
- Research on policy questions related to rangelands, including land tenure, state recognition of collective management and mobility, and conflict management, across areas associated with CRP1.1 and CRP 1.2
- Research on animal health delivery systems, including financial sustainability, maintenance of professional standards, and necessary policy support
- The need for strengthening of the human resource capacity for disease epidemiology and impact assessment within a production system and agro-ecology context to link effectively the emerging technology development for animal disease control from CG programmes and their partners, and the effective delivery of animal health services in the three systems CRP environments.

- The role of the private sector in smallholder agriculture intensification, and seek dialogue with the few success stories in Africa and Asia
- The role of small ruminants in processes of poverty reduction and livelihood strengthening beyond the current intensification initiatives in Ethiopia and Mali under CRP 3.7
- Research on improving the efficiency of draught animal power, given the high and relatively static numbers of farmers still depending on it for land preparation, and continuing uncertainty over fossil fuel prices
- The need to investigate options for facilitating stronger linkages and cross-CRP learning on feed research across all CRPs involved in feeds and livestock research, in order that feed (and livestock) research is conducted as part of systems research and not in isolation without linkage to either CRP 3.7 or CRPs 1.1 and 1.2
- The need to establish mechanisms for discussing and addressing feed gaps in the different value chains, livestock systems and target environments, and encourage the various ‘feed suppliers’ to conduct research that addresses these needs.
- Consideration of how the ILRI Business Plan, building on its new strategy document, can provide greater specificity to the roles and activities of the different CRPs in achieving its institutional mission and vision

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9. ANNEX 1. THE LIVESTOCK RESEARCH PORTFOLIO IN THE CGIAR RESEARCH PROGRAMMES: AN ANALYSIS OF CRPS

Below we review briefly each of the CRPs, and comment on their engagement with different aspects of livestock research and/or their interface with ILRI.

CRP 1.1 DRYLAND SYSTEMS: INTEGRATED AGRICULTURAL PRODUCTION SYSTEMS FOR THE POOR AND VULNERABLE IN DRY AREAS⁶⁵

This CRP, led by ICARDA, is an extremely important component of the CGIAR's research offer on livestock, dealing as it does with regions where livestock are a crucial, and in some regions dominant, component of production systems and livelihoods. The programme operates with four Strategic Research Themes:

- SRT1: Approaches and models for strengthening innovation systems, building stakeholder innovation capacity, and linking knowledge to policy action
- SRT2: Reducing vulnerability and managing risk
- SRT3: Sustainable intensification for more productive, profitable and diversified dryland agriculture with well-established linkages to markets
- SRT4: Measuring impacts and cross-regional synthesis.

SRT1 is an overarching theme on methods for stimulating innovation and ensuring policy uptake, involving researchers collaborating closely with multiple actors including farmers themselves, NGOs, the private sector and policy-makers. Some of the more livestock-specific activities include development of pro-poor and pro-women livestock and fodder value chains, through multi-stakeholder alliances.

A major feature of CRP1.1 is that SRT2 and SRT3 are geographically complementary. SRT2 is tailored to dryland areas/systems with the highest levels of absolute poverty and vulnerability, while SRT3 is tailored to areas/systems with greater potential for impact through market-led intensification and diversification. Research will take place in Action Sites and Satellite Sites in Benchmark Regions, largely inherited from previous CGIAR programmes, within five Target Regions: the West African Sahel and dry savannas; East and Southern Africa; North Africa and West Asia; Central Asia; and South Asia. Each of the major regions will contain some sites associated with SRT2, and some with SRT3.

SRT2 is well-described in relation to the vulnerability experienced by producers in the more marginal dryland areas. The methodology statement which talks of "classic systems analysis and modelling informed by agro-ecological approaches, with recent emphases on eco-agriculture and eco-efficiency" somewhat belies the openness demonstrated towards the broader determinants of pastoral vulnerability. Some of the most important and leading-edge issues in current pastoral development are incorporated, including early-warning systems, index-based livestock insurance, Payment for Environmental Services (PES) on rangelands, and the coexistence of (pastoral) livestock with wildlife. Sub-themes are laid out in a logical progression through development of risk-management strategies, through their upscaling, to an analysis of trade-offs between strategies.

SRT3 revolves more around crop-livestock integration and intensification. There is a similar progression between sub-themes of developing intensification options, upscaling them, and analysing trade-offs. Activities are described (compared to SRT2) in ways that are more generic across crops, livestock and trees, but there are significant mentions of developing and promoting improved livestock feeding and grazing strategies,

⁶⁵ ICARDA (2011)

including development of multipurpose forages, trees and crops and use of new livestock breeds, and gender-sensitive approaches to creating new market linkages for yogurt, cheese and other added-value milk products.

SRT4 is mainly about measuring and monitoring impact, with a strong emphasis on spatial analysis using GIS and quantitative techniques, but also paying attention to recent developments in “softer” methodologies. Maps form a dominant feature of the CRP website.

Significant opportunities for collaboration with other CRPs, including CRP3.7, are set out. Indeed while the small ruminant value chain work of 3.7 in Ethiopia is coordinated by the ICARDA/ILRI team of small ruminant scientists, they are also engaged in CRP1.1 on improving productivity and profitability of sheep and goat production in the drylands, with emphasis on feeding systems, rangelands and forages but including husbandry, genetic diversity, and value addition (dairy and fiber).

CRP1.1 demonstrates its relevance to all four SLOs. The dual structure of CRP1.1 around reducing vulnerability and integration through the market allows research attention to two important themes in livestock development. It will be important as the research develops not to assume that these relate to two discrete systems/areas. Development of value chains in livestock and livestock products may have unforeseen impacts on equity and the wellbeing and vulnerability of those not in a favourable market position, but if done with consideration of the context may also serve to reduce vulnerability. It should also be noted that CRP1.1 presents well-developed arguments and plans for incorporating gender issues, though they do not spell out the very specific opportunities for research and upscaling around women’s ownership of, and role in managing, small ruminants.

The most important missing set of research issues from a livestock perspective is around land rights, conflict and broader policy issues, including the voice and representation of dryland dwellers. These cannot be separated from the sorts of issues around systems vulnerability and its remedies (early-warning, insurance etc.) On the other hand, through its engagement in policy processes, such as its management of the USAID-IGAD Technical Consortium for Ending Drought Emergencies and Building Resilience to Drought in the Horn of Africa, ILRI as a Centre retains an involvement in policy research and links with some key non-CGIAR players.

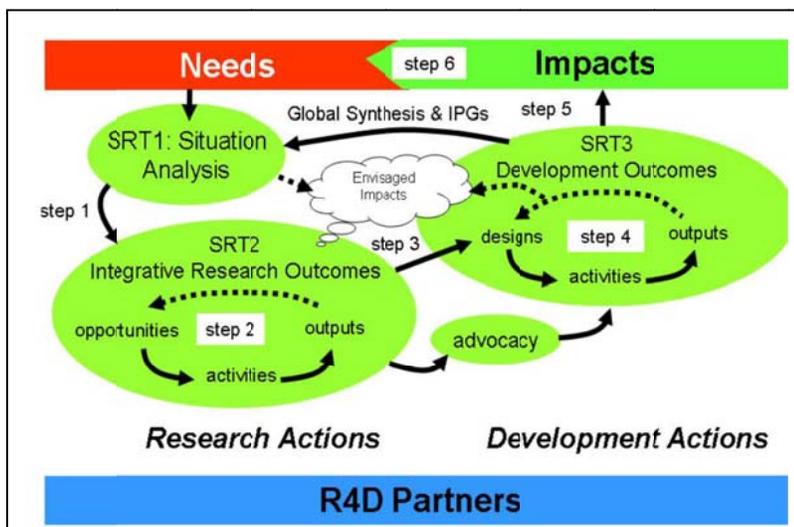
CRP 1.1’s programme for work on crop-livestock integration is less abstract in its conceptualisation than that of CRP1.2, and more open to multiple options and pathways for crop-livestock integration in different areas.

CRP 1.2 HUMID TROPICS: INTEGRATED SYSTEMS FOR THE HUMID TROPICS⁶⁶

The programme, with IITA as Lead Centre, seeks to transform the lives of rural poor people in humid lowlands, moist savannas and tropical highlands in Africa, Latin America and Asia, specifically through promoting *integrated systems* that may include arable crops, trees and livestock. The programme focuses on the intensification of production systems under increasing resource pressures of increasing land and labour prices, through improving access to markets. The intensification process involves not only increasing the yields of single commodities, but also complementarities between system components such as trees, crops and livestock (although the concept of “trade-off” is also heavily used). The programme uses the impact pathway concept and plans to influence “Impact Zones” through work in “Action Sites” in 11 “Action Areas” where it will work on the interrelated Strategic Research Themes (SRTs) of:

- 1) Situation Analysis and Synthesis
- 2) Integrated Systems Improvement at Action Site level (with underlying components of value chains and markets, productivity improvements and natural resource management), and
- 3) Scaling-up and Institutional Innovation at Action Area Level.

⁶⁶ IITA (2012)



The conceptual framework of the CRP is shown above, illustrating the logical flow from situational analysis, through research actions, to development actions with expected impact.

