CGIAR Research Program 3.7

More meat, milk and fish by and for the poor

Proposal

Submitted to the CGIAR Consortium Board by ILRI on behalf of CIAT,ICARDA & WorldFish Center
5 March 2011

CIAT

ICARDA

WorldFish CENTER

ILRI
INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

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FOREWORD

In accepting the invitation to develop a CGIAR Research Program to increase global food security through livestock and farmed fish, the participating CG Centers have embraced the spirit of the ongoing change process to propose a bold new approach for organizing and conducting our research. This new approach relies on two key principles: focus and new partnerships that together allow us to take more active responsibility for impact.

To improve our focus, we have agreed to concentrate our collective efforts on just nine animal-product value chains in eight countries, replacing our conventional approach of more piece-meal research across scattered sites. This will allow us to integrate our research in a holistic manner to generate the solutions that will transform the selected value chains and produce more food. Although counter-intuitive, we see this focus actually enhancing rather than restricting our ability to generate international public goods for impact more widely.

Transforming value chains requires new partnerships, and here we propose to build on recent experiences in which Centers have been working more closely with development and private sector partners. This emerging model has the Centers serving as the knowledge partner within large-scale development interventions. This arrangement increases the urgency and relevance of our research while providing a mechanism for translating our research results directly into use at scale. This also means that the Centers contribute directly to—and become accountable for—achieving verifiable development outcomes.

Clearly this approach will present new challenges and risks, but we are excited about its potential for generating measurable impact and are keen to begin. It will have implications for the way we organize ourselves and work together, but we have already been encouraged by the interactions and synergies being created among the four Center partners.

In the spirit of the GCARD meeting in Montpellier, we actively engaged a wide range of stakeholders for their feedback and input as we developed the original proposal, both through a series of face-to-face meetings and through a public e-consultation. We greatly appreciated and benefited from both the quantity and quality of response: the e-consultation alone received over 14,000 visits and generated over 400 thoughtful—and often thought-provoking—comments. We have now also benefited from the Consortium Board review which, though positive, has also challenged us to sharpen the logic behind the proposed program and its plan of action. This revised version has also benefited from further public e-consultation to test our responses more widely. Both have contributed to strengthening the revised proposal we are submitting today.

We now look forward to continuing to work with these stakeholders and new partners as we prepare to implement the Program to deliver impact on the ground for thousands of poor producers and improved supply of animal source foods for millions of poor consumers.

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5 March 2011

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We are grateful to the organizers of the Forum for Agricultural Research in Africa (FARA) Africa Agriculture Science Week, held in Ouagadougou in July, for kindly hosting a side-meeting consultation.

We thank the following colleagues who accepted to review the draft proposal in an unreasonably short time: John Gibson, Kristen Grote, Cees de Haan, Philippe Lecomte, Simplice Nouala, Joachim Otte and Ian Scoones.

Finally, we thank the Consortium Board and the anonymous reviewers for their insightful comments and questions which have enabled us to develop this revised version.

EXECUTIVE SUMMARY

Consumption of adequate amounts of meat, milk and fish is a proven way of achieving nutritional security which enables children to develop normally and reach their full potential as healthy, productive adults. However, productivity of these animal source foods in the poorest countries lags behind the rest of the world and consumption rates amongst the poor, women and children remain well below recommended levels. In many systems, opportunities for increased production and marketing of these commodities lie particularly with smallholder producers and other small-scale actors. This offers an opportunity for improved food security through better incomes and livelihood assets for the poor and women livestock keepers. The roles of men and women in production, processing and marketing and in household decision-making in resource allocation, technology adoption, marketing and consumption vary across the target countries of Africa, Asia and Latin America and there is great potential to use livestock and fish as a way for reducing inequities in access to resources, income generation and nutrition in these regions.

Vision

This CGIAR Research Program's vision is for the health, livelihoods and future prospects of the poor and vulnerable, especially women and children, to be transformed through consumption of adequate amounts of meat, milk and/or fish and from benefiting from the associated animal source food value chains.

CRP3.7 aims to realize this vision by seizing upon an unprecedented opportunity to integrate and exploit three ongoing revolutions – the Livestock Revolution, the Blue Revolution and the Gene Revolution. It will do this by fostering partnerships that harness the respective strengths of research and development partners, including the private sector, and also other relevant CGIAR Research Programs. The Program will be led by ILRI working closely with CIAT, ICARDA and the WorldFish Center.

MP 3.7 is testing the hypothesis that *increased access to animal source foods by the poor, especially women and children, can be achieved at scale by strengthening carefully selected meat, milk and fish value chains in which the poor can capture a significant share of the benefits. Technologies and lessons generated through this focused approach will be applicable in broader regional and global settings.*

Goal

The over-arching goal of CRP3.7 is to increase productivity of small-scale livestock and fish systems so as to increase availability and affordability of meat, milk and fish for poor consumers and, in doing so, to reduce poverty through greater participation by the poor along animal source food value chains.

This will be achieved by making a small number of carefully selected animal source food value chains function better, for example by identifying and addressing key constraints and opportunities (from production to consumption), improving institutional arrangements and capacities, and supporting the establishment of enabling pro-poor policy and institutional environments.

Program objectives

The Program objectives that will contribute to the goal include to:

- increase sustainably the productivity of small-scale livestock and fish production and marketing systems
- increase access to affordable animal source foods to enhance food and nutrition security for the poor, women and children
- enable participation in and access to pro-poor and gender equitable production and marketing systems that promote uptake of productivity-enhancing technologies and increase value generation, with emphasis on addressing current gender disparities

- secure household and community livestock and fish assets for sustained livelihoods, and conserve livestock, fish and forage/fodder biodiversity as public good assets that will provide genetic diversity for continued growth and adaptation
- protect the natural resource base and its ability to continue providing ecosystem services
- strengthen capacity to enable public and private sector actors to support and exploit appropriate research and development efforts for sustainable intensification of small-scale livestock and fish production and marketing systems that provide equitable benefits to men and women
- facilitate scaling up and out by undertaking research and emphasizing learning and its communication

At the core of CRP3.7 are a small number of carefully selected national meat, milk and fish value chains. This focus is made in order to effectively implement the Program's innovative R4D approach and to maximize impact. The focus is on those value chains for which we judge there is a high potential for transformational improvement - from the producer to the consumer. The criteria by which these value chains have been selected include:

a) Evidence of market opportunities for continued expansion of production, through growing demand for livestock and fish products
b) Opportunities for smallholder producers to actively participate in and benefit from those opportunities, especially women and the poor, either as producers or as other actors in the value chains
c) Productivity gaps and identified supply constraints that research potentially offers solutions to overcome
d) A supportive policy and infrastructure environment to facilitate uptake and scaling out
e) Existing momentum and experience, including key research and development partners, that can enable outcomes and impacts to occur within a relatively short timeframe

Based on these criteria and the evidence available, the selected value chains and countries are:

- Small ruminant value chains in mixed crop-livestock systems in Ethiopia and Mali
- Tilapia and catfish aquaculture value chains in Uganda and Egypt
- Smallholder dairy value chains in India (selected states), Tanzania and Nicaragua/Honduras
- Smallholder pig value chains in Uganda and Vietnam

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 program will have as its centre three Research Themes. These are organized so as to: a) provide significant critical mass and investment in generating improved productivity through technology development and adaptation in the main areas of feeding, breeding and animal health, b) ensuring that the technology development is driven by the real world context of agricultural value chains, and c) providing the cross-cutting analysis of development process and outcomes to ensure that target beneficiaries benefit. These coherent research themes will also play a key role in generating the strategic and global public good outputs the lie at the heart of the CGIAR's comparative advantage, by working and employing harmonized approaches across the selected value chains and regions. The three themes are:

Theme One: Technology Development. This Theme is concerned with adaptation and generation of technologies to address priority constraints in the focal value chains, especially for feeds, genetics and

health. Here a careful balance will be maintained between adaptive research to meet current pressing needs, and 'blue sky' research to provide transformational advances in the medium to longer term. Strong linkages between those responsible for technology generation and the value chain actors will be established to ensure that former address the real needs of the latter.

Theme Two: Value Chain Development. This Theme will provide a setting for integrating the technology adaptation and generation work, improving delivery systems, and developing value chains that promote intensification through new partnerships and innovation capacity. Strong emphasis will be on action research, and on working closely with development partners, including the private sector, and governance actors. Piloting and assessing interventions within the context of target value chains is required to avoid past failures that may have led to inappropriate or ineffective technologies and strategies.

Theme Three: Targeting, Gender and Impact. The final Theme is concerned with ensuring that gender and equity are mainstreamed in a transformative way in the whole Program; the Program has its intended impact among target beneficiaries, including women and vulnerable groups; monitoring and assessing the level and manner of that impact, and the outcomes that brought it about; understanding and supporting the processes of innovation and research to development, to improve the performance of the Program and its partners; understanding the political economy and governance of value chains; supporting the internal M&E, planning and decision functions, and the communication strategy of the Program to continually ensure efficiency, accountability and relevance.

In addition to achieving impact at scale in each of the selected value chains, it is anticipated that the research products and lessons generated will be applicable and, with adequate promotion, will be taken more broadly, such as in neighbouring countries. Some research products (such as new generation vaccines and improved varieties of dual-purpose food-feed crops) and lessons are also likely to have even broader applicability. So, while direct impacts are anticipated to benefit tens or hundreds of thousands of poor people for each value chain, broader regional impacts could reach millions, while international public goods could reach tens or hundreds of millions.

Finally, an organizational and implementation strategy and framework will be established to ensure the smooth functioning of the Program and its partnerships. The elements of this include:

- a Partnership Strategy for ensuring that the key partnerships that the Program will rely on are developed and supported, so as to make a strong contributions to the Program goals
- a Gender and Equity Strategy to ensure that the design, implementation, monitoring and evaluation address gender and equity, and distribution of Program impacts is particularly significant among those target groups of particular need
- a Communications, Advocacy and Knowledge Management Strategy to enable key potential users globally of the Program's knowledge products to make best use of those, to reach the decision-makers and investors that can scale up Program outcomes, and to ensure the knowledge generated is organized and made available for wider user,
- a Capacity Development Strategy to maximize the potential for increase capacity for research for development among a range of partners, and
- a Management and Governance Structure that aims to both exploit the strong skills and capacity of the Program partners through joint processes of decision-making and implementation, while at the same time providing a streamlined structure to limit transactions costs of Program implementation.

After six years, this Program will have had direct impact on up to nine value chains which will result in significantly improved livelihoods for value chain actors and better nutrition security for poor consumers. It

is anticipated that these direct impacts will benefit tens of thousands of households who will participate in more effective value chains, with larger numbers of consumers enjoying increased access to more affordable animal source foods.

MP 3.7: MORE MEAT, MILK AND FISH - BY AND FOR THE POOR[1]

PART 1: OVERVIEW

> "Chronic undernutrition in early childhood ...results in diminished cognitive and physical development... [Affected children] may perform poorly in school, and as adults they may be less productive, earn less and face a higher risk of disease than adults who were not undernourished as children.
>
> For girls, chronic undernutrition in early life, either before birth or during early childhood, can later lead to their babies being born with low birthweight, which can lead again to undernutrition as these babies grow older. Thus a vicious cycle of undernutrition repeats itself, generation after generation." UNICEF 2008

OUR PROPOSITION

Consumption of even small amounts of milk, meat, eggs and fish (the animal source foods) is an effective way of preventing undernutrition and achieving nutrition security[2], thereby enabling children to develop normally, reaching their full potential as healthy, productive adults.

However, the productivity of livestock and aquaculture systems, and the availability and affordability of animal source foods in poor countries lags behind the rest of the world and consumption rates remain low, exacerbated by recent upward pressure on food prices. Undernutrition therefore remains widespread amongst the poor[3]. It is implicated in the deaths of a third of all children under five (Black et al 2008); an estimated 195 million children are too short for their age (stunted) and 129 million children are underweight (UNICEF 2008). The prevalence of stunting and underweight children is highest in Africa and Asia, but also prevails amongst the poor in other regions, such as Latin America and the Caribbean.

The expected contribution of the CGIAR is to sustainably increase production of the animal source foods needed to help improve nutritional security and reduce undernutrition. Livestock and fish production continues to be driven primarily by smallholders in most developing countries, especially in sub-Saharan Africa (FAO 2009). This is particularly the case in ruminant (cattle, sheep and goats) and pig production where availability of under-utilized crop residues, roughage and other feedstuffs, combined with under-employed family labour, ensure that smallholder producers compete strongly with larger commercial livestock enterprises, and will do so for the foreseeable future (Omiti et al 2006; Delgado et al 2003a). In the case of small stock and some dairy systems, women also play an important role in generating income and control of assets. The required production increases to provide more animal source foods for the poor thus can at the same time generate improved incomes and livelihoods for smallholder producers and other actors along the value chain.

[1] One of the strategic objectives of the CGIAR's new model is to "*Create and accelerate sustainable increases in the productivity and production of healthy food* ***by and for the poor***". http://www.cgiar.org/changemanagement/index.html

[2] Nutrition security is defined as adequate nutritional status in terms of protein, energy, vitamins, and minerals for all household members at all times.

[3] In this proposal, the 'poor' is taken to mean people living on less than the equivalent of US$2 per day.

There is a now a huge, unprecedented opportunity to mobilize livestock and fisheries research-for-development to enable the poor to access adequate supplies of animal source foods at affordable prices, and simultaneously generate improved livelihoods. Capturing this opportunity will jointly address two of the central pillars of improved food security: **availability**[4], the sustained physical presence locally of adequate and appropriate food, and **access**[5], reliably having the financial or productive resources required to obtain that food.

Factors converging to create this opportunity include increasing demand for animal source foods in many poor countries, the growth of the private sector and increased dynamism of markets in many developing countries, and the long-term dependence in many systems on smallholders for the large bulk of production. The recognition that technology development must go hand-in-hand with effective targeting and uptake pathways, recent advances in both the natural and social sciences, and new institutional flexibility provided by the CGIAR change process are also significant.

Building on these opportunities, CGIAR Research Program 3.7 will test the hypothesis that *increased access to animal source foods by the poor, especially women and children, can be achieved at scale by strengthening carefully selected meat, milk and fish value chains in which the poor can capture a significant share of the benefits. Technologies and lessons generated through this focused approach will be applicable in broader regional and global settings.*

It is envisaged that direct impacts along the selected value chains will improve the livelihoods of tens of thousands of poor households. Additional production of more meat, milk and fish (of the order of ten thousand tonnes per year) will extend these benefits to tens of hundreds of thousands or more consumers, including the poor.

JUSTIFICATION: WHY MEAT, MILK AND FISH MATTER

Animal source foods are important for three main reasons. The first is simply the relative weight of the sector in the global economy. The total value of global meat, milk and egg production, and farmed and wild-caught fish exceeds US$ 730 billion annually – or about US$ 109 for every man, women and child on Earth (FAOSTAT; www.census.gov). Animal source foods are reported to occupy four of the world's top five agricultural commodities by value (FAOSTAT) - see figure, over.

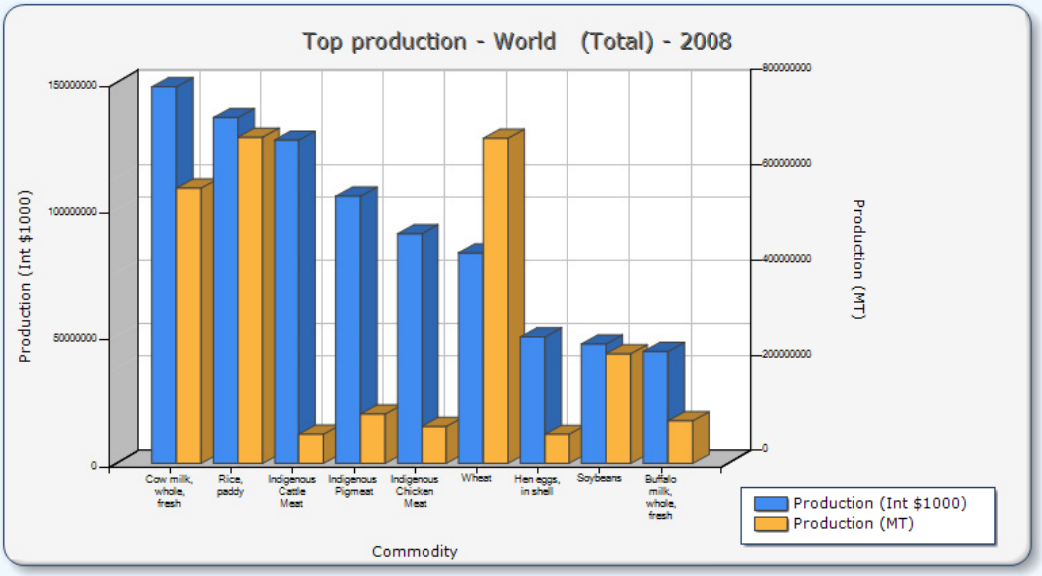
Demand for milk, meat, eggs and fish has increased rapidly in developing countries over the last few decades, especially in the rapidly growing economies. This growth is projected to continue during the coming decades (Table 1.1) and has warranted the coining of the terms the *Livestock Revolution* (Delgado et al 1999) and the *Blue Revolution* (Entis 1997). Although capture fisheries plateaued in the 1980s, aquaculture (the Blue Revolution) has expanded rapidly: in 1970 aquaculture provided less than 4% of global fish, molluscs and crustaceans, but by 2009 it provided half the fish consumed in the world (FAO 2009).

Table 1.1 Projected increase in demand for animal source foods to 2020, % per year (Delgado et al 1999)

	Developed Countries	Developing Countries
Milk	0.2	1.8
Meat	0.5	1.7
Fish	0.0	0.6
Cereals	0.3	0.4

[4] Definition of Availability: Sufficient quantities of appropriate, necessary types of quality food are consistently available to the individuals or are within their reach (adapted from USAID).

[5] Definition of Access: Individuals have adequate incomes or other resources to purchase or barter to obtain levels of appropriate foods needed to maintain consumption of an adequate diet/nutrition level (adapted from USAID)



A second and more pertinent reason for the CGIAR to invest in increasing the production of animal source foods is that in poor countries livestock and fish make significant contributions to diets. In East Africa, for example, livestock provide on average 11% of energy and 26% of protein in poor people's diets (FAOSTAT). Fish, meanwhile, account for at least half the animal protein intake for the 400 million poorest people in Africa and South Asia (FAO 2009).

While livestock and fish clearly make important contributions to overall food security, there is an indispensable role of animal source foods in achieving nutrition security. This is especially important for vulnerable groups, such as infants, children, pregnant and nursing women, and people living with HIV. Animal source foods are dense sources of energy and high-quality protein. They also provide a variety of essential micronutrients, some of which, such as vitamin A, vitamin B_{12}, riboflavin, calcium, iron, zinc and various essential fatty acids, are difficult to obtain in adequate amounts from plant-based foods alone (Murphy & Allen 2003). Animal source foods provide multiple micronutrients simultaneously, which can be important in diets that are lacking in more than one nutrient: for example, vitamin A and riboflavin are both needed for iron mobilization and haemoglobin synthesis, and supplementation with iron alone may not successfully treat anaemia if these other nutrients are deficient (Allen 2002). Micronutrients in animal source foods are also often more readily absorbed and bioavailable than those in plant-based foods (Murphy & Allen 2003). Bio-fortification targets staples, a good approach as intakes of staples are high and therefore higher nutrient concentration in staples – if planted and consumed – will provide more of the nutrient. Fortification and bio-fortification approaches can help but generally target single limiting nutrients. They should be seen as are complementary, not alternative, approaches to increasing intake of animal source food, an issue we intend to explore with colleagues working on CRP 4.

Consumption of even small amounts of animal source foods has been shown to contribute substantially to ensuring dietary adequacy and preventing undernutrition and nutritional deficiencies (**Neumann et al 2003).** Extensive longitudinal studies in Egypt, Kenya and Mexico (Neumann et al 2002) have shown strong associations between intake of animal source foods and better growth, cognitive function and physical activity of children, better pregnancy outcomes and reduced morbidity from illness. Consumption of adequate amounts of micronutrients, such as those that can be found in animal source foods, is associated with more competent immune systems and better immune responses (Keusch and Farthing 1986; Neumann et al 1975, 1991). Similar conclusions have been made for fish and micronutrients in Bangladesh and Cambodia (Larsen and Thilsted 2000, Roos et al. 2007a, 2007b).

A recent report by UNICEF draws attention to children's particular vulnerability to nutritional deficiencies during their first 1000 days from conception and describes how chronic undernutrition of young girls means that 'a vicious cycle of undernutrition repeats itself, generation after generation' (UNICEF 2009).

The first 1000 days

"Recent evidence makes it clear that in children under 5 years of age, the period of greatest vulnerability to nutritional deficiencies is very early in life: the period beginning with the woman's pregnancy and continuing until the child is 2 years old...Chronic undernutrition in early childhood also results in diminished cognitive and physical development, which puts children at a disadvantage for the rest of their lives. They may perform poorly in school and, as adults, they may be less productive, earn less and face a higher risk of disease than adults who were not undernourished as children.

For girls, chronic undernutrition in early life, either before birth or during early childhood, can later lead to their babies being born with low birthweight, which can lead again to under nutrition as these babies grow older. Thus a vicious cycle of undernutrition repeats itself, generation after generation."

United Nations Children's Fund (UNICEF) 2008

Low levels of consumption of animal source foods by the poor are due to limited supply in some regions, such as sub-Saharan Africa, as well as income constraints. It has been estimated that to effectively combat undernutrition, 20 g of animal protein per person per day is needed, which can be achieved by an annual consumption of 33 kg lean meat, 230 kg milk or 45 kg fish (FAO 2009).

The high income elasticity for animal-source food demonstrates there is clear demand: the poor *want* more animal source food in their diet and, indeed, are entitled to enjoy a diverse diet. Consumption of meat, milk and fish take off rapidly when incomes start to rise (Schroeder et al 1995) or when prices stabilize or fall. Over recent decades there has been a significant increase in demand for animal source foods, with the greatest increases occurring in rapidly emerging economies, especially in South, Southeast and East Asia (Delgado et al 1999; Delgado et al 2003b). The fast rate of growth in demand for animal source foods has created challenges in continuing to provide adequate supply at affordable prices. In the case of fish, this is compounded by the global crisis in capture fisheries and the failure to date of aquaculture to fill the growing gap in many developing regions, especially sub-Saharan Africa. In many countries in the region per capita fish consumption has fallen dramatically in recent decades. In Malawi, for example, per capita annual fish consumption was 10 kg in 1986; by 2006 this had fallen to 6 kg. The processes linked to climate change and consequent dynamics of supply constraints further increase the challenge.

The third reason why increasing production of animal products is critical are the roles that livestock and fish play to the poor that raise animals or are involved in the related food systems. Close to a billion poor people depend on livestock and aquaculture for their livelihoods (Staal et al 2008). Animals and their products provide these poor with an important source of cash income, much of which is used to buy staple foods thereby enhancing food security (Kawarazuka and Bene 2010). In East Africa, almost half their incomes are derived from their livestock. Smallholders generally can produce animal source foods from low-value and underused resources, such as fibrous crop residues and land that is unsuited to crop production, increasing their level of competitiveness. In addition, some types of livestock, such as cattle, equines and camels, can provide draft power, which significantly improves efficiency and the area that can be cultivated while reducing the drudgery and burden of hand cultivation. Livestock and fish can also make significant contributions to sustaining crop production, especially through nutrient cycling, e.g. when manure or waste fishpond water is applied to farmers' fields (Tittonell et al 2010). Horses, donkeys, mules or cattle facilitate transportation for marketing farm products such as milk and other products.

Justification: why small-scale production and traditional marketing systems matter

Animal source foods are strategically important for nutritional security of the poor and for the livelihoods of the poor who raise and market livestock and fish. Smaller-scale production and marketing systems offer the means to increase access to animal source foods for poor consumers and opportunities for the poor who produce them.

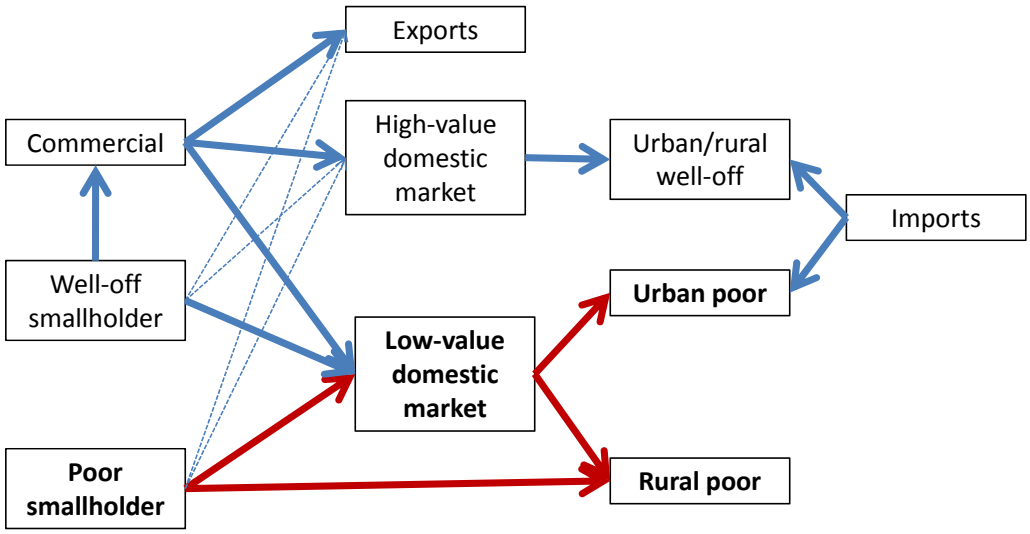
For livestock, the bulk of the increased global production of animal source foods over recent decades has been from poultry and pigs produced in industrial systems supplying formal marketing systems in the rapidly emerging economies (Delgado et al 1999). Similarly for fish, explosive growth of aquaculture has occurred in Asia in larger-scale production systems: Asia now accounts for 85% of global aquaculture production (De Silva & Davy 2009).

Industrial systems[6], however, are not well developed in poor countries and consumers continue to rely largely on traditional food systems (Jayne 2007). Importantly, industrial production suffers from low competitiveness in environments where labour costs are low. Delgado et al (2003a) found little evidence of economies of scale in such environments, even in rapidly developing countries in Asia. Poor consumers tend to buy the cheaper calories offered by plant-based foods, and can afford only small quantities of animal source foods. What meat, milk and fish they can afford usually comes from traditional or informal marketing systems which often offer lower priced products of lower quality or in the form preferred (e.g. raw milk). These informal systems typically draw their supplies of animal products locally from smaller-scale mixed production systems. Both in India and in Kenya, for example, these systems are responsible for over 80% of milk production (Staal et al 2008) and the same pattern in found in higher-income countries such as Nicaragua and Honduras in Central America (Lentes et al 2010). Further, because these systems are typically driven by demand for traditional products, such as raw milk, live animals or fresh unchilled meat, which also form the largest market share, they are generally resistant to competition from imports, which typically cannot offer such products (Tisdell et al 2010). Such systems take advantage of the availability of relatively cheap labour, which favours labour-intensive production methods, and marginal and under or unused resources, such as land unsuited to crop production and crop by-products, which can be used to produce meat, milk and fish and be competitive with industrial systems. As a consequence, they are likely to provide the bulk of production in many countries for years to come, and so need to form the central focus for efforts to increase productivity.

The part of the demand revolution for animal products that is driven by increasing income may often bypass the poor. Demand among the poor will depend primarily on the trends in numbers of poor and changes in consumption associated with urbanization, although recent innovations in cheaper packaging and smaller retail units is showing evidence of increasing poor consumer demand. Expanding industrial systems will provide animal products for at least a portion of the urban poor, but the majority of the poor – especially those in rural areas – will continue to obtain much of their animal source foods from the smaller-scale production and traditional marketing systems. For livestock, smaller-scale production systems generally refer to smallholder mixed crop-livestock farms, whereas for aquaculture, smallholder producers will dominate smaller-scale production value chains in some contexts but micro, small and medium enterprises (MSME) will be more often the norm elsewhere.

[6] This refers in particular to formal, regulated industrial systems that follow international standards in practices, bio-security, etc. It should be note that medium and large scale less formal and less regulated industrial production is also growing, such as large urban dairy production units in India.

It is increasingly apparent that a value chain approach is essential to understanding what interventions are likely to prove most effective and cost efficient at delivering nutrition benefits of increased production to the poor and socially marginalized who need them most (Hawkes and Ruel 2011). The figure, below, illustrates a typical value chain for livestock products in a lower income country (due to economies of scale issues, fish production may be related more to small and medium-scale commercial aquaculture rather than smallholder farms as such). An important feature of livestock and fish markets is the linked nature of high and low-value local markets: production of prime cuts for better-off consumers or export at the same time supplies lower-priced by-products to the lower-valued market for lower-income consumers.



TYPICAL SUPPLY FLOWS FOR LIVESTOCK PRODUCTS IN A LOWER-INCOME COUNTRY

Poor consumers get most of their animal source food from lower-value domestic markets where poor livestock keepers sell their products (beyond what is consumed directly on-farm

There are complex gender and intra-household dynamics around increased incomes, decision making, and food allocation and consumption patterns. Gender disparities in food allocation and in nutritional status have especially been found in South Asia where food allocation is skewed in favour of men and boys (Haddad et al. 1996). Numerous studies on commercialization have shown that increases in cash income do not necessarily translate into gains for all household members (von Braun et al. 1989). Women with control over resources tend to have a large say in how the household allocates resources, and women are typically more likely to skew resources to the production of nutrition. Women's control of income is a key promoter of household food security and nutrition. An approach to livestock and aquaculture value chain development that leverages on value chain interventions which avoid transferring of income and income control from men to women and that generate positive gender outcomes can contribute to meeting the goals of nutrition.

Pro-poor productivity improvements would increase supplies generated particularly by poor livestock in the medium term, but also undoubtedly increase production among better-off smallholders through spillovers and as the benefits to poor livestock keepers lead them out of poverty into the better-off group. Though some benefits would be captured by the better-off smallholders, we would view this as an added indirect and positive outcome.

Much of the new production will supply lower-value domestic markets, where our pro-poor value chain development efforts will seek to improve efficiencies and benefits for the poor dependant on these value chains for their livelihoods. Improved efficiency at farm and market level and increased supply will keep downward pressure on prices, keeping products in these markets affordable and accessible to the rural and urban poor who depend on them for their animal source foods, allowing them to improve – or at least protect—the quality of their diets. There is an associated suite of research questions that will be asked around the importance of animal source foods in the diets of the poor and vulnerable, such as the trade-offs between poor producers selling high value products to increase income versus consuming their produce themselves.

We fully recognize that there is a lot of 'leakage' across markets and producer and consumer groups. For example, some of the smallholder production increases can be expected to end up in commercial production or higher-value formal marketing systems serving the better-off consumers. But such leakages also contribute to positive outcomes since they imply increased income is captured by the poor—contributing to more and better food purchases—and because the linked nature of the two markets means that increased supplies to high-value markets also result in more by-products going to the lower-value markets; therefore, we do not see such leakages creating any fundamental inconsistency with the stated objective of the Program. In short, by focusing on pro-poor productivity improvements both in small-scale production and informal market systems, our hypothesis is that we will increase the availability, accessibility and affordability of animal source foods for the poor. This must be complemented by research to determine how food is processed and, at the household level, on food preparation and intra-household distribution patterns and the reasons governing it. This then allows the design of interventions such as better health education to help ensure an equitable share of nutrition benefits among family members. If further complemented by carefully designed interventions targeted at women and children, such as programs that purchase smallholder milk locally for school lunch programs or that encourage the development of school fish ponds to provide fish for children's meals, and other vulnerable groups identified in the CRP on agriculture, health and nutrition (CRP4), we believe the benefits will extend to those who stand to benefit most from increased production and consumption of meat, milk and fish.