Livestock are referred to *passim* throughout the programme document, usually in formulae such as “tree, crop and livestock enterprises”. The most important highlighting of livestock in research hypotheses, questions and components are as follows:

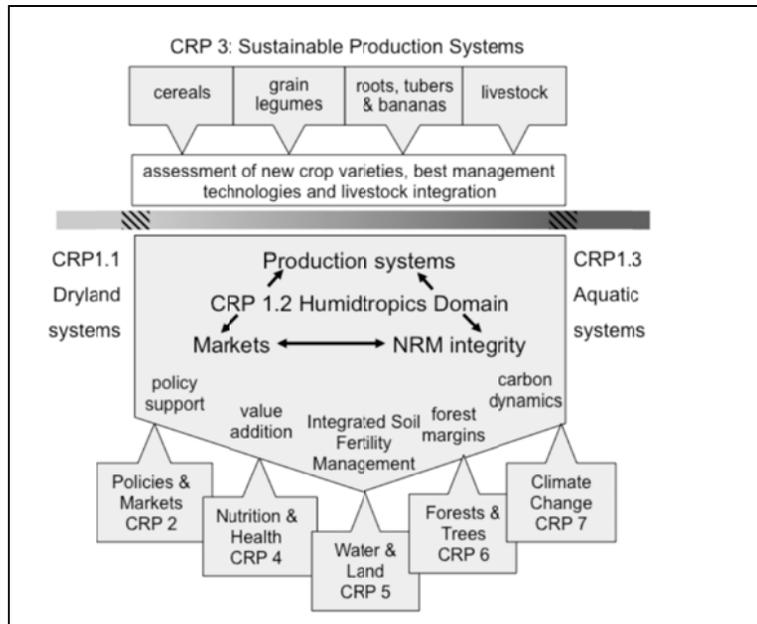
One of the nine Specific Research Hypotheses of the Programme, H₄: “Livestock enterprises become more integrative and profitable in more intensively managed systems but also present increasing environmental risk and equity challenges”.

Research Question 2 of SRT 2 (Integrated Systems Improvement) reads: “What is the impact of population density, land availability, initial natural resource condition, agro-biodiversity status and market access on the management of trees, crops, livestock and their interactions in mixed systems? How may system productivity, natural resource integrity, farmer income and household wellbeing best be enhanced simultaneously and how do these interventions differ by gender?” The rationale for this research question centres on integrating livestock management with other system components, with both direct interactions (e.g. trees providing both feed and shade for livestock) and indirect interactions (reinvestment of livestock income on trees). An expansion of the research questions runs “How, and under what circumstances, can tree intensification along agro-ecological principles contribute to the productivity and sustainability of livestock production systems?”

The sub-theme SRT2.2 “Increasing system productivity” is concerned with specific farm-level technologies, which for livestock may improve interventions in breed, feed and animal health, as well as better management of manure for soil fertility. All these interventions will be considered within the context of an agro-ecological intensification paradigm that sees increasing efficiency coming progressively from current practice, improved germplasm (plant or animal), better management and market opportunities.

Sub-theme SRT2.3 “Natural Resources Improvement” is concerned with the integrity of the resource base, including those aspects threatened by livestock. This sub-theme makes explicit mention of greenhouse gas emissions, the use of life-cycle analysis, and the prospects for intensification leading to greater production per unit of GHG emission. In the context of lifecycle assessments, selected technical interventions will be offered to mitigate livestock impacts on water, land and biomass.

The project document provides a conceptualisation of the relationship with the commodity and cross-cutting CRPs which depicts Humidtropics (and its counterparts CRP 1.1 and 1.3) as the focal point and synthesiser of research outputs in the different action sites, action areas and ultimately impact zones it is addressing (see figure below).



In terms of collaboration with other CRPs, CRP1.2 will source knowledge on feed requirements from CRP 3.7 and will contribute knowledge on use of natural resources in relation to livestock production. Joint research is foreseen through involvement of key researchers in both CRPs. On the livestock side it is likely to be constrained by the very limited geographical scope and production system overlap with CRP 3.7 (pigs in Uganda and Vietnam and dairying in India and Central America). And it is unclear how the value chain activities of 3.7 will integrate with the intensification activities of CRP 1.2.

More minor cross-CRP linkages relating to livestock are envisaged with CRP 4 on health implications of livestock intensification in SE Asia and around cities generally, and on pastoralists as a “neglected population”. CRP 1.2 will source knowledge on nutrition, food safety and emergent disease, and contribute knowledge on improving production (which increases the demand for food safety. Some collaboration is envisaged with CRP 5 on rainwater management in crop-livestock systems, and with CRP 7.

This CRP is very strongly driven by an elaborately-defined interdisciplinary intellectual agenda around intensification, driven by resource pressures, and taking the form of integration at the farm level of tree, crop and livestock components. It is beyond the scope of this overview to comment on that agenda *per se*, although there are grounds for concern that the high level of abstraction tends to imply a single unilinear model of integration (in contrast for example to the concept of multiple pathways of crop-livestock interactions mediated by institutions⁶⁷).

The research appears to be driven by two of the same drivers have been identified for livestock research:

- Natural resource management: Rising competition for resources such as land and water: trade-offs between food, feed and bio-fuels

⁶⁷ Scoones and Wolmer (2002)

- Continued weaknesses in the links and contribution of research to development outcomes

While also relating to some others, including:

- Natural resource management: Concerns about effluent pollution from intensive, concentrated livestock production systems
- Increased recognition of the key roles of small stock for women farmers and the extreme poor

The most important gaps identified, in relation to livestock research are as follows:

Land access and conflict: issues of land tenure and access to land (but not necessarily through the route of titling) are crucial in intensification processes and there is a lost opportunity here to tie this research into research on the multiple routes to land security. In particular, the Western Moist Savanna Action Area (Northern Ghana, the Nigerian Middle Belt, and areas of Togo and Benin in between) are subject to some of the same issues of relations between farmers and specialised pastoralists (in some areas bearing distinct ethnic identities) that characterise the Sahel further to north. These issues include different forms of land tenure for farmers and pastoralists, and relations between them that may be co-operative, or occasionally conflictual. In a rather different way some of these issues around different forms of tenure for arable and grazing land, and in certain cases conflict, may affect the East and Central Highland Action Area zones of Western Ethiopia, the Cattle Corridor of Uganda, and particularly Rwanda and Burundi post-conflict.

Animal health: references to animal health interventions in sub-theme SRT 2.2 are somewhat vague. In particular there are no references to tsetse or trypanosomosis control, which are recognised as one of the biggest constraints on livestock survival and productivity in many of the areas of Africa targeted. Furthermore the health service delivery component, critical to the intensification processes envisaged, do not appear to receive the attention they arguably deserve.

Draft power: research on draft power has become rather unfashionable of late, not least because of perceived low uptake. Yet draft power is a central issue in crop-livestock integration and is significant in some of the areas targeted. Continuing uncertainty over fuel prices, and the persistence of fragmented land tenure patterns should keep draft power on the research agenda. For example, it is thought that the proportion of Indian farmland that receives its primary land preparation under draft power is now rising again from its previous level of around 45%. Draft power research aimed at increasing efficiency (output per unit of feed, per unit of human labour, and per unit of fossil fuel use avoided), and minimising environmental impacts, could usefully be incorporated in some of the research sites.

CRP 1.3 HARNESSING THE POTENTIAL OF AQUATIC AGRICULTURAL SYSTEMS FOR THE POOR AND VULNERABLE⁶⁸

This CRP is focussed on the poor and vulnerable who live in the world's major rivers and coasts, where aquatic agriculture offers a tool for livelihood enhancement and poverty reduction. The CRP has six objectives:

- Increased benefits to AAS-dependent households from environmentally sustainable increases in productivity.
- Improved markets and services available to poor and vulnerable AAS households.
- Strengthened resilience and adaptive capacity in poor, vulnerable and marginalized groups and households.
- Reduced gender disparities in access to and control of resources and decision making through beneficial changes in gender norms and roles.

⁶⁸ WorldFish (2011)

- Improved policy and formal and informal institutional structures and processes implemented to support pro-poor, gender-equitable and sustainable development.
- Productive relationships, partnerships and networks capable of achieving research and development outcomes sustained through effective knowledge sharing and learning.

The budget is US\$59.4 million over the first 3 years, \$27.1 million of which has been identified in existing restricted grants together with projected increases, and \$12.3 million of which comes from existing core resources. A gap of \$20.0 million remains to be met. The project proposal states that the investment of \$59.4 million in CRP 1.3 will leverage impact through partner funding of approximately \$300 million over the 3-year period.

CRP 1.3 focuses initially on three Aquatic Agricultural Systems: (i) Asia's mega deltas (targeting Bangladesh and Cambodia); (ii) Asia-Pacific islands (targeting the Philippines and the Solomon Islands); and (iii) African freshwater systems (initially targeting first Zambia, with consideration to extend subsequently to Uganda and Mali). Within each of the countries the CRP will have hubs (such as the Upper Zambezi, Kafue flats and Luapula Province are those in Zambia).

The CRP places emphasis on reduction of vulnerability and increase of voice in these marginalised communities, with particular reference to the role of women. The proposal provides a model among CRPs with regard to its planning framework, presenting the hypothesis of change behind each objective, providing verifiable indicators of both outcomes and impacts, and linking these to the SLOs. The CRP conveniently packages its objectives in research themes corresponding to the objective theme, and develops a series of research questions under each, exemplifying them in each of the five widely dispersed countries targeted initially (Bangladesh, Cambodia, Philippines, Solomon Islands and Zambia).

While livestock are mentioned in many places, the functional link with livestock research appears to be restricted in the documentation to Uganda, where CRP 3.7 was due to be involved in the aquaculture value chains of Lake Victoria in partnership with WorldFish. However, it was subsequently determined that there was an insufficient base for value chain development there, so work there is not being pursued. There is also inference to links with ILRI and potential input on value chain technology. Surprisingly, perhaps, there is little mention of the livestock-specific marketing and productivity enhancements in the main operational sites of Bangladesh, Cambodia and Zambia.

CRP 2 POLICIES, INSTITUTIONS, AND MARKETS TO STRENGTHEN FOOD SECURITY AND INCOMES FOR THE RURAL POOR⁶⁹

This CRP aims to “bring together analysis of policies and institutions related to food security, poverty and sustainable agriculture from across the CGIAR” for the first time. It sets out a vision of impact through:

- Improving and enriching research and bolstering the capacity of research communities
- Influencing policy development and implementation by major development agencies
- Providing policy recommendations for policy-makers and decision-makers at the global, national and local levels

This impact will be achieved under the following Themes:

- Effective Policies and Strategic Investments
- Inclusive Governance and Institutions

⁶⁹ IFPRI (2011-a)

- Linking Small Producers to Markets

The Effective Policies and Strategic Investments Theme 1 seeks to improve policy options at the global, regional, and country levels by modelling scenarios of future trends, analysing how best to allocate public resources for research and investment, and strengthening governments' capacity to design and carry out policies and investments that will increase agricultural productivity and enhance rural incomes. While there has progressively been some livestock involvement in this, particularly in improving the quality of livestock data inputs (animal numbers, feed, etc.), and on parameterization with relation to livestock specific interventions, these modelling initiatives are at a very general level, and arguably cannot capture some of the livestock specific issues currently facing countries and regions.

As part of the parameterization exercise, each centre was asked to come up with 10 – 15 technologies to test in the Impact model; from the livestock side, this included assessment of East Coast fever (ECF) vaccination (see Annex 3 for a full listing of those on livestock).

Theme 2 entitled Inclusive Governance and Institutions examines the scope for policy, institutional, and governance reforms to contribute to effective and equitable access to rural services, property rights, collective action, and assets by studying existing systems and testing institutional innovations in these areas.

Built into CRP 2 is a cross-cutting Strategic Gender Research Theme. Research under this theme seeks to generate evidence and improve the information base on gender in agriculture, evaluate the linkages between agricultural/rural transformations and gender relations, and apply gender analysis to policy reform and implementation. There does not appear to be adequate emphasis on the gender-specific aspects of livestock keeping, marketing and consumption under CRP 2.

The third theme, Linking Small Producers to Markets, seeks to increase the competitiveness of markets to benefit producers and consumers, and offer greater income opportunities by integrating small-scale producers into upgraded value chains. This theme apparently takes responsibility for development of new methods and tools, which are then tested in the commodity CRPs. With respect to livestock, this is undertaken in CRP 3.7. The boundary of where CRP 2 ends and the commodity CRPs start is not clear; certainly CRP 3.7 value chain research does not appear to deal with the broader issues generic to those provided in the parent modelling research of CRP 2.

The CRP document mentions livestock throughout in conjunction with crops and fish, but contains very little content, and very little planning, that is *specifically* relevant to livestock. Similarly, the tables showing cross-CRP and cross-CGIAR linkages mention ILRI under all three Themes, but usually in connection with a number of other Centres. The more specific linkages are under Theme 2, as follows:

Under Subtheme 2.3 Collective Action and Property Rights, work will be done on tenure security for environmental management, productivity and participation in value chains, on community and state actions needed to secure resource rights, and on the tenure of woman and marginal groups. Research will engage with multi-stakeholder networks already established through the Systemwide Program on Collective Action and Property Right (CAPRI). Pastoralists and rangelands, which are of course classic foci for such research, feature prominently in the research outlined under this sub-theme.

Subtheme 2.4, Institutions to Strengthen the Assets of the Poor, creates valuable opportunities to link with research on pastoralism, including the work of the PARIMA component of the Global Livestock CRSP⁷⁰. A paragraph on risk management and insurance does not mention, but creates space to link to, ILRI's work on Index-Based Livestock Insurance.

⁷⁰ Doss, McPeak and Barrett 2008 is cited on risk

What the programme does not appear to do is capture some of the important specificities of livestock policy issues. For *overarching policy* (roughly theme 1) these include the fact that livestock policy, even more than agricultural policy, needs to address multiple policy objectives with a shifting balance between them: food security, livelihoods, food safety/health and environment⁷¹.

Under *rural services*, the problems of ensuring animal health coverage in poorer and more sparsely populated rural areas are not considered.

For *markets*, while there is mention of the importance of high transaction costs, there is no sense of the peculiar techno-economic characteristics of livestock and livestock products that tend to increase transaction costs and lead to (apparent) oligopolies and dominance of middlemen:

The authors of this analysis consider CRP 2 is a very welcome part of the CGIAR strategy, but hope that it can engage further with concrete areas where livestock production, livestock trade and the livelihoods of livestock producers raise issues that differ in crucial ways from those raised by crop agriculture.

CRP 3.1 WHEAT- GLOBAL ALLIANCE FOR IMPROVING FOOD SECURITY AND THE LIVELIHOODS OF THE RESOURCE-POOR IN THE DEVELOPING WORLD⁷²

WHEAT is implemented by CIMMYT and ICARDA in collaboration with over 200 partners. WHEAT specifically targets the needs of low- and middle-income wheat-producing countries, which together produce more than two thirds of the world's wheat. The proposal cites Rosegrant and Agcaoili (2010) who projected that demand for wheat will increase 60% by 2050. In 2010-12, FAO (2012) estimated that 18-21% of total wheat grain production was used as feed for animals.

The proposal states that “the overall challenge facing WHEAT is to dramatically boost farm-level wheat productivity and stabilize wheat prices, reduce its vulnerability to globally important diseases and pests, enable it to grow in warmer climates, reduce water, fertilizer, labour and fuel requirements for more efficient and sustainable production, while meeting end users' quality and nutritional needs”. WHEAT addresses this challenge through 10 interrelated Strategic Initiatives (SI) that include productivity and efficiency outputs, technology targeting, capacity development and a systems-oriented output SI 2: Sustainable wheat-based systems: Improving livelihoods while safeguarding the environment.

When crop CRPs were developed, ILRI made the decision to not join any of the crop CRPs as they felt that they were already involved in too many CRPs. ILRI left open the possibility of collaboration with CRPs as part of CRP 3.7. In the WHEAT proposal, ILRI is listed as a partner in SI 2: Sustainable wheat-based systems: ILRI conducts research on the digestibility of wheat straw and (imminently) the intensification of wheat-based crop/livestock systems in South Asia. These activities are funded through the Gates-funded Cereal Systems Initiative for South Asia (CSISA) project. SI 2 intends to establish research hubs in five irrigated and seven rainfed wheat production systems in the developing world, including two small-scale cereal livestock systems in rainfed agricultural systems (one in West Asia and one in North Africa) where livestock are important components of the farming systems.

The interactions between WHEAT and livestock research relate to feeds. There is minor collaboration between WHEAT and ILRI, and this is funded through a special project that existed prior to the WHEAT CRP. While, in general, there is strong recognition by crop CRPs that crop breeding programmes need to go beyond grain yield and consider stover/straw yield and quality, this was not emphasized in this proposal. The collaboration with ILRI (or CRP 3.7) on improving stover/straw quality and quantity in breeding programs has merit and often

⁷¹ FAO, 2009

⁷² CIMMYT and ICARDA

can be achieved without jeopardizing grain yields⁷³. Improving the nutritional quality and quantity of crop residues available as livestock feed can contribute to reducing rural poverty and improving food security by increasing the availability of fodder for ruminants.

In SI 2, the WHEAT proposal also identifies research on optimum levels of crop residues needed to reduce evaporation and increase soil organic matter content and soil biological activity, while freeing residues for other uses such as livestock feed. This trade-off between utilisation of available crop residues as animal feed versus soil improvement and water use efficiency (e.g. conservation farming) is likely to be an important research issue relating to sustainable management of natural resources.

CRP 3.2 MAIZE - GLOBAL ALLIANCE FOR IMPROVING FOOD SECURITY AND THE LIVELIHOODS OF THE RESOURCE-POOR IN THE DEVELOPING WORLD⁷⁴

MAIZE is implemented by CIMMYT and IITA. MAIZE specifically targets two groups of farm households in low- and middle-income countries. These are (1) smallholders who live in stress-prone environments and who have poor market access, and (2) market-oriented smallholders in more favourable production areas and with potential to supply markets but who lack access to appropriate technology. A third target group is poor maize consumers. Two thirds of the maize produced in the developing world comes from low and lower middle income countries. Farmers in these countries grow maize for food, feed, and income in 24 diverse and mostly mixed rainfed farming systems.