These hypotheses will be specifically tested in the value chains that we propose to work on. Barriers to the equitable sharing of benefits from increased production from the various animal source food value chains will be identified and interventions designed to address these.

AN OPPORTUNITY FRONTIER

The current conjuncture is creating the possibility of much greater progress than in the past for research-led productivity gains and production increases of animal source foods. Focusing in particular on the market systems where the poor buy their animal products, and on the smallholder livestock producer and smaller-scale aquaculture businesses that supply these market systems, will increase access and improved nutritional security for poor consumers while at the same time generating widespread livelihood benefits for the poor who produce the animal products.

Smaller-scale production and marketing systems are in many cases less able to respond rapidly to increased demand than industrial systems. This is due to a number of factors including lack of access to appropriate technologies and value chains: value chains encompass both backward linkages to input markets and services, including credit, institutional and governance arrangements, such as farmer co-ops, contract farming, MSMEs and forward linkages to product markets.

Productivity of livestock and fish in small-scale production systems in Africa, Asia and Latin America lags significantly behind that achieved in richer countries (Table 1.2) and rates of productivity gain are also low. This signals a systemic failure of many past investments in livestock and aquaculture research-for-development: high-quality research and scientific advances have largely failed to bring about transformational impacts in poor countries. In Africa there is increased awareness among decision-makers of these disappointments: key ministers responsible for animal resources are currently aligning plans to identify the factors affecting competitiveness of animal resources and the interventions needed to address them (AU-IBAR 2010). The key challenge now is to enable smallholder livestock and MSME aquaculture to transform into viable and sustainable market-oriented producers, and evolve the pro-poor value chains that can support them, and to the extent possible provide income and employment to others amongst the poor.

Table 1.2: Productivity of meat and milk in selected world regions

	Meat (kg output/kg biomass/yr)			Milk (kg/cow/yr)		
Year:	**1980**	**2005**	**% increase**	**1980**	**2005**	**% increase**
Sub-Saharan Africa	0.06	0.06		411	397	
Latin America	0.08	0.11	38%	1,021	1,380	35%
South Asia	0.03	0.04	33%	517	904	75%
Industrialized countries	0.17	0.20	18%	4,226	6,350	50%

Biomass is calculated as inventory x average liveweight. Output is given as carcass weight.
Source: (Steinfeld et al 2006)

Case studies of past attempts to intensify small-scale livestock production systems in developing countries demonstrate a range of reasons for failure (Ashley et al 1999; Pica-Ciamarra 2005). In some cases, such as promotion of high-input and high-risk exotic breeds, the constraint was lack of adaptation to the low-input systems, prevailing disease burdens and environmental stresses that characterize small-scale systems in developing country contexts. In other cases, poor uptake of available technologies was due to lack of supporting input markets and services, and poor access to market outlets, as well as insufficient early-stage consultation with the intended beneficiaries (Shelton et al 2005). Policies and development strategies in many countries also fail to recognize and provide adequate support to smallholder production systems and value chain development, focusing instead on higher-profile industrial production whose chances of success are often mixed at best. Failure to take into account gender issues, especially the role of women and the constraints they face in ownership of livestock, access to technologies and services and low participation in markets, have further led to poor performance of livestock and fisheries initiatives.

In the case of aquaculture, the failure of investments to stimulate growth in sub-Saharan Africa can largely be attributed to an almost exclusive focus on the biophysical aspects of fish production. Insufficient attention was paid to the institutional and governance settings necessary to sustain aquaculture enterprise, such as access to markets, value chain linkages and incentives for participation (Brummett & Williams 2000).

There are now real opportunities to make progress, including by exploiting new developments in science, especially the biosciences in terms of feeds, genetics and health, combined with much improved systems-based understanding of the problems. Advances in social sciences and refinements in application of participatory processes and gender transformative approaches have greatly improved our capacity for effective and equitable targeting and adoption of technologies and other innovations. There is also a much improved understanding from systems perspectives that adoption of technologies requires an enabling value chain and a strategy for stimulating its development that aligns with local, national and regional priorities.

Constraints to improving productivity in small-scale systems comprise a complex mix of technological and institutional or policy dimensions that impede delivery, access and uptake of potential solutions. Both sets of constraints must be addressed to achieve the significant increases in production targeted; solutions for each individually are necessary but insufficient conditions. Focusing only on the policy and institutional bottlenecks to delivering improved technologies currently on the shelf will provide short-term improvements, but must be supported and sustained by a continuous stream of technology development, as demonstrated by the contribution of public and commercial agricultural research in developed countries. And technology development must include an appropriately balanced portfolio of shorter-term, lower-risk adaptive research, tailoring existing technologies for their immediate application in a variety of contexts, and longer-term, higher-risk strategic research, preparing the productivity breakthroughs of the future. Existing technologies for improving on-farm feed utilisation and health care, for example, can provide important gains to support initial intensification of animal production, but as production levels rise so too will other requirements, e.g. improved vaccines, and new technologies will eventually be needed to squeeze yet more out of available feed and genetic resources if the intensification process is to be sustained.

Increasing supply and availability of animal source foods in systems in which the poor are major actors serves not only food and nutrition security objectives but also helps bring about broad-based poverty reduction. Countries which have taken advantage of lower opportunity costs of labour and promoted small-scale agriculture instead of large-scale farms have historically achieved better outcomes in terms of equitable growth and poverty reduction as they evolved from agrarian to modern economies (Tomich et al 1995). To date, opportunities to use livestock and fisheries development in a similar way for poverty reduction have largely been ignored by national governments (Pica-Ciamarra 2005). Exceptions include the success of smallholder dairy development in Kenya (Staal et al 2008) and small-scale commercial poultry production in Indonesia (Forster 2009). Such an approach is consistent with the World Bank's call for a 'large-scale and sustainable smallholder-based productivity revolution for African agriculture', capitalizing on this growth to develop the rural non-farm sector (World Bank 2007). Promoting smaller-scale systems in this manner can ensure continued access of the poor to animal source foods while generating income and employment to ease the transition as economies diversify away from agriculture. As economies transform and the opportunity cost of labour rises, smaller-scale systems will inevitably become less competitive and economies of scale will lead to consolidation and larger-scale industrial systems, but improving the smaller-scale systems during this transition (which is likely to last for decades in some countries) can minimize potential social disruption in rural areas. During the transitional period, if smallholders can effectively participate in growing markets, those opportunities can be translated into other livelihood assets such as child education and off-farm opportunities, leading to positive inter-generational exit from livestock and fish production as systems consolidate and commercialize.

There are also associated employment and small business opportunities through MSMEs in fisheries and processing and marketing of livestock and fish products, and in supply of inputs and services, such as feeds and health services. In many countries this takes place largely in the informal sector - 'by and for the poor'. In Kenya for example, research has shown that some 12% of the entire rural workforce is employed on smallholder dairy farms, in addition to the farmers themselves (SDP 2005)

Despite the promise, it is important to recognize and address risks associated with intensification, such as pollution of water, greenhouse gas production and catastrophic disease outbreaks, including those that can spread to people from animals or are associated with contaminated animal source foods (Steinfeld et al 2006). Fortunately, we are becoming more aware of these risks, and are better able to identify, assess and mitigate them.

WHAT'S NEW IN THIS PROGRAM?

This Program addresses the challenge of reducing the productivity gap in small-scale livestock and aquaculture systems and inefficiencies in the related distribution systems so as to increase consumption of animal source foods by the poor. It will do this by integrating and exploiting three ongoing revolutions – the Livestock Revolution, the Blue Revolution and the Gene Revolution (FAO 2004) - and by innovative partnerships with research and development actors.

In the past, the CGIAR's research has tended to be fragmentary, addressing a particular constraint – often at the production level. The result has often been that overcoming one barrier simply results in the emergence of another constraint that hinders real progress. In contrast, this Program will combine foundational technology research with focused research on entire value chains, including their regional dimensions, for selected animal source food commodities in specific areas. This more holistic and joined-up approach explicitly recognizes that technology development must go hand-in-hand with effective targeting and viable uptake pathways.

Our integrated and focused approach will also better harness the growth of the private sector and the increased dynamism of markets in developing countries. Our underlying premise is that, by developing partnerships between research, development and private sector actors to stimulate pro-poor innovation in selected high-potential animal source food value chains, we will better enable uptake of existing technologies and facilitate learning. It will also help identify and prioritize demand for new technologies that exploit scientific advances in both the natural and social sciences, especially the transformational potential of the biosciences and genomics.

The Program also maximizes the benefits of the new institutional flexibility provided by the CGIAR change process by bringing to bear the combined capacities and resources of a number of CGIAR Centers.

In the past, gender integration in the CGIAR has been ad hoc, often without a clear gender policy or a strategy for mainstreaming gender into the research process. The result has been a lack of impact of CGIAR research on key groups of the population including women. The Program uses the analytical framework proposed by the gender scoping study (Kauck et al 2010) to mainstream gender and equity. This has been done through (i) articulation of the role and constraints that women and poor the face in livestock and aquaculture production and marketing systems (ii) use of existing gender data for prioritisation of value chains (iii) inclusion of gender responsive objectives (iv) integration of gender in the technology and value chain research including gender analysis, use of gender responsive tools and approaches and specific activities addressing existing gender disparities in technology access, market access and nutrition (v) integration of gender specific outputs, outcomes and impacts and explicit recognition of need for gender disaggregated data for all other relevant outputs, outcomes and indicators (vi) a budget specific to gender, targeting and monitoring and evaluation.

New science and partnerships for solving the productivity gap

Industrial livestock and fish production systems are able to achieve and sustain high productivity largely because they create a controlled environment and because they rely on nutrient-dense feed (production of which often competes with human food production); in contrast smaller scale producers in the developing world often have little control over the myriad of environmental factors and stresses that constrain the productivity of their livestock and fish. Research breakthroughs in the past have often had only modest impact, in part because they have been difficult to adapt to the wide variation in environmental contexts faced by location-specific production systems. They have also often failed to account for the gendered

needs, assets and preferences of the poor. Now, however, advances in the biosciences, particularly in the field of genomics, are creating unprecedented opportunities to accelerate this process of discovery and adaptation for production technologies tailored to location and evolving system-specific conditions. This Program will build on efforts already underway to channel research advances, including those from the private sector, to finding research solutions for the challenges faced by the poor in the developing world, while using participatory processes and gendered approaches to ensure it is addressing real needs.

Better strategies for getting the results to more people more directly

In recent years the CGIAR has been changing the way it does business - increasing its ability to develop practical solutions and work with partners who can scale them up and out. CRP 3.7 consolidates these lessons as the central theme for its delivery strategy, integrating the research process more directly into the impact pathway. This is the result of two trends. The first is the dynamic evolution and opening of markets in the developing world, which has encouraged external investment in the livestock and fish sectors, and local development of related business services. Increasingly, opportunities are being created to partner with the private sector, tapping into their research and business expertise to benefit the target value chains, while at the same time providing a means to create market pull or ensure commercial provision of appropriately designed pro-poor gender responsive inputs and services that promote and support uptake of productivity-enhancing technologies by the target groups. The second trend relates to recent experiences across the CGIAR Centers of working more closely with development actors as knowledge partners on large development interventions. This formula is proving extremely effective in giving urgency to their research, ensuring it is demand-led, and providing a direct channel for wide impact. This Program builds on these innovations to develop effective partnerships for impact.

VISION, GOAL AND OBJECTIVES

Vision

The Program's vision is for the health, livelihoods and future prospects of the poor and vulnerable, especially women and children, to be transformed through consumption of adequate amounts of meat, milk and/or fish and from benefiting through improved incomes and livelihood by participating in the associated animal source food value chains.

Goal

The over-arching goal of CRP3.7 is to increase productivity of small-scale livestock and fish production systems and performance of associated value chains so as to increase availability and affordability of meat, milk and fish for poor consumers and, in doing so, to reduce poverty through greater participation by the poor along animal source food value chains.

This will be achieved by making a small number of carefully selected animal source food value chains function better, for example by identifying and addressing key constraints and opportunities (from production to consumption), improving institutional and governance arrangements and capacities, and supporting the establishment of enabling pro-poor policy and institutional environments.

The poor consumers targeted will include people living in rural and urban area, and many consumers will also be producers: the relative composition of these different sub-groups will vary amongst the different value chains. In all cases, however, instruments and approaches will be identified and implemented that enable poor women, children and other vulnerable people to increase their consumption of animal source foods as these are especially important for these groups. An important element of that will be to ensure

that women play an important role in the production, thereby directly increasing availability and access. Ensuring that value chains enable 'nutritionally smart' and pro-poor outcomes will be undertaken in close collaboration with CRP4; instruments and approaches to achieve this might include campaigns to increase awareness of the benefits of animal source foods targeted at pregnant and nursing women and young children, school feeding programs and cash and commodity transfers to help the poorest and most vulnerable to access meat, milk and fish.

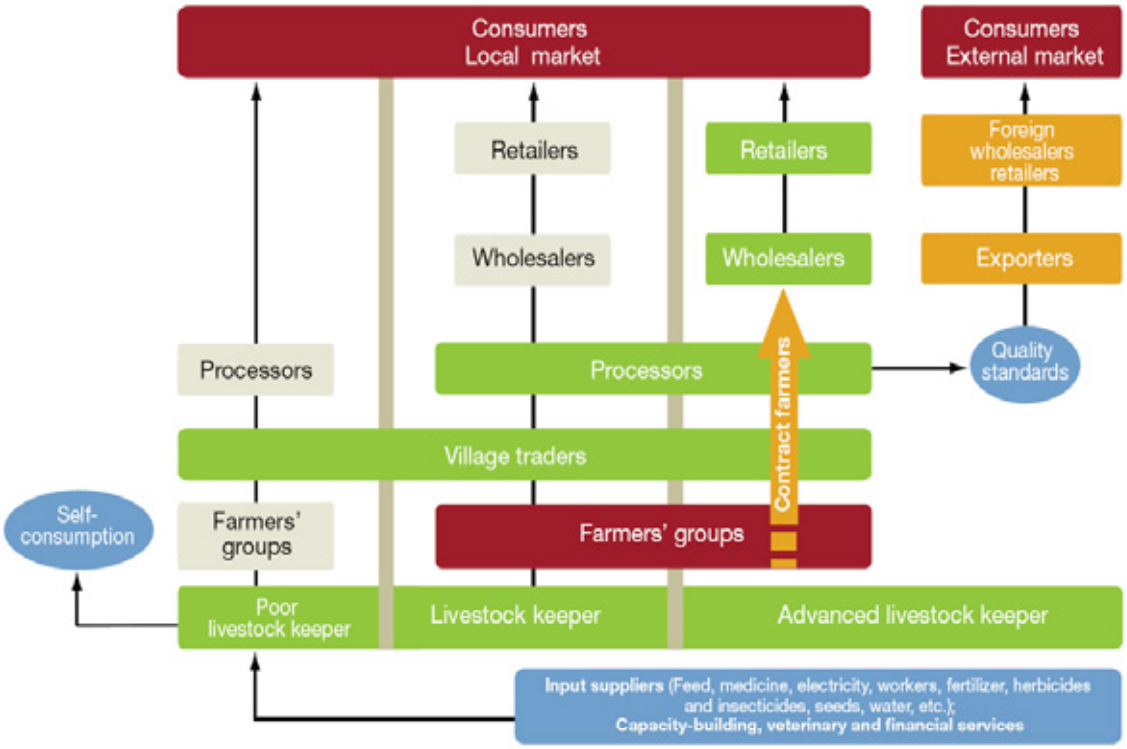
What are value chains?

Value chains, which actually more closely resemble intricate webs, include all the links that begin with an idea for a product or service and continue through to when that product/service is consumed, and sometimes also beyond to when it is disposed of after use (see figure). Here, in the case of animal source foods, value chains include all the farm-level inputs and services that enable production of milk, meat or fish (e.g. feeds, breeding services and stock, health services - which also have their own sub-value chains), through transporting, processing and marketing of outputs, to creation of added-value products, such as cheese, through to consumption of the animal source foods and related products. Value chains also include the institutional and governance arrangements that enable these systems to function. Value chain analysis considers how and by whom the value in the value chain is captured: to maximise developmental outcomes and equity, carefully designed and targeted interventions are likely to be needed, for example to ensure poor women and children and other vulnerable groups share in the benefits.

Simple representation of a value chain

The value chains selected as the focus of this Program are those which primarily serve lower-income consumers, providing cheap products that meet consumer preferences (e.g. raw milk in East Africa and India), often through informal marketing channels. These are also value chains in which poor people can actively participate and their families can benefit along the chains. The form in which poor people participate will vary amongst value chains but will include roles as small-scale producers, employees on small- and medium-sized livestock and fish enterprises, as small-scale entrepreneurs and employees in small and medium-sized enterprises that supply goods and services along value chains – farm inputs and services, transport, processing and marketing of meat, milk and fish, and production of a range of added-value animal source food products – and as consumers. The figure below depicts how value chains for a typical livestock product can evolve from semi-subsistence (on the left side) towards commercially oriented and articulated marketing systems (toward the right side). The focal value chains of CRP3.7 will be similar to those on the left side, with the goal of 'growing' them towards the more intensive and productive value chains towards the right, increasing supplies to poor consumers while generating income and employment for actors within the value chain. Increasing the participation of women and benefits accruing to them across this range of activities will be a key priority of the Program. It is considered that the private sector adequately promotes small-scale commercial poultry production in most situations where it can still compete with industrial production and this sector is therefore not targeted in the current proposal (a more detailed explanation is provided further below).

Livestock keeper value chain



Source: IFAD

Previous experience suggests that in the selected livestock value chains small-scale producers can be as efficient if not more so than large-scale commercial enterprises. This situation is likely to prevail so long as labour is cheap and alternative employment opportunities scarce: in the poor countries targeted this is likely to remain the norm for the foreseeable future. As the economies of poor countries grow and more attractive opportunities develop for poor people, for example through employment in construction, manufacturing and service industries, the dynamics will change and the relative competitiveness of large-scale commercial producers will likely increase – as has already happened in the most rapidly developing economies, such as China. But until that economic transformation occurs, livestock and fish will remain important multi-dimensional components of livelihoods for the poor.

Program objectives

The Program objectives that will contribute to the goal include to:

1. increase sustainably the productivity of small-scale livestock and fish production and marketing systems
2. increase access to affordable animal source foods to enhance food and nutrition security for the poor, especially women and children
3. enable participation in and access to pro-poor and gender equitable production and marketing systems that promote uptake of productivity-enhancing technologies and increase value generation, with emphasis on addressing current gender disparities
4. secure household and community livestock and fish assets for sustained livelihoods, and conserve livestock, fish and forage/fodder biodiversity as public good assets that will provide genetic diversity for continued growth and adaptation

5. protect the natural resource base and its ability to continue providing ecosystem services
6. strengthen capacity to enable public and private sector actors to support and exploit appropriate research and development efforts for sustainable intensification of small-scale livestock and fish production and marketing systems that provide equitable benefits to men and women
7. facilitate scaling up and out by undertaking research and emphasizing learning and its communication

FRAMEWORK FOR RESULTS

In this proposal the **Program** refers to CGIAR Research Program 3.7, *More meat, milk and fish-by and for the poor*

The Program is based on nine animal source food **value chains** (see box above for definition)

The research focus of the Program is made up of three complementary **Research Themes.** Within each Theme are clusters of activities that make up a **Component**

The Program will be a combination of focused research components and cross-cutting integrative processes. In this way, the Program is designed to allow both: a) the critical concentration of appropriate scientific skills to generate new and appropriate science, and b) the joint learning, planning and outcome feedback processes needed to ensure that research priorities match the needs of beneficiaries, and that interventions are evaluated and grounded in real-world settings with partners. The Program will thus comprise a combination of more upstream, globally relevant research and targeted research-for-development designed to address the particular development challenges of a set of priority livestock and fish systems with tailored science-based solutions. Key partnerships, including the private sector at several levels, will be a focus in all components of the Program.

The Program will be implemented through a common Medium Term Plan (MTP), developed jointly by the implementing partners, that sets the strategy and intended outcomes and impact for an initial 6 year period. The primary components for managing research and delivering knowledge products and outcomes will be three MTP Research Themes covering the range of upstream and adaptive research agendas described above.

The three Research Themes are:

1. Improved technologies to sustainably increase productivity and efficiency of livestock and fish production
2. Development strategies for pro-poor, gender-equitable value chains for livestock and fish products
3. Targeting, gender and impact assessment

These Themes provide a means for communities of CGIAR researchers and their partners to work more effectively together, with clear focus on an agreed agenda and outputs and with a common vision and plan for how those outputs will translate into development outcomes. While these Themes provide appropriate clustering of skills to deliver new science, they also benefit from an organizing methodological focus and community of practice for ensuring synergies, integration and joint learning, as well as relevance to target beneficiaries.

Theme 1: Technology development: To provide the technologies needed to boost the key productivity drivers of livestock and fish production, Theme 1 will seek a balance between short-term adaptive research-for-development and longer-term upstream research, with both led by the engagement at field level through value chain analyses to identify opportunities and key constraints that impede delivery, access and uptake of potential solutions at the field level. Much of the promising work in Theme 1 is occurring at the

level of upstream science, and will be enabled by facilitating interactions between researchers in the bio-physical science elements of the Program and development and private sector partners. At the core of these synergies will be new opportunities through evolving genomics science, including livestock-fish synergies in genetics and genomics applied to crops/forage/fodders to improve quantity and quality of animal feeds [7]and their utilization. Important private sector players in the life sciences will also participate, as well as appropriate co-investors. This Theme will make use of existing crop and forage gene banks and biosciences platforms in the CGIAR, where scientists from several Centers and their developing country partners can share expensive research facilities and technologies and apply these to new challenges. Equal priority will be given to designing immediate solutions and achieving gains quickly through innovative adaptation of existing technologies and improving their delivery. Key to success will be creating a seamless interface between the lab and the field.

Theme2: Delivering through value chains: The focus of Theme 2 will be more downstream, and will provide a setting for integrating the technology generation and adaptation work, improving delivery systems, and developing value chains that promote intensification through new partnerships and innovation capacity – in the context of specific production systems and market settings (linked to CRP1, CRP2 and CRP5). The key component technologies for livestock and fish genetics, feed and health each have their challenges and specificities as to how they can be delivered to their end users. This is where people with specific delivery and institutional skills from the science component in Theme 1 will interact and work together to develop integrated approaches (e.g. those with skills in veterinary service delivery, forage and fodder innovation, animal breeding strategies) with specialists in value chain analysis, innovation systems, policy outcomes and livelihood, gender specialists, and knowledge management/capacity development professionals. Private sector and development agency partners in livestock and fish systems development will also be directly involved.

Theme 3: Targeting, gender and impact: To highlight our commitment to ensuring relevance and appropriate focus, Theme 3 will be devoted to taking stock for priority setting, planning strategies for translating outputs into outcomes, gender analysis and integration, and monitoring progress and assessing impact. While ensuring an internal M&E function, this theme will also be active in testing new approaches for mapping the relevant target domains, using experimental approaches for structuring interventions for learning, and scanning the horizon so that our research today is already addressing the challenges of tomorrow.

SELECTED VALUE CHAINS

At the core of CRP3.7 are a small number of carefully selected national meat, milk and fish value chains which are judged to have high potential for transformational improvement - from the producer to the consumer. The criteria by which these value chains have been selected are shown in Table 1.3:

Table 1.3: Criteria for value chain selection

Criteria	Indicators
Growth and market opportunity	Evidence of market opportunities for continued expansion of production, through growing demand for livestock and fish products locally or regionally, and why, particularly among the resource poor.

[7] Animal feeds include fodder and forages, as well as grains, by-products, and other feedstuffs.

Pro-poor potential	How much of the value chain product is consumed by the poor and at what price? How will the poor be involved within the value chain? Is there evidence they can play a significant role in increased production, or being employed in value chain activities, or will benefit be from increased consumption? In particular, are there opportunities for participation by women and vulnerable groups?
Researchable supply constraints	Evidence of significant supply constraints, such as large productivity gaps or transactions costs that evidence suggests research may be able to provide solutions for, and would create production and welfare gains.
Enabling environment	A supportive policy environment for uptake affecting the poor, adequate infrastructure, adequate NRM and ecosystem service provision. Plans for relevant development investments that would leverage program outcomes.
Existing momentum	CGIAR and key partner experience and credibility locally, partnerships with research, NGO, government, and private sector that can aid implementation, uptake and impact. Ongoing government, NGO, private sector efforts that can be built on.

These criteria in essence provide a *sequenced filter* of target opportunities for Program impact, starting from the top. Opportunity for market growth is a basic requirement for any agricultural research investment, and so is the starting point for considering choice of country and value chains. The next filter considers opportunity for impact among the resource poor, followed by whether supply constraints lend themselves to research. In the case of poultry production, for example, the private sector already provides a well-proven package for highly productive broiler and layer systems to which research can add only limited value – thus it was excluded. In that manner, the filters are then used sequentially to identify priority value chains.

Box: The case of poultry

The critical role that poultry plays in the livelihoods of the poor is well established. Backyard flocks are a strategic source of food and income for women and the young, and chicken is often the cheapest meat available to the urban poor. CRP 3.7 is, however, primarily about getting household livestock and fish activities out of extensive, low-input backyard systems for home consumption and occasional sales, and into graduated, intensive, higher-input systems to generate a steady supply of animal source foods for the market and poor consumers, as well as income for poor producers and other actors in the value chain. Poultry is an archetypical example of this process – particularly in peri-urban zones throughout the developing world, small-scale layer and broiler operations have been set up to varying degrees of sophistication. These small-scale operations benefit from the development of larger poultry farms that import the exotic breeds particularly suited to intensive high-output production systems. The private sector is usually quick to respond to this opportunity, creating distribution channels for packages of day-old chicks, vaccines, and feeds through agro-vet shops or their equivalent, and often providing the needed knowledge to their clientele to promote their sales. Because the essential technology and its delivery are already available from the private sector, we could not identify any obvious opportunities for CRP 3.7 to have significant large-scale impact in improving poultry value chains.

We posted this reasoning in our e-consultation. An option proposed by a contributor would focus research in backyard flocks of free-ranged indigenous poultry, which often attract premium prices. The benefits of improved productivity would certainly benefit smallholder poultry keepers – and so could be a candidate strategy to explore for CGIAR research to enhance this livelihood role for the poor, especially within the systems perspective adopted by CRP 1, but a lower priority for value chain development to increase supplies to poor consumers more generally. It will continue, however, to be evaluated as a candidate for future work.

To undertake a full-fledged prioritization exercise requires a major research effort to develop meaningful indicators and compile or generate the associated data, many of which are not readily available. For the purposes of this proposal, we were able to draw upon a recently completed donor-commissioned review for livestock development investment. That exercise combined qualitative information with available data to create indicators for the first three filters (ILRI 2009). The study was limited, however, in that it only considered sub-Saharan Africa, South and South East Asia, and did not include fish or pigs. Our selection of proposed value chains for initial focus is therefore based on a combination of constrained data analysis and

a reasoned process of prioritization, which was validated to the extent possible during consultations with stakeholders in the relevant countries.

A final consideration in the selection of focus value chains was to build in an underlying research design in terms of ensuring that: (i) the principal product systems (as defined by the product produced, e.g. fish, pork, goat meat, mutton or milk) are represented, and at the same time (ii) individual systems are addressed in different regions (e.g. pig systems in Africa and in South East Asia). 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 of wide applicability, and the delivery of strong international public good knowledge outputs.

Applying the various filters and the evidence available, the following value chains are selected for focus in this Program:

1. Uganda and Egypt: tilapia and catfish aquaculture value chains
2. Ethiopia: small ruminant value chains in mixed crop-livestock systems
3. Mali: small ruminant value chains in mixed crop-livestock systems
4. India (selected states): smallholder dairy value chains
5. Nicaragua/Honduras: dual-purpose cattle value chains
6. Tanzania: smallholder dairy value chains
7. Vietnam: smallholder pig value chains
8. Uganda: smallholder pig value chains

Detailed descriptions of the value chains and evidence supporting their selection are presented later in this proposal in the form of value chain profiles (see Part 4). Refining the indicators, generating the relevant data, and continuously improving the evidence base for identifying value chains with high potential for impact will be an integral component of the CRP3.7 research agenda (see Research Theme 3 on Targeting). This preliminary selection is considered sufficiently robust to guide the initial focus for CRP3.7 activities while the improved analysis is being developed.

IMPACT PATHWAYS

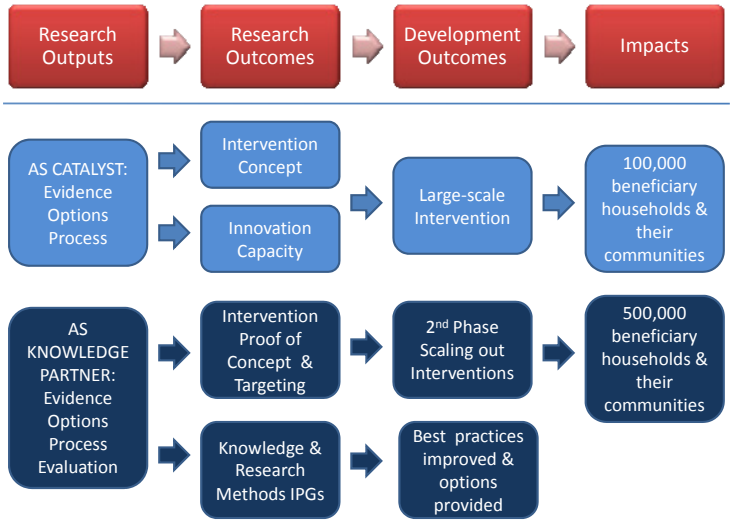
CRP 3.7 is proposing an approach consistent with the CGIAR Strategy and Results Framework and its vision of the impact pathway of research, as summarized in the figure below.

CGIAR role in the impact pathway for research

To address the challenge of taking more accountability for how our research outputs translate into development outcomes, we commit to increasing production and benefits to the poor in the selected value

chains noted above. To do this, we will focus our efforts on aligning and supporting research and development partners to prepare, obtain funding and implement major development interventions in the selected value chains. While CRP3.7 cannot *guarantee* that it will successfully deliver development interventions in each target value chain, it will hold itself accountable for doing 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 (see figure below).

Principal impact pathways for CRP3.7



After securing development funding with development partners, CRP3.7 and research collaborators will serve as knowledge partners to the development intervention, orienting their research agenda to improve the effectiveness of the intervention through better technologies and strategies and to learn from its successes and failures. In this role, CRP3.7 will share accountability with development partners for achieving the development objectives set by the intervention. This arrangement will focus CRP3.7 research on addressing priority opportunities for increasing productivity and performance of the value chain and provide the mechanism for disseminating research outputs at scale within the intervention for immediate development outcomes and impact.

There is a perceived risk that concentrating CRP3.7 research on a few value chains in a few countries will limit the geographical scope of its research benefits. But we anticipate much wider impact being achieved in several ways. First, target value chains have been selected in part because of the potential to develop the same type of value chain elsewhere in the region. As knowledge partner for the development intervention, we will generate evidence to demonstrate proof-of-concept of the effectiveness of the intervention approach as we repeat the catalytic role of engaging stakeholders in other countries of the region to prepare second generation development projects for scaling out the intervention. Such scaling out will certainly not be automatic – production and marketing systems vary significantly from zone to zone and country to country within a region. Emphasis will be given to scaling out the approach of consultation and appropriately adapting the intervention to these different contexts using value chain development methods, as much as scaling out the specific intervention itself.

Second, target value chains comprise pairs of value chains for each production system across different regions, such as smallholder dairying in both Tanzania and India. This design will permit cross-site

comparison and learning to better understand the aspects of the intervention that are shared and those that are specific to the individual site.

Thirdly, a strength of the CGIAR is generating international public goods (IPGs) in the form of research methodologies as well as technologies. The focus on selected value chains will not impinge on our ability to continue generating IPGs. CRP3.7 activities across the sites will be developing common approaches and methodologies to address priority constraints which will have some degree of shared commonality as well as site specificity. Each subject area, such as genetics, feeds or value chain development, will form a type of research platform in which relevant research methodologies are developed and applied in identifying solutions specific to the individual value chains. For example, stimulating local small-scale feed milling and marketing services to improve farmer access to feed is likely to be a strategy relevant across the sites, and so the feed research methodological platform will include creating feed market development toolboxes with strategies for assessing feed needs, scoping feed resources, and applying business development services techniques. The toolboxes, once tested and validated in the target value chain sites, will be applicable anywhere. Documenting in scientific publications the testing of the toolboxes in the target value chain and the results achieved will further promote their wider uptake and application.

A potential drawback of the proposed focus on a few selected value chains is that it will not provide sufficient variation across contexts to permit extrapolating or generalizing results from the CRP3.7 sites. We are convinced, however, that the benefits to be gained from focusing our efforts within CRP3.7 in a few sites will outweigh the risk of continuing to try to work everywhere. We also expect that there will continue to be opportunities for some limited complementary work in other sites outside of CRP3.7 as part of each Center's non-CRP portfolio.

In essence, this CRP3.7 proposes to embed the impact pathway more directly within the design and approach of our Program so that research outputs translate more immediately to development outcomes at a significantly large scale, and with potential for much wider impact in the medium term.

PART 2: RESEARCH FOR DEVELOPMENT IN LIVESTOCK AND FISH SYSTEMS

INTRODUCTION

At the core of this Program are three Research Themes around which the research program will be designed and implemented. The Themes will also support outcomes and innovations along the value chains. Together they will: provide significant critical mass and investment in generating improved productivity through technology development and adaptation in the main areas of feeding, breeding and animal health; ensure that technology development is driven by the real-world context of agricultural value chains; and provide the cross-cutting analysis of development process and outcomes to ensure that target beneficiaries are impacted. This coherent set of research themes will also play a key role in generating the strategic and global public good outputs that are central to the CGIAR's comparative advantage and mission. These will result from working and employing harmonized approaches across the selected value chains and regions.

In this proposal we are presenting these themes in the following order: Technology Development, which will deliver the productivity gains in our targeted livestock and fish systems; Value Chain Development, which provides the demand-driven context for technology; and Targeting, Gender and Impact, which will enable the processes and measurement of success. This sequence of presentation has been selected to highlight the important role of technology in this Program: this is reflected by the allocation of about half of the Program's resources and effort to technology development.

This ordering of main Themes does not, however, represent the *sequence* of implementation of the Program. Given the value-chain paradigm employed by the Program, and the importance of targeting the research and interventions carefully at priority communities, the targeting and value chain assessments will be implemented first, with that learning then being used to drive and refine the choices for priority technology development. Beyond those initial stages, iterative and coordinated implementation will occur, with the targeting, gender and impact learning, and experiences from value chain development continually feeding into the technology development process.

RESEARCH THEME ONE: TECHNOLOGY DEVELOPMENT

In this section, options and strategies are described for research focused on adaptation and generation of productivity-enhancing technologies. A key challenge here is to achieve the correct balance; maintaining space for 'blue-skies' experimentation (for which there will often be few other suppliers) while respecting the requirement for research to be demand-driven, responding in real-time to the needs and constraints identified in the different value chain. Given the long lead times required to develop and deliver new technologies, such as vaccines and genetic improvements, the latter is clearly more likely to be met through adaptive research based on existing technologies. The former, however, could offer opportunities for truly transformational improvements in value chain productivity.

Technology generation and adaptation has critical gender implications. Since both productivity and environmental improvements arise from changes in the way people manage (feed, water, treat, herd, care for) livestock, it is important to understand how these decisions are made, and what factors promote or constrain adoption of new, more efficient technologies and practices. Men and women often manage different types of animals and are responsible for different aspects of animal care. Women and men also typically have different objectives for keeping animals, different authorities and responsibilities regarding

animal management, and different abilities to access and use new information and improved technologies. These differences may lead them to have different priorities regarding investments in the adoption of new technologies and practices.

While most livestock and fish farmers and in Africa and Asia continue to be limited by choices and constraints at the household level with respect to access to and use of improved technologies, women often face particularly severe constraints and also exhibit relatively low rates of adoption. Studies have shown lower adoption rates by women for technologies such as vaccines (Heffernann et al. 2008), veterinary services (Due et al, 1997; Wood et al. 2003) mainly due to lower access, knowledge and information with higher adoption for other technologies such as stall feeding and other dairy technologies (Kaliba eta al. 1997; Tripathi et al 1994) that require less land and other resources. Where new technologies have been adopted (Doss 2001) these technologies have differential impacts on the well-being of men and women. The research on technology development and adaptation will focus on how gender affects technology adoption among men and women farmers; strategies to increase involvement and use of technologies by both men and women; and how the introduction and adoption of new technologies affects women's and men's well-being including labour allocation, income management, and general wellbeing. The research design will take gender into consideration especially in the types of technologies and how they are developed, disseminated and supported.

Technologies are considered here under the headings: animal health, breeding and genetics, and feeds. It is recognized that there may also be need for technologies to address post-harvest issues, such as processing and food safety; however, it is thought that these will be very value chain specific and, with a few exceptions (notably ILRI for milk), the CGIAR Centers have few comparative advantages in this area. Strategies to meet needs arising in the post-harvest area include utilizing the proposed CRP 3.7 competitive grants mechanism and identifying potential supplies, such as from the private sector and NARS, from within value chain-based innovation platforms. Some aspects of post-harvest, such as food safety and zoonotic risk, could also be addressed in collaboration with CRP 4.

Component 1.1: Animal health

Interventions aimed at controlling or preventing animal diseases can improve productivity by decreasing mortality and morbidity. The key interventions on which we shall focus to improve animal health are vaccines and diagnostics for livestock and improved biosecurity for fish hatcheries. In these areas, opportunities exist for immediate impact by modifying current interventions to make them more suitable for poor livestock owners, e.g. thermostable vaccines and rapid field diagnostics, as well as for longer-term research for more intractable problems.

Vaccines are particularly suited to poor livestock farming systems as they are often cheap and can offer a sustainable means of disease control by providing life-long protection. Vaccines have the power to eradicate diseases, as has been shown with smallpox and rinderpest, viral diseases of humans and animals, respectively. Diagnostic tools play a critical role in establishing the geographical extent of diseases, in vaccine development by elucidating pathogen variability, in underpinning disease control strategies such as movement restriction, in facilitating trade and in disease surveillance and pathogen discovery. The implementation of improved hygiene and biosecurity measures can have major effects in limiting the introduction and spread of livestock and fish diseases. For example, this is the case for the major diseases affecting aquaculture, where control is mediated by preventing the introduction of diseased seed stock rather than the elimination of extant diseases.

Our approach will consist of two interdependent activities. First, we shall examine each of the value chains and identify the constraints to productivity imposed by infectious diseases. This will involve disease mapping to identify the prevalent infections, an assessment of the magnitude of the constraint imposed by the disease and technology scanning to determine if suitable interventions exist or can be developed and applied. This will also include an analysis of current institutional arrangements for the manufacture and delivery of technological interventions and the social and gender implications of these to determine if these act as a constraint. There are social and gender implications to development and delivery of animal health services including vaccines (Homewood et al 2006; Fandamu et al 2006). For example, Homewood *et al*. (2006) found that uptake of the ITM (Infection and Treatment Method) vaccine against East Coast fever in Tanzania was strongly associated with a measure of wealth that included livestock numbers and economic security. Medium and poor pastoralist households found it hard or impossible to access the full benefits of the vaccine. The wealthiest households vaccinated on average 43% of their herd, compared to the poorer households who had vaccinated on average 14% of their herd. In addition, the currently available vaccine is packaged as a 40-dose straw, which may be unsuitable for poor and women livestock keepers who often have smaller herds.

The second activity will build on current research activities to deliver practical solutions in already identified disease constraints. Where possible, emphasis will be placed on the development of 'generic' research platforms within the context of a disease focus, so that the required expertise and equipment can be applied to research topics uncovered in the first component. It is acknowledged that rapid advances in the power of tools to understand basic biological processes can be applied to develop new and improved vaccines and diagnostic assays. These include genomics-based approaches to identify pathogen molecules for inclusion in new vaccines and diagnostic assays, to understand host responses to infectious disease, and to acquire greater knowledge of how pathogens evolve and how diseases are transmitted and spread.

Envisaged outputs of these activities include novel vaccines and diagnostic assays for diseases that constrain productivity in the identified value chains, maps of disease prevalence, improved arrangements for the delivery of animal health interventions to poor livestock owners that have potential to reach women and marginal populations, and documented strategies and enhanced capacity for greater biosecurity to prevent disease incursions. The outcome will be greater access of poor producers to novel or improved animal health inputs and services that will improve their wellbeing and enhance the resilience of their livelihoods. To achieve this, it is essential that the program champions and assumes stewardship for the whole development chain, from the identification of areas of need through development, manufacture, implementation and impact assessment of these solutions.

Activities

Assessment of disease constraints across value chains (with Theme 2): We shall use an integrated approach to identify where diseases impose a constraint to productivity and where achievable goals can be set to develop and deliver appropriate technological solutions. The approach will involve producers including women, animal health service providers, disease experts, policy makers and the private sector. The economic importance of any particular disease constraint will be weighed against the prospects for creating new institutional arrangements or vaccines and diagnostic tools, the time required for the implementation of the intervention and the potential for private sector involvement. The key questions for consideration in any value chain are:

- What are the diseases which constrain productivity and by how much?
  - are key diseases well-recognized?
  - do disease mapping tools exist?

  - are there diseases present which prevent the introduction of better breeds or species?
  - are there diseases which prevent access to other markets?
- Do vaccines or diagnostic assays offer a solution?
  - better delivery of current vaccines through non-technological advances (better distribution channels, increased awareness, coordinated vaccination campaigns)
  - better delivery of current vaccines through technological advances (improved thermostability, cheaper production, more relevant components in response to pathogen evolution)
  - what are the prospects for the development of new vaccines (what is limiting the effectiveness of current vaccines, does immunity exist after natural infection, and what is known about the immune response)?
  - would better or more available diagnostic assays facilitate disease control through movement restriction or by identifying animals for treatment or slaughter, or underpin vaccination programs?
- Does improved biosecurity offer a solution?
  - can more stringent hygiene practices prevent the incursion of diseases
  - can the establishment of disease-free zones improve the control of diseases and access to markets

Assessment of animal health policy and institutional constraints across value chains (with Theme 2):
As a part of the value chain development in Theme 2, the priority animal health constraints will be identified. For animal health constraints for which there are existing technical interventions (vaccines, diagnostics, drugs and preventative/biosecurity measures) but which are not being used, analysis will be undertaken to determine the reasons for the lack of uptake. This will involve consultations with:

  - livestock owners and farmers' and women's groups, to determine if there is a lack of awareness or access, or if the solution is perceived as ineffective, harmful or too expensive
  - manufacturers from the private and public sector, to assess their perception of the factors which influence demand for the particular intervention
  - animal health workers, to gauge their reasons for not using or promoting the intervention and the presence or absence of incentives
  - government authorities, to understand policy and institutional requirements which may be hindering uptake of the intervention and what kind of enabling policies could be introduced or amended to promote uptake of the intervention

A comparative analysis of cases with successful uptake of similar interventions will provide insights into the factors influencing uptake, such as incentives for actors along the value chain. Each of the proposed interventions will be assessed to determine how they will fit into the policy and institutional landscape (again an integral part of the value chain assessment in Theme 2) and the potential for developing business development services to provide affordable, quality animal health services. The findings will be targeted at the different stakeholders with media and formats selected as being most appropriate and cost-effective for each audience in accordance with the Communication Strategy (p. 79).

Studies will be undertaken to determine the level of adoption of animal health services among poor and women livestock keepers and the factors (economic, social, policy, institutional) driving the adoption and continued use of these services. In particular, we shall identify gender issues in the development and delivery of animal health interventions, focusing on constraints to access and use of current and proposed interventions by women and poor livestock keepers. We shall identify and develop interventions which are amenable to technology modifications or improvements in delivery systems and, with key partners, assess different delivery systems for their potential to increase access.

Building on current projects

Technology platforms – livestock: The development of vaccines and diagnostic assays is underpinned by generic technology which can be applied to specific diseases. We are using such platforms in our current research activities and we shall apply these to new projects identified by value chain analysis, described above, while completing the projects already in progress. The platforms are described in Tables 2.1 and 2.2.

Table 2.1: Vaccine technology platforms

Platform	Purpose	Scientific disciplines involved
Antigen identification	To identify pathogen molecules which stimulate a protective immune response. These molecules can be • incorporated into subunit vaccines • monitored in whole pathogen vaccines • analyzed to determine the variation within pathogen species • used in quality assurance of vaccine production	Immunology Microbiology Protein chemistry Recombinant DNA technology Pathogen genetics / evolutionary biology Genomics/bioinformatics
Vaccine formulation	To develop vaccine formulations into which antigens are incorporated for inoculation. The formulations determine the type and magnitude of the immune response and can lengthen the time needed between booster vaccinations	Immunology Protein chemistry Adjuvant chemistry Viral vector biology
Lyophilization	To produce vaccines which are stable at room temperature for several months to years	Physical chemistry Thermo-stabilizers

Table 2.2: Diagnostic assay technology platforms

Platform	Purpose	Scientific disciplines involved
Analyte identification	To identify pathogen molecules, usually protein or DNA, which are incorporated into a diagnostic assay. These molecules are • unique to the target pathogen • detectable in easily obtained samples from the host	Immunology Microbiology Protein chemistry Recombinant DNA technology Pathogen genetics / evolutionary biology Genomics/bioinformatics
Diagnostic assay platforms	To facilitate analyte detection in routine laboratories or in the field. Commonly used technologies include: • ELISAs • Polymerase chain reactions • 'Pen-side' tests, such as lateral flow devices There is potential for use of mobile telephone technology to extend diagnostic capacity.	Protein chemistry Nucleic acid chemistry Microfluidics

Additional activities exist in other key areas to facilitate the identification of disease constraints and the delivery of technological interventions. These are listed and described in Table 2.3.

Table 2.3: Identification of disease constraints and the delivery of technological interventions

Activity	Purpose
Vaccine delivery	To develop institutional arrangements to facilitate the delivery of vaccines through sustainable distribution channels to poor livestock owners. Issues which are addressed include • engaging manufacturers for products for which there is little commercial attraction • assessing the advantages of private or government animal health services • assessing delivery systems with high potential for reaching women , youth and marginalized populations • registration and regulatory compliance
Pathogen discovery and surveillance	To monitor the introduction and spread of pathogens in target regions, and to understand how pathogens evolve. This area relies heavily on genetics and genomics technology to identify and characterize discrete populations of pathogens within a species, and contributes to the control of disease outbreaks and whether vaccine or diagnostic assays require modification.
Biobanking	To characterize and store biological specimens systematically and sustainably to allow use of the material in future research projects, possibly for currently unforeseen aims.

Diagnostic laboratory strengthening	To ensure that national and regional laboratories can undertake necessary laboratory testing. Key factors here include: • developing assays which can be routinely and sustainably performed • ensuring that staff are trained in assay performance, sample collection and result reporting • establishing laboratory networks

Building on current projects – livestock: The development of novel vaccines and diagnostic assays is a long-standing component of ILRI's research strategy. The current target diseases have been selected on the basis of their importance to poor livestock owners. For the most part, they are 'orphan' diseases, as they do not present a sufficiently attractive market opportunity for funding agencies and the private sector in developed countries. The reasons for this are varied and include their geographical distribution being restricted to the developing world and their being controlled or eradicated from the developed world using means which are not applicable to areas of poor infrastructure and regulatory control. While not all of the projects are relevant to the identified value chains, we shall continue to work on them in the near future to deliver the specific outputs. At the same time, it is clear that the technologies used in these projects will be needed to address the disease constraints identified in the value chain analysis. Table 2.4 presents an analysis of current research activities with respect to identified value chains and technology platforms being employed.

Table 2.4: ILRI's current animal health research and its relevance to target value chains

Disease	Value chain	Vaccine and diagnostic technology	Supporting activities
East Coast fever	Tanzanian dairy	antigen identification vaccine formulation	vaccine delivery pathogen surveillance
Contagious bovine pleuro-pneumonia		antigen identification vaccine formulation analyte identification diagnostic platforms	vaccine delivery
African swine fever	Uganda pigs	analyte identification	pathogen surveillance laboratory strengthening
Porcine cysticercosis	Uganda pigs Vietnam pigs	analyte identification diagnostic platforms	
Peste de petits ruminants	Ethiopian small ruminants Mali small ruminants	thermostability	vaccine delivery
Rift Valley fever	Ethiopian small ruminants Mali small ruminants	diagnostic platforms vaccine trials	pathogen surveillance vaccine delivery

Fish health: The incidence of disease and its impacts on the different stages of the Ugandan fish value chain is poorly understood. However, preliminary analysis of the tilapia and African catfish value chains suggest that disease is primarily an issue in hatcheries. This was confirmed during a recent visit to a commercial hatchery, where several diseases affecting African catfish were reported, including:

- Ich, or white spot, caused by the parasite *Ichthyophthirius multifilis*
- Columnaris disease, caused by the bacterium *Flexibacter columnaris*
- *Saprolgenia*, a fungus that affects eggs

It is anticipated that these and similar diseases will become more important as the fish industry grows and production methods intensify. Of particular concern are new diseases, such as Epizootic Ulcerative Syndrome (EUS). EUS has recently been transferred from Asia to the Zambezi system, with potentially significant impacts on fish, fisheries and those who depend on them for their livelihoods. The key to control of hatchery diseases is improved biosecurity - better hatchery management, especially hygiene, and more stringent screening and monitoring of seed stock. These activities must be underpinned by well-trained veterinarians and modern diagnostic laboratory capacity. We are already partnering with the FAO and the private sector in the region to improve biosecurity.

As in the livestock sector, we shall undertake a needs assessment to determine current and potential disease constraints and the capacity of the extant fish health services to address these issues. This will be followed by implementation of appropriate interventions. Access to the CGIAR disease platform offers tools to screen for and detect potential new pathogens will be invaluable. We envisage synergies with the pig value chain in Uganda.

Partners: The most appropriate and relevant partners will vary according to the animal health constraint/solution; where possible existing partnerships will be built upon. The specific value chain analyses will identify the priority animal health issues, the solutions to overcome these, whether the solutions are available or require development, their limitations and any barriers/constraints to their implementation. Barriers, constraints and limitations could be primarily technological or policy/institutional in nature and each would require very different types of partners. For example, if a vaccine exists but is not widely used because it is ineffective or has undesirable side-effects, then partners with expertise on that disease/vaccine would be engaged with a view to developing and delivering an improved vaccine: these could come from national, regional or international universities, research organisations and veterinary services, or public or private vaccine manufacturers. A key partner for African initiatives is AU-IBAR. The NGO GALVmed, a global alliance which specialises in establishing and managing public-private partnerships to develop and make available vaccines and other animal health products for neglected livestock diseases, is likely to be another key partner. GALVmed has indicated an interest in aligning their priority diseases to have better fit with CRP3.7's target value chains. ILRI has extensive experience of working with partners with expertise in the policy and institutional arena; for example, during research on the Kenya dairy sector, productive partnerships were developed with the Institute for Development Studies, UK. With regard to delivery of animal health services, partners might include NGOs with expertise in this area, such as FARM-Africa and VSF. In summary, key partners will be sought according to the nature of the proposed solution and the constraint which is being addressed.

BecA Hub laboratory facilities: It is envisaged that many of the activities will be undertaken at the BecA Hub, Nairobi. This comprises state-of-the-art laboratories, equipment and large and small animal facilities to enable a wide range of biological experimentation to be conducted. These include facilities for tissue culture, serology and cellular immunology, genomics, bioinformatics and high-throughput sequencing.

The outputs and their expected outcomes and impacts for the animal health technology development component are summarised in Table 2.5.

Table 2.5: Animal health technology development outputs, outcomes and impacts

Outputs	Outcomes	Impacts
Diseases which constrain productivity in target value chains identified and their relative impacts assessed Extent to which vaccines and diagnostic assays offer a solution assessed Existing vaccine technology platforms focused on priority diseases of selected value chains Existing diagnostic assay development platforms focused on priority diseases of selected value chains Options for delivery of vaccines to poor and women livestock keepers in value chains developed Gender issues around vaccine development and delivery identified and integrated into technology development and delivery for selected value chains Pathogen evolution, introduction and spread in value chains monitored Capacity building for national and regional labs Extent to which improved biosecurity offers a solution assessed.	Development of better systems to deliver existing and forthcoming vaccines Development of better vaccines and diagnostics targeted on priority diseases in selected value chains Development of appropriate biosecurity systems Development of delivery systems that increase access to animal health services to women livestock keepers, and poor smallholders Improved systems and capacities for monitoring evolution, introduction and spread of pathogens	Better control and prevention of priority animal diseases in selected value chains contributes to increased productivity and production of animal source foods to enhance livelihoods and nutrition security of the poor Reduction of disparities between men and women in the access to and use of animal health services, and in the productivity of livestock owned and managed by them

Component 1.2 Livestock and fish genetics

Introduction

The following sections describe the rationale, key research questions and activities for livestock and fish genetics. Whilst it is recognized that many principles surrounding the utilization and improvement of genetic resources can equally be applied to both terrestrial and aquatic species, they are discussed separately here for clarity and due to the value chain specificity. Means to capitalize on the important synergies between livestock and fish genetics are outlined under the section titled 'animal genetics research platform'.

Livestock – rationale

Livestock breeding strategies in developed countries have resulted in significant and sustained increases in livestock productivity. Livestock have shown extraordinary and sustained response to production traits such as growth rate and milk production, and fitness traits such as disease resistance, albeit at the cost of reduced livestock genetic diversity.

This dramatic improvement in genetic merit has been ascribed to three major factors:

1. Choice of breeds, development of new composite breeds, and the use of cross-breeding systems
2. Accurate trait and pedigree recording and use of these records to evaluate individual animals and use estimates of genetic merit to make breeding selection decisions.
3. Reduction in environmental variation through disease control, improved housing and nutrition.

In the developing world, however, the same increases in livestock productivity due to breeding strategies have not been realized. This is due to a number of reasons including the lack of recognition of the importance of breeding strategies to the livestock sector (as opposed to crops where significant progress has been made), the lack of capacity (there are few trained animal breeders within developing countries), and the lack of supportive institutions and policies (Kosgey et al 2006, Kosgey and Okeyo 2007). That said, these constraints are beginning to be addressed and will form an important component of the CRP.

In a number of developing country livestock systems, exotic breeds have been introduced with the aim of producing animals that are both productive and adaptive, via crossing to indigenous breeds. Commonly, however, this crossing is not done in an organized way and over the years a range of different cross-breeds emerge. In such situations a pertinent question is which of these cross-breeds match best to the livestock keepers' demands and resource situation. Recent advances in genotyping, such as the availability of SNP-chips, allow the breed composition of individual animals to be determined in the absence of pedigree (Marshall et al 2011) (see box, below). This allows for comparison studies using performance and economic data collected in-situ (e.g. from smallholder farms), which has not previously been possible. Such studies will be directly relevant to several of the proposed value chains.

Within-breed improvement programs should be considered in developing country livestock systems in cases where the most appropriate breed is already in wide use, other system constraints (such as feed and health-care) are being addressed, and it is accepted that a long-term approach is required. Whilst within-breed improvement is not a new technology, many issues remain in terms of adapting approaches taken in the developed world to a developing country context. These include, for example, the development of incentive systems for participation of livestock keepers in recording schemes and institutional and organizational (i.e. breed associations) models for sustainability. It is expected that demand for higher genetic merit animals (and thus genetic improvement and dissemination technologies) will increase as livestock keepers become more commercially orientated and the other relevant actors, especially local agents of international and regional breeding service providers, become more engaged as can be anticipated using the value chain and innovation platform approaches.

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.

Development and delivery of animal genetics will be implemented in ways that take into account the constraints faced by poor and women livestock keepers and which help them not only make the best use of their existing assets, but also helps them to build these assets (Rege et al 2011). Attention will be paid to issues such as gender and poverty-group differentiated ownership and management of livestock; gender and poverty-group differentiated livestock and fish production objectives; and constraints specific to socio-economic groups that influence involvement in breeding activities, farmer organizations, or access to genetically improved animals. This will result in a reduction in the gender and equity gaps in relation to access to improved animals and thus livelihood outcomes.

Box: The livestock breed concept: The Western and developed countries' definition of a breed is: "a distinct, intra-specific group of animals, with shared peculiar characteristics that are distinct from other such groups, with each member having pedigree tracing its ancestry, often to a specific family tree and geographic region or a people. Usually a breed has defined breed standards, and official register of pedigree (stud book) and performance recordings are undertaken by a formal organization (breed society) that develops, safeguards, promotes it and lobby for it" (FAO, DAD-IS: http://dad.fao.org). Examples of breeds include Holstein Friesian, Charolais and Angus for cattle; Corriedale and Merino for sheep, and Alpine, Toggenburg and Saanen for goats.

However, in developing countries pedigree and performance recording rarely take place and the nearest equivalent to a breed is a locally adapted population which has been subjected to common breeding objectives, often separated by cultural or community 'boundaries' or differential preferences for specific animal attributes (Rege et al 2006). Thus, the breeds documented in the Domestic Animal Genetic Resource Information System (DAGRIS 2007: http://dagris.ilri.cgiar.org), typically encompass several adapted 'ecotypes'. The net result is that the concept of 'breed' in the developing world context is much more complex than in the West.

Livestock – key research questions

1. What are the available breeds for each of the livestock species and selected value chains and how appropriate are these for the different gender and poverty groups? Can genomic tools combined with novel phenotyping approaches provide enhanced descriptions of these resources?
2. What are their genetic attributes, current levels of production, existing production systems, the key constraints, men and women farmer trait and market preferences (key trait combinations) for each of the selected livestock and value chains?
3. What breeding and market services are available to the different gender and poverty groups, who are providing them, and how good are they?
4. What are the existing institutional and organizational arrangement for delivery of/access to input and market services to the different gender and poverty groups and are they satisfactory?
5. What currently available reproductive technologies are being used and by whom? Is there scope for introduction of existing or incrementally improved technology into the value chains under study?
6. What is the potential of novel genomic approaches, including comparative genomics, to leapfrog bottlenecks in provision of adapted animal types (These approaches are under active research by ARIs, but CGIAR has a responsibility to ensure they are applied to pro-poor traits and to facilitate development of enabling policy environments)?
7. Can these technologies be sustained to match the demands projected over the next 50 years, especially when faced with uncertainty about the impact of climate change on the production environment?

As we look to medium-term development it is important to pay attention to the significant developments in the genetic tool-box which may further extend our ability to deliver genetic improvement. Some of these, such as improved breeding services delivery systems, are likely to be directly applicable to the value chains selected in this CRP. However, the CGIAR, through this CRP, also has a responsibility to evaluate and, where appropriate, consider adapting other developments to the needs of the poor farmer. Many of these

technology developments are driven by the needs of the North but there are likely to be opportunities to adapt them to address the needs of the South. Obvious examples include use of comparative genetics to study gene function and transgenic platforms which have made major leaps recently, but with North-driven traits being addressed. This requirement includes monitoring and guiding the policy environment. Whilst not all of these approaches will be driven by the perceived and immediate needs of the value chains they are, however, essential to allow the CRP to maintain its ability to detect and take advantage of new developments, and do not represent a major effort or budget expenditure.

An important aspect of the CRP is a unified and comprehensive data management system. We will ensure that all value chains use, as far as possible, common data collection standards and ontologies. This will ensure that, at the very least, analysis tools will be readily applicable across value chains. Such platforms and systems are well established through our experience of multi-site and multi-species projects in which data are comparable and visualisable in a unified manner. In addition to its practical usefulness, such a data platform will also serve to unify the diverse activities of the CRP.

Livestock – activities

Working closely with ILRI's Markets, Gender and Innovation Teams, and in collaboration with the farmers, farmer organizations, and other stakeholders, the above research questions will be addressed by:

1. Assessment of the men and women farmers' trait preferences and market demands for small ruminants, cattle, and pig breeds and relative performance of the breeds currently being used in the selected value chains and production systems.
2. Establish databases for each of the livestock value chains, and design the architecture for comprehensive data capturing, biobank sample management, processing, synthesis, analysis and use of results for feedbacks, reporting and wider cross-referencing.
3. Assessment of the farm and community level animal management practices and performance in the selected value chains and production systems, in order to determine which ones are the most suitable.
4. Gendered participatory approach to development of breeding objectives, multiplication and delivery of improved genetics.
5. Collection of DNA, tissue and serum samples for strategic bio-banking and for running of high density SNP assays and undertaking association and bio-informatics studies on selected phenotyped individuals. The material will be used to inform characterization programs aimed at identifying the most desirable breed / cross-breed combinations and may also be of future strategic value, thus contributing to the FAO Global Plans of Action.
6. Undertake strategic assisted reproductive research in response to observed limiting factors within the value chains.
7. Participation in the development of high-end genomic studies, transgenics and use of comparative genomics to support long-term breeding and conservation strategies.

Aquaculture – rationale

Current indications are that Asian and African aquaculture will need to grow substantially to meet the demand for fish and it must do so partly by increasing production per unit land and water use. In response, WorldFish is placing growing emphasis on developing technologies that can support national and regional efforts to meet this need.

Together with the lack of affordable and effective feeds, the absence of improved strains capable of producing high quality seed is consistently identified as the most widespread and persistent technical obstacle to the development of aquaculture among both smallholders and medium sized enterprises. In

developing countries, very often farmers' strains are not more productive than their wild counterparts (and in some cases they are even less productive) due to poor management of the genetic resource (inbreeding and inadvertent selection in the wrong direction, for smaller fish). To address these issues WorldFish has focused on the development and use of genetically improved strains of fish.