More than two-thirds of the global maize production was used as animal feed in the late 1990s, and this proportion is expected to grow, particularly as incomes rise and create greater demand for animal products⁷⁵. Maize grains form an important part of pig and poultry rations, leaf thinning are fed to ruminants during the crop growing period, maize stover is fed to ruminants after grain harvest, and maize is purpose-grown as fodder for ruminants.

The challenge of MAIZE is to “to stabilize maize prices and double the productivity of maize-based farming systems, making them more resilient and sustainable and significantly increasing farmers’ income and livelihood opportunities, without using more land and as climates change and fertilizer, water, and labour costs rise”. MAIZE addresses this challenge through 9 interrelated Strategic Initiatives (SI):

SI 1: Socioeconomics and policies for maize futures

SI 2: Sustainable intensification and income opportunities for the poor

SI 3: Smallholder precision agriculture

SI 4: Stress tolerant maize for the poorest

SI 5: Towards doubling maize productivity

SI 6: Integrated postharvest management

SI 7: Nutritious maize

SI 8: Seeds of discovery

SI 9: New tools and methods for NARS and SMEs

The proposal stated that MAIZE will contribute to and benefit from other CRPs. These are CRPs 1.1 and 1.2; CRP 2; GRiSP; CRP 4; CRP 5 and, especially, CRP 7. Neither ILRI nor CRP 3.7 were mentioned as collaborators, however, ILRI has received a sub-grant from MAIZE to collaborate on feeding value of maize.

⁷³ Sharma et al. 2010

⁷⁴ CIMMYT and IITA (2011)

⁷⁵ Pingali 2001

While MAIZE acknowledges the importance of maize as animal feed (two thirds of total production!), the effort going into this research area is relatively minor given the importance of maize for animal feeding. For example, in Africa market prices for crop residues vary from USD \$40 per ton at harvest to USD \$130 per ton during the next season, implying that storing crop residues can yield substantial economic benefits⁷⁶. In many areas, maize is grown as a fodder crop but there has been little emphasis on fodder production.

SI 2 Sustainable intensification and income opportunities for the poor: SI 2 employs an integrated systems approach of maize-based interventions and those of other crops and livestock. It aims to make rapid and pronounced impact on poverty reduction, food insecurity, and the sustainability and resilience in six major maize-dominated farming systems in Africa, Asia, and Latin America, especially for farmers of target group 1. Considering the importance of maize as a fodder, both fed green and as stover, ILRI (and CRP 3.7) should be a major partner in SI 2.

SI 6 Integrated post-harvest management to improve maize food security and safety: Economic losses result from reduced grain quality and mycotoxin contamination—especially aflatoxin and fumonisin (produced by *Aspergillus flavus* and *Fusarium verticillioides* respectively)—making grain unsafe for food or animal feed, and constitutes an obstacle to developing trade and export markets.

SI 7 Nutritious maize: SI 7 refers to animal feeding and acknowledges the important role of maize in livestock production and makes the point that grain yield is the primary trait to improve in maize for commercial feed. It acknowledges that the whole maize plant—including young maize stems, leaves, the husks, and cobs—can be consumed by livestock. Silage from the maize plant is an excellent and highly nutritious dry-season feed for ruminants. Maize residues after grain harvest can be used as livestock feed. In terms of use of grain for animal feed, CIMMYT developed quality protein maize (QPM) during the 1970s–80s which has enhanced levels of lysine and tryptophan, and has been used in pig production systems. SI 7 states that there are prospects of developing yellow maize with high essential amino acid content for livestock applications. Carotenoids and vitamins are essential micronutrients in poultry diets and pro-VA-enhanced yellow maize may have value as poultry feed. In terms of stover, the proposal highlights the interest of smallholders in using maize stover as feed. There is scope to improve the energy content and digestibility of stover without compromising grain yield⁷⁷, which is also of interest to biofuel (ethanol) production⁷⁸. One of the outcomes of SI 7 will be improved protocols for routine screening of maize varieties for forage quality, and this where ILRI and CRP 3.7 collaborate.

Livestock-related research in MAIZE contributes mainly to reducing rural poverty and improving food security. Key drivers are economic growth, population increases and urbanisation, and feed use efficiency in livestock systems.

CRP 3.3 GLOBAL RICE SCIENCE PARTNERSHIP (GRISP)⁷⁹

GRISP is implemented by IRRI, AfricaRice and CIAT. IRRI is the lead centre and also leads the activities in Asia; AfricaRice leads the work in Africa and CIAT the work in the Latin America & Caribbean region. Its mission is “to reduce poverty and hunger, improve human health and nutrition, reduce the environmental footprint and enhance ecosystem resilience of rice production systems through high-quality international rice research, partnership, and leadership”. The key entry points for achieving this mission lie in lifting the productivity and resource efficiency of rice production systems to unprecedented levels. GRISP argues that this will enable

⁷⁶ de Leeuw 1997

⁷⁷ Blummel and Friesen 2009, Zaidi et al. in press

⁷⁸ Hansey et al. 2010

⁷⁹ IRRI (2010)

farmers to enter a virtuous circle, allowing them to also invest more in diversification and sustainable management practices.

Rice grain is not extensively used or traded as animal feed. Rice bran, a by-product of milling rice, is an important animal feed that is used extensively for pigs, poultry and to a lesser extent for cattle. Similarly, broken rice (largely a by-product of small-scale rice mills) is also fed to animals. Rice straw is used extensively as a ruminant feed as an important dry season feed. In areas where rice occupies most of the land, rice straw from the previous season is also an important wet season feed when no other feeds are available (e.g. southeast Cambodia). Rice straw is traded in many areas. Rice plants are not usually grown as a fodder crop.

GRiSP research has been structured into six major rice research and development themes, each with several product lines and numerous products. The themes are:

- T 1: Harnessing genetic diversity to chart new productivity, quality, and health horizons
- T 2: Accelerating the development, delivery, and adoption of improved rice varieties
- T 3: Ecological and sustainable management of rice-based production systems
- T 4: Extracting more value from rice harvests through improved quality, processing, market systems and new products
- T 5: Technology evaluations, targeting and policy options for enhanced impact
- T 6: Supporting the growth of the global rice sector

Livestock-related research is part of Theme 4: Extracting more value from rice harvests through improved quality, processing, market systems and new products. One of the products is: Rice straw with increased digestibility for feeding to livestock with the objective of producing new varieties with improved straw digestibility for livestock feed. ILRI is mentioned as the lead centre for conducting research on husks and straw to determine the variability in digestibility of the straw, and identify and address the main constraints to using straw as livestock feed.

GRiSP is only marginally involved in livestock-related research, although it conducts research both on rice value chains and on farming systems in major rice systems. The collaboration with ILRI on improving the feed value of rice straw is funded through the Gates-funded CSISA project in South Asia. As for other cereal crops, there will be increased competition for crop residues from conservation agriculture.

CRP 3.4 ROOTS, TUBERS AND BANANAS FOR FOOD SECURITY AND INCOME⁸⁰

CRP 3.4 is led by the CIP in partnership with Bioversity International, CIAT and IITA. The crops covered are banana, plantain, cassava, potato, sweet potato, yams and other tropical and Andean root and tuber crops (RTB). RTBs are a key source of food, nutrition, and income in some of the poorest countries and regions and for the most marginalized populations. Women are very often the main producers and processors of these crops.

Approximately 60% of RTB production is used for food; the remainder is used as animal feed (not specified how much), planting material, or industrial raw material. The rapid growth in demand for meat has increased the use of RTB as animal feed. There has been a rapid shift in the use of RTB from food to animal feed in China, Thailand, and Colombia. Sweet potato, cassava, or banana pseudostems are used as animal feed, especially for pigs, in China, Vietnam and Thailand. In East Africa, intensive mixed farming systems use banana crop residues for zero-grazing livestock.

⁸⁰ CIP (2011)

CRP 3.4 is structured into seven themes and product lines under each theme:

T 1: Conserving and accessing genetic resources

T 2: Accelerating the development and selection of varieties with higher, more stable yield and added value

T 3: Managing priority pests and diseases

T 4: Making available low-cost, high-quality planting material for farmers

T 5: Developing tools for more productive, ecologically robust cropping systems

T 6: Promoting postharvest technologies, value chains, and market opportunities

T 7: Enhancing impact through partnerships.