Aquaculture – key research questions

Genetic improvement by selective breeding is an area in which WorldFish has been active and successful. An improved strain of tilapia (*Oreochromis niloticus*) called GIFT, an appealing acronym for Genetically Improved Farmed Tilapia, is one of the products the Center is especially proud of and is one of the cases highlighted in the publication 'Millions Fed: proven successes in agricultural development', produced by the International Food Policy Research Institute (Spielman et al 2009, Ponzoni et al 2011). WorldFish also contributed to the development of Jayanti rohu (*Labeo rohita*), an outstanding strain that is now widely used by farmers in India. WorldFish also provides advice and support to genetic improvement programs with a number of species in more than a dozen Asian, African and Latin American countries. Improved strains are essential to small farmers; otherwise, the resources they assign to feeding and to managing the production environment are largely wasted.

Growth and survival rate are two key traits in making aquaculture economically viable. The value of survival is obvious since dead fish constitute a total loss. When fish of a particular size are desired greater growth rate enables achieving that aim in a shorter period of time, whereas if the duration of the production cycle is fixed, larger fish will be produced. In either case greater growth rate is advantageous. It is our perception that replication across species and countries of the very successful approach developed by WorldFish would result in substantial impact at the farmer and consumer level. WorldFish has state-of-the-art expertise in the planning, design and conduct of genetic improvement programs, as well as ample experience in research, development and technology transfer in the area.

Genetic improvement typically takes place in a relatively small population of the order of a few hundred individuals. The economic impact of genetic improvement in any such population is small, but it becomes spectacular when it is multiplied through hatcheries, disseminated to farmers, and expressed millions of times in the production system. It is this attribute of genetic improvement by selective breeding that makes it such a unique and powerful technology. Furthermore, genetic gain is permanent and cumulative, that is, the new gain achieved in each generation builds upon gains made in earlier generations. These characteristics too (being permanent and cumulative) are unique to genetic improvement and cannot be found among other aquaculture technologies. WorldFish scientists have shown that investment in genetic improvement programs at a national level can result in very favourable benefit /cost ratios, of the order of eight to 60, depending on the specific circumstances, and sometimes even greater (Ponzoni et al 2007, 2008).

Among the key research questions we ask in CRP 3.7 are:

1. How can the long term evolutionary potential of genetically improved strains, currently curtailed by financial and physical limitations of breeding facilities, best be maintained?
2. What are the economic benefits, at national and individual farmer scale, of use of genetically improved strains?
3. What are the animal welfare implications of selecting for fast-growing productive strains and how can these be addressed in breeding programs?
4. How can molecular techniques refine and improve current programs, especially in selection for traits that are difficult to handle with currently used quantitative methods?
5. How can aquatic animal genetic diversity, most of which still resides in the wild, best be protected?

6. What are the risks to wild fish populations posed by genetic improvement programs and how can these be managed?
7. What sort of capacity development programs are required to sustain long-term genetic improvement programs implemented in a responsible manner from a biodiversity viewpoint?
8. What sorts of breeding objectives might be both desirable and implementable in responding to climate change?
9. What sorts of private and public partnerships are needed to multiply and disseminate genetically improved strains and how are these best developed and maintained?

Aquaculture – activities

The species chosen to work in Uganda and Egypt are Nile tilapia and Africa catfish. The WorldFish Center has played a pioneering role in the initiation and conduct of genetic improvement for aquatic animal species in developing countries. From the WorldFish Center we approach work in this area in a logical and systematic manner, by addressing, as deemed appropriate in each circumstance, all the activities that the planning, design and conduct of a genetic improvement program entail, namely:

1. Description or development of the production system(s)
2. Choice of the species, strains and breeding system
3. Formulation of the breeding objective
4. Development of selection criteria
5. Design of system of genetic evaluation
6. Selection of animals and of mating system
7. Design of system for expansion and dissemination of the improved stock
8. Monitoring, impact assessment and comparison of alternative programs

This approach is not only useful in itself in the sense that it enables a logical treatment of the matter, but it is also helpful in the identification of areas in which knowledge or its application are deficient, and that should therefore become the target of research, development and technology transfer. During the implementation of well designed genetic improvement programs, weaknesses, deficiencies and areas where there is room for improvement are frequently identified. Such program limitations provide pointers to potentially useful research areas, which if addressed will provide information that will enable refinements that may further increase the effectiveness of the program.

Where aquaculture is relatively new and there are still wild populations readily accessible by escapees of a genetically improved strain of the same species, the risks are high. The escapees may interbreed with the wild population with unknown but likely undesirable consequences (e.g. loss of the uniqueness of the wild population, change in the fitness of the resulting population with consequences to the ecosystem as a whole).The conduct of systematic environmental risk analyses can be of great value for the identification and subsequent management of the risks associated with development, introduction and dissemination of genetically improved fish strains in a given region. Where the adoption of genetic improvement programs may pose environmental, ecological or genetic risks to local fish populations and indigenous biodiversity, WorldFish will actively work with partners towards the development of tools and methodologies that improve local capacity to implement environmental risk analyses. Molecular techniques may be useful in surveillance, establishing whether introgression between escaped farm and wild populations has occurred.

All steps itemized above will be followed in Uganda. In Egypt, steps 1-6 have already been carried out and research will focus on determining how to develop the private and public sector partnerships essential to maintaining the genetically improved populations and on Steps 7 and 8. Complementary research activities which will provide essential information about how we will execute the programs in Egypt and Uganda, as

well as serve as areas where we can eventually scale out impacts, are also being supported at various levels of involvement elsewhere in Africa (Ghana, Malawi) and Asia (Bangladesh, China, India, Malaysia, Sri Lanka, Vietnam).

Animal Genetics Research Platform

There are differences between livestock and aquatic animals in relation to conservation and utilization of genetic resources. In livestock there are many breeds and very few wild relatives remain. The 'unit' of conservation is often taken as the breed, and conservation by utilization is thus a useful approach. By contrast, with aquatic animals there are very few breeds and most of the genetic diversity is in wild populations. The fraction of genetic diversity that is conserved in the few improved breeds in existence is very small. Hence the importance assigned to the prevention of further habitat degradation where natural populations of aquatic animals live.

However, the core expertise and principles in genetics are identical across species, whether we are dealing with terrestrial or with aquatic animals. ILRI has the greater expertise in molecular genetics and immunology, from which WorldFish and ICARDA would benefit, and also a long history of involvement in breed characterisation and improvement programs in Africa and Asia. WorldFish geneticists have been working on a wide range of aquaculture genetic improvement programs and on aspects of characterization and risk assessment associated with the use of improved fish strains. ICARDA geneticists have expertise in small ruminant breed characterization, sustainable use of local breeds and have started working on breeding programs for smallholders. In addition, the genetic groups in WorldFish and ILRI have been very active in the area of capacity building, frequently running training courses for partners at different levels on the application of genetics to aquatic animal and livestock improvement.

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. This will increase the attractiveness of establishing collaboration between the CG Centers and the leading research groups in this field, such as the University of New England, Wageningen University, and the University of Guelph. The physical location of the three Centers also favours the notion of working together. The animal breeding and genetics group of ILRI, WorldFish and ICARDA are located in Africa, Asia and the Near East, respectively. However, all Centers are active in both continents. Working together, WorldFish geneticists can provide support to lLRI's livestock programs in Asia while ILRI's geneticists may do the same for WorldFish's projects in Africa. In many instances this would make monitoring and overseeing of projects easier and more cost effective. Further, the frequent interactions among geneticists from the different institutes would be a very stimulating development for all involved, and one can expect improved scientific productivity and standards as a consequence.

Component 1.3: Feeds

Rationale

Feed is at the very interface of the positive and negative effects of livestock and fish production on food security, income and livelihoods and the environment. Lack of affordable, adequate feed (quantity and quality) represents a major constraint to smallholder competitiveness and the overall profitability of livestock and fish production systems (Ayantunde et al 2005; Rana et al 2010) because of its direct impact on animal productivity. Choice of feeds and feeding strategies also have major implications for natural resource usage, greenhouse gas emissions (Subbarao et al 2009; Blümmel et al 2010) and carbon sequestration

(Fisher et al 2009). For example, feed production can significantly deplete water, particularly in concentrate and irrigated forage-based systems (Singh et al 2004), which potentially relates to the CRP5 research on land and water management. Use of crop residues as feed can compete with soil improvement interventions (an aspect that is addressed in CRPs 1.1 and 1.2). Feed type also influences the amount of methane emitted from ruminants, and poor feed resources contribute to low animal productivity and, therefore, high greenhouse gas emissions per unit of livestock product; this presents a potential intersection with CRP7. Ecological foot prints of various feed resourcing strategies need to be investigated in collaboration with those CRPs.

The largest proportion of women's time in livestock production is taken by sourcing feed and /or feeding livestock. In most parts of sub-Saharan Africa and India, work, such as preparation of feed, cleaning sheds and making dairy products is done only by women, while fodder collection, taking animals for grazing and milking are undertaken by both men and women; similarly in Latin America and the Caribbean, women are strongly involved in milk processing and care of monogastric animals such as swine. In pastoral systems, young men spend considerable amounts of time grazing cattle, while women often graze small ruminants and collect forages and feeds for monogastric animals. In India for example, women spend up to an average of 5.3 hours in livestock production, most of which is on collecting feed (Upadhyay 2005); in South Kivu, DR Congo, mostly women and children spent between 1 and 4 hours daily to fetch forage for the livestock (Maass et al 2010).Similarly, women can spend considerable amounts of time collecting crop by-products and animal waste to be used in fishponds.

Feed marketing, however, also provides great opportunities for increasing women's income through sale of livestock feed or from growing and marketing feed/ fodder seed for specialized forages. Some of the feed sources are legumes which are important for food security and are often managed by women. Feeding systems that reduce women's labour and that provide income opportunities for women and youth will be an important component of the research under this sub-component and will involve participatory research with men, women and the youth.

Optimizing the contribution of feed and forage resources to animal productivity and therefore the profitability and efficient natural resource use of livestock and livestock based farming systems, while minimizing their negative environmental impact, will be at the core of livestock feed work in CRP3.7. For aquaculture, the major challenge is to provide farmer access to the affordable quality feeds that are essential for developing productive, profitable production systems as part of pro-poor value chains and in determining the effects of intensification of production on the participation of women as producers. Access to key ingredients currently used, especially fishmeal and fish oil, is limited, in decline and increasingly expensive, signalling the need to shift increasingly to plant-based feeds.

Approach: A value chain framework will be used as a systematic approach to define a set of research areas that include: (i) producing more and better feeds, (ii) making better use of the feeds that exist; and (iii) processing, densification, fortification and redistribution options, including transfer of feed (and generally biomass) from surplus to deficit areas to provide additional farm income and employment in surplus areas and mitigate feed constraints in deficit areas; and (iv) understanding the implications of different feeding systems on labour allocation and time use, and income generation potential especially by women.

Specific technology options will be targeted to the value chains described in Part 4, while feedback from value chains will help to refine technology requirements in an iterative process. Placing feed research in the context of specific value chains, and working through innovation approaches will circumvent some of the previous pitfalls of feed research that has been limited to technology dimensions. Feed work will also

support development of sustainable feed resources beyond the confines of CRP 3.7 value chains, for example through building of regional feed resource scenarios, interacting with crop-focused CRPs on feed aspects of major food crops, and accessing new feed resources such as from biofuel production.

Producing more and better feeds

Food feed crops: Food feed crops (potentially: sorghum, maize, wheat, rice, millets, triticale, barley, cowpea, pigeon pea, groundnut, cassava, sweet potato, soya bean) are already major livestock and fish feed resources and show high potential for increases in the quality and quantity of available biomass without compromising food (grain, tuber) yield or additional inputs of land and water, which are also required to produce food for people. Their importance in the future is, therefore, likely to increase. Multidimensional crop improvement research for development with partners from CG Centres, NARES and the private sector will detect and exploit available genetic variation for livestock feeding, and further target genetic enhancement towards multi-purpose traits using conventional and marker assisted crop breeding. Variations in existing cultivars will be exploited by integrating crop residue fodder traits into the advance and release procedures and decisions for new cultivars and by comprehensive screening of released cultivars. Further targeted improvement will be achieved by recurrent selection procedures, QTL identification and backcrossing. Proof-of-concept of these approaches has been established by ILRI and national and international crop improvement partners (Sharma et al 2010). Research here provides a platform for the evaluation of feed dimensions of crop breeding research implemented in crop-focused CRPs, in particular (but not only) dryland cereals and grain legumes, which specifically plan to implement research on crop residue feed quality and quantity linked to CRP 3.7. While food-feed crops seem particularly suited for ruminant and fish nutrition, substantial potential exists also for pig nutrition namely from sweet potato and cassava production.

Key activities are:

- Identify potential food-feed crops for planned dairy, small ruminant, pig and fish value chains in the context of prevalent cropping systems.
- Upgrade basal diet components contributed by food-feed-crops through identification of superior food-feed type cultivars from breeding and cultivar release programs and from fodder trading.
- Conduct studies and participatory evaluation trials to assess important traits to women and men for integration into improved food-feed cultivars.
- Establish regional hubs (East Africa, West Africa, Latin America and the Caribbean, and South Asia) to enable phenotyping for crop residue fodder traits in new cultivar advance and release procedures and integrating feed research with international and national public and private crop improvement. Such hubs will also provide the intersection with crop breeding research implemented in CRPs, in particular on dryland cereals and grain legumes.
- Connect with partner CRP (especially those focused on key crops) and regional networks to facilitate the inclusion of crop residue traits and traits preferred by men and women in new cultivar release criteria, through providing a platform for such evaluations.
- Conduct research to analyze labour and other implications of integration of food-feed crops into livestock feeding systems especially for women and children
- In close linkages with theme 2, identify and evaluate opportunities for increasing women's and youth participation in livestock feed markets through feed agro-enterprises

Key outputs are:

- Feed resource scenarios developed for specific value chains including improved basal diets and availability and use of variety release criteria for quantitative and qualitative traits of major crops.
- New variety release criteria that take into account quantitative and qualitative fodder traits and men and women's preferred traits
- Coordinated approach for food-feed crop work in the new CG developed and implemented including efficient networks that can phenotype for fodder traits.
- Improved dual-purpose varieties of food-feed crops that integrate men's and women's preferred traits, outperform existing cultivars not only by 10% grain, pod or root/tuber yields but also by 10% higher crop residue yield and 5% higher crop residue fodder quality traits such as metabolizable energy content in cereal crop residues and metabolizable energy content (when major feed component) and/or protein content (when supplement) in leguminous crop residues.

Key partners are:

- NARES and national crop improvement programs, and CRPs that target key food-feed crops, such as dry land cereals, grain legumes, roots and tubers, and the partner national and international crop improvement institutions, including public and private enterprises.
- Actors in value chains trading crop residues, such as sellers, middlemen, fodder traders and buyers.

Specialized forages

Where livestock systems intensify there is often increased demand for forages for specific temporal and spatial niches and systems to feed animals in a resource efficient (e.g. water, nutrients, land, labour) and cost-effective way. In this context, the selection and development of improved forages needs to recognize that a high proportion of smallholder crop-livestock systems in the tropics are located in vulnerable (and often degraded) environments with low fertility, acid soils, prolonged dry seasons (e.g. Mugisa et al 1999; Kabirizi et al 2006; Mtengeti et al 2008) and/or exposure to water-logging. Trade-offs in resource use between forages and food crops also needs to be assessed in some instances, meaning that careful assessment and targeting of forage resources, tailored to the diversity of economic, institutional, policy and biophysical conditions, is also important.

The CGIAR forage collection, which comprises over 70,000 accessions of 1,500 species of tropical and sub-tropical grasses, legumes and fodder trees (forage registry: http://icarda-genebank.icarda.cgiar.org/crs/forage/public/), is an essential resource to provide candidates for improved forage genotypes which can be directly used or incorporated into forage breeding programmes (such as the extensive breeding programs on *Brachiaria* in CIAT: Miles et al 1996; 2004). As with food feed crops, new molecular-based tools offer potential for QTL identification and targeted improvement through recurrent selection procedures for key use traits, such as drought tolerance, feed quality, insect and disease resistance.

Legumes contained in the CGIAR forage collection are candidates to be developed as components in forage-based animal feeds for ruminants and as supplements for monogastrics and fish in smallholder systems. Locally produced grain and leaf meals from these plants provide high-quality protein feeds that can substitute for high-cost imported feed ingredients. In addition, perennial forage grasses and cultivars derived from key rain-fed crops, such as sorghum and pearl millet, have the potential to provide very promising multi-cut or short-duration forages, which links also into research conducted in the context of CRPs on cereals and legumes. While conserving the diversity of tropical and sub-tropical grasses, legumes and fodder trees, the comprehensive CGIAR forage germplasm collection (Maass et al 1997) provides options for future use of either genotypes or specific genes for improving forages to deal with multiple biotic and abiotic

constraints. The collection has been recognized as an international public good that is being made available to *bona fid*e users.

Key activities include:

- Approaches to target forages to particular value chains including options that fit into existing crop-based farming systems and that have economic and social viability including reductions in women's time constraints.
- Conserve, maintain and distribute the CGIAR forage collection and evaluate targeted material in the CGIAR forage collection.
- Combining phenotypic forage screening with new associated molecular techniques to identify forages for special niches (agronomical, physiological, cropping pattern, phyto-chemical characteristics) and forage gene discovery to use specific desired traits (e.g. disease and drought resistance).
- Where appropriate for specific value chains, develop through conventional and molecular selection and breeding activities improved forage grasses and legumes resilient to multiple stresses (e.g. biotic and abiotic constraints, climate change) and suitable for differentiated spatial and temporal niches. This includes selection and breeding of short duration annual forages that are eco-efficient with adequate biomass yield and nutritional quality.
- Different animal species have different nutritional requirements. Thus in the development of forage options specific approaches and evaluation methodologies will be employed to target either monogastric or ruminant animals, with the former requiring a higher nutrient density. In the case of forages for monogastric animals, while there are a number of case studies, the data and approaches to test a wide range of forages for suitability is relatively scarce and thus will require the adaptation of nutritional analysis to test a wide range of options. However, in both cases high quality forages will be emphasized, in particular in respect to protein and energy concentration. While the work in the value chains targets specific animal species, development of forages for the ruminant cattle and sheep and the monogastric swine will allow some insight in suitable as well for goat and poultry, cavies and rabbits, respectively. Forages can also be a suitable feed for some fish species, complementing their existing diet either as fresh feed or as green manures. This may be explored specifically in the fish value chains that will be developed in Uganda.
- Define mechanisms for adaptation of forages to abiotic and biotic stresses to develop rapid and reliable phenotypic screening methods.
- Work with private and public seed industries and men's and women's farmer associations to facilitate sustainable dissemination and promotion of seeds and planting material of superior forages in the context of specific value chains.
- Development and upgrading of decision support tools for forage choices within both an agro-ecological, economic and value chain production systems context.
- Knowledge sharing about available forage germplasm and forage options for specific niches and the economic benefits and environmental services that integration of forages contributes to systems sustainability.

Key outputs include:

- Well targeted resource efficient forages with adequate biomass yield, nutritional quality, seed production and resilience to multiple stresses available to provide improved plant based feeds for ruminants, fish and monogastrics.

- Appropriately conserved, maintained and phenotyped forage collection available for public use under appropriate international conventions.
- Phenotypic and genomic screening methods available for germplasm characterization
- Seeds of forages that improve feed resources in specific targeted value chains multiplied and disseminated.
- Decision support tools, including economic considerations, and knowledge base for forage/feed based interventions available.
- Tools for trade-off analysis between feed and food production, fuel provision and natural resource management and the gender issues around these trade-offs.

Key partners:

- Private seed sector and feed companies.
- Smallholder producer associations
- Regional and national research institutions that address productivity and environmental components of forage/livestock research.
- Advanced research institutions for strategic research such as development of methodology for gene discovery in relation to physical stresses.
- International and national bodies concerned with appropriate management of plant genetic resources.
- Development partners and value chain actors.
- CRPs that target agricultural systems (CRP 1), soil and water resources (CRP5) and climate change (CRP 7).

Biofuel residues and spin-off technologies from cell wall hydrolysis

First and second generation biofuel production provides both threats and opportunities to ruminant, pig and fish feeding. There may be competition for biomass, land and water but such interventions can also provide additional feed resources, such as in the case of sweet sorghum bagasse remaining after bio-ethanol production (Blümmel et al 2009) and cakes from bio-diesel production, for example from Jatropha (Makkar and Becker 1999; Tacon et al 2009). Far-reaching opportunities lie with technologies developed by global private sector players to hydrolyze the ligno-cellulolytic plant cell walls for release of sugars. For second generation biofuel to succeed, these hydrolysis technologies need to be environmentally sustainable and economically viable. There exists a huge untapped potential for adapting and adopting these technologies for smallholder livestock nutrition on a large scale. Less IP issues are associated with hydrolysis approaches to release sugars from the cell walls than with enzymes technologies that convert sugars to ethanol. Only the first step is required for harvesting spin-off technologies from second generation biofuel technologies for livestock nutrition. The by-products of bio energy technologies – often a mixture of protein, fibre, and un-fermentable carbohydrates - can also be used in limited quantities as a feed ingredient for the omnivorous farmed tilapia and African catfish that are being targeted in the fish value chains.

Key activities:

- Investigate residues from bio ethanol and bio-diesel production as fodder for livestock pig and fish and facilitate their entry into feed, ruminant, pig and fish value chains.
- Investigate and modify second generation biofuel technologies for spin-offs useful for upgrading ligno-cellulolytic biomass for feed and fodder for livestock and monogastrics.

- Analyze with key private industry partners different approaches to plant cell wall hydrolysis and choose, further refine, adapt and develop technologies that can make use of second generation biofuel technologies for improving feed resources especially for small farmers.

Key outputs:

- New feed resources available from bio-energy value chains and reduced competition for biomass for food-fuel and fodder.
- Awareness established and linkages generated between major players in second generation biofuel and feed technologies in order to deliver research results providing more accessible sugars from ligno-cellulose material for host animal and possibly human digestion.

Key partners:

- Private industry in bio-energy technologies (local and decentralized, small-scale enterprises through to major multi-national players).
- Advanced international research institutions.

Making better use of available feeds on farm

Making better use of available feeds will be achieved by exploiting associative effects, for example between cereal and leguminous residues, supplementing dry feeds with green forages, roots and tuber vines and leaves, conserving (silage, hay) plant-based feeds, defining and allocating most limiting nutrients (energy, nitrogen sources and amino acids, minerals and vitamins) to basal diets, and by well targeted allocation of feed to the most responsive livestock and fish value chains. In pond aquaculture, where feeding response is not always easy to assess, poor feed management often results in good quality feeds simply acting as expensive pond fertilizers.

These different combinations of feeds on farm will have different implications for the gendered labour allocation in livestock production and the prioritisation of species targeted for allocation. The involvement of both men and women on decision making around these issues will be a critical component of the operational research.

Key activities:

- Optimize use of improved basal diet components from multidimensional crop improvement through fodder combinations that increase synergistic effects such as combining residues from cereals and legumes, supplementation of dry roughages with green forages, sweet potato vines, cassava leaves etc.
- Develop approaches for strategic allocation of available feed according to livestock species and physiological stage on life-cycle production taking into account important species for different functions and livestock ownership patterns.
- Develop technologies for feed conservation /processing that reduce women and men's labour and evaluate them for their effectiveness
- Develop feed conservation (e.g. hays, silages, meals) approaches suitable to smallholder systems and promotion of best practices in processing and storage of feedstuffs for fish, ruminants and monogastrics including mitigation options for mycotoxin contamination
- Determine effects of different feed formulations on livestock and aquaculture feed stability, palatability, food conversion profitability and, for aquaculture, wastes. Determine effects of diet and fodder nutritional quality on product quality.
- Conduct studies to determine the gendered adoption trends and impacts of feed /forage systems

Key outputs:

- On-farm feeding rations, feeding regimes and supplementation strategies developed including ration components that act synergistically to increase feed intake and feed conversion into meat, milk or fish.
- Feeding strategies developed that lead to improved biological and economic herd, flock and fish productivity and better product (milk, meat, fish) quality.
- Forage/feed conservation technologies for smallholder systems (e.g. selection of feeds, forage conservation technologies and practices , silage additives) for better balancing feed surplus-deficit times in the feed calendar and for maintaining feed quality and standards
- Forage/feed conservation technologies that optimize men's and women's labour and that reduce the gender gap in adoption and productivity.

Key partners:

- Extension and other development agencies
- Farmer organization and dairy and small ruminant cooperatives
- Small-scale entrepreneurs
- Supermarkets, retailers
- Private feed sector
- Crop CRPs

Transporting, trading and processing of feeds

While feed is often scarce – at least seasonally – opportunities exist to transport regionally underused feed resources from surplus to deficit areas. In some regions there are examples of livestock systems evolution that have moved from transport of feeds to transport of animals, which raises some challenges about nutrient management and pollution (Steinfeld et al 2006). Whilst this research will not directly address this issue, the opportunities presented with regard to feed processing and transport will be explored. Targeting feed production and utilization in combination with comprehensive feed/fodder/forage price-quality relationship investigations, as well as collaborations with fodder traders and feed producers, has opened a window of opportunity to systematically exploit surpluses on a regional scale. Feed markets provide opportunities for engaging and benefiting women in livestock and fish value chains. It is now feasible to optimize feed nutrient content, their transport and storage potential and the physical (chopped, feed block, mash, pellets) and biological (most limiting nutrients, balanced diets, total mixed rations) characteristics of feeds (Tacon et al 2009; Anandan et al 2010a; Anandan et al 2010b). These activities will also address district and village level needs for feed processing, working with feed manufacturers that are increasingly prepared to down-scale processing units to cater for decentralized feed processing options (which also limit nutrient removal from the feed producing areas). For fish the main approach will be to identify reliable supplies of quality feed materials, understand and remove barriers to their supply and effects of different processing technologies on palatability, consumption and digestibility, feed losses and pollution. Links to actors that can support men and women with addressing constraints to their participation in feed markets will also be explored.

Key activities:

- Map current and predict future feed resources (including demand-supply scenarios, quantity and quality) along with indications about natural resource usage implications especially water and environmental services.

- Conduct a gender analysis of the feed value chains from production to processing and marketing and identify the constraints and opportunities for increasing women's participation and benefits from them
- Develop tools that support decisions along feed value chains including transport and centralized and decentralized feed processing options.
- Determine effective and cost-efficient methods of pre-treatment of fish and livestock feed to reduce anti-nutrients, increase palatability and digestibility and reduce wastes and identify synergies with other agricultural feed producers.
- Identify nutritional requirements of farmed tilapias and catfish, understand effects of processing on feed quality and develop improved technical advice.
- Determine impacts of storage conditions on nutritional value of aquaculture and livestock feeds and on contaminants.
- Determine feed transport constraints and methods to address these, including synergies with other agricultural input distribution and storage services.
- Explore use of Life Cycle Analysis to look at impacts of feeds developed from different feedstuffs on ecological footprints, for example in the Egyptian fish value chain (links to CRP5 and CRP 7).
- Design business models for smallholders especially women and the youth to participate in feed markets

Key outputs:

- Assessment of feed options that facilitates policy maker and development practitioners to make informed decisions on investment into feed resource development and its implications for natural resource use.
- Economic information on feeds to enable fodder producers, fodder traders, feed manufacturer and fodder users to make economically sound decisions quickly.
- Strategies for the development and promotion of decentralized and small-scale feed processing units.
- Business opportunities for women farmers associations in feed value chains within decentralized feed processing systems identified and evaluated for profitability and sustainability
- Nutritionally sound, affordable and environmentally friendly feeds available for monogastric and aquaculture producers.
- Tested business models (that include financing options) for smallholders to participate in feed marketing

Key partners:

- Commercial feed producers, fodder traders, farmers, NARS and national universities in value chain locations.
- Agro-business incubators and financial institutes targeting small scale entrepreneurs.
- Women and Men' farmer associations /producer groups
- ARIs with interests and expertise in livestock and aquaculture nutrition.

Outputs, outcomes and impacts

The outputs and their expected outcomes and impacts are summarised in Table 2.10.

Table 2.10: Feed technology development outputs, outcomes and impacts

Outputs	Outcomes	Impacts
Food feed crops Feed resource scenarios for specific value chains Improved basal diets from food-feed-crops Coordinated approach to food-feed crop work in the new CG including efficient networks that can phenotype for fodder traits Ecological footprints associated with different types of feeds New variety release criteria that take into account quantitative and qualitative fodder traits and men and women's preferred traits Improved dual-purpose varieties of food-feed crops s that outperform existing cultivars not only by 10% grain, pod or root/tuber yields but also by 10% higher crop residue yield and 5% higher crop residue fodder quality (measured in terms of metabolizable energy, protein content, digestibility) Forage /feed conservation technologies that optimize men's and women's labour and that reduce the gender gap in adoption and productivity *Specialized forages* Well targeted resource efficient forages with adequate biomass yield, nutritional quality, seed production and resilience to multiple stresses Appropriately conserved, maintained and phenotyped forage collection available for public use under appropriate international conventions Phenotypic screening methods available for germplasm characterization Forages identified for providing ingredient for improved plant-based feeds for ruminants, fish and monogastrics Seeds of forages that improve feeding resources in specific targeted value chains multiplied and disseminated Decision support tools, including economic considerations, for forage/feed based interventions available *Biofuels and spinoffs* New feed resources from bio-energy value chains and reduced competition for biomass for food-fuel and fodder Awareness established and linkages generated between major players in 2nd generation biofuel and feed technologies More accessible sugars in ligno-cellulose available for host animal and even human digestion *Making better use of feeds* On-farm feeding rations and feeding regimes with ration components that act synergistically to	Appropriate food-feed options identified and developed, for the selected value chains Improved food/feed crop varieties and feeding systems targeted at women managed value chains developed and tested Appropriate specialized forage options identified and developed for the selected value chains Appropriate options identified and developed to exploit biofuels and associated spinoff technologies for the selected value chains Appropriate options identified and developed to enable better use of feeds on farm for the selected value chains Appropriate options identified and developed for the selected value chains Aquaculture, livestock and monogastric feeds with reduced ecological footprints Feed value chains that support selected livestock value chains and in which women are engage identified and developed	Cost-effective feed options used in value chains which make available sufficient quantity and quality of feed contributes to increased productivity and production of animal source foods to enhance livelihoods and nutrition security of the poor and vulnerable, without excessive impacts on global warming A reduction in the gender gap in the adoption of feed /fodder technologies and livestock productivity

increase feed intake and feed conversion into meat and milk	
Improved biological and economical herd and flock productivity	
Forage/feed conservation technologies for smallholder systems (e.g. selection of feeds, forage conservation technologies and practices , silage additives) for better balancing feed surplus-deficit times in the feed calendar and for maintaining feed quality and standards	
Improved product quality (milk, meat fish)	
Transporting, processing and trading feed Assessment of feed options that facilitates policy maker and development practitioners to make informed decisions on investment into feed resource development and its implications for natural resource use	
Economic information on feeds to enable fodder producers, fodder traders, feed manufacturer and fodder users to make economically sound decisions quickly	
Strategies for the development and promotion of decentralized and small scale feed processing units	
Business opportunities for women farmers associations in feed value chains within decentralized feed processing systems identified and evaluated	
Supplements well designed and targeted to optimize utilization of prevalent basal feeding systems	
Nutritionally sound, affordable and environmentally friendly feeds available for monogastric and aquaculture producers	

RESEARCH THEME TWO: VALUE CHAIN DEVELOPMENT

Strategies for pro-poor, gender-equitable value chains for livestock and fish products

Over the past decade, development practitioners have increasingly shifted their attention from farming systems to targeting agricultural value chains to improve smallholder production and participation in markets (see, for example, Rota and Sperandini 2010). This is because small-scale producers are often unable to increase production by adopting productivity-enhancing technologies unless the value chains for their products are sufficiently developed and dynamic. Accordingly, value chains must provide both 'push' and 'pull' for technology uptake to justify the investment of the various actors along the value chain to increase production and productivity. More emphasis has been given, therefore, to a business orientation to stimulate agricultural production and related services rather than viewing smallholder agriculture simply as a means of survival (Webber and Labaste 2010). The underlying assumption is that increasing the commercial orientation of smallholders and 'growing' the associated value chain to create pro-poor value-addition opportunities will result in sustainable and resilient outcomes and prevent smallholder livestock keepers and fish farmers from being marginalized.

Agricultural research has taken the cue from these trends in the development sector, recognizing that technologies and strategies being generated need to be relevant within such a value chain context if they are to be taken up and achieve impact. This Program adopts this type of value chain perspective; Theme 2, on Value Chain Development, will serve as the mechanism for directly engaging within the selected animal product value chains.

The objectives of Theme 2 will be to:

- Identify technological and institutional opportunities to increase supply of animal products from the target value chains that benefit poor consumers
- Align research and development partners to mobilize resources to transform the target value chains through major development interventions
- Develop strategies for working effectively as knowledge partner to development actors by supporting improved design, gender integration implementation and assessment of interventions that enhance value chain performance, output, and innovation capacity as well as development impacts.

Approach

A large literature already exists offering a variety of conceptual frameworks and a range of methods and tools under the general label of value chain analysis (see Webber and Labaste (2010) for a recent review). Value chain analysis includes a characterization component to describe the structure and relationships within a chain, a diagnostic component to identify opportunities to increase its efficiency and equity, and a prescriptive component for designing, implementing and sequencing interventions. Key features of value chains highlighted by economists include understanding trust and cooperation, governance, market power, innovation and knowledge, and intervention points (Webber and Labaste 2010), but other perspectives of political economy and socio-cultural context and dynamics also require consideration.

The strength of value chain analysis is that it harnesses the energy and innovation of functioning systems involving motivated stakeholders serving well-defined customers. Its limitations are that it tends to be inward focused and at times under-analytical (ignoring consequences outside the chain of proposed change) or over-analytical (dealing with issues that stakeholders and development actors do not recognise as important). Two complementary approaches are therefore needed. The first is through sectoral and policy analysis, to understand the broader context within which the target value chain functions, and its

implications for the chain's longer-term viability. Economic and policy analysis tools will be adapted and applied to assess, for example, supply and demand dynamics and the competitiveness of the target value chains relative to alternative value chains and opportunities faced by the actors, as well issues related to political economy. The second approach addresses the challenge of stimulating market-led development when the value chain's innovation capacity is weak. Stimulating development of value chains is a particularly promising area where our understanding of innovation systems can be improved and translated into practical actions to facilitate interactions between actors both within and outside (e.g. researchers) the value chain to co-create solutions. Ongoing work that will be applied includes Integrated Agricultural Research for Development (IAR4D) in the form of innovation platforms in which researchers facilitate interactions between actors to co-develop innovation capacity for sustained innovation (Tizikara and Kwesiga 2006; van Rooye and Homann-Kee Tui 2009; New Agriculturalist 2010).

What are innovation platforms?

Innovation platforms are networks or loose coalitions of individuals and organizations who come together to share experiences, knowledge, skills, resources and ideas with the objective of addressing problems and opportunities of mutual interest in new ways. In a developmental context, the objective would be to achieve beneficial and equitable outcomes which target poor people, including women and other vulnerable groups.

In the example of an innovation platform focused on improved production and marketing of an agricultural commodity, members might include those along that commodity value chain – e.g. individual farmers, farmers' organizations, large-scale producers, women's groups, CBOs, NGOs, FBOs, local government officers, traders, transporters, processors, input and service providers, micro-financiers and insurance agents, retailers and wholesalers, agri-businesses, researchers and journalists amongst others. Innovation platforms evolve with time; members of the platform change as incentives and need for their participation change.

Innovation platforms need to be effectively facilitated. Innovation brokers, who can come from the research or development community, can play this important role. Ideally they ensure effective networking between platform members, act as conduits for knowledge, capacity building and finance, provide conflict resolution services and negotiate deals and alliances, amongst other roles.

Innovation platforms are transitory arrangements. The success of an innovation platform should not be judged on whether or not it is sustainable. On the contrary, successful innovation platforms often evolve in to different types of entity, such as farmers' organizations, cooperatives, businesses or contracted arrangements. It is, however, desirable that innovation capacity is enhanced and remains available locally so this can be galvanized and targeted to address future needs.

Gender inequalities are often critical to understanding and addressing the 'weakest links' within value chains, and the most critical areas for upgrading quality and growth as well as poverty reduction. Gender analysis is, however, generally also the weakest point in most value chain analyses, and largely ignored in most value chain manuals (Mayoux and Mackey, 2007). Gender inequalities affect where power is located and where and how change can occur in order to translate chain upgrading into poverty reduction. Gender inequalities are often important in explaining why different parts of the chain are blockages to growth. Gender analysis is needed to explain why particular chains are dominated by men or women, in what circumstances women have been able to become successful at creating employment, and how women can be supported to make a more effective economic contribution.

A gender and equity inclusive process would entail (i) giving women and the poor at all levels a voice in the process (ii) gender disaggregation of all data to identify areas of gender difference (iii) investigating areas of gender difference to identify whether this is due to gender inequalities of opportunity or differences in choice (iv) gender equitable planning which mainstreams equality of opportunity and identifies supportive strategies needed to enable women to realize these opportunities, and to promote the support of men for the necessary changes and (iv) gender accountable implementation and learning which involves women as

well as men in implementation, incorporates gender indicators in monitoring and informs women as well as men of learning outcomes.

This Program's CG partners have a track record in exploring and applying value chain analysis in pro-poor development of value chains for animal products (Negassa 2009; Rich et al 2009; Baker et al 2009). Animal product value chains have particular characteristics that distinguish them from other agricultural products, such as: the asset-related, cash flow and social functions of livestock that often see people accumulate large numbers; product perishability and associated public health risks; the role played by livestock in risk management; the divergent paths of crop and livestock pricing during crises; and seasonality of feed and of demand (Upton 2004; Negassa and Jabbar, 2008). Certain livestock species are also associated with marginalized populations, gender-demarcated control and intra-household division of labour. These features present opportunities, but demonstrate the need for devising strategies that may be specific to animal-product value chains encompassing animal source foods, live animals, an array of service and distribution functions, and input supplies such as feed and veterinary care that may come from within or beyond the farm household system.

As a consequence of their nature, measuring productivity and efficiency in animal-product systems presents some unique challenges. The performance of their value chains offers interesting avenues of approach (Rich et al, submitted 2010). A core feature of this Theme is that it will build on experiences to date (e.g. Baker et al 2009) to continue developing **a methodology platform for tailoring value chain development methods to animal products**, and its application to value chains – often in the informal sector – that benefit the poor. The methodology platform will take the form of a set of common approaches, such as value chain analysis, being continuously adapted and refined through community of practice of the members of the research team and their research and development partners working in this area. The team will work closely with the value chain component under CRP2, drawing from its cross-cutting, generic methodology development and contributing the animal-product perspective and case studies from our experiences in applying the methods.

A second key feature of our approach will be **integrating technology generation and adaptation** under Theme 1 directly into value chain development. While value chain development specialists can help identify particular constraints and bottlenecks in the target value chain, it requires the expertise and insight of the technical scientists to identify potential technological solutions, while interacting with social scientists to ensure their appropriateness. Both technical and social scientists will also have roles in identifying the organisational conditions and changes required for technology adoption, and this approach specifically addresses anticipated problems with 'top-down delivery of inappropriate technology' as experienced in the past. CG technical scientists will therefore participate in the value chain development team for each site. Their role will be to assess technological constraints, identify and develop potential solutions – whether adapting existing technologies or creating novel ones – and then pilot the solutions through to their scale-up within development interventions. Devising strategies for improving service provision to deliver and support technologies (e.g. breeding schemes) will benefit from interaction between the technical and social scientists. This arrangement will orient the technology generation research agenda to addressing the priority needs of the target value chains, which will largely consist of common key technical problems (e.g. increasing the fodder value of food crops). Participating in the team is also expected to enhance the appreciation and understanding of the scientists developing and combining technologies about the context in which the technology is to be used.

A third principle central to this Theme will be structuring most of our work through **our role as knowledge partner to development actors**. This makes explicit a new approach, not without risks, based on ongoing CG experiences in a major dairy development project in East Africa and projects elsewhere (e.g. with Tata Trust

in India). It entails initial activity to scope the target value chain, its relevant stakeholders, and potential research and development partners willing to support a major development intervention. The CG team will then work towards aligning the various partners in designing such an intervention and mobilizing the required resources, using evidence generated during its initial scoping study and value chain analysis to inform the process. Several of the target value chains were chosen in part based on demonstrated donor interest; this will minimize the risk of failing to mobilize resources. The CG team and its research partners will seek to participate as knowledge partners for implementation of the intervention, permitting them to be directly involved and providing the 'field laboratory' for implementing value chain development activities as they respond to the needs and demands of the development partners to ensure the success of the intervention (and learn from failures where possible and necessary). This formula also provides an immediate impact pathway for our work as we support the development intervention in achieving its objective of impact on a large number of beneficiaries. To implement this approach, staff responsible for leading the engagement with national and local partners and developing expertise on the target value chain will be posted full-time in-country.

A fourth principle will be the **integration of gender in the value chain approach**. This will entail gender sensitive value chain selection which has already formed the basis for the selection. A gendered analysis of these value chains using some of the existing frameworks, including the Gender Dimensions Framework and the Women Empowerment in Agriculture Framework, and adapt them for use in livestock and fish value chains. This analysis will systematically identify gender issues that may limit the overall effectiveness of the value chain development. The World Bank estimates that women engaged in agricultural value chains would increase their production and incomes by 10% to 20% if they had access to the same knowledge, education and inputs as men do. For value chains to be an effective approach for poverty reduction, these disparities will need to be addressed. We will use different strategies that reduce the disparities in participation and benefits from value chains by women by being sensitive to intra-household relations and resource flows, supporting service providers that increase women's access to essential value chain services, addressing unequal distribution of entitlements, addressing women's time poverty through improved technologies and reducing women's risk aversion. This will require involving women in the whole value chain development process, disaggregating value chain data by gender and designing the value chain programs so that women have the equal opportunities as men to participate and benefit from the value chain interventions.

Theme 2 will therefore consolidate existing capacity within the four CG Centers in an interdisciplinary team of value chain development specialist together with technical researchers from Theme 1, specialists from Theme 3, and M&E and gender researchers working under Theme 3, working across the target value chains, and with staff based in-country to coordinate the efforts in the specific target value chain.

Research activities and outputs

Research activities will be structured around 3 principal, but integrated, sub-components that reflect the three dimensions of the approach described above: sectoral and policy analysis, value chain analysis, and value chain innovation.

Component 2.1. Sectoral & policy analysis

The animal-product value chains targeted by this CGIAR Research Program typically represent only one of several production and marketing systems for the animal product in question, which together represent only one sub-sector within the larger agricultural sector and national economy. Value chain development efforts cannot ignore this broader context, either in terms of the constraints it may impose on the target value chain or incentives it may create. Moreover, this context extends to the highly policy-relevant impacts that changes in the target value chain may create in other parts of the sector or economy. We therefore apply

economic and system modelling techniques to evaluate and monitor the interactions between the value chain and its context, to inform the value chain development interventions. Research questions to be addressed include:

- How competitive is the target value chain vis-à-vis others for the same or similar animal products? How do policies currently influence the viability of the value chain and its capacity to deliver pro-poor development?
- How will market react to improved competiveness of the target value chain?
- What policy interventions will boost competiveness of the target value chain?
- What will be the implications of improved productivity and increasing production and efficiency within the value chain for factor use and competition for resources? What cross-commodity effects will be created, e.g. crop-livestock interactions, particularly with respect to feeds as crop outputs and draft power and manure as crop inputs?
- What will be the implications on gender roles, participation and benefits by the poor and women with improved productivity, increased production and efficiency of the value chain?
- How is demand for the animal product expected to evolve, and which changes can be expected in livestock and fishery industries and delivery systems? What are the implications for prices and trade opportunities?
- How will macro-economic trends and political economy context be expected to affect the value chain over time?

There will be overlap and synergies with the types of analyses undertaken within Theme 3, with the distinction being that Theme 3 will be looking more at larger-perspective, cross-cutting issues and methods (e.g. which value chains to target), whereas Component 2.1 will concentrate on specific studies to inform strategies and policies for the individual target chain (e.g. how are macro-economic policies affecting the trajectory of the target value chain).

Component 2.2. Value chain assessment

There are a wide range of methods and tools for assessing value chains from a definitional, identification and diagnostic perspective (as reviewed in Webber and Labaste 2010). Tools for gender analysis of value chains have been deleoped and tested in different types of value chains. Such tools include the Gender Dimensions Framework-GDF (Development and Training Services, 2009), and the Women's Empowerment in Agriculture framework –WEA (Care, 2009). These assist practitioners in analyzing structure and governance within the value chain to identify potential entry points for upgrading: to add more value, improve equity in distribution of value added, or to improve flexibility or resilience in uncertain environments. The gender analytical tools help in identifying the gender based constraints in value chains and opportunities for women and the poor to participate in these chains. Component 2.2 will build on ongoing work to refine and adapt these tools to the specificities of animal product value chains, integrating institutional and technical insights from our collective knowledge base. An example is the data collection tool VAIMS developed by ILRI with partners in southern Africa (Baker et al. 2009). We propose to focus on five areas of research.

The first will develop metrics and modelling approaches, such as system dynamics models, for quantifying and monitoring value chain performance and simulate performance under different intervention scenarios (Rich et al submitted 2010). The second seeks to quantify productivity gaps and their impacts, similar to the way yield gap analysis has already been used in crop research, but building on existing livestock and fish production models. This would improve our ability to prioritize research and development investment to address productivity constraints and predict potential impact. Third, health risk associated with animal products is a recurrent concern and constraint. We therefore propose to build on some preliminary work to

integrate risk analysis tools from epidemiology as part of our value chain analysis toolkit. The community of practice described above would ensure a productive interface with CRP4, specifically in applying the One Health approach within a market context. The fourth area, highlighted by participants during the stakeholder consultation, is risks (e.g. price, transaction) and their influence on value chain actors' investment in productivity-enhancing technologies and institutional arrangements, and how such risk can be managed. The fifth area will focus on the gender-based constraints and opportunities in livestock and fish value chains, building on current work on selected value chains in East Africa. We propose to analyze /model the potential impacts of these gender based constraints and the potential for different gender integration strategies to address these constraints.

Component 2.3. Value chain innovation

Whereas Sub-component 2.2 focuses on 'where' in the value chain to intervene to improve productivity, this Sub-component deals with 'how' to intervene to promote uptake, and capacity to sustain growth of the value chain. Activities will centre on three main topics.

The first topic is co-creation of innovation capacity with value chain stakeholders consistent with the IAR4D approach (Jones 2004, Moriarty et al 2005), and the necessary process. The CG partners have begun working with innovation platforms as learning alliances of stakeholders from various levels (local to national) and sectors (smallholder, private, public, civil, research). Researchers help establish fora (platforms) where actors and stakeholders meet and are facilitated in a collective analysis of the value chain. Researchers then participate as a knowledge partner, providing information and evidence to stimulate interactions among the stakeholders and value chain actors to co-develop new strategies to pilot and evaluate within the value chain. This mechanism serves to improve access to market information, improve contacts and build trustworthy relations amongst partners, and in doing so establish community capacity to deal with other opportunities and challenges as they emerge. A major contribution will be to develop metrics for evaluating the performance of this approach. A further challenge is consolidating emerging lessons on how to apply business development services to stimulate small-scale agri-business (e.g. creating small-scale feed processing services accessible and affordable to smallholder farmers that provide employment opportunities for women, or certification schemes for milk hawkers in informal raw milk market systems (ILRI 2006)). Strategies are also needed for developing effective public-private partnerships with the local and international commercial sector to provide commercial services appropriately formulated for pro-poor value chains, such as those currently being established to develop forage pulveriser services in EADD (Hartwich & Tola 2007).

The second topic in this component examines organizational strategies to address the lack of economies of scale so prevalent in smallholder systems. Smart design of development interventions can integrate research to test a range of different strategies, such as producer or business groups to allow collective product marketing and input purchase, and schemes for clustering of services such as provision of micro-credit, input provision, technical and market information, and marketing services that support uptake of productivity-enhancing technologies. The role of women and youth in producer and business groups and as service providers will be a critical element under this topic. This will benefit from interaction with CRP2 activities targeting collective action more generally.

The third topic examines different strategies for addressing gender and equity within value chains, such as incentive based schemes for women to engage in value chains, addressing systemic barriers, improving domestic service markets, savings- led asset or capital mobilization amongst others. While some of these strategies are best implemented by development partners, research can play a role in targeting these and evaluating their effectiveness in addressing gender based constraints within value chains.

Fourthly, the proposed approach of working as the knowledge partner in major development interventions raises questions about how research can effectively play such a role. One aspect concerns the ability of research to sharpen the M&E systems used by development partners. Another is the development of methods for responding in real-time to development partners' needs for information, as well as action-research techniques for testing new technologies and institutional strategies within the interventions.

Implementation in target value chains

The value chain development team will consist of a multidisciplinary mix of technical and social (including gender) scientists, some of who will focus on a specific value chain to gain a deep understanding of its specificities, and others who will work across value chains providing a methodological perspective. The CG partners have already been conducting research activities within several of the selected value chains, but have less experience in others. The first task of the team will be to conduct a rapid assessment of the current status of the value chain, including identifying the relevant actors and stakeholders in both the research and development sectors. The team will create a forum for the interested stakeholders to work towards a consensus on research and development priorities for the value chains and begin developing an intervention concept, with the objective of preparing and submitting a development proposal for funding within the first year. The initial research activities undertaken by the team will generate information to inform the stakeholders and preparation of the proposal. The goal will be to align sufficient interest and capacity among stakeholders and research and development partners, and mobilize sufficient resources to undertake a large-scale development intervention that will significantly improve value chain productivity and efficiency involving at least tens of thousands of households.

The Program will seek to participate as the knowledge partner within the development intervention, leveraging development funding for additional capacity to support this role. In the case of the ongoing East Africa Dairy Development (EADD) project, this role translates primarily in providing an M&E function to the development actors responsible for implementing the intervention, which will allow the team to evaluate what works and what doesn't, and adjustments needed. After initiation of the development intervention, the Program will complement the knowledge partner role with a parallel program of strategic research to identify, develop, and test pilot technological and institutional strategies to enhance the performance of the intervention and the value chain. The team will leverage its role within the development intervention to feed in research outputs for validation and promotion at the scale of the intervention.

Again, following the example of EADD, we would envisage an initial development intervention phase of 4-6 years to achieve proof-of-concept; during this period the team will provide support to mobilize additional development resources for subsequent scaling out of the intervention to new beneficiaries nationally or regionally. At this point, a decision will be made whether to maintain a focus in the value chain or to pursue an exit strategy to disengage and re-deploy to focus on another value chain elsewhere.

Research theme 2:

Table 2.11: Outputs, outcomes and impacts for Research Theme 2

	Outputs	Outcomes	Impacts
2.1 Sectoral & policy analysis	• Situation analyses of the selected value chains, including analysis of trends in competitiveness of existing value chains, market analysis, political economy factors • Multi-market and sectoral models to assess o factor use and distribution of benefits o cross-sectoral price dynamics o policy scenarios • Spatial equilibrium models to guide target locations for investment and trade opportunities • Resource trade-off modelling • Scenarios for organising and developing value chains that benefit the poor and women rural producers and urban consumers	• Consensus on role of target value chain development within national development strategy • Evidence available to policymakers for value chain investment scenarios • Better alignment of policies with pro-poor value chain development •	• Public and private value chain investments yielding higher than average returns • Improved competitiveness of the target value chain
2.2 Value chain assessment	• Gendered value chain analyses within target value chains identifying technological and institutional entry points for improving productivity and efficiency • System dynamics models and metrics for quantifying animal product value chain performance • Productivity gaps estimated for target value chains • Toolkits for pro-poor and gender integrative animal-product value chain analysis • Methods for assessment of animal	• Improved targeting of development interventions to entry points within value chains with highest potential for improving productivity • Better targeting and relevance of technology adaptation and generation research and value chain development research • Improved capacity to monitor value chain performance • Gender-specific value chain interventions are implemented during value chain development •	• Better performing and equitable value chains • Value chain development interventions are more program- and cost-effective •

	production gaps and research prioritisation		
2.3 Value chain innovation	• Innovation platforms established for co-development by value chain actors and other stakeholders • Public-private partnerships created for private-sector provision of services target value chains • Micro- and small-scale agri-businesses engaged in improved value addition, efficiency and equity in the target value chains • Novel organizational strategies to create economies-of-scale and that effectively engage women and the poor are evaluated and adopted • Strategies formulated and tested for research as knowledge partner within major development interventions • Business opportunities for	• Innovation platform approach adopted by development actors for stimulating value chain innovation • Innovation capacity within target value chains strengthened • Engagement or creation of small business services, including a significant portion by and for women, improves value chain actor access to inputs and services, supporting intensification • Farmer and trader business groups with at least 40% women participation • Improved men and women member access to inputs and services, and enhanced market power • Improved integration of research in development actions	• Target value chains are more resilient and responsive, adapting better to changing market conditions and opportunities • Increased market activity and professionalism as value chains become more business oriented • Poor value chain actors, including women, invest in and intensify their production and marketing systems • Research achieves impact at scale more directly • Reduction of gender disparities in participation in value chains and in benefits accrued including income under the control of women •

RESEARCH THEME THREE: TARGETING, GENDER AND IMPACT

Overview, aims and context

Impact is central to this Program and to its vision of going further than traditional research efforts of the past to ensure the Program's activities and outputs lead to significant and measurable improvements in the lives of poor men and women. A dedicated theme on targeting and priority setting, integrated gender research, monitoring and capacity support is required to enable success. The aims of this theme include: a) generating the data to inform targeting and priority setting, b) supporting the mainstreaming and carrying out strategic gender research on livestock value chains, technology development and delivery systems, c) ensuring impacts on the intended beneficiaries including poor and women livestock keepers and consumers, d) supporting learning and continuous programme improvement to enhance performance and impact.

The research for development experience over several decades has highlighted multiple shortcomings in the manner in which science and knowledge outputs are designed for and/or translated into behavioural change among target clients, and impacts in livelihoods, welfare and resources. The frequent lack of uptake of technologies and strategies that on paper, or on station, demonstrate clear potential for impact has led to widespread questioning of the way research is conducted, how technologies and other innovations are communicated and disseminated, and how the impacts of research and development projects are assessed. The most significant determinants of lack of impact are not often identified. 'Confirmation bias' in which success stories are used to confirm and justify investments, while failures are not documented or are quietly shelved is common among development agents and investors. Mutual self interest of donor and implementer contributes to this, and so learning from failure - the important test of the counter-factual - rarely occurs. This is coupled with the fact that when success occurs, there is inability to identify those central elements which brought that about, and so inability to replicate or scale out. A model that works is typically replicated wholesale in another location, where it may fail due to unidentified locational factors, or unidentified capacity requirements. There has also been an inability to predict what the most successful strategies are likely to be from location to location as well as to anticipate even in the medium term what may lie ahead in the future, and prepare rural communities and market actors to respond to alternative likely scenarios.

Other shortcomings relate to the inability to clearly measure, document and predict how changes in productivity and technology uptake translate into real increases in welfare and livelihood assets. The differential access to and capacity among researchers for tools that enable them to understand and monitor impacts, and the processes that brought them about, which in turns leads to the continuation of the above shortcomings and prevents projects from making mid course adaptations that would allow them to reach their target beneficiaries and generate intended outcomes and impacts.

The lack of effective and context-specific strategies for addressing gender and equity issues has led to a neglect of a large proportion of potential economic players, including women and the youth while marginalizing whole populations. This is despite the presence of gender strategies on paper that have failed to translate to impacts on women and other marginalized groups. The rationale for considering

gender in agricultural research and innovation relates to agricultural productivity, food security, nutrition, poverty reduction and empowerment (Meinzen-Dick et al, 2010). In all of these cases, women play a critical role but often an unrecognized role and face greater constraints than men. Although two-thirds of the world's 600 million poor livestock keepers are rural women (Thornton *et al* 2003), little research has been conducted in recent years on rural women's roles in livestock keeping and the opportunities livestock-related interventions could offer them. This is in contrast to considerable research on the roles of women in small-scale crop farming, where their importance is widely recognized and lessons are emerging about how best to reach and support women through interventions and policies (e.g. Quisumbing and Pandolfelli 2010, Gladwin *et al* 2001).

To address these issues, good practice has been identified in many areas such as systematic characterization and targeting (Herrero et al 2010; Hyman et al 2008, Quiros et al 2009), involving beneficiaries in R&D processes including M&E (Sanginga et al, 2009; Kristjanson et al, 2009), and in moving beyond anecdotal success stories to evaluate impact using counterfactuals (Walker et al 2008) and, where appropriate, controls (Maredia 2009). Additionally, there have been tools, and approaches developed for integrating gender in agricultural research and development. Tools for gendered value chain analysis tools (Rubin et al, 2009; Mayoux and Mackie, 2007) and approaches for integrating gender in research (Kaaria et al, 2009; Ashby, et al 2000; Njuki et al, 2009) are available for adaptation to the Program.

The extent to which these are being taken up varies, however, due not only to knowledge, capacity and funding constraints but also to a lack of incentive on the part of researchers, practitioners and donors to look critically at their impacts, acknowledge failures, and learn from them to improve future performance. The results-based approaches that are being adopted by many funders and R&D managers, including in the CRPs, are providing that incentive, encouraging projects to becoming more learning oriented in order to become more impact oriented.

The rationale for including this Theme as a central component of the Program, and which determines its structure and functioning is based on the following principles:

1. Identifying our target beneficiaries and understanding their communities and how to reach them is critical for having the desired impact
2. Non-spatial factors, such as household-specific attributes and resources, are often as significant as determinants of opportunity and impact as spatial factors such as agro-ecosystem or proximity to infrastructure.
3. In order for research and development processes to be effective, those processes in themselves require explicit analysis, capacity development, support, and monitoring.
4. Integration of gender has in the past been ad hoc and uncoordinated, and in most cases limited to programs working on participatory research. Systematic integration of gender in the priority setting, research design and implementation, monitoring, evaluation and impact assessment and the generation of new evidence on gender and livestock and aquaculture value chains requires a dedicated effort and resources.
5. Monitoring outcomes and impact is an essential part of research process and re-design, for good science and impact, not just for accountability.

6. Internal M&E is best integrated with outcome and impact analysis through construction of detailed impact pathways and explicit impact hypotheses in order to combine learning about results with monitoring of process and activity, by which those results are achieved.

Approach

Based on these principles, Theme 3 will conduct complementary and cross-cutting research and provide the support required to guide CRP3.7 research by identifying target beneficiaries within our selected countries and value chains, prioritizing their needs and linking to regional and national strategies, integrating gender and equity concerns and monitoring and assessing the outcomes of the research and objectively assessing its impact. Given the increasingly result-oriented nature of the CGIAR, this is a critical element of the research portfolio. Not only will this help us understand whether, where and among whom research is having impact, but importantly the feedback process will improve program design and implementation, including the explicit development of outcome and communication strategies that leverage partnerships to achieve innovation and impact among target communities.

Theme 3 will be devoted to working with scientists and partners in Themes 1 and 2 in taking stock for priority setting, in guiding interventions to where they have greatest utility and impact, planning strategies for translating outputs into outcomes, integrating gender and equity, and monitoring progress and assessing impact. This Theme will also be active in testing new approaches for identifying and mapping the relevant target domains, using experimental approaches for structuring interventions for learning, and using scenarios and a forward looking approaches so that our research today is already addressing the challenges and exploiting the opportunities of tomorrow. Theme 3 will also support an internal program M&E function by providing the base information required to evaluate outcomes and impacts so as to assess and redesign program directions.

The team in Theme 3 will also work with other scientists and partners in integrating gender in the technology development and delivery systems and value chain development, leading efforts in gender analysis and supporting Theme 1 and 2 to integrate the results of the analysis in the design and implementation of the research. The team will work within value chain teams to ensure good practices are applied in the value chain and technology research as well as across the value chains to synthesise data and lessons across value chains. The theme will be responsible for gender specific research aimed at getting new insights into gender issues in livestock and aquaculture value chains including research on labour, markets and nutrition.

The Theme will be structured around three organising components, designed to assemble critical mass across the program around the main focus areas. These are:

Component 1.1: Spatial, systems and farm-household analysis

Component 1.2: Gender and equity

Component 1.3: Monitoring, evaluation, impact assessment and learning

It is important to note that each Component will deliver sets of outputs that will include both:

- Research outputs in line with the Program aims and deliverables

- Capacity and program support outputs in the form of analytical and decision tools, frameworks and guidelines to support program implementation and informing targeting and priority setting, particularly in the value chains (Research Theme 2).

Component 3.1 Spatial, systems and household analysis and targeting

Objective: The objective of this component is to generate the spatial, systems and farm-household level related data, knowledge and tools required to guide the effective targeting, implementation and scaling out of the Program, and support the value chain team in the use of those tools. The key target groups for the Program are poor and women livestock keepers and urban consumers of livestock products. The Program will evaluate different measures for poverty targeting including the US$ 1 a day, level of expenditure on food which is especially relevant for urban consumers, asset holdings and consumption for their relevance to the program purpose.

Research questions

- What are the main challenges and opportunities for our target communities within the selected value chains?
- Within the selected value chains, what are the key characteristics (agro-climate, resource, market, and demographic) that are likely to influence program success and how are they distributed spatially and temporarily?
- What are the likely future scenarios for supply and demand of the target commodities, and what implications do they pose for program interventions?
- In the context of program target beneficiaries, what is the likely distribution spatially and among communities of livelihood, gender and nutrition outcomes?
- Beyond the selected value chains, where are the likely areas for successful replication of program interventions, for consideration in future priorities?
- If Program interventions are scaled out, what are the likely future scenarios for demands on ecosystem services and natural resources, and what constraints may they pose?
- What are the spatially-differentiated determinants of successful livestock and fish technology uptake along the value chain?

Key activities under this component will be:

(i) Macro scale mapping (multi-country, multi-continent) and spatial analysis of livestock and fish production systems integrated with the associated socio-economic and agro-climatic variables.

- Trend and scenario analysis and modelling of production systems, market flows, production, demand and supply and will be used to identify constraints, opportunities, trade-offs and further guide value chain targeting.
- Aggregation of higher resolution information and analysis on livelihoods, nutrition, gender, production and practices, to understand broad patterns of association between livestock systems and rural livelihoods

(ii) Landscape level analysis – agro-ecozones and associated social and market systems.

- Technology uptake analysis, prediction, and targeting through integrated recommendation domains to guide program design and value chain interventions.