Livestock-related research features in themes 2, 5 and 6: Theme 2 includes breeding of dual purpose food-feed RTB varieties that combine broad adaptation, stable yields, high productivity, highly nutritious genotypes and high foliage production for animal feed, and breeding for traits desired by the animal feed industry such as nutritional quality (vitamins and proteins) and starch quality. Theme 5 includes research on increasing productivity in RTB cropping systems through nutrient, water and light management practices, including management of dual-purpose crops. Leaves of cassava and sweetpotato in particular serve as nutritious food for humans; most RTB crops provide livestock fodder. Research will study the effect of leaf pruning on productivity and tuber yields of RTB (particularly cassava and sweet potato) to better understand the trade-offs between food and feed, between harvesting roots for household consumption, or feed for animals. Theme 6 includes studies of nutritional and anti-nutritional characteristics of RTB. This has relevance to livestock as some RTBs contain anti-nutritional compounds. For example, cassava leaves contains cyanide which can be reduced by postharvest technologies such as ensiling⁸¹. It also includes research on linking smallholders to feed markets such as cassava for starch and/or feed.

CIP, as lead centre of CRP 3.4, has had a strong participatory / end-user focus in its research, which provided a sound understanding of the needs of smallholder farmers for multipurpose crops. CIP has conducted research on feeding of sweet potato (tubers and leaves) in smallholder pig production systems in Vietnam.

Linkage with other CRPs were highlighted in regard to breeding varieties suitable for different value chains such as animal feeding (CRP 2 and CRP 3.7) and management of dual-purpose crops (CRP 1.1, 1.2 and 3.7). ILRI is not a partner in this CRP despite the relatively strong emphasis on feeds. Overall, there seems to be considerable emphasis on feed issues in CRP 3.4, however, details on how CRP 3.4 collaborates with CRP 3.7 and the systems CRPs 1.1 and 1.2 are not clear.

CRP 3.5 GRAIN LEGUMES: LEVERAGING LEGUMES TO COMBAT POVERTY, HUNGER, MALNUTRITION AND ENVIRONMENTAL DEGRADATION⁸²

CRP 3.5 is implemented by ICRISAT (lead centre), CIAT, ICARDA and IITA. Its objective is 'to increase production, sales, consumption and beneficial contribution of grain legume farming systems that reduce poverty, hunger, malnutrition of smallholder farmers and their households, while improving the health of mankind and sustainability of farming systems'. CRP 3.5 targets four regions and 8 key grain legume species most widely grown by smallholders in the four regions. These are:

- South and Southeast Asia (SSEA): Chickpea, groundnut, pigeonpea, lentil
- Sub-Saharan Africa (SSA): Groundnut, cowpea, common bean, soybean, faba bean, pigeonpea
- Central and Western Asia and North Africa (CWANA): Chickpea, lentil

⁸¹ e.g. Kavana et al., 2005; Tewe 1991

⁸² ICRISAT (2012-a)

- Latin America and the Caribbean (LAC): Common bean

Legume crops provide important high protein animal feed supplements through use of seeds (e.g. soybean), oilseed press-cakes (e.g. groundnuts) and crop residues (i.e. legume haulms). While CRP 3.5 placed strong emphasis on N fixation and grain yield, the CRP notes that fodder residues, being rich in protein, are expected to take an increasingly important role as ruminant feed. It also notes that demand for legumes is decreasing in some regions as food preferences change to increased consumption of animal products. The use of grain legume residues as fodder enriches protein-limited livestock diets and enhances the sustainability potential of crop-livestock mixed farming systems (e.g. return of manure).

The CRP identified impact pathways (intermediate and end users) and uses a value chain approach in its research. It identified five Strategic Components (SCs):

SC 1 – Analyzing demand and setting research priorities

SC 2 – Developing productive varieties and management practices

SC 3 – Facilitating legume seed and technology delivery systems

SC 4 – Enhancing post-harvest processing and market opportunities

SC 5 – Fostering innovation and managing knowledge

Using this research process, CRP 3.5 will deliver research outputs that fall into 8 product lines. In SC 4 the proposal refers to opportunities for improving income of smallholders, particularly women, by enhancing post-harvest processing and marketing of grain legumes. Examples include the use of legume haulms to provide high quality animal feed and the use of legume seed as an important source of protein and other nutrients for animal feed rations. A concrete feed research output is breeding groundnut cultivars with higher haulm nitrogen concentration.

In terms of livestock-related research, CRP 3.5 expects particularly close collaboration with CRP 1.1 (also led by ICARDA). It will provide varieties and crop management practices to CRP 1.1 (and also to CRP 1.2), which will provide feedback to CRP 3.5. It collaborates with CRP 3.6 on feed quality analysis for plant breeding, and will provide dual-purpose legume varieties for evaluation in CRP 3.7.

ICARDA has a strong background in livestock research for dry areas, particularly small ruminants and forages for dry areas. While feed is mentioned frequently throughout the proposal and feed has been predicted as becoming even more important in the future, there are no livestock-related product lines. Feed issues are mentioned in the research process but are a minor part of the overall research program. There is a need for an assessment of the demand for and potential contribution of the various grain legumes to livestock production in the various livestock value chains and mixed crop-livestock farming systems.

Livestock related research in CRP 3.5 contributes to poverty reduction (crop residues add value to sales, diverse uses of legume products), food security (more milk and meat) and sustainable management of natural resources (N-fixation, high-protein supplements for animals, sustainability).

CRP 3.6 DRYLAND CEREALS: A GLOBAL ALLIANCE FOR IMPROVING FOOD SECURITY, NUTRITION AND ECONOMIC GROWTH FOR THE WORLD'S MOST VULNERABLE POOR⁸³

CRP 3.6 is led by ICRISAT working in partnership with ICARDA. The focus of CRP 3.6 is on improving the productivity of key dryland cereal crops targeted primarily to Low-Income, Food-Deficit Countries (LIFDC) in sub-Saharan Africa and South Asia. In the target area, smallholder agricultural systems are based mainly on

⁸³ ICRISAT (2012-b)

dryland cereals highly linked to livestock enterprises where almost the entire crop production is consumed for subsistence as family food and animal feed/fodder.

The crops covered are barley, millet (finger millet, pearl millet) and sorghum. All four crops are used in multiple ways: directly for food, as critically important sources of feed and fodder for livestock, and increasingly for industrial purposes.

- Barley: Grain used as feed for livestock (mainly ruminants but also monogastrics), for malting and food for humans. About 75% of world barley is used for animal feed (proposal page 109). Barley straw is used as a feed, animal bedding and hut roofs. After harvest barley stubble is grazing in large areas of West Asia and North Africa. Barley is also used for green grazing or fodder, either fed fresh or made into silage.
- Finger and pearl millet: Grain used mainly for food. Stover is highly valued as a fodder for livestock.
- Sorghum: Grain is used mostly for food, some for feed and industrial uses and bioenergy. Sorghum stover is a significant source of dry season fodder for livestock. WStur addition: In some areas, sorghum is grown as a fodder crop for ruminants (e.g. dry zone of Myanmar).

The importance of dryland cereal crops for livestock feed is well recognized in CRP 3.6 and is expressed in its vision of success: “to increase farm-level crop productivity and total crop production of at least 16% over ten years. Total grain production will rise by 11 million metric tons to reach a total value of USD 20 billion, along with increases in animal feed and fodder with a value of about USD 10 billion”. The CRP expects that demand for cereals and livestock feed/fodder will increase strongly in the target regions, driven by population increases, urbanisation and increased demand for livestock products. Markets for feed and fodder are evolving rapidly. Recent studies by ICRISAT revealed that 30% of sorghum and 50% of millet is now allocated to non-food use in India⁸⁴. The CRP also recognises that women frequently have key roles in crop and livestock production, with women often having a decisive role in livestock feeding, milking, birthing and animal health care. The CRP is structured around 7 Product Lines (PL) and several of these PLs include feed-related research outputs:

- PL1. Supporting farmers’ transition from subsistence to market orientation with productive, nutritious, photoperiod-sensitive sorghum production packages for multiple uses in West Africa
- PL2. Improving food security for subsistence smallholder farmers in East and West Africa with productive and nutritious pearl millet food and fodder production technologies.
- PL3. Drought tolerant, highly productive multi-use sorghum varieties for food and processing uses in the dry lowlands of East Africa.
- PL4. Improving nutritional security with productive and nutritious finger millet production technologies for East and Southern Africa.
- PL5. Multi-purpose barley production technologies to meet food, feed and fodder demands in the driest regions of Africa and Asia.
- PL6. Improving food security and incomes with productive and nutritious multi-purpose pearl millet hybrid production technologies for East Africa and South Asia.
- PL7. Multi-purpose post-rainy season sorghum hybrid production technologies for improving food and fodder availability in the driest regions of South Asia.

CRP 3.6 has specific crop objectives but has also strong development linkages with CRP 1.1 and CRP 3.7. Collaboration with CRP 1.1 focuses on characterizing different farming systems and understanding the varietal needs for dryland cereals, as well as developing sustainable crop management options. With CRP 3.7, Dryland

⁸⁴ Parthasarathy et al., 2010; Basavaraj and Parthasarathy, 2011

Cereals will collaborate on improving feed value of crop residues, and developing more suitable feed and fodder crop varieties.

CRP 3.6 emphasizes the importance of livestock to livelihoods in their target areas, and the increasing importance of the key dryland cereals as livestock feed throughout the proposal. This is much stronger here than in other Crop CRPs. The ILRI group based at ICRISAT has been engaged in collaboration on feed value of dryland cereals and grain legumes. ILRI is not a partner in CRP 3.6 so there may be a reduced emphasis on livestock-related issues.

The proposal refers to the livestock revolution as having important implications for dryland cereal demand, and for how research should be focused. Improving the feed value of crop residues is the main thrust of livestock-related research. For example, the proposal states: “Crop residues, especially stover but also straw, are increasingly important commodities that significantly increase the overall value of dryland cereals. The current estimated value of sorghum stover in our target regions, for example, is USD 5.8 billion (Table A6-7 in Appendix 6). The increasing value of stover has been a prominent trend in Asia⁸⁵, and stover markets are emerging in the drier, more densely populated areas of West Africa. The increasing demand for livestock and livestock products is raising the importance of fodder and feed. Dryland Cereals will thus focus on increasing the quantity and quality of stover and straw, as well as grain”. Targeted breeding for improved crop residue quality is possible since there is significant genetic variability for grain yield, stover and straw yield, and fodder quality among the dryland cereals, and there are weak negative correlations among these attributes.

CRP 3.6 has highlighted collaboration with 3.7 and 1.1, which are essential, and also with other Crop Centres on breeding for fodder traits. The question is how these interactions are financed. We understand that MAIZE is the only crop centre that provided a sub-grant to CRP 3.7 (or ILRI?) to collaborate. Much of the ILRI-Crop Centre collaboration was funded through existing projects and the question is if CRP 3.6 (and other Crop CRPs) will be willing to allocate specific funds for this collaborative research, especially if funds are limited. Unless CRP 3.7 obtains funds from CRP 3.6, it may not have the capacity to engage fully. These interactions need to be planned and funded appropriately in the next round of CRPs.

The livestock-related research of CRP 3.6 will contribute to reducing rural poverty, improving food security and improving nutrition and health. Key drivers of the livestock-related research in CRP 3.6 are economic growth, increasing population and urbanisation, and feed use efficiency in livestock systems.

CRP 3.7 MORE MEAT, MILK AND FISH BY AND FOR THE POOR⁸⁶

This CRP provides the flagship of livestock research at the intensification interface, and is led by ILRI. The CRP has three operational themes which separate the types of research and development disciplines. These are:

- **Technology Development.** This Theme tackles adaptation and generation of technologies to address priority constraints in the selected value chains, especially for feeds, genetics and health. It aspires to develop strong linkages between the technology developers and the value chain actors to ensure that former address the real needs of the latter. It has a wide-ranging and ambitious agenda in each of the disciplines of feeds, genetics and health, ranging from the diagnostic (determining priorities and demand) to interventions (from vaccines to breed improvement to feed resource scenario development for the different value chains).
- **Value Chain Development.** This Theme provides the system intensification setting for integrating the technology work, improving delivery systems, and developing value chains that promote productivity through new partnerships and innovation capacity. The CRP aspires to do action research, and work closely with development partners, including the private sector, and governance actors. It advocates

⁸⁵ Nordbloom 1983; Kelley et al. 1996

⁸⁶ ILRI (2011)

piloting and assessing interventions in target value chains to avoid past failures that may have led to inappropriate or ineffective technologies and strategies.

- Targeting, Gender and Impact. The third Theme ensures that gender and equity are mainstreamed, including women and vulnerable groups. It aims to specifically measure changes in these groups.

The CRP focuses entirely on the following value chains:

- Egypt: tilapia and catfish aquaculture value chains
- Ethiopia: small ruminant value chains in mixed crop-livestock systems
- Mali: small ruminant value chains in mixed crop-livestock systems
- India (selected states): smallholder dairy value chains
- Nicaragua: dual-purpose cattle value chains
- Tanzania: smallholder dairy value chains
- Vietnam: smallholder pig value chains
- Uganda: smallholder pig value chains

The CRP has aligned itself with the impact pathway concept now adopted in the CGIAR, and commits to increasing production and benefits to the poor in the selected value chains. It focuses efforts on aligning and supporting research and development partners to prepare, obtain funding for, and implement major development interventions in the selected value chains. It cautions that it cannot guarantee successful delivery of development interventions in each target value chain, but it will hold itself accountable for undertaking the research needed to inform the design of appropriate interventions, generate evidence for their potential impact and serve a catalytic role in mobilizing stakeholder support and building innovation capacity.

This CRP is targeted specifically at the food security SLO, and with some components of poverty, nutrition and sustainable management of natural resources. It is the only CRP managed by ILRI (although ILRI did compete for leadership in two others: CRP 4 and CRP 7). As such, it is sometimes seen as the flagship livestock project, and by some as the representation of ILRI, something which the CRP 3.7 Director quickly corrects. It represents one particular side of the livestock agenda, testing and accelerating the understanding of process of sustainable intensification in selected smallholder systems. It was a courageous change from a universal approach previously adopted by ILRI, progressively moving away from a ruminants only agenda to a wider, but still global, agenda of livestock systems in almost all regions of the developing world (and struggling to deliver on that agenda), to a focus on just four commodity value chain chains in nine countries, conveniently straddling West and Eastern Africa, the Middle East, South and Southeast Asia and Latin America.

In its focus on the value chains of small ruminants, dairy products and pork products, it has selected commodities for which there is a growing demand within the regions under study. And in fulfilment of one of the cross-cutting issues, it anticipates that “the inclusion of multiple countries and regions, together with some common species of focus, will allow comparisons and cross-system learning that will support the development of strategic lessons, methodologies and technologies of wide applicability, and the delivery of strong international public good knowledge outputs”. The CRP reflects ILRI’s attempt to become smarter in bringing together the species, value chains and regions in which livestock really will make a difference to the poor. The role of livestock as a pathway out of poverty has been extensively used, and undoubtedly over generalised over the last decade, allowing sceptics to dispute the pathway concept; by tackling the specifics, and incorporating (at least in part) natural resource management components, this initiative is a constructive development.

In aligning the CRP with the identified drivers of livestock research, the CRP appears to go against the grain by not selecting poultry. It argues that while there is indeed demand for poultry in all four regions, it is the private sector which has the comparative advantage in building and resourcing this market opportunity. The only area in which it concedes there might be a role for the CGIAR in poultry is the indigenous bird value chains. However it also concedes that this issue has not yet been discussed in a strategic manner across the CRPs.

Should there be a beef value chain at some stage in the future? In Asia, smallholders in mixed-crop livestock systems have a comparative advantage to grow/fatten cattle for sale to the beef markets looking initially at simply producing meat more efficiently and with time accessing higher-quality meat markets as they produce beef from younger animals in good condition⁸⁷. They may be less competitive in breeding operations unless combined with milk production (the dual-purpose cattle production systems in Central America). While the focus of CRP 3.7 on the value chains selected is understood, some might argue that beef production would add value in future livestock CRPs. Green / organic / fed on farm-grown feed / no concentrates that compete with human feed: is this the way beef should be grown⁸⁸?

A major gap and opportunity identified in this CRP is the area of post-harvest losses in each of the commodities. This includes the areas of storage, transportation, marketing and processing, seeking options for the different value chains, and exploring targeting for optimal distribution and nutritional impact. This is a substantial component of a value chain analysis, and the underlying hypothesis of broadening the range of impacts to a wider range of stakeholders than just producers. A further gap is the need for an understanding of consumer preferences, including the willingness to pay component.

But perhaps the most significant area in which this CRP could draw on its comparative advantage in the CG Consortium is to take these selected case studies up to a higher level, and engaging is a trans-regional analysis which would help to put the selected value chains in a wider global context.

The CRP has pragmatically adopted much of the biotechnology research previously underway at ILRI, under the components 1.1 and 1.2 of research theme 1 (technology development). Clearly animal health and breeding are highly likely to feature as constraints to the target pork, dairy and small ruminant value chains, but it will be important that these supply-driven technology platforms are amenable to adjustment once health constraint priorities in these systems have been determined, and capable of responding to the development or partnership facilitation of technologies for other diseases. It seems highly likely that there will be a valuable convergence of supply and demand with African swine fever research in the pork value chains of Uganda, cysticercosis control in those of both Uganda and Vietnam, with the need for Peste de Petits Ruminants (PPR) control in Ethiopia and Mali, but inevitably others will emerge. But most importantly, whatever the health constraint, and whatever the potential technological intervention (vaccine, therapy, management, etc.), the common denominator will be the need to address the technical services responsible for delivering these for the different target beneficiaries, which may require a new range of animal health skills to those currently prevailing in these value chains (see additional comments in section 4.5 above).

CRP 4 AGRICULTURE FOR IMPROVED NUTRITION AND HEALTH⁸⁹

CRP 4, led by IFPRI, stands out as a unique cross-cutting initiative within the Consortium portfolio tasked specifically with improving the nutrition and health of poor people by exploiting and enhancing the synergies between agriculture, nutrition, and health. An exciting concept. It achieves this through four key research components: value chains, biofortification, control of agriculture-associated diseases, and integrated agriculture, nutrition, and health development programs and policies.

The CRP then identifies six research objectives which cut across the four different components as follows:

1. Generate knowledge and technologies to improve the nutritional quality and safety of foods along value chains (Components 1, 2, and 3).