- National level supply and demand multi-market modelling, implications for opportunities and impact of target commodities
- Analysis of carbon footprints, ecosystem service provision, needs, and sustainability, differentiated spatially
- Decision-support tool development based on above modelling , particularly to support targeting and scaling out of technology and value chain interventions

(iii) Farm-household analysis

- Bio-economic modelling of smallholder livestock and fish production systems to identify ex-ante opportunities for productivity growth and income generation
- Development of harmonized measures of livestock productivity, and pragmatic strategies and tools for measuring them in data-scarce smallholder systems
- Analysis of livestock and fish productivity gaps, and identification of their determinants
- Live cycle analysis of livestock and fish production and marketing, to evaluate carbon footprints, environment and resource implications and demands
- Collect household level data to determine appropriate levels for targeting of program interventions

(iv) Using the spatial, landscape and household analysis results for priority setting, targeting and scaling out

- Use the generated data to identify current and future hotspot areas. These hotspots can be defined in terms of (technological, environmental, institutional) constraints but also in terms of opportunities present. Both will have to be taken into account for setting priority areas for action.
- Using spatial and household level data to develop and implement criteria (to include poverty levels, household types including % FHH, agro-ecology, and potential demand for products, potential impact and associated trade-offs) for targeting locations for program interventions.
- Use developed criteria for the targeting of program interventions and define development domains for future scaling out of program interventions

Component 3.2: Gender and equity

The Program proposes to use gender transformative approaches that will examine, question and change gender inequalities in livestock and fish development interventions as a means for achieving increased productivity, income and poverty reduction as well as gender equity objectives. The Program will take three different approaches to addressing gender and equity:

- Using gender analysis to identify the different needs, roles, priorities, capacities, constraints and opportunities in different livestock value chains, technology development and dissemination processes.
- Mainstream gender in different components of the programme using data from the gender analysis. Using existing data, this is already reflected in the research design and will be integrated in the approaches for value chain development, technology development,

dissemination, monitoring, evaluation and impact assessment and in other areas such as budgeting and staffing issues.

- Specific gender research around key focal areas of the programme especially looking at gender and consumption of animal source foods, the potential of livestock and fish value chains to achieve women's social and economic empowerment, and research /evidence on strategies that best address gender issues in livestock and fish value chains.

Objective: The objective of this sub-component will therefore be generate evidence through gender analysis to support all elements of the Program in incorporating gender into design, implementation approaches, their data collection and analysis, and to lead in carrying out gender specific research and analysis of gender-related data. This sub-component will also develop /or adapt evidence-based, participatory and gender-responsive technology development, social marketing and extension approaches that engage women and men in the equitable access to technologies, benefit-sharing from value chains and consumption of animal products. The methods, approaches and strategies developed under this sub-component will be adapted and applied across the different value chains, countries and contexts.

Both women and men are engaged in the production, marketing and consumption of livestock and fish in many developing countries but their roles, contributions, benefits and costs differ. Women constitute a disproportionate share of the poor within livestock and fish value chains due to lack of access to assets, technologies and resources, and lower economic returns to labour. This is despite their widespread participation in the care of livestock and fish, in processing and trading of aquatic and meat products, and efforts to improve their status through development interventions.

In addition to using gender analysis to integrate gender in the different programme components, some of the specific interventions to address women's specific constraints will use the framework on livestock and fish as a pathway out of poverty for women focusing on (i) increasing and securing their access to livestock, fish and associated assets (ii) increasing productivity through increasing access to appropriate technologies , inputs and services and (iii) enhancing participation and benefits from livestock and fish value chains.

Research questions:
Under this sub-component, we will address the following key research issues:

- What are critical gender issues and trade-offs in participation in and benefits from specific livestock and fish value chains?
- How can productivity of the livestock and aquaculture sectors be increased to enable poor women and men to consume adequate supplies of meat and fish at affordable prices, while ensuring inclusive participation by men and women in value chains that will result in equitable poverty reduction?
- What kind of ex ante gender analysis, targeting, interventions and pathways are needed for effective outcomes and impacts?

- How can we address gender issues at all points along the value chain in such a way that women can benefit from increased incomes and opportunities, and consumption of animal source foods without increasing their workloads.
- What are the advantages and the disadvantages of the value chain approach for reducing poverty among women through increasing productivity and income the livestock and aquaculture sectors?
- What are best strategies we can use in targeted project interventions to improve women's access to technologies, services and products within fish and livestock value chains in:
    - the development and dissemination of technology
    - increasing economic and social benefits from these value chains
    - equitable intra-household consumption

Activities:

The key activities are grouped around gender analysis activities in Theme 1 and 2, gender mainstreaming in Theme 1 and 2, and gender specific activities across themes and value chains.

Gender Analysis:

(i) **Gendered value chain analysis of livestock and fish value chains to** understand the differing roles of women, men, children and the poor in different segments of the value chain, female and poor dominated enterprises, decision-making, access to resources and their share in the benefits (within Theme 2).

(ii) **Gendered value chain analysis of the feed sector to identify types of feed chains that the poor and women can benefit in have the most economic benefits, identify the roles, constraints and opportunities for their participation (within Theme 3)**

(iii) **Gender analysis of livestock and aquaculture systems, identifying the roles, constraints and opportunities for men, women and poor.**

Gender Mainstreaming:

(iv) **Development of methods /approaches and identification of strategies to address gender in value chain development, technology development, delivery and adaptation and marketing:** Participatory tools and approaches for value chain analysis, technology development, gender analysis, social marketing among others will be developed and tested across value chains with value chain scientists and partners.

(v) **Develop the skills/capacity of program staff and partners to identify and address gender issues in the development of livestock and fish value chains.** Work with the capacity development team to strengthen skills in gender analysis and gender integration through: linkages with north and south universities with training programs on gender, value chains, livestock and fisheries or willing to develop such programs; targeted workshops and hands on training for value chain scientists and partners; graduate training for NARS, NGO and regional partners with attachments to different value chain projects.

(vi) **Enhance participation in and benefits from different value chains by both men and women and other social groups through**: Identification of opportunities to enable women and men to have equity of opportunity to participate in value chain development activities; targeting in segments of value chain which would have the greatest benefits for women, poor and children; test mechanisms for increasing and securing their livestock, fish and other associated assets; develop, test and pilot approaches for strengthening the organizational and entrepreneurial capacity of women and other social groups individually or collectively to participate in value chains

Specific gender research /activities

(vii) **Test and evaluate approaches for Increasing access to women and other marginalized social groups to assets, technologies, services and other innovations**: This will include testing and evaluating different approaches to increase access to technologies (community breeding programs), financial and other service innovations (business development services, innovation hubs, innovation platforms), assets (multiplier schemes, micro-leasing, group based purchase schemes, pass-on programs). Effective approaches and their impacts in addressing gender issues will be disseminated to value chain actors and policy makers.

(viii) Analysis of the gender and intra-household implications of changes in livestock value chains including on consumption and nutritional status, distribution of economic and social benefits and the trade-offs between market orientation and food security

(ix) Adoption studies to analyse changes in the gender disparities in the access and use of technologies, inputs and services and changes in production and productivity

(x) Establish an information sharing and learning platform for sharing gender good practices, lessons and challenges across all the value chains, centres and other stakeholders (with links to other value chain research in CRP2)

Component 3.3: Monitoring, evaluation, impact assessment and learning

Objective: The objective of this subcomponent is to develop a robust set of monitoring, evaluation, impact assessment and learning mechanisms that will serve multiple functions a) maximizing the probability of achieving intended impact among target beneficiaries, including women and vulnerable groups, b) documenting the level and manner of that impact, and the outcomes that brought it about, c) understanding and supporting the processes of innovation and research to development, to improve the performance of the program and its partners, d) supporting the internal M&E, planning and decision functions, and the communication strategy of the Program to continually ensure efficiency, accountability and relevance.

Key Focal Areas of Assessment

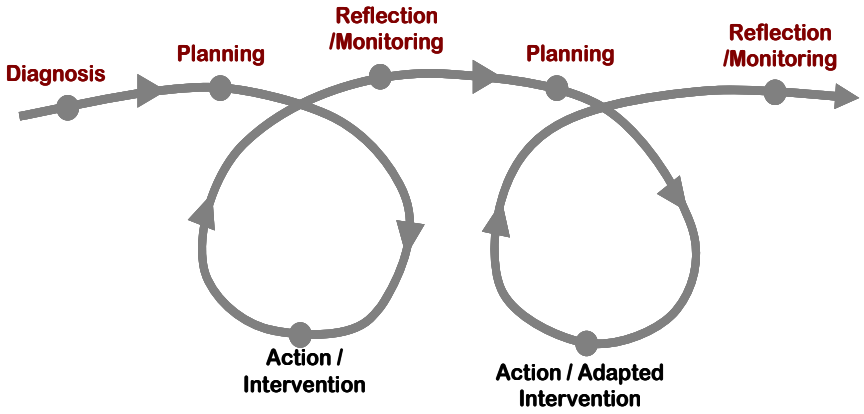
(i) Development of a monitoring and evaluation framework and appropriate tools at program and value chain level

An initial framework will be developed that maps outcomes and impacts for which the Program is accountable to projects and activities and outputs, including identification of intermediate and final indicators and a plan for achieving them and monitoring progress along the way. As priority projects sites and interventions are selected and targeted within value chains (with support from 3.1), impact

pathways mapped (see iii below) and baseline data collected (see iv below), the framework will be will adapted and updated with more specific indicators (disaggregated by gender where appropriate) , their current levels, and their targets. Results will be fed into the ongoing monitoring and learning process (ii below).

(ii) Process monitoring to improve learning during project implementation

A diagnosis, planning, implementation, monitoring and learning process will be initiated at the different levels of the project. This will integrate the process M&E (PM&E) within the project implementation processes allowing lessons to be distilled and integrated back into the planning process. Forums convened at different horizontal and vertical levels will participate in these learning processes with regular meetings forming a learning cycle. Key indicators will be developed for the process monitoring. Examples of such indicators are shown in Table 2.12.



Data collection tools for capturing these indicators will be developed with partners and monitoring schedules agreed. A PM&E and data management system that all partners have access to, will be developed. Key partners and field staff will be trained on the use of the PM&E system.

Table 2.12: Examples of process indicators

Partnerships	Scaling out strategies	Information sharing	Participation
Number and types of partners involved in the project activities	Number of farmers, stakeholders being reached by different strategies	Number and types of information sharing strategies being used	Number of men and women farmers effectively participating in different activities of the project (at least 40% women)
Effectiveness of different partners in delivering on mutually agreed activities	Farmers and stakeholder perceptions of project strategies	Number of men and women farmers receiving information from the different information sharing mechanisms	
Changes in skills, knowledge and behaviour by partners		Effectiveness of the strategies on different target groups	

(iii) Assessing outcomes and behavioural change among value chain actors

This will utilize multiple tools including value chain analysis and outcome mapping. The *outcome mapping* approach developed by the International Development Research Centre (www.idrc.ca/evaluation) will be used to build project partner cohesion and to analyze project outcomes in terms of desired behaviour change rather than just performance indicators. The process of outcome mapping, which will be part of the development of the framework in i above helps a project team to be specific about the participants it targets and the changes it expects to see, and to be creative in the strategies it employs to achieve the identified output targets. Results are measured in terms of the changes in behaviour, actions or relationships that can be informed by the project.

Outcome mapping is based on principles of participation and purposefully includes those implementing the project in the design and data collection so as to encourage ownership and use of findings. It is intended to be used as a consciousness-raising, consensus-building, and empowerment tool for those working directly in the development program. Proposed roles of partner organizations will be screened and refined through this process at the onset of project implementation.

Table 2.13: Outcome and behaviour change indicators among value chain actors

Outcome areas	Indicators
Adoption of VC as an approach for livestock and fisheries research and development	Increased investment by private and other actors in focus or other value chains
	Uptake of value chain innovations and other institutional mechanisms by value chain actors
Increased capacity by actors to address key value chain issues	Innovation capacity among key beneficiaries and actors strengthened
	Partnering becomes a routine in organizations, rather than being episodic and limited to projects or programs

(iv) Analysis of household and community outcomes and impact

The impact of the Program on individual, household and community level outcomes and impacts will be assessed in selected sites where Program interventions are implemented. Once the specific combinations of interventions that will be tested in each site is identified, a study design and sampling strategy will be developed to assess relevant impacts across beneficiaries and scales, incorporating to the extent possible best practice regarding counterfactuals and controls, and collecting data disaggregated by gender. Analysis of community and household level outcomes and impacts will use tools such as focus group discussions, value chain mapping, and household, individual and firm surveys. To the extent possible, the process will start with the development of harmonized indicators (building on the framework in i, above) that cut across different value chain projects, common sampling strategies and data collection tools.

Once the baseline data are collected, they will be used to benchmark the M&E framework, and to inform design and implementation of project R&D, directly and through the kinds of ex-ante analyses described in 3.1. This will integrate economic modelling principles and scenario analysis for different combinations of technological and institutional innovations. An analysis of productivity, production, livelihoods and asset relationships will give indications of the potential impacts of the program on different target groups.

Using results from this and sub-component 3.2, decision support tools for technology recommendations will be developed and used across the value chain projects to inform technology development, adaptation and delivery.

Table 2.14: Potential indicators of impact assessment and for monitoring and evaluation

Impact/outcome focus	Indicators
Livelihoods	Income gains disaggregated by gender, value chain reduced costs, from project activities and their outcomes along livestock and fish value chains Accumulation of, access to and control over livelihood assets by men and women among target beneficiary groups (Carter and Barrett 2006)
Food security	Individual (including child) and family food consumption for both producers and consumers Individual (including child) nutritional status (in collaboration with CRP 4)
Technology uptake, and productivity	Increase in uptake of improved technologies among target beneficiaries, differentiated Reduction in the gender disparities in the adoption of technologies, services and inputs Increase in productivity of livestock and fish systems, based on harmonized measures Reduction in disparities in productivity of livestock and fish systems managed by men and by women NRM and ecosystem sustainability, and lifecycle efficiency (in collaboration with CRP 1)

The above measures of outcome and impact will be developed and harmonized across the program and its constituent value chains where feasible.

Implementation and link to other learning and M&E elements

A Component Leader will be designated from within one of the CGIAR partners, and will likely be chosen from among researchers with strong capacity in livelihood and impact analysis. Key researchers will be designated from each of the value chain team to work together with the leader to ensure both that specific value chains priority needs are addressed, and that common frameworks and tools are applied across the value chains. They will be selected to ensure that each of the CGIAR partners is represented on the Theme 3 team. Analysis of value chain process and performance will be closely integrated into the performance tools used by Theme 2, addressing value chain development. Basic M&E indicators of performance and impact will be linked to the over program M&E framework, coordinated at the level of the Program Director.

Systematic efforts will be made to include wider stakeholders and clients in the learning and M&E process in order to ensure relevance, accuracy, and to contribute to joint learning and wider outcomes. These will include the regular program mechanism of the Science and Partnership Forum and value chain innovation platforms.

Implementation of the activities of this Theme will also be closely coordinated with the Communications leader of the Program, to ensure that outcome strategies that include strong components of communication and advocacy are reflected in the overall Theme communication strategy, that supported by the communications capacity in the Program coordination.

Table 2.15: Theme 3 outputs, outcomes and impacts.

Component 3.1 Outputs	*Component 3.1 Outcomes*	*Component 3.1 Impacts*
• Evidence-based recommendation zones for program technology and value chain interventions, differentiated spatially and disaggregated by gender, by wealth level and/or other socio-economic category. • Evidence-based extrapolation zones for program priority setting for future value chain selection • Predictions under likely future scenarios of commodities supply and demand, and associated livelihood and nutritional outcomes, spatially differentiated and where possible disaggregated by gender, by wealth level and/or other socio-economic category.. • Predictions under likely future scenarios of value chains development of demands on and constraints posed by ecosystem services and natural resources, differentiated spatially and by farm size and type • Decision-support tools for development partners and investors to support targeting of livestock and fish technology and value chain interventions • Identification of potential productivity increases in smallholder livestock and fish systems, potential trade-offs and their implications for welfare and the natural resource base, differentiated spatially, by system and by gender and wealth categories. • Harmonized sets of data-efficient indicators of smallholder livestock productivity, and estimates of current levels and their determinants in projects sites, differentiated spatially, by system and by gender and wealth categories.	• Uptake by project leaders, partners and decision makers of evidence-based targeting information for technology and value chain development, aimed at more successful impact among target communities and groups • Revised value chain development strategies and implementation based on understanding of likely future scenarios in markets and ecosystem services demand, to maximize opportunities while minimizing negative environmental impact • Use by development partners and decision makers of decision-support tools to improve pro-poor impact of interventions and investments • Better targeting of program and partner technology development to address key identified productivity gaps and opportunities • Use by project leaders and partner of harmonized productivity indicators, and so more informed and consistent comparisons of productivity gaps and opportunities.	• Increased productivity and production among target communities of livestock and fish systems, with less likelihood of environmental impact. • Improved livelihoods and food security among target communities due to increased marketed surplus • Improved nutrition among target producer communities and among poor consumers served by these value chains

Component 3.2 Outputs	*Component 3.2 Outcomes*	*Component 3.2 Impacts*
• Tools and methods for gendered value chain analysis, technology development, social marketing and extension that are tested across value chains, countries and market contexts • Gender disaggregated data on the role of men, women and other social groups in the selected value chains for use in future programming and policy making • Refereed and non refereed publications of evidence of strategies for integrating gender in value chain projects and more generally in livestock and fisheries development projects • Evidence of approaches for enhancing access to assets, technologies and other innovations to women and other socially, economically and geographically marginalized populations • Evidence of what value chains have the greatest impacts on women's economic empowerment • Evidence of the gendered tradeoffs between the market oriented value chain approach and household nutrition security and how these trade-offs can be minimized	• Gendered tools for value chain analysis, value chain development, technology development and delivery are used by value chain scientists and partners within the context of the CRP and beyond • Gender disaggregated database is used by decision makers to identify and promote value chain options with the greatest gender and equity impacts • Increased capacity within partner organizations to address gender issues in livestock and fish value chains • Increased collaboration between north and south organizations with interests in gender and livestock	• Improved productivity and remunerable market participation by women and other vulnerable groups. • Improved livelihoods and accumulation and control of livelihood assets among women and other vulnerable groups. • Improved nutrition among women, children and other vulnerable groups
• *Component 3.3 Outputs* • A harmonized framework for monitoring and evaluation and appropriate tools for its implementation at program and value chain levels • Framework and tools for development process monitoring to improve learning during project implementation • Assessment of outcomes and behavioural change among value chain actors, including changes in innovation capacity • Targeted analyses program outcomes impact at household and community levels, based on harmonized indicators	• *Component 3.3 Outcome* • Use by program and partners of harmonized frameworks and tools for monitoring and evaluation • Better understanding among program and partners of key determinants of development outcomes and impact, and strategies to influence them • Improved design and delivery of program interventions with value chain actors • Better understanding among investors and decision-makers of strategies for impact	• *Component 3.3 Impacts* • Increased productivity and improved livelihoods among target communities due to better designed and evaluated interventions • Increased innovation capacity among value chain actors, and improved value chain performance • Improved food security and nutrition among target communities •

PART 3: ORGANIZATIONAL STRATEGY FOR EFFECTIVE IMPLEMENTATION

MANAGEMENT AND GOVERNANCE

This Program brings together CGIAR institutions and their partners from multiple regions, each with a broad range of strengths, to address the production of multiple livestock and fish species and the associated systems. Management of this complex partnership may risk imposing significant transactions costs if it not carefully designed and implemented.

Some of the underlying principles that will be applied in this program are: a) applying a *consortium model* to the partnership, which implies a consultative process of decision making and overall shared ownership of and responsibility for program success and outputs; however retaining b) *clear leadership roles, and specific accountability* for designated elements of the program by each institution and team. The consortium principle helps ensure that the capacities and skills of each institution are fully utilized and leveraged, while clarity of roles and accountability helps reduce transactions costs, and ensures delivery of agreed outputs. For the consortium approach to work effectively, the lead institution is required to create a consultative, joint decision-making mechanism with the other core partners, and to generally cede a significant part of the strategic decision process to the partnership. However, in return for the opportunity to participate in the strategic decision making, the core partners assume joint responsibility for those decisions and for the overall success of the program. Success of the program is shared by all, and shortcomings also reflect on all the partners. The development of the program proposal so far has been based on this principle, and has demonstrated its potential value through joint evidence gathering, decisions on priorities, and leveraging synergies and experiences.

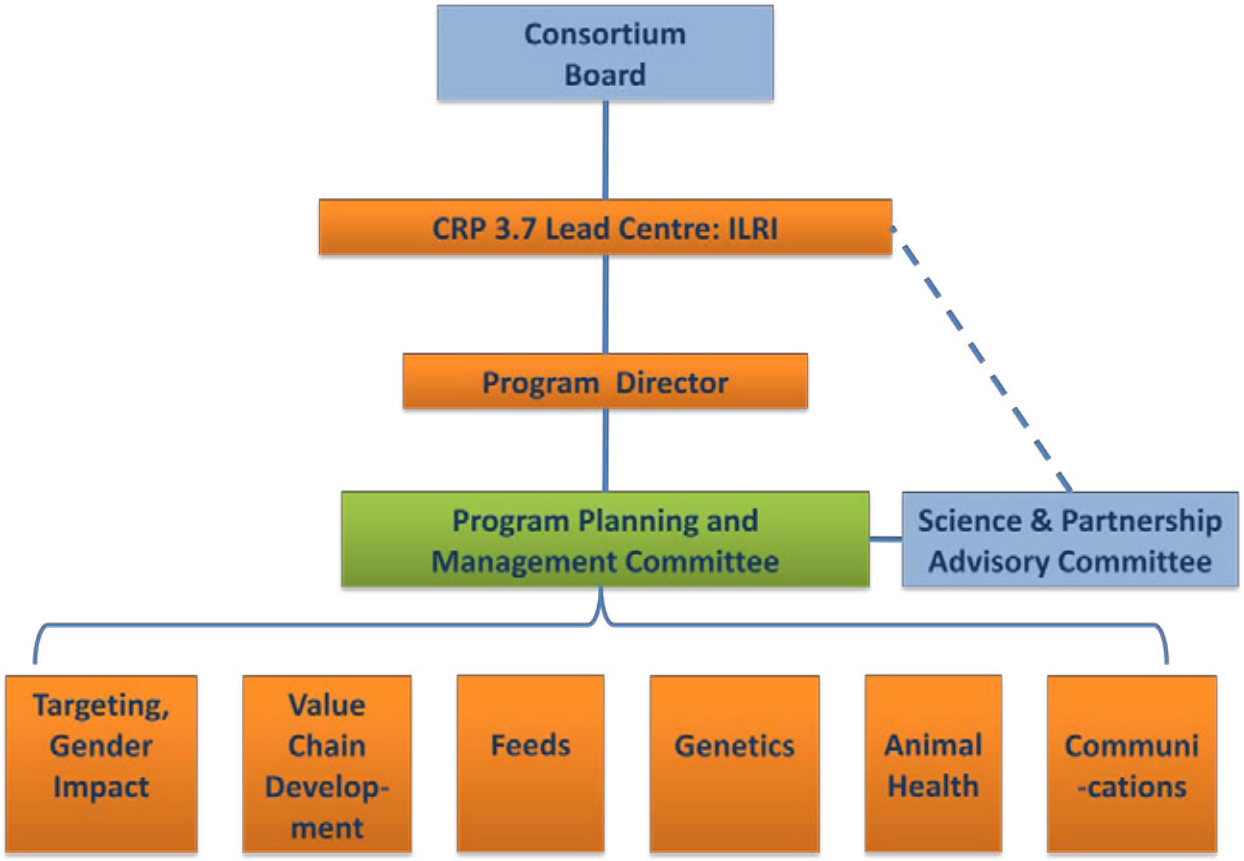
At the same time, contractual responsibility for the program remains with the lead Center, and in the case that the Center does not agree with joint group decisions, that Center is required to take decisions that it feels will meet its responsibilities to the CGIAR Consortium and the Fund Council. An effective consultative mechanism between the partners will ensure however that that rarely occurs. Contractual ties between the lead Center and the core partners will also ensure clarity of specific responsibility and deliverables, and also provide the required financial mechanisms and legal commitments to allow the smooth administrative functioning of the Program.

The lead CGIAR Center will be ILRI, with WorldFish, ICARDA and CIAT as the core CGIAR partners in the management of the program, although as explained below, mechanisms will be created to allow major development and science partners to have a role in decision-making. Therefore overall responsibility for the implementation and delivery of the program will rest with the ILRI, who will represent the other Centers to the CGIAR Consortium for this program, although with the consortium approach providing for joint decision making and overall accountability to the extent feasible.

Program Planning and Management Committee: The PPMC is the body that will oversee the planning, management and implementation of the CRP and will ensure that the Performance Contract Agreement for the CRP between ILRI and the Consortium Board is being effectively delivered. Towards that end, the PPMC will review and agree the program workplans, milestones and budgets. The PPMC will also agree the strategic directions of the program, new funding initiatives, and will advise on the development and implementation of the program, including strategic linkages. The PPMC will comprise the Program

Director, who will chair the Committee, and the lead individuals responsible for each of the main program elements. Among the Program component leaders will be the main Program representatives of the partner CGIAR organisations, thus providing the required institutional representation for joint program development and implementation across the Centres. Given the emphasis on technology development within the program, and the diversity of skills required for the main technology components of Feeds, Breeds, and Animal Health, the Leader of each of those components will be represented on the PPMC. As the Program develops, it is anticipated that key external partners central to program implementation, and who commit resources and staff towards its implementation, will play a role on the PPMC, possibly on a rotational basis depending on numbers. The PPMC will thus be the primary mechanism to ensure joint decision-making by the partners, that various elements of the program work effectively together, and that the cross-cutting components of the program are closely tied to the specific country value chain needs and contexts.

CRP 3.7 Management structure



It is anticipated that the PPMC will meet monthly during the first year but less frequently thereafter (bi-monthly). Meetings will not all be face-to-face.

The Directors General of the partner CGIAR institutions in the Program will consult as required to ensure smooth functioning of the Program governance structure and its progress towards delivery of outcomes.

Science and Partnership Advisory Committee. The SPAC will made up of a small group of internationally-recognized scientists, development partners, and private sector representatives, and will play a strategic

advisory role with a focus on ensuring best science as well as appropriate and effective partnerships for development. The SPAC will also facilitate linkages with global and regional stakeholders. The SPAC will meet twice annually in conjunction with meetings of the PPMC, to which it reports. The SPAC will also report annually to the ILRI DG and Board of Trustees as to its assessment of the Program's science, impact and strategic direction. This will ensure that the SPAC is able to provide input to decision making at both oversight and implementation levels.

Program management will be designed to provide a clear, streamlined structure of reporting and accountability, and will bring together key elements of: a) overall science and research for development leadership, b) grounded experience in agricultural development and partnerships, and c) an internal M&E process that supports the timely achievement of program milestones and accountability.

Program Director. A Program Director will be appointed, reporting to the DG of ILRI, to will be responsible for ensuring implementation and delivery of all aspects of the program and for ensuring that all reporting and contractual obligations through the Performance Contract Agreement to the Consortium are met. The Program Director will chair the Program Planning and Management Committee, and will lead the joint implementation and decision-making process that the PPMC is responsible for. S/he will directly supervise the Development Manager and the M&E Officer. The Program Director will also act as secretary to the Program Governance Committee, and lead the development of and interaction with the Science and Partnership Advisory Committee.

Development Manager. One of the innovative and central elements of this program is a greater level of interaction and partnership with development actors in the livestock and fish value chains, not only in the selected countries but at a global level, such as with multi-national companies who have a strong stake in the outcomes of the CRP. We recognize that CGIAR scientists may rarely have the skills and experience to engage effectively with such partners. For that reason a Development Manager will be assigned to build and manage strategic partnerships with private sector actors and development partners that provide opportunities for scaling up and leveraging CRP investments. S/he will also backstop and advise the implementation of the country value chains, and provide practical input to their development, particularly in the context of engagement with development partners and investors. The DM is not expected to be a researcher, but will be an individual with significant agricultural development and/or agri-business experience.

Communications Officer. The Communications Officer will design and implement the strategic communications functions of the Program to enhance the regional and global outcomes of the Program, employing a wide range of appropriate media and engagement strategies. S/he will also support the communications needs of the specific value chain development efforts. The Communications Officer will also oversee a Knowledge Management system that provides a platform for global public access to Program knowledge products, tools and data resources.

M&E Officer. The M&E Officer will manage the internal M&E process of the program, ensuring that the program milestones are identified and met in a timely fashion, and supporting the reporting responsibilities of the program to the Consortium Board. External M&E support will be contracted where specific assessments are required.

Finally, it is vital that the program includes other partners in the decision-making and oversight process, both to help ensure sound and cutting-edge science, but also to facilitate a more effective development partnership.

This is a complex program in which integration of the different components is crucial to the success. The effectiveness of the management arrangements will be continually monitored and reviewed and the management structure and arrangements will be modified as necessary.

A strong culture of communications (both internal to the program and with stakeholders), gender mainstreaming, participatory M&E, impact assessment and continuous learning will underpin the whole effort. To ensure that this succeeds those responsible for these activities will participate in the PPMC.

TIMEFRAME AND MILESTONES

As part of the approval process for CRP 3.7, we anticipate that the operations plan to be prepared, as per the Strategy and Results Framework, will serve as the basis for establishing performance contracts with ILRI as the lead Center and between ILRI and the core CGIAR partners. The Operation Plan will comprise a set of activities structured to achieve measurable impacts in the focal value chains by Year 6.

Upon approval, the core CGIAR partners will work quickly to establish the governance and administration arrangements and to bring the research teams and other partners together to develop more detailed strategies and implementation plans. By the end of Year 1, existing projects will have been integrated to the degree possible and joint activities with partners will have been initiated in the target value chains. To ensure good progress is achieved as quickly as possible, priority will be given to efforts in those value chains where there is both significant need, and strong momentum among research and development partners and donors to prepare and fund a major development intervention.

With the caveat that considerable effort will continue to be devoted initially to delivering on commitments to existing projects having their own milestones and outputs, CRP 3.7 commits to the critical milestones of its efforts having mobilized new major development initiatives in each target value chain over Year 2 to Year 4.

Milestone	Year 1				Year 2				Year 3				Year 4				Year 5			
Quarter:	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Institutional arrangements among core partners established	X																			
PPMC established	X																			
Appointment of staff	X																			
SPAC established	X	X																		
M&E framework established	X	X																		
Inception meeting		X																		
Thematic, communication and resource mobilization strategies elaborated	X	X	X																	
Prioritization exercise completed	X	X	X																	
Value chain partnership engagement		X	X																	
Value chain scoping studies completed			X																	
Integrated operations initiated			X																	
Annual review and planning meeting				X				X				X				X				X
Mid-term review – including long-term prioritization and redesign										X										
New major joint research-development interventions initiated in 3 value chains								X				X				X				

ROLES AND PARTNERSHIPS

Introduction

The ever increasing complexity of agricultural and rural development challenges is demanding complex solutions, which no one organization/actor has the capacity or competence to address. The policy and institutional context within which agricultural research and innovation occurs have changed dramatically over the years. Rapid changes continue to take place in the structure and authority of governments, the global economy, the structure of the farming sector and the global and local food industries. The institutional landscape has also changed dramatically with the third sector (such as non-governmental organizations, farmer organizations and civil society organizations) playing an important role in agricultural R4D.