⁸⁷ e.g. Stur et al. 2013

⁸⁸ Bassett (2013)

⁸⁹ IFPRI (2011-b)

2. Develop, test, and release a variety of biofortified foods, as well as other nutrient-rich foods that are affordable for the poor and accessible to them (Components 1 and 2).
3. Generate knowledge and technologies for the control of zoonotic, food-borne, water-borne, and occupational diseases (Component 3).
4. Develop methods and tools to improve the effectiveness, efficiency, and timeliness of surveillance and monitoring systems and to permit meaningful evaluation of complex multisectoral programs and policies (Components 1-4).
5. Produce evidence of nutritional and health burdens and benefits and of the returns to different interventions in different sectors (Components 1-4).
6. Assess and document changes in dietary and nutritional patterns and risks of agriculture-associated diseases among poor people in intensifying systems, and identify and test agricultural options to enhance nutrition and health benefits and mitigate risks of agriculture intensification in these populations (Components 1 and 3).

Livestock products are a major nutritional component of diets⁹⁰, and as such livestock is central to this CRP. In effect, however, the major livestock-specific component is found in component 3, dealing with the prevention and control of agriculture-associated diseases, which is led by ILRI. This component aims to enhance environmental sustainability, reduce poverty, increase food security, and contribute to the health of poor communities by assessing, preventing, and mitigating agriculture-associated health risks, through research for improved food and water safety; control of bacterial, viral, parasitic, or fungal diseases that can be transmitted from animals to humans (zoonoses); and managing agroecosystems for better health.

Unlike most of the other CRPs, CRP 4 has a very broad geographical mandate, “focussing in particular on sub-Saharan Africa and South Asia”. It also interfaces with other CRPs and partners, including CRP3.7 value-chain work on high-value animal source foods in Ethiopia, India, Mali, Senegal, Tanzania, Uganda, and Vietnam (Component 1); with community-based ANH programs implemented by non-governmental agencies such as Helen Keller International (HKI), Concern Worldwide, Save the Children, and Catholic Relief Services, as well as governments and other partners, in Burkina Faso, Nepal, Zambia, and other locations (Component 4); and on institutional commodity procurement for food emergencies by agencies such as the World Food Programme (Component 3 on mycotoxins).

Specifically, CRP 4 is “piggy-backing” on the value chains of CRP 3.7. Component 3 has three research sub-components. These are:

- Food safety: fungal toxins (mycotoxins), biological hazards, plant toxins, chemical hazards
- Zoonoses: neglected zoonoses; emerging diseases
- Other health risks of agroecosystems: water-associated disease; occupational hazards; drug and chemical resistance; ecosystem services; climate change and disease; shaping agroecosystems for health outcomes

In this CRP, the control of specific diseases is central to Component 3, and the emphasis has been placed on developing technologies and knowledge. But as with CRP 3.7, and indeed with the three systems CRPs, so much depends of the capacity to deliver these to the end user, a component which does not appear to receive the attention by the CG Consortium it arguably deserves; see also comments below in section 5.5 below.

CRP 5 WATER, LAND AND ECOSYSTEMS: IMPROVED NATURAL RESOURCES MANAGEMENT FOR FOOD SECURITY AND LIVELIHOODS⁹¹

⁹⁰ Randolph et al. (2007)

⁹¹ IWMI (2011)

CRP 5, led by IWMI, addresses natural resource management at the Basin and Landscape scales of resolution. It has identified five Strategic Research Portfolios (SRPs). These are

SRP 1 Irrigated Systems

SRP 2 Rainfed Systems

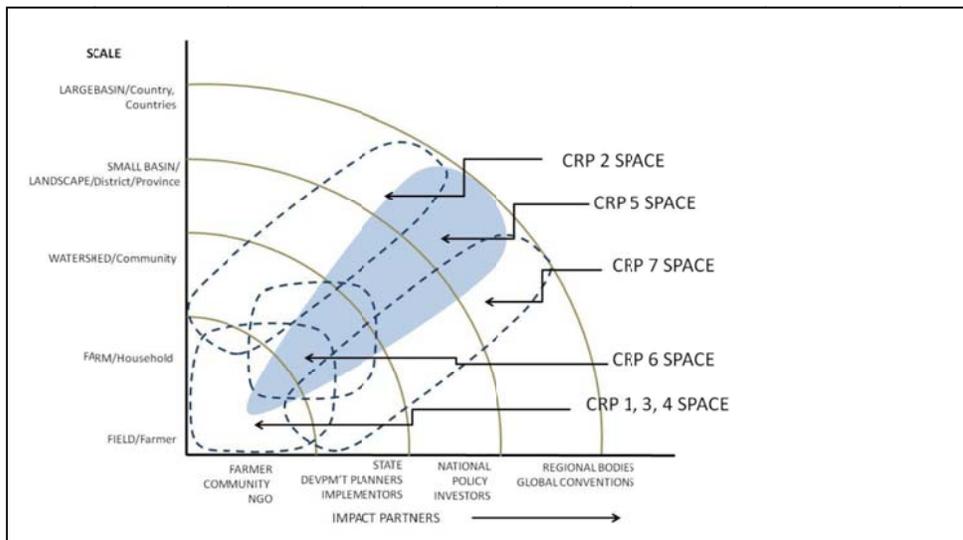
SRP 3 Resource Reuse and Recovery

SRP 4 River Basins

SRP 5 Information Systems

It has also established two cross-cutting themes, namely Ecosystem Services and Institutions and Governance. And it has a defined, and very wide, geographical focus centred on large river basins:

Region	Basin
Southeast Asia	Mekong
South Asia	Indus and Ganges
Central Asia	Amu Darya and Syr Darya
Middle East	Tigris and Euphrates
West Africa	Volta and Niger
East Africa	Nile
Southern Africa	Limpopo and Zambezi
Latin America	Andes basins



The CRP has

taken the interesting approach of focussing its research around key “problem sets”, which contain a mixture of regional, basin-specific, global and methodological issues; each problem sets is specific to research sites. It cites its major CRP linkages as with the systems CRP in drylands, the crop CRPs addressing wheat maize and rice, the policy CRP, and naturally the climate change CRP. In doing this, it presents an interesting graphic of the different scales at which its partner CRPs operate (above).

The problem sets for irrigated and rainfed systems are presented below.

Irrigated Systems SRP

Finally unlocking Africa’s irrigation promise
 Revitalizing public irrigation systems in Asia
 Managing groundwater overexploitation in India through the energy–irrigation nexus
 Revving up the ‘Ganges Water Machine’ through intensive groundwater use for livelihoods and environmental benefits
 Managing salt–water balance in Indus and Central Asian irrigation systems

Rainfed Systems SRP

Recapitalizing African soils and reducing land degradation
 Revitalizing productivity on responsive soils
 Using agro-biodiversity to sustain agricultural production
 Reducing risk by ensuring water access for pastoralists
 Reducing risk by providing farmers with supplemental irrigation

Almost one third of the water footprint of agriculture in the world is related to the production of animal products⁹². And from a freshwater perspective, animal products from grazing systems have a smaller blue and grey water footprint than products from industrial systems. Clearly, this illustrates that the role of livestock in water management under different production systems is likely to be a priority for the CG Consortium. As mentioned, CRP 1.1 is a priority partner for CRP 5, and it is here where there is potential for greater understanding of the livestock/water interface, particularly in marginal areas, and associated with forage crops and feeding systems. There is remarkably little reference to livestock and links with CRP 3.7, but this is perhaps understandable given the different geographical focuses held. And the division into irrigated and rainfed systems of CRP 5 is perhaps not conducive to clear delineation of livestock pertinent research issues. In broad terms, the issue of water use in livestock production is considered a priority, and ILRI is engaged at least in a dialogue with CRP 5. It also receives some funds from this CRP, but these amount to less than \$200,000 per year. It is understood that there will be planning meetings in each of the identified priority regions, and ILRI is likely to participate in the East Africa focus in the Nile Basin. This will address particularly livestock/water interactions, and payment for ecosystem services.

CRP 6 FORESTS, TREES AND AGROFORESTRY: LIVELIHOODS, LANDSCAPES AND GOVERNANCE⁹³

CRP 6 is led by CIFOR in partnership with the World Agroforestry Centre, Bioversity and CIAT, and their partners. *The overarching challenge will be how to enhance livelihoods through forestry, agroforestry and other uses of forest resources while sustaining environmental services and resource resilience.* In addressing the issues that cross the boundary between small scale agriculture and forestry, the programme will encourage improved forest and agroforestry management practices by smallholders and increase the synergies between them, increase the use of sustainable forest management strategies to better conserve tree genetic resources and biodiversity in forest habitats, support the development and adoption of more effective and equitable land use policies for conserving ecosystem services at the landscape scale, magnify the contribution of forests, trees and agroforestry to enable society to mitigate and adapt to climate change, and promote more equitable and environmentally sound outcomes from forest-related trade and investment.

In developing countries, agroforestry systems provide essential fodder and non-timber forest products, and contribute significantly to the revenues of smallholder and women-led households. ICRAF has shown the

⁹² Mekonnen and Hoekstra, 2012

⁹³ CIFOR (2011)

contribution fodder trees and shrubs such as Calliandra can make to smallscale dairy producers in Kenya⁹⁴. These tree/shrub legumes can provide high quality fodder for animals, but require careful management, especially during the tree establishment period. These systems have been adopted in areas where specific tree legume species were well adapted and fitted into the particular farming system. Examples are Calliandra for dairy farms in Embu, Kenya, and Gliricidia and Leucaena for beef cattle in eastern Indonesia.

CRP 6 has identified five research components:

1. Smallholder production systems and markets.
2. Management and conservation of forest and tree resources.
3. Landscape management for environmental services, biodiversity conservation and livelihoods.
4. Climate change adaptation and mitigation.
5. Impacts of trade and investment on forests and people.

Livestock-related research is mentioned in component 1: Smallholder production systems and markets (feed) and component 5: Impacts of trade and investment on forests and people (policy), but no concrete research outputs have been identified. Being one of the first CRPs to be developed, there was limited opportunity to identify linkages with other CRPs. Those that were identified were somewhat tentative. CRP 6 identified possible livestock-related research collaboration with CRPs 1.1 and 1.2 (forage, livestock integration in systems), CRP 3.7 (wild life) and CRP 4 (forest products and food security).

CRP 7 CLIMATE CHANGE, AGRICULTURE AND FOOD SECURITY (CCAFS)⁹⁵

CCAFS is the CGIAR's flagship programme on the vital issue of climate change. The lead centre is CIAT, but unusually for a CRP, there is also a Co-ordinating Unit/secretariat housed in a non-CGIAR institution, the University of Copenhagen. Of the four Theme Leaders, one is an ILRI staff member, one a CIAT staff member and two are drawn from non-CGIAR institutions, and the Regional Program Leader for East Africa is also based at ILRI. There is collaboration across the CGIAR system.

CRP 7 has four themes:

10. Adaptation to Progressive Climate Change
11. Adaptation through Managing Climate Risk
12. Pro-Poor Climate Change Mitigation
13. Integration for Decision-Making.

Themes 1 to 3 started to work in three regions - eastern Africa, West Africa and the Indo-Gangetic Plain – and are now also establishing programmes in Latin America and South-East Asia. Theme 4 “provides an analytical and diagnostic framework for the whole of CRP 7”.

Theme 1 focusses on adaptation over decadal timescales. While it makes extensive use, as would be expected, of agro-climatic modelling and long-term projections, it also works along the impact pathway from strategic science to capacity-building for adaptation. However, its research questions, activities and outputs tend to be generic across the domains of crops, livestock, trees and fish, with the important exception of a research question under Theme 1 Objective 2 on breeding strategies; “can currently farmed livestock and fish species cope with expected changes in temperature and salinity, and if not, how can new species or improved breeds be brought into production?”.

⁹⁴ e.g. Place *et al.* 2009

⁹⁵ CIAT (2011)

Theme 2 addresses current risks associated with climate variability (such risks serve as an analogue for future risks and addressing them now contributes to long-term variability). Again research questions, activities and outputs tend to be generic across crops, livestock, fish and trees, but space is created for work on important topics of livestock and climate risk: index-based insurance, early warning systems and safety nets, co-ordination of agricultural development and humanitarian response. Work under theme 2 Objective 3, on seasonal forecasting and climate services for farmers, so far seems not to have addressed the specific needs (both in terms of information products and delivery systems) of livestock-keepers.

Theme 3 concerns Pro-Poor Climate Change Mitigation. Even here, explicit references to livestock-specific processes and their mitigation are not numerous, but the Theme description does acknowledge both methane emissions from enteric fermentation and carbon dioxide emissions from land-use change. On the former, there are clear plans to investigate possible win-win scenarios, of practices that reduce methane emissions in livestock with increased feed-use efficiency.

Theme 4 has an overarching mandate on linking knowledge with action, development of data and tools for large-scale planning, and policy analysis. The section on data and tools singles out impacts of climate on rangelands and livestock productivity as a specific knowledge gap.

Opportunities for partnerships with other CRPs are set out in detail under each Theme. The various commodity CRPs are presented here as an undifferentiated CRP 3. Mentions of livestock include collaboration under Theme 1 with (presumably) CRP 3.7 on development of new livestock management technologies, and under Theme 4 on training on data and modelling approaches to livestock performance, and evaluation of policies concerning livestock.

It was noted that CCAFS has developed a memorandum of understanding with the AGA policy group in FAO, which is very constructive, as the FAO group seeks to explore sustainable livestock sector development as part of the Global Agenda of Action. This constructive partnership highlights the absence or weakness of other partnerships between FAO and CRP 3.7, the system CRPs and ILRI⁹⁶.

CRP 7 represents a significant achievement in planning research across the CGIAR on climate change and agriculture. However, it gives relatively little attention to livestock-specific aspects of climate change adaptation and mitigation. For adaptation, these include animal health issues: the possible spread of certain animal diseases, opportunities for weather-linked early warning of disease risk, and impacts on rangeland composition and possible bush encroachment. For mitigation, the agenda is all too clear, not least because of the well-publicised findings of *Livestock's Long Shadow* that "the livestock sector" is responsible for 18% of global anthropogenic GHG emissions by CO₂ equivalent, and 37% of global anthropogenic methane emissions. These figures are not relayed in the CRP document, which interestingly cites a lower figure for total GHG emissions, 10-12% *for the agriculture sector as a whole*, but neither are they challenged. There is a research agenda around verifying the methane emission figures in particular, investigating the interacting effects of diet and breed on tropical livestock as well as the counterfactuals of emissions from rangelands without domestic livestock, and also finding analytical and policy tools which take account of both GHG emissions from livestock and competition between livestock feed and human food cultivation⁹⁷. These issues may be covered in future under the partnership with FAO noted above

An important role for CRP 7 is presumably to be responsive to demands from both systems and commodity CRPs on specific issues: what are the impacts of specified climate-smart intervention opportunities on greenhouse gases, on carbon sequestration, etc?

⁹⁶ It is understood that CRP 3.7 is in the process of bringing an FAO staff member into the CRP3.7 Advisory Committee as the aquaculture specialist

⁹⁷ Gerber et al., 2010

A major gap identified in CRP 7 is exploration of the impacts of climate change scenarios on changes in disease occurrence and impact (particularly vector-borne diseases, but also those which are water-borne and temperature sensitive, of both plants and animals).

10. ANNEX 2. LIVESTOCK INTERVENTIONS FOR CRP 2 MODEL PARAMETERISATION

Options for improving productivity/impact of Livestock in developing countries^{i,ii}

I. Animal Nutrition	1	Feed/Fodder Preservation
	2	Fodder development (including trait improvement of fodder varieties for drought resistance, improved quality, etc.)
	3	Improved feeds through development and use of dual-purpose crop cultivars
	4	Better livestock feed processing (silage, fortified feed blocks, etc.)
II. Disease Control	1	(Better access to available vaccines and) Improved vaccines for East Coast fever (ECF)
	2	(Better access to available vaccines and) Improved vaccines and diagnostic tools for Contagious Bovine Pleuro-Pneumonia (CBPP)
	3	Thermostable vaccines for Peste de Petites Ruminants (PPR)
	4	Monitoring and surveillance of and improved biosecurity protocols for African Swine fever (ASF)
	5	Monitoring and surveillance of zoonotic diseases
	6	Decision support tool for Rift Valley fever (RVF)
III. Genetic Improvements	1	Improved knowledge and application of principles of animal breeding management for sustainable productivity
	2	Improved reproduction technologies for livestock genetics (e.g., embryo transfer technologies, reproductive and productivity profiling of animals under diverse production systems)
	3	Platforms for smart collation of data and information on phenotypic and genetic diversity of animal genetic resources and feedback systems
	4	Improved livestock genetics using such technologies as marker-assisted selection (MAS) and livestock breeding schemes that incorporate strategic crossbreeding and gene introgressions
	5	(Research to support) Enhanced knowledge of indigenous livestock breeds and genetics, especially better understanding of tolerant traits
	6	Improved indigenous poultry genetics in Africa
IV. Others	1	Improved livestock water productivity
	2	Livestock insurance and related risk-management

ⁱ An attempt has been made here to prioritize the technologies identified under the Global Futures project. The major categories (animal nutrition, disease control, etc.) are listed in what may be considered order of relative importance, indicating the extent to which they address the 'most limiting' constraints to livestock productivity in developing countries. Technologies are further prioritized within the major headings (where, for example, improved livestock water productivity is given precedence over the development of livestock insurance tools). However, no absolute ranking is implied by this simple prioritization exercise as the usefulness of livestock technologies is highly contextual and relevance ranking may change from one production system to another. In additions, technologies to improve productivity of livestock in developing countries, particularly in smallholder systems, are considered better delivered as packages of technologies (i.e., combinations of feed, breed, animal health and other technologies).

ⁱⁱ Prioritization of the promising technologies (PT) for livestock in mandate regions of ILRI was done by Ben Lukuyu, Bernard Bett, Henry Kiara, Julie Ojango, Mwai Okeyo and Phil Toye; The PT reports were compiled by Dolapo Enahoro. Please address questions and comments to d.enahoro@cgiar.org.