Innovation systems are about exploiting available and new knowledge for socio-economic use. Innovations emerge from social processes in which networks of actors (from the public, private civil society, research, enterprise and policy sectors, i.e. the entire value chain) play a crucial role. Innovation is a result of co-operation and is determined by interaction between them. Partnerships form the core of innovation systems.

Partnership strategy and management

Purpose: CRP 3.7 proposes to serve as the catalyst to align research and development actors in coalitions to address the development challenge. These include reducing undernutrition and enhancing food security, and also enhancing livelihoods through strengthening the associated value chains, amongst poor vulnerable households and other target groups. These coalitions will mobilize resources for major development

interventions to improve productivity and production in selected animal source food value chains to benefit the poor; they will also mobilize relevant knowledge and support its application during program implementation.

Types of partners: To address the complete value chain, the program will engage with a wide range of partners according to their competencies, mandates and interests. On the research side, it will partner with researchers from the national agricultural research system and universities, and will leverage technical expertise from advanced research institutes. On the development side, it will work closely with national ministries and public services, civil society (non-governmental and community-based organizations), farmer and producer organizations, and the private sector. It may also need to partner with specialized organizations in the communication area. Making these partnerships effective will be critical to the success of the program.

There will be several types of partners:

- *Strategic program partners*, who will be either active participants in the research program, or play a significant role in guiding the program and leveraging or scaling out the outcomes. The Program will capitalize on the new and emerging models/experiences of partnerships with the private sector, where the CGIAR Centers are playing a knowledge brokerage role (e.g. the Bill & Melinda Gates Foundation-funded East African Dairy Development project, and the Global Alliance for Livestock Veterinary Medicines -GALVmed). These also include international and regional bodies with roles in developing agricultural, livestock and fish systems, such as FAO, OIE, and AU-IBAR, and the continental research coordination organizations such as FARA and its regional units, and APAARI. Particularly in the area of technology development and delivery, multi-national private sector science companies can play an important role. Representatives of this group of partners will participate in the Science and Partnership Forum described below in the Governance section.
- *Value chain partners*, at the grassroots level where the action happens. This will include people and organizations who work within the value chain, including farmers, processors and traders amongst others. Key members of this set of partners will also be public and other representatives of bodies responsible for policy, investment, value chain governance, and consumer interests. They will be members of the platforms that will be formed as part of the innovation systems approach to implement development actions, which will form a core mechanism for engagement.

Identification of partners: CRP 3.7's Partnership Strategy will include an assessment of the actor and organizational landscape at the national and sub-national levels. This will be followed by a participatory partnership analysis, in which the value chain development needs will be identified along with the potential roles each partner can play in responding to these, their particular strengths, the incentives motivating their contribution, and their expectations. An important criterion will be the gender and equity relevance of the agendas of potential partners. Experience has shown that building networks with diverse agencies can lead to enhanced efficiency in delivery of mandates of various agencies to support communities. However, a general improvement in service delivery does not necessarily guarantee access by the poor and this has to be negotiated by champions in the network. Table 3.1 summarizes the potential core program partners and roles they can play (*from the stakeholder consultation meeting, Addis, August 2010*).

Table 3.1: Categories of core Program partners and potential roles

Type of partner	Potential role
CG Centers	Research (especially adaptive), capacity building, knowledge brokerage, provide access to networks, source of new technologies (including breeds, feeds, vaccines, vet drugs etc)
Advanced RIs	Basic and strategic research, technology development, advanced capacity building
NARS including universities	Research (especially adaptive), stakeholder mobilization and networking, training, capacity building, source of new technologies (including breeds, feeds, vet drugs etc)
Government	Provide access to new knowledge, information and technologies through extension, providing an enabling environment through policy making and implementation, provide resources for capacity building, fund mobilization, scaling up and out
Private sector	Service and input provision, marketing, technology generation (e.g. seeds, feeds, breeds etc)
Regional and sub-regional organizations	R4D priority setting, access to funding, capacity building, coordination, policy learning, scaling up and out
CBOs	Collective action for accessing inputs and marketing, training of farmers, social mobilization, networking, scaling up and out
NGOs	Social mobilization, capacity development, pro-poor advocacy, environmental development, scaling up and out

We want to highlight the multiple roles of the private sector, both as a potential contributor to technology development and as a self-interested central player in value chain development:

As an international science partner: Large international companies have impressive capacity in R&D and can leverage patented technologies that can accelerate the discovery process. ILRI has partnered in the past with pharmaceutical companies for vaccine development. In the development and deployment of vaccines and diagnostics, the private sector is essential for the manufacturing of these products. It is crucial that private sector is involved at the initial stages of development of the products.

More recently, ILRI and WorldFish Centre have similarly engaged with international feed companies in developing feed products tailored to small-scale systems. ILRI is currently partnered, for example, with one company in field testing prototype feed products appropriate for beginner dairy farmers in Kenya and Uganda. CIAT collaborates with multinational seed companies for the multi-locational evaluation and dissemination of bred grass cultivars mainly, but not only, targeted at the Latin American market. The motivation for the international company may partly be to meet corporate social responsibility objectives, but clearly remains largely commercial – such collaboration provides them an opportunity to develop appropriately designed products aimed at emerging markets that have been ignored to date, as well as facilitating testing of new products. For the Program, once a new technology has proven its viability, such companies can immediately scale it up for subsequent widespread dissemination internationally motivated by a healthy profit incentive.

As a national business partner: We cannot forget that an animal-based value chain ***is*** private sector, and so the value chain development work will necessarily be done within a private sector context. Within specific

value chains, we will seek to identify opportunities where existing companies could contribute to developing the value chain in a pro-poor manner while expanding their own business. A current example is the East Africa Dairy Development project, a large-scale intervention being implemented by Heifer Project International and other partners, with ILRI supporting as the knowledge partner. A Kenyan genetics company, African Breeders Services Total Cattle Management Limited (ABS TCM LTD), is one of the core partners in the project; not only does it benefit from the immediate business gained from working with project, but it also is keen to test strategies for creating new markets among lower-income dairy farmers who they have failed to reach previously. Similarly, the WorldFish Center has partnered with the commercial feed industry in Egypt to help develop fishmeal- and fish-oil-free nutritionally-complete tilapia feeds. In pork value chains, an opportunity may be to replicate smallholder outgrower schemes with the small meat processing enterprises that have emerged in Uganda, and so on.

As a local small-scale business partner: At local level, we will work with existing small-scale operators such as butchers and fish traders whose products are sourced from and destined to low-income clients. But we are also finding it increasingly critical to help develop—and often create—small-scale business services to support emerging production and marketing systems. This approach will be central to value chain development efforts. In post-tsunami Aceh, Indonesia, for example, the WorldFish Center has fostered thousands of small-scale, enterprise-oriented aquaculture businesses, improving food security and helping create resilient livelihoods. Under the dairy development project mentioned above, ILRI has been instrumental in responding to feed demand by using business development services approaches to introduce and promote small-scale feed processing services. On the output side, training and certification schemes for informal milk traders have been developed for upgrading these important market services. Similar experiences exist from the work of CIAT and partners in Latin America with milk collection centres and small-scale cheese factories, and in South East Asia working with livestock traders and national institutions to connect consumer demand to producers. The key is to create a vibrant network of local business actors who each have it in their interest to sustain the development of the value chain.

Partnership building and management: Appropriate partnership arrangements in each country will then be established using a 'working group' format to coordinate activities and to continuously monitor the partnerships. A key indicator of a healthy partnership dynamic will be the ability of the working group to attract both research and development funding to support the value chain development agenda.

Value chain development is complex and requires working closely with a wide variety of actors. The gendered value chain analysis will help identify required partnerships at the grassroots level. However, value chain development is a dynamic process, and so the partners involved and the roles they play—including the CGIAR partners—will continuously evolve and change over time. The innovation platforms formed around the value chains will be quite fluid; partners will enter or exit based on the functions that are required to be played and their respective incentives to participate at different stages of the value chain development. Smallholder farmers, traders and processors will require strengthening of their organizational capacity in order to effectively engage in these platforms. Producer organizations that will include women organizations and trader organizations (livestock and fish marketing organizations) will be strengthened and supported to play a more decisive role in the value chains. The same actors might play different roles in different segments of the value chain. Some partners will have a bigger role to play than the others in some stages. Brokering action networks at this level is a critical role that has to be played by the partners who operate in the areas and have the necessary legitimacy, credibility and social capital. Who is most appropriate to play this role, is very context specific.

Identifying the common interest space and incentives for participation of such a wide variety of partners is challenging, but critical commitment and competence of involved partners are crucial to the success of the program. The incentives for the private sector will be profits; getting access to larger and new markets; assured supply of quality raw materials; access to technologies and financing; and market intelligence. For the researchers, government organizations and NGOs, they will be the opportunity to fulfil their mandates/agendas efficiently and gain recognition for their contribution. The poor households and women will be motivated by the possibility of having better access to inputs and markets, knowledge and services to improve their enterprise productivity for enhanced incomes and well-being (from stakeholder consultation meeting). These have to be understood and negotiated during partnership design and management processes.

Leadership and coordination of the partnership strategy and implementation at the Program level with sit within the team of the Program Director, but will be a key role of the Development Manager position (described in the Management and Governance section, above). At the level of specific value chains the value chain leaders will play that role, with focus on value chain specific and national partners, supported by the Development Manager.

What makes partnerships work?: A strong internal communication system will be the bedrock of effective and sustainable partnerships. The foundation elements that should be addressed during the partnership formation include: compelling shared vision, strong participatory leadership, shared problem definition and approach, power equity, interdependence and complementarity and mutual accountability. The sustaining elements that should be addressed during the implementation that help to reduce tensions, smooth out interactions, build trust, enhance effectiveness and contribute to sustainability include: attention to process; communication linkages; explicit decision-making processes; trust, respect and commitment; and credit and recognition (Gormley 2001).

Monitoring and evaluating partnership processes and outcomes: Partnerships have implications for resources and are critical for innovation. It is therefore very important to monitor how they are functioning and evaluate if they are achieving the joint goals that were defined. Developing an M&E system for assessing partnership processes and outcomes is a crucial step in the design stage and M&E should be an integral part of the implementation process. Partnerships and networks are a means to an end. The ultimate end is defined in terms of the goals and purpose of the Program. The M&E components should include monitoring partnership processes and an interactive or stakeholder evaluation of outcomes of the collaborative activity (Sullivan & Sketcher 2002). Through the M&E systems, incentives will be developed for program teams to demonstrate the development and effective management of required partnership. At the same time, using partnership mechanisms described, we will seek to involve key partners at several levels in the M&E process itself, to increase its relevance, accuracy, and to promote joint learning.

Partnership skills and implications for CGIAR staffing: For an organization to realize the full potential of the collaborative advantage of partnerships, it must be skilled not only in identifying the right partners, but also should be able to manage these partnerships effectively. This requires a new set of skills and tools. Among others, the key sets of skill required are: interpersonal, facilitation, conflict management, feedback and negotiation skills. The strategic staffing profile in the participating CGIAR Centers will be modified to include individuals who bring such skills to the table. The Capacity Development activities (see below) will also ensure that these skills are available in the relevant partner organizations and wider stakeholder groups.

Competitive grant mechanism: As one mechanism for exploring the horizon and engaging with partners with relevant and complementary research capacity, resources will be set aside and calls announced for delivery

of specific focused research outputs on topics for which the themes have identified clear need, yet for which there is evidence that other players have a comparative advantage to deliver (inspired by the InnoCentive model - http://www2.innocentive.com).

This would allow strategic research input into the program by key NARS, ARI and private sector researchers and agencies, and capacity building targeted at potential fail-points for uptake of program outputs or achieving planned outcomes.

GENDER AND EQUITY STRATEGY

The roles of men and women in agricultural production and household decision-making in resource allocation, technology adoption, marketing and consumption vary across the target countries of Africa, Asia and Latin America. This implies that whereas the program is expected to contribute significantly to improving nutrition, welfare and poverty conditions, its impact on men and women will not be uniform, interventions may affect men and women differently, and could potentially even worsen gender and income inequalities, unless specific efforts are designed to address gender specific issues, and the unequal relations between women and men that create these disparities. Consideration of gender and social equity should affect decisions at all stages of R4D, including assessing R4D processes as well as outcomes. In the context of this CGIAR Research Program, we are referring to social groups including men and women; male and female headed households; indigenous and ethnic groups; rural and urban poor; socially and economically underprivileged groups; and people living with HIV.

The 2009 Global Hunger Index (GHI) is highly correlated with gender inequality – that is countries that exhibit high levels of global hunger are also those with a high degree of gender inequality (von Grebmer et al 2009). There is increasing evidence that those countries which have performed well towards achieving gender equity have also reached higher levels of economic growth and/or social wellbeing and exhibit greater competitiveness in trade (World Economic Forum 2005).

Both men and women are employed in large numbers in the livestock, fisheries and aquaculture sectors but women's work is often underestimated or invisible. For example, the current estimates from the Big Numbers Project (which aims to fill an information gap by providing disaggregated data on capture fisheries) for employment in small-scale capture fisheries in developing countries alone reach 25-27 million, with an additional 68-70 million engaged in post-harvesting (Rolf et al 2008). However, customary beliefs, norms and laws, and/or unfavourable regulatory structures of the state, reduce women's access to fisheries resources, assets and decision-making (FAO 2006; Porter 2006; Okali & Holvoet 2007), confining them to the lower end of supply chains within the so-called 'informal' sector in many developing countries. This results in women receiving lower returns on their labour. This implies that women are likely to constitute a larger proportion of the poor within this sector. They often have little or no access to productive technologies which could increase the economic returns from their labour.

In livestock, ownership of different livestock by men, women and in male and female headed households vary. In general however, women are more likely to own small livestock than large livestock. In East Africa, only about 30% of female headed households owned livestock (EADD 2009). In cattle owning households, women owned less than 20% of the cattle. In West Africa, women owned more goats, sheep and poultry than they did cattle. In 80% of the households, women owned goats, in 70%, women owned poultry while they owned cattle in only 40% of households (PROGEBE 2010). Overall, control over livestock resources is neither one-sided (where male heads of household dominate) nor clear-cut. Decision-making patterns in any society are usually more complex than they may first appear and take place on both informal and formal

levels (Kabeer 2000). Among the Nandi in Kenya, women were found to exert a strong influence on decisions regarding cattle, even when the animals formally belonged to men (Smith-Oboler 1996). The degree of control over livestock was also found to vary according to the relative importance of different livestock products in total household income.

Even where men own livestock, women are often responsible for them, and this has implications for interventions and technologies in livestock production and management, especially zero-grazing systems. In India, women play a significant role in providing family labour input for livestock-keeping. Especially in poorer families, their contribution often exceeds that of men (George et al 1990). In Asian intensive livestock systems, more than three-quarters of livestock-related tasks are the responsibility of women. In the tribal low rainfall, semi-arid areas of India, much of the work with regard to animal management is in the hands of women due to migrations of male labour.

Women and poor households are often constrained by limited access to resources/inputs and services (land, livestock, finance, knowledge, information and so on); lack of control over assets; limited access to markets; limited formal knowledge networks/sources and social networks and; limited decision making power. It is important to note, however, that women in male-headed and female-headed households, respectively, face different sets of constraints. This affects their ability to access and use improved agricultural technologies or engage in resource intensive enterprises. For example, gender differences in aquaculture adoption in Central African Republic revealed that costs of feed and fingerlings in addition to tight feeding schedules prevented women low on cash, labour, and information from investing in catfish farming; they found the low-input, low-cost tilapia more appropriate to their needs (Van der Mheen-Sluijer & Sen 1994). This also holds true for poor households.

The impacts due to the constraints faced by women are manifold and affect the household wellbeing in general, going beyond just productivity. High labour requirements demanded by certain enterprises keep children away from schools. Increasing the resources women control has been shown to improve child health and nutrition and increase allocations toward education (Quisumbing 2003). In Bangladesh, fish pond programs that targeted poor women empowered them and improved the long-term nutritional status of women and children as well as gender-asset equality more than untargeted programs (Kumar & Quisumbing 2009).

The gender and equity strategy of CRP3.7 is designed to provide equitable opportunities in value chain development, technology generation and access to animal source foods to the groups mentioned. The overall purpose of the strategy is to promote equity these focus areas following a multi-pronged approach and a combination of strategies that address the multiple constraints and opportunities in a context specific manner. The program will aim to integrate gender through the whole research-development cycle from planning and design, technology development and delivery, value chain analysis and development, monitoring and evaluation and impact assessment.

The gender and equity strategy will focus on four interrelated areas of interventions with potential for high impact: Targeting and value chain selection, productivity, value chains development and consumption.

- **Targeting and value chain selection:** One of the criteria for the selection of the value chains within the program is the potential for the value chain to benefit women in terms of market opportunities, reduction of gender asset disparities and nutrition disparities. Targeting for technologies, services and other innovations will use gender and especially the potential to reach and benefit men, women, and other social groups as criteria. As described in Theme 3, this will require a gendered and socially differentiated systems and livelihood analysis to identify gender issues in livestock and fish

production, technology development, marketing and consumption in different systems, countries and contexts.

- **Productivity**: Women are often excluded from most parts of the research-development cycle of fish and livestock technologies. Their preferences in species and traits are often overlooked – this has, for example, resulted in neglecting the potential of micronutrient-rich small indigenous fish species and low investment in small livestock such as pigs, poultry and small ruminants. Thus, we propose to focus on gendered preferences for species, traits, production models and markets and effective engagement of men, women and other social groups in the research process. Increasing access to productivity enhancing technologies and services to both men and women will be a priority.
- **Value chains**: These are gendered and do not often provide a level playing field for the poor and women although women engage substantially within them as producers, gleaners, processors and traders, their contribution is undercounted and their returns disproportionately lower. Gendered value chain analysis can determine points of the chain where women, the poor and socially and economically marginalize are located, constraints to improve their economic benefits from livestock and fish and opportunities upon which to build.
- **Consumption**: Gendered intra-household consumption patterns of livestock and fish products, considered high-value 'prestige food' in many developing countries, favour men in many cases, thus depriving women and children of adequate proteins and micro-nutrients when they need them most. We propose increased awareness on nutrition and equity issues that relate to productivity choices to be a priority focus. Research on the variable dynamics of intra-household food allocation, as well as interventions implemented to increase the consumption of meat and fish, especially by women, children and other vulnerable groups(such as people living with HIV), can be conducted through linkages with CRP 4 on agriculture, nutrition and health.

The strategy will be implemented through two main general approaches. The first is cross cutting gender analysis, integration and gender research that cuts across the entire program, led by Theme 3, on Targeting, Gender and Impact. This will involve development of approaches and tools for gender analysis across value chains, countries and sites, development of gendered indicators for monitoring and evaluation of outcomes and impacts, developing guidelines for use in integrating gender and equity issues within individual value chains, carrying out research on cross cutting research questions. The second will be capacity development among program teams and partners to support the integration of gender in different components of the program. This is described in more detail in Research Theme 3, which will play both a research and capacity support role.

COMMUNICATION, ADVOCACY AND DATA AND KNOWLEDGE MANAGEMENT

Introduction

This section sets out some 'principles' that will guide our investments in this area, briefly describes the expected 'actors and clients' for this component of the Program, and identifies four 'areas of intervention' and associated results where we will focus our efforts.

Knowledge, information and data – and the social and physical infrastructures that carry them - are widely recognized as key building blocks for more sustainable agriculture, effective agricultural science and productive partnerships among the global research community (Ballantyne et al 2009).

Through investments in e-Science infrastructure and collaboration, and rapid developments in digital devices and connectivity in rural areas, the ways that scientists, academics and development workers create, share

and apply agricultural knowledge is being transformed through the use of information and communication technologies (ICTs).

These ICTs are being applied to all parts of the research for development continuum that connects agricultural science with agricultural and rural change: 'e-Science' (or e-Research) is characterized by global collaboration and the next generation of infrastructure that will enable it while 'm-Agriculture' uses mobile digital devices, such as phones, laptops and sensors, that puts ICTs, connectivity and applications into the hands of rural communities. Between these, ICTs are transforming agricultural extension, facilitating the delivery of education and learning through distance education, helping to empower the rural poor in developing countries, and powering a wide array of agricultural finance, credit, market, weather and other services delivered by public and private organizations.

The integration of data management, knowledge management, information sharing, communications and advocacy across the Program is thus an essential way to achieve the necessary synergies and collective action that will be required for the Program to have impact.

The CGIAR Centers can do much in this area, but certainly not all. Particularly in the seven focus countries, a lot of 'ground-truthing' is required to match the general approach to local situations. To take on all the roles and tasks we envisage, we will need to draw on the skills and capacities of local and national partners as well as those of specialized partners. We will therefore include an assessment of capacities and opportunities in this area as part of the proposed 'participatory partnership analysis' processes that will take place in each of the seven focus countries.

Principles

In the design of different interventions, we are guided by the following principles:

- *Knowledge generated by the Program will be open and public*. We will encourage all partners to document and share their work from the outset using open platforms and systems with the minimum of technical, financial and legal restrictions. This knowledge will be accessible to all as an international public good, so it can 'travel' and be put to use locally and globally.
- *We value the knowledge of our clients and partners*. The idea that everyone has useful knowledge to offer underpins the notion of innovation systems and the 'social' web. We will explicitly encourage different actors to contribute their different forms of knowledge to the program, avoiding too much 'push' from the centre.
- *Multi-purpose knowledge*. Recognizing that different actors and clients in and beyond the Program have different knowledge needs and interests and that they respond differently to messages in different formats, we will 're-purpose,' re-format, adapt and translate different outputs and messages for different audiences and purposes.
- *Knowledge management*: *Collect, connect, converse.* We will ensure that the knowledge of the program is 'collected' and disseminated for re-use and posterity. We will ensure that the actors and partners in the program are 'connected' to one another and to sources of data and knowledge. We will catalyze 'conversations,' dialogue and interactions among stakeholders, mobilizing and listening to diverse perspectives.
- *Face-to-face communication*. We will use all suitable ways to generate and exchange information and knowledge, paying particular attention to effective face-to-face events that also reinforce the social and human relationships that are essential for good development.

- *Advocacy is everyone's responsibility*. We recognize that different partners in the program have different strengths. Researchers are usually good at generating evidence; development partners are often better in providing avenues into policy and change processes. We will combine the strengths of both groups to advocate collectively for pro-poor change.
- *Communication inextricably linked to outcomes*. What we communicate, who to, and how will have a strong influence on program outcomes. We will integrate our communication activities into our outcome strategy.
- *Internal communication and M&E are part of our communication strategy*. We do not see communication solely as an 'external' activity towards external audiences. This Program aims to align and integrate the efforts of many people spread across four CGIAR Centers, associated research partners, seven countries, and within them large multi-stakeholder networks of actors. We will maximize learning and communication across the Program as a value addition to other dispersed activities.
- *Partnerships are the key to impact.* We will mobilize the various skills and capabilities of the program's partners to create, share, communicate and put data, information and knowledge to use. These skills do not exist in any one partner so we need to build on – and reinforce as necessary – the capacities of the whole Program.
- *Innovation and ICTs*. New information and communication technologies are revolutionizing both the ways we do science and the ways that the private sector, governments, and local communities engage in 'development.' We aim to grasp the opportunities these new tools provide to improve the ways we collect and create data and information; integrate, share and communicate this knowledge into our research and technology development activities; and get it into the hands of people directly working with the poor.

Actors and clients

Everyone engaged in the Program is a potential creators and consumer of data, information, and knowledge. There is also a large audience beyond the Program – locally, nationally and internationally – that will be interested in its results.

Who are the people we will work with, and what are their knowledge needs?

- **Researchers** – within the Program and elsewhere need in-depth knowledge products, data, data sources, as well as methods and tools. We may need to help them produce a wider range of communication products than they are used to.
- **Development practitioners and partners** – public, non-governmental and private – need targeted knowledge products, dissemination products, training and capacity building products, decision-support tools, synthesized data and the chance to join events and dialogue. We will need to look carefully at communication between these groups and the researchers – there is frequently a cultural/communication gap that needs to be overcome. We also need to find innovative ways to capture and share their knowledge, recognizing that they may not be as used to publishing as are scientists.
- We aim to influence **decision-makers, investors and the global support community**. They need focused knowledge and advocacy products, awareness products, decision-support tools, and synthesized data. Influencing them requires targeted strategies that combine a range of approaches, as well as timely advice and inputs from people they trust and the media.

- **Value chain actors** – producers, traders, and the like – must also be reached. Here, we are likely to have greatest impact by working through other partners who are close to them, translating or adapting the program's outputs into locally accessible formats. National/local radio, print and television media will often be important partners in this. We will also join with organizations and initiatives that use more interactive tools that integrate web applications with mobile phones for example. These enable value chain actors to interact in real-time and to transact in more transparent ways.
- A vital 'internal' community of **Program managers and implementers** needs access to an effective M&E system, information on current program activities and events, shared methods and tools, data, training and capacity building products, outcome support tools, communication and collaboration spaces, and event planning tools.

Areas of intervention

The program will operate in four different 'spaces' comprising different actors and stakeholders and requiring different knowledge and communication support. These are introduced below.

1. *Connecting and powering value chain development*

Working through innovation platforms in seven countries, we will catalyze rich interactions and communication among the key actors and partners working on each value chain. We will facilitate interactions with each other and with the specialized research teams working to overcome the identified technology development constraints. We will assist them to communicate their findings for local, national and global uptake, facilitating their access to relevant information and knowledge, locally and globally.

Much of this communication will be face-to-face, requiring effective facilitation and innovative ways to engage multiple actors and their multiple interests. We expect to generate large amounts of 'raw' data and information that will be captured and organized for re-use. Many non-scientists will be involved in these activities, so we will use different approaches, incentives and tools to ensure that their different types of knowledge are also captured and incorporated in the process.

Particularly in this component, we are likely to generate a wide range of intermediate knowledge products and outputs – and few classic scientific articles, books, and the like.

We will capitalize on the increasingly widespread use of mobile phones and other devices that are now accessible and used in the remotest and poorest communities. We will partner with specialized partners – many from the private sector – that use these tools to apply relevant applications and content right across the value chain. By working with partners to integrate a range of different services and applications with mobile phones, we will enable poor and illiterate producers to better participate in the value chains and participate in local social networks.

In this area, we expect to contribute directly to the value chain development efforts by informing all the actors involved, mobilizing their knowledge and know-how, creating a level 'knowledge space' for them to access and share information, and helping document and communicate the lessons and results for use elsewhere. We see these communication activities performing an essential 'gluing' role that reinforces the operation, cohesion and reach of the innovation platforms.

2. *Enabling technology development*

We will ensure that each research group that is conducting technology development across countries and value chains on a small number of issues has necessary support and tools to gain access to its specific global

knowledge and data 'base', to communicate and share the results of its work with partners working in the targeted value chains, and to inform science and policy audiences globally.

Since the teams will be geographically dispersed, we will ensure that they are able to collaborate and 'do science' virtually across organizational, geographic and time boundaries. The communication products in this area are likely to be more 'traditional' – reports, articles, data and the like. One challenge will be to complement these with more accessible formats and channels for other audiences. Experimenting with emerging social media and alternative ways to do 'e-science' – for instance with the support of mobile phones - will maximize the potential for these products to travel and be taken up elsewhere. We foresee an important 'translation' and brokerage aspect to ensure that 'science' messages from this part of the Program are globally valued and are made accessible to 'local' stakeholders engaged in value chain development and associated activities.

We expect these activities will get research results into the public domain and into the hands of target actors in the seven focus countries and beyond. They will also contribute to the scientific process by supporting collaboration spaces and platforms and providing access to global knowledge and databases.

3. *Communicating and learning across the Program*

We will establish mechanisms to facilitate and catalyze learning, knowledge sharing and communication among the various elements of the Program. Within the countries, the working groups of partners play a key role in this. We will support 'routine' information sharing and communication in support of the efficient running of the program's components. We will also ensure that knowledge, data, and information is documented, captured, shared, synthesized, and put to good use across the program.

This 'sharing' space will thus produce efficient information flows among the program's actors and partners. It will also capitalize on and reinforce learning across the various levels of the program. As in the other spaces, we will use emerging social and other media to ensure that these tasks are done in as open and accessible ways as possible.

4. *Communicating for wider impact*

We aim to get our results and messages out beyond the program. We will establish necessary advocacy and communication products and approaches to ensure that these results and messages reach, and influence, national and international audiences. The public awareness end of the spectrum will include use of print, video and radio to deliver information and messages packaged appropriately for a range of stakeholders including farmers, extension workers, policy makers and scientists.

We expect most of the outputs in this area will be synthesized, polished or adapted for non-specialist audiences.

These activities need to be spread across the whole Program, with responsibilities for specific value chain advocacy and public awareness based in countries, but linked to an overall coordinated approach.

Dealing with data

The Program will use a common data platform, collecting and collating data from the diverse systems under study. Data collection will be system specific and embedded within each value chain, but by requiring that it conforms to common standards of format and content, we will allow it to be used by common analysis tools across the program.

Integration, synthesis and communication of research data will be centralized where appropriate. This will allow lessons to be drawn across different value chains. The data management platform will ensure that

data is made readily available in as near real-time as possible to researchers across the Program through the provision of web-based tools to extract information from the underlying databases.

All data will be placed in the public domain as early as possible. There will be practical and ethical constraints in some cases; for example we may not allow information to be traced back to an individual farmer and we may not release information that would require national approval, such as evidence of a notifiable disease. But within these constraints, the overriding principle will be to make data available and to encourage its use and examination by the broad community.

Communication channels and tools

Our communication approaches and tools will be used to: co-create knowledge and information with our partners; inform and influence many audiences (directly or via partner 'infomediaries'); integrate, translate and adapt knowledge for different uses; and reinforce the potential 'network effect' of the program. We will also use these tools to help coordinate and manage the Program. Especially among national partners, we expect these tools to reinforce their communication capacities and provide a legacy of skills and expertise that can be spilled over into other activities.

In general, we will use the following **main channels**:

- The Internet will be the most critical communication tool that we will use – from the exchange of basic email and SMS messages, through collaborative work spaces for teams and sharing learning, online video and blogs, mobile phones and other devices, to targeted dissemination and outreach to audiences worldwide.
- Face-to-face and interpersonal discussions and meetings are critical; we will ensure that they are well-facilitated to foster excellent dialogue and interaction; we will also use social reporting approaches to capture and share the essence of these discussions promptly.
- Traditional mass media like television, radio and newspapers still play an important role in reaching wide audiences – beyond the web – and we will seek out partners and expertise to ensure that our messages reach targeted audiences.
- Traditional science communication and publishing – articles, books, posters and papers – will be a strong element of the overall program, especially the technology development component. We aim to better integrate such scientific products with a wide range of other communication channels and products that may better influence pro-poor policy and development change.
- We will experiment and innovate with tools like mobile phones – as ways to collect and share data, to interact with and reach many people, to get beyond the web, to link spatial information with other applications, and to connect various information and advisory services and applications (such as questions and answers, voice services, expertise networks, market prices and weather) with value chain actors. These applications also offer avenues for program monitoring and quality control systems that involve all stakeholders.

W will also pay particular attention to five **tools and approaches that reinforce communication**:

- Mobile devices – that bridge and integrate local needs and demands with specialized information, advice, and knowledge services. We already have various experiences in this area; we will extend and deepen these with specialized partners.
- Social media – that enable many actors to easily create, share and communicate information and knowledge to various audiences. Some partners have started using these tools to enhance the reach of their research; we need to extend these uses across the entire program.

- Networking and community/network tools – that connect the partners and actors in networks and communities in support of learning and sharing across the program. To fully engage our partners, we will put these in place early, providing easy to use facilities for all partners to contribute and be informed.
- Information and data repositories – that capture and make accessible the knowledge created and compiled and allow local and global re-use and permanent access to these assets. We will need to re-align and re-purpose some of the resources we already have, looking to integrate better different systems and content with emerging needs. We will also explore how they can be connected and presented to new audiences through, for example, mobile phones or enhanced graphic and mapping applications that enable better visualization of data and information.
- 'Crowd sourcing' – a way of approaching data and information creation and maintenance that draws on the contributions of many participants, amateur and expert. Using widely available ICTs (especially phones), these approaches allow us to draw in knowledge from many sources, reinforcing the multi-actor emphasis of the program and our intention to draw on all of their knowledge.

A key element in the successful use of these tools and approaches is that participants adopt 'open' and 'pro-sharing' mindsets and attitudes. We will work towards this from the start, building on the positive lessons we gained developing the Program through an open process of consultation and engagement with multiple stakeholders.

SYNERGIES AND LINKAGES WITH OTHER CRPs AND CG CENTERS

The focus in CRP 3.7 on producing more meat, milk and fish is based on the core premise that the CGIAR will deliver greater benefits to the poor and vulnerable living in specific geographies if we adopt a more effective approach to integrating the resources, skills and energy of the 15 CGIAR Centers and the other 14 CRPs. Considerable efforts have been made to pursue such integration through the design of the CRPs and substantial progress has been made. Initial development and the subsequent revision of the various CRP proposals has been a dynamic and evolving process, but it has largely confirmed the opportunities initially identified for integration between CRP 3.7 and other CRPs. However, until the proposals are approved and governance structures have been established to lead more detailed discussions, the specific mechanisms for integration remain speculative.

The current status of Center and CRP integration in CRP 3.7 is summarized in Tables 3.2 and 3.3. Table 3.2 provides an initial indication of the science that each Center is expected to bring to CRP 3.7, together with the current status of mechanisms to achieve this integration.

Table 3.3 summarizes our current assessment of the scope for collaboration between CRP 3.7 and other CRPS, the specific contribution that each can make, and proposed mechanisms for achieving integration. First indications suggest that there are clear synergies on common research areas between CRP 3.7 with the CRP 3's on food-feed crops, with CRP 2 on value chains and policy, CRP 4 on health and nutrition, and with the system CRP 1's on technology adaptation and natural resource management.

Table 3.2: Potential contribution and current status of engagement of CGIAR Centers in CRP 3.7

Center	Potential contribution	Current status of engagement
Active role in specific aspects of CRP 3.7		
CIAT	Livestock value chains; also via CRP 1.2 and CRP 7	Contributed to consultations and to proposal design and writing; developed dual purpose cattle value chain for Nicaragua
ILRI	Livestock value chains; also via CRP 1.1, CRP 1.2, CRP 2, CRP 4, and CRP 7	Led in development of proposal structure and content and in establishing and management of consultation processes; developed dairy value chains for East Africa and India, pig value chains in Uganda and Vietnam, and small ruminants in Mali and Ethiopia
ICARDA	Small ruminant value chains in drylands; also via CRP 1.1 and CRP 7	Contributed to consultations and to proposal design and writing, especially in nutrition and genetics; developed value chain program for small ruminants in Ethiopia
WorldFish	Aquaculture, markets and value chains, governance, gender, nutrition; also via CRPs 1.3, 2, 4 and 7	Led in development of proposal and in establishing and management of consultations; developed value chain programs for fish in Uganda and Egypt
No or limited direct contribution, but contributing via CRPs		
CIMMYT	Via CRP 3.2 and 3.3	Collaboration via CSISA project in Bangladesh; technology platforms on improvements in forage crops
IFPRI	Markets, policies and institutions, links to wider development environment; also via CRP 2 and 4	Limited engagement in proposal development; will seek to engage in participatory scoping and value chain research agenda at national and hub levels in focal countries
IITA	Via CRP 1.2	Identification of synergies in East Africa and South East Asia
IRRI	Via CRPs 1.3 and 3.1	Limited at present to collaboration around CSISA project in Bangladesh
IWMI	Via CRP 5 on water management;	May contribute to policies, models and technologies regarding rights to and use of water
ICRISAT	Via CRPs 1.1, 3.5, 3.6	Improvement of basal feed resources through multidimensional crop improvement Identification of synergies in Mali and India
No direct contribution, limited via CRPs		
Bioversity, CIFOR, CIP, ICRAF, WARDA		

Table 3.3: Collaboration, linkages between CRP 3.7 and other CRPs, and mechanisms for achieving effective integration

CRP	Scope for collaboration	Form of linkages			Mechanisms for achieving integration
		Contribution to 3.7	Contribution from 3.7	Joint research and supporting actions	
1.1 Dry areas	Large in Ethiopia Mali and India (AP in particular) and moderate in other CRP 3.7 value chains and through joint learning and development of appropriate technologies to address major constraints in livestock production.	Sharing learning from approaches to build pro-poor, gender equitable technologies and value chains and in dry areas; NRM; ecological foot print	Sharing learning from approaches taken to: focus program on selected hubs; pursue impacts at scale; partnership management; use value chain approaches; spill over from technology development	Focus on the supply of fodder in dry areas for small ruminant systems, using Ethiopia and Mali as learning systems, and dairy systems in India and Tanzania; policy coherence across sectors	Participation in inception meetings in order to explore potential for joint research and supporting activities in each overlapping target country to help ensure that CGIAR conveys a coherent approach to integrated agricultural systems and value chain development.
1.2 Humid tropics	Moderate in Uganda and Vietnam and through joint learning and development of appropriate technologies to address major constraints in livestock production.	Sharing learning from approaches to build pro-poor gender equitable technologies and value chains in humid tropics	Sharing learning from approaches taken to: value chain analysis; focus program on selected hubs; pursue impacts at scale; partnership management; use livelihood and farmer first approaches	Focus on the role in humid tropics, using as learning systems	Participation in inception meetings in order to explore potential for joint programming for activities in each overlapping target country to help ensure that CGIAR conveys coherent approach to integrated agricultural systems and value chain development.
1.3 Aquatic agriculture systems	Moderate in Uganda, Zambia and Bangladesh and through joint learning and development of appropriate	Sharing learning from approaches to build pro-poor gender equitable technologies and value chains in aquatic agriculture systems	Sharing learning from approaches taken to: value chain analysis; focus program on selected hubs; pursue impacts at scale; partnership management; use livelihood and farmer first approaches	Development and governance of value chains that maximize opportunities for poor participants, including women	Participation in inception meetings in order to explore potential to extend scope of Ugandan aquaculture value chain to include poor producers and to coordinate efforts to better align the supporting policy environment

	technologies to address major constraints in livestock production.	

2. Policies, institutions and markets	Large in all value chain countries	Global, regional and national analyses of macroeconomic factors, poverty scenarios and food security for meat, dairy and fish value chains Provision of information on global best practice regarding institutional arrangements for agricultural research and extension, finance and insurance, and other areas of innovation Provision of information and methods on global best practice on value chain governance Provision of information and methods for value chain research methodologies	Hub level information on factors studied by CRP 2 at larger scales, so providing grounded contextual information on the implications of analyses and the applicability of their recommendations Comparison across value chains on learning from CRP use of best practice and innovative approaches to institutional arrangements, including specific impacts of CRP linkages with social protection mechanisms and support to improved extension Comparison across value chains on learning from CRP use of best practice Comparison across value chains on learning from CRP use of best practice regarding value chain research	Integrated research on policies, institutions and markets ,which brings together learning from the livestock and fish sectors (CRP 3.7) into the global agricultural sector (CRP 2); cross-learnings from regional and national level policy analyses undertaken by both CRPs; methodological and evidence-based learnings from livestock and fish value chains as specific category within CRP 2 focus on value chains and its proposed roles as a “knowledge clearing house” on the subject. CRP 3.7’s selected value chains will provide a laboratory for CRP 2’s generated hypotheses.	Pending the establishment of the respective CRP governance structures, it can be anticipated that researchers on the CRP 3.7 teams working on Targeting will in many cases be the same individuals working within the CRP 2’s strategic foresight work in its policy and modelling component. Similarly, the researchers leading work on gender and the socio-economic dimensions of Value Chain Development in CRP 3.7 will also be members of the cross-Center teams working on the CRP 2 components on value chains and institutions. These researchers will inevitably seek to build direct synergies into their activities to meet the needs of both CRPs and thereby provide the mechanism for cross-learning. An early opportunity already flagged for joined work will examine the role of animals as assets for the poor whichCRP2 sees as a major institutional issue, and CRP 3.7 is well placed to test the mechanisms and their resilience in the face of higher productivity and greater market utilisation.

3.1 GRiSP	Limited	To be determined	To be determined	To be determined	To be determined
3.2 Wheat	Limited	To be determined	To be determined	To be determined	To be determined
3.3 Maize	Important in small number of value chains where maize is grown (e.g., Mali, Ethiopia, Tanzania, India)	Provision of improved germplasm and other technologies	Provision of comprehensive integrated framework in focal countries and sites, within which to better channel application of maize technologies	Joint analysis of how best to integrate maize cultivation with other crop, livestock and fish production options in CRP 1.3 hubs where maize is important crop	We will build on the CSISA collaboration described above and pursue similar modalities where possible.
3.4 Pulses	Important especially in dryland areas in conjunction with CRP1.1 in Mali, Ethiopia, India;			Intersection with the feeds platform for multidimensional crop improvement	To be determined
3.5 Roots, tubers, bananas and plantains	Important - potential for the pig and fish value chains especially where roots/tubers and by-products can be used as feed or processed into silage	Improved dual-purpose varieties as value chain upgrading interventions	Identification of target characteristics and screening strategies; field testing and dissemination within target value chains	Intersection with the feeds platform for multidimensional crop improvement	Build on ongoing joint project activities with SASHA in East Africa
3.6 Sorghum, millet and barley	Significant in relation to dryland areas in conjunction with CRP1.1 in Mali, Ethiopia, India	Improved dual-purpose varieties as value chain upgrading interventions	Identification of target characteristics and screening strategies; field testing and dissemination within target value chains	Intersection with the feeds platform for multidimensional crop improvement	To be determined
4. Nutrition and health	Large in all countries given the objectives of the CRP to produce	Global, regional, national and household level analyses of health and nutrition issues that need	Provision of comprehensive integrated framework in focal countries and sites, within which to better channel	Joint analysis of health and nutrition issues in value chain countries	We will build on participatory diagnoses to develop integrated projects in each country and hub that link both CRP 3.7 and CRP 4

	more meat, milk and fish for the poor in order to reduce malnutrition and hunger, of which health is also a critical dimension	to be addressed in the CRP value chains, and provision of guidance on best practice as to how to do so.	research on health and nutrition for communities dependent on AAS		
5. Water scarcity and land degradation	Moderate, in all value chains; initial potential synergy in Ethiopia and Mali	Global, regional, basin and national analyses of water management issues that impact on value chains in different countries. This involves in particular analysis of water management at the basin scale and assessment of impacts on ecosystems downstream.	Improved management of value chains demonstrating best practices for use of water, contributing to better appreciation of options for water use	To be determined but possibly involving joint analysis of water productivity in value chain areas and of the local impacts of water management at the basin scale	We will establish a dialogue with CRP 5 to design the necessary collaboration as the program proceeds; potential early interactions with Nile Basin and Volta Basin project activities
6. Forests and Trees	Limited	To be determined	To be determined	To be determined	To be determined
7. Climate Change	Large given high vulnerability of value chains to climate change induced changes in water availability, stress and pathogens	Global and regional analyses of climate change vulnerability and adaptation, including implications for focal systems, countries and hubs	Provision of comprehensive integrated framework in value chain countries in order to better understand impacts on food security; climate change mitigation in relation to increased productivity and the potential to reduce animal numbers; better feed quality also reduces methane output.	To be determined, but possibly including how value chains can be made more resilient to climate change shocks	To be determined, but we will build on participatory diagnoses to develop integrated projects in each value chain that link both CRP 3.7 and CRP 7.

RISK

The approach proposed for CRP3.7 entails two new principal internal sources of risk in addition to the generic ones faced by all international agricultural research programs. The first two are:

Too tight a geographical focus limits ability to generate international public goods for wider impact. CRP3.7 is proposing to focus its research to improve production in a few selected value chains. As highlighted by stakeholders during our consultation process, this approach could limit our ability to extrapolate our research results more widely. As explained in the earlier section on Impact Pathway, this risk is being addressed by: (1) carefully selecting value chains and countries with the highest potential for short-term impact and wider scaling out regionally; and (2) working through research platforms that develop generic cross-cutting tools and methods across the sites. Whether this approach is working will be periodically evaluated.

CRP3.7 fails to align partners and mobilize resources for development interventions in the target value chains. This could happen either because CRP3.7 researchers do not have the skills required to broker such efforts, or because there is insufficient investor interest. We are reducing this risk by including existing stakeholder support, capacities of potential partners, and known donor interest as key criteria when selecting the target value chains. Developing the necessary brokering skills among researchers will certainly be a challenge, but staff implementing the value chain development activities will be expected to have strong research-for-development experience.

The other traditional internal risk remains:

CRP3.7 research results fail to be taken up or translate into impact. As explained under the Impact Pathway section, the proposed CRP3.7 approach of focusing our research as a knowledge partner in interventions to develop selected value chains is designed explicitly to minimize this risk, which will be monitored and addressed as necessary.

Key external risks include those related to the transition to the new Consortium arrangements:

CRPs increase transaction costs but fail to add value to existing efforts. To avoid excessive costs, we have strived to keep the management and governance structures to the minimum required. We expect that guidance from the Consortium will facilitate adequate coordination and collaboration to avoid duplication across CRPs.

Insufficient funding significantly delays or hampers implementation of the Program. The CRP3.7 partners will support the Consortium as it works to address the uncertainty about the level and timing of CRP funding. They have also agreed to orient new projects with restricted funding to align and support CRP3.7 to compensate for possible funding shortfalls.

Other risks, outlined in the Table 3.4, below, will be evaluated on a continuous basis as part of the CRP3.7 management strategy.

Table 3.4: Risks, likelihood of occurrence and mitigating actions

REALM	RISK	MITIGATION
Risk with HIGH likelihood of occurrence:		
Management	MPs increase transaction costs but fail to add value to existing efforts	Provide incentives to CRPs for cross-centre & trans-disciplinary programs
Risk with MEDIUM likelihood of occurrence:		
Public policy	National policies not conducive to increasing private sector investments	Engage with governments when selecting focus countries so as to identify countries with pro-business policy environment
Public policy	National policies promote industrial livestock production & small producers squeezed out of markets	Identify combinations with pro-business/pro-poor policy environment; target relevant evidence of trade-offs; demonstrate & advocate pro-poor pro-business win-wins
Public policy	Strategy requires coordination across multiple sectors (livestock, feeds, fish, health & environment)	Engage with high level policy makers on need for integrated approach; include institutional capacity building component
Public policy	Regulatory environment limits scientific options	Select target countries with enabling regulatory environment
Investment	Negative environmental perceptions of livestock & fish lead donors not to invest in sector due to reputational risk	Articulate specificity of negative livestock externalities & importance of addressing these as public good; private sector unlikely to address these
Investment	Insufficient funds to implement CRP holistically	2011 transition phase, using currently committed funds; design modular program which can be implemented as new funds become available
Technology	Tools not efficiently disseminated, with low adoption	Explicitly addressed by priority for collaboration with private sector & development partners, but must be attractive to them; design program with participation of partners

BUDGET

The indicative investment of CRP 3.7 is presented in the budgets below, with US$ 29.7 million in initial activity in 2011 rising to US$ 36 million in 2013. This reflects investments among the four core CG Centers, working though a number of partners and focused on the eight selected Value Chains, but supported by technology platforms and research support services located centrally at the primary institutional facilities.

We present two sets of budgets: those based on current resource envelope expectation, following the Consortium guidelines (the "as is" budget), and a Budget for Global Outcomes which outlines the type and levels of investment required to achieve the impacts that are desired at a global scale. This is explained further below.

The expenditure budget for CRP 3.7 is broken down several ways, reflecting both the target areas for investment along the Program Themes (Table 3.5) and the expenditure categories (Table 3.6). The main areas of investment are:

- Program Coordination (Management and Communication)
- Theme 1 - Technology Development
- Theme 2 - Value Chain Development
- Theme 3 – Targeting, Gender and Impact

The Program Coordination budget comprises some 5-6% of the total investment, and declines over time. It includes the costs of supporting the Program Director, the Development Manager, and the Communications and M&E officers, as well as associated support staff and materials, including all those related to knowledge management, Program-level publications and media. The Coordination budget also includes all the costs of facilitating the work of the Program Planning and Management Committee and the Science and Partnership Advisory Committee.

Theme 1, Technology Development comprises about half of the Program investment, reflecting the emphasis on productivity growth which is central to the Program. That emphasis is maintained through the first years of the Program and will be expected to continue beyond that. The components of that are described below under budget assumptions.

Theme 2, Value Chain Development is expected to comprise about 20% of the Program investment, in order to ensure that technology development is linked to the needs of the target systems, and also to address the complexity of delivery of livestock and fish technology, and the need for innovation in institutions to make that happen successfully.

Theme 3, Targeting, Gender and Impact will comprise some 16% of investment initially, declining by 2013 as strategies and cross-cutting mechanisms are put into place for ensuring Program outcomes meet the needs of target clients, and processes established to continually monitor Program learning processes to support redesign and prioritization.

Institutional overhead reflects the administrative and management support cost of the partner CGIAR centers, and ranges from 17% to 20%, depending on their cost structure.

Table 3.5: Program Investment by Themes, 2011 to 2013

Component	Description	2011 US$ 000s	2012 US$ 000s	2013 US$ 000s	Total US$ 000s
Coordination	Program management and communications	1,777	1,868	1,961	**5,607**
Theme 1	Technology Development	12,131	15,215	16,034	**43,380**
Theme 2	Value Chain Development	6,141	6,838	7,936	**20,914**
Theme 3	Targeting, Gender and Impact	4,795	4,326	4,217	**13,339**
	Total	**24,845**	**28,247**	**30,148**	**83,240**
Overhead	**Institutional Overhead**	4,885	5,543	5,914	**16,342**
	Total Program Cost	**29,730**	**33,791**	**36,062**	**99,583**

Another table with annual budget by cost items

Table 3.6: Program Expenditures by Category, 2011 to 2013 ($000's)

Cost group	Description	2011 US$ 000s	2012 US$ 000s	2013 US$ 000s	Program Cost US$ 000s
1	Personnel Cost	10,869	11,110	12,467	34,446
2	Travel	922	838	998	2,758
3	Operating expenses	7,882	8,607	9,042	25,530
4	Training / Workshops	352	107	380	840
5	Partners / Collaborator / Consultancy Contracts	4,508	5,975	6,771	17,254
6	Capital and other equipment for Program	43	1,212	48	1,303
7	Contingency	268	398	443	1,109
	Total	**24,845**	**28,247**	**30,148**	**83,240**
8	**Institutional Overhead**	4,885	5,543	5,914	16,342
	Total Program Cost	**29,730**	**33,791**	**36,062**	**99,583**

Table 3.7: Sources of Program Funding, 2011 to 2013 ($000's)

Description		2,011	2,012	2,013	Program Cost
		US$ 000s	US$ 000s	US$ 000s	US$ 000s
Funding					
	CGIAR Fund	10,333	11,881	12,969	35,183
	Current Restricted Donor Programs	16,982	19,963	21,381	58,326
	Other Income	2,415	1,947	1,713	6,074
Total Funding		**29,730**	**33,790**	**36,062**	**99,583**

Figure 3.1: Program Expenditures by CGIAR Partner, 2011 to 2013 ($000's)

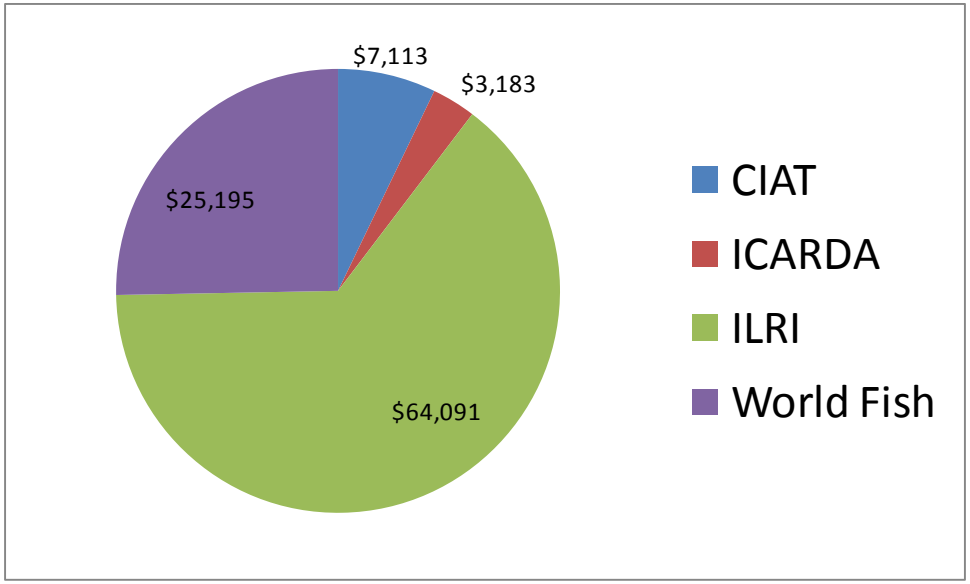


Table 3.6 shows expenditures by cost category, the largest components of which are Personnel (35%), Operating Costs (26%), and Partner expenses (17%). These reflect respectively, the heavy demands on human resources for generating science and knowledge outputs, the operating costs of working in many sites and countries, and the policy of working with and through partners in all cases. These expenditure plans are based almost entirely on current cost structures and the commitments made through restricted projects. From 2012 on, there will be increasing flexibility to adjust these to fill priority funding gaps, and to suit the longer term Program strategy. The funds indicated for Partners are only those that are directly channeled to them, and do not reflect the significant additional funds which go to partners indirectly. These take the form for example of PhD students seconded by partners (appearing in Personnel), direct payment for partner operating costs and travel, and wide range of other support to partners which goes through other expenditures channels.

Table 3.7 describes the sources of funding for the current resource projections. The relative contributions of the two main sources, the CGIAR Fund and Restricted Funding, are expected to remain constant during this initial 3 year planning horizon. The request of the Program on the CGIAR fund grows from just over $10M in 2011 to about $13M in 2013, a modest growth. An alternative Budget for Global Outcomes as described below, would require higher levels of funding from multiple sources. The value chain development component is expected to leverage substantial development funding that will contribute to addressing the policy and institutional bottlenecks specific to each target value chain; the technology development component is not likely, however, to leverage additional funding in this manner, and so will need to be fully funded from CRP 3.7, justifying its larger budget allocation.

Figure 3.1 illustrates the relative levels of investment in the Program through the partner CGIAR Centers. Reflecting its unique and primary commitment to livestock research, some 65% of the Program investment will be undertaken through ILRI and its partners. Investment through WorldFish will comprise some 25% of the Program, and ICARDA and CIAT have committed smaller shares of their resource envelopes, reflecting the wider range of research areas they are dedicated to.

Budget Assumptions and Composition

Budget figures are stated at conservative levels and do not include upside or overly optimistic estimates (apart from the Budget for Global Outcomes which follows). Following Consortium guidelines, first year budgets were based on 2010 projections for Centers, and comprise approximately 110% of actual expenditures for 2009. Years following the base year show a modest cost increase of 5% per year. An exception to that is that following the Consortium Board's request, CIAT has assumed a 2009 actual funding + a 10% increase to establish year 2011 budget. Budgets for 2012-2013 assume a 5% increase in order to be able to deliver on the outputs. A change in overall Program resources reflects the addition, since the Sept 2010 proposal submission, of Egypt as part of the fish Value Chain portfolio. That increase in budget is entirely based on new sources of restricted project funding. Given the demand from stakeholders and Donors for these research topics, the budget illustrates a clear and achievable transition to a mega-program financing structure that supports a rapid deployment of CRP 3.7 in 2011.

Projections for the specific value chain investments are based on a combination of existing project commitments closely linked to the target value chains on one hand, and approximations as to what proportion of headquarter-based platform support accrues to each value chain. Those support investment include the cross-cutting Themes support to VC-specific needs, such as technology needs assessment and adaptation, value chain methodological support, gender strategy, etc. Resources for the value chains are thus imbedded within, and not differentiated from, the main Coordination and Thematic investments. Based on those combined projections, we have estimated the follow levels of investment in the specific value

chains for the initial phase. These will however be more highly refined during the operation plan development:

Dairy value chains in India and Tanzania: Some $11M of investment over 3 years which reflects in particular ILRI's significant attention to smallholder dairy as the mostly widely recognized and globally relevant avenue for sustained rural livelihoods through livestock. CIAT will support feed systems in Tanzania in particular, where they have particular comparative advantage.

Small ruminant value chains in Ethiopia and Mali: This is an important area of work for ICARDA and a growing priority for ILRI, and the investment during this phase of the Program will comprise some $9M.

Aquaculture in Uganda and Egypt: This is of course an important pillar for WorldFish work in Africa and will comprise nearly $7M of investment, growing from a relatively small base to an anticipated level of $3M in 2013.

Smallholder pig value chains in Uganda and Vietnam: This is a relatively new area of work for ILRI, particularly in Uganda. Expected investment will be some $7M. There are good opportunities for synergies with CIAT in feeding systems in both target countries.

Dual-purpose cattle in Central America: This is a priority area of work for CIAT, and the relatively low level of investment through this program of some $1.7M reflects the fact that this is a co-investment with other CPRs working in that area. ILRI expects to increase its role over time to support this work in the area of dairy value chain development.

Other cross-cutting areas of investment that are critical to achieve the desired outcomes of the program include Gender and Capacity Building. Like the value chains above, these investments are imbedded across both the Thematic programs and the specific country level investments. Anticipated levels of investment are expected to be as follows:

Gender: In addition to the dedicated support to development and implementation of gender strategies in Theme 3, work on gender analysis and support to delivering specific outcomes and impacts for women and other disadvantaged members of communities cuts across the other Themes and value chains, and is also incorporated in part in Program-level M&E and communication strategies. The anticipated sum of this investment across the Program is $5M over the initial 3 years.

Capacity Building: This important component of the Program, which will be supported and coordinated at the level of the Program Director, cut across all aspects of research, from lab-based science to field-level piloting of value chain interventions. Examples of capacity building include not just degree-oriented graduate training, but co-development with research partners of new tools and approaches, and training of development partners in scaling up and supporting evidence-based systems for development interventions. The anticipated level of investment, cutting across all components of the Program and imbedded within those budgets, is $10M.

Allocation procedure and prioritization

The development of the operation plan upon anticipated approval of this CRP proposal will review in far more detail the planned investments and compare those to anticipated needs for the initial phase of the Program. Key elements of that process will include:

- Inventory of existing project-based funding through restricted projects
- Development of detailed implementation strategies for all components of the Program, from coordination and strategy, to Thematic development, to Value Chain development.

- Identification of resource gaps based on comparison of the above to identify priorities. That will drive both re-allocation of Program resources, and will set priorities for next initiatives in resource mobilization.

More of this is detailed in the section on timeframe and milestones which follows.

Budgeting for Global Outcomes

The budget developed to date reflects current Centre resource allocations and bilateral project commitments, and can be regarded as the budget "as is." The Program has been designed to more effectively use that resource envelope by building on synergies between the partner Centres, and by focusing those resources on a limited number of countries and value chains. As has been explained, effort will be made to build on those platforms to the extent possible to generate global public goods that can be scaled up more broadly.

However it should be recognized that in the context of the fact that livestock comprise some 40% of global agricultural GDP, a share which continues to grow, this Program effort, no matter how well intended and implemented, may not achieve the needed broad changes in productivity across the many dozens of countries that fall within the critical livestock and fish needs domain of the CGIAR. In order for that to occur, higher levels of investment are required to establish and implement the long-term technology platforms that livestock and fish science require, and to build the delivery and partner mechanisms to scale up and out globally.

We have outlined below the additional needs that would be required to be met to achieve that, and the indicated resources for that investment. This **Budget for Global Outcomes** would very significantly raise the prospects of achieving the higher levels of productivity change and increased supply that it is now certain that the developing world will need to meet demands, while at the same time transforming rural communities through livestock and fish based livelihood growth.

Feed resources: Current feed resources research funded includes work on food feed crops, feed options (processing, transport, use of biofuel residues) and on forage development and adoption. This is in particular being carried out in proximity to the planned value chains on dairy in India and Tanzania, dual purpose cattle in Nicaragua and pigs in Africa. However, additional investments would facilitate speedier development of research on feed resources targeted at small ruminant value chains, where current investment is extremely low, and the expansion of monogastric and fish value chains through feed resources of specific relevance to smallholder producers. Further investments will also speed up research on the interface between livestock and the environment. To do this effectively we would need to employ the full emerging potential of biotechnology (molecular breeding, transgenics, synthetic biology) for improvement of food-feed crops and forages and standard economic research to assess the cost and benefits and trade-offs in the use of diverse feed resources. Resources for this expanded scenario would be in the order of an additional $1.7M in 2012 and $2.5M in 2013 above the current budget, which would include dedicated staff time on monogastric and small ruminant feed resources, and specific research support into the economics of feed, and into environmental research.

Vaccines: It is expected that the value chain development activities will identify a demand for new generation vaccines as more effective and sustainable solutions to disease constraints to animal productivity. The development of novel vaccines is a high-risk but high-return investment, which requires a substantial resource base and time. These activities require specialist staff, access to animals and appropriate, specialized equipment and facilities, and include field testing of prototype vaccines. It should be emphasized that the application, and thus the benefits, of a novel vaccine will almost certainly not be limited to a particular value chain and will have regional or international application. Further, the

technology platforms which are established will also be of use for the development of vaccines against a range of pathogens. An indicative budget to fund multiple partners, including early involvement of the private sector, for the development of a novel vaccine is at the level of $15M – $20M, which would be required over a period of five to eight years. The funding and consequent research activities are easily divided into phases defined by verifiable milestones with target 'stop/go' decision points. Anticipated initial investment to fully develop these activities is $2.2m in 2012, $3.3m for 2013 and then $3.5m per year after that.

Genetics: The area of genetic resources is central to long term productivity growth in all livestock and fish systems. At the same time, the development of improved animal genetics and the sustained delivery systems required for impact suffers from long-generation cycles in key species, and complex systems for germplasm production and delivery. The current portfolio in CRP 3.7 serves to make incremental changes to genetic-based productivity gains, but in order to achieve game-changing impact among target regions, additional investment will be needed. The components of that include: a) integrated genetic data management platform across the Value Chains and across centers. This will include bio-banking and associated data systems, b) strengthened capacity at all levels across key Value Chains, especially among farmers and NARS scientists, especially in relation to management of breeding programs in order to achieve the long-term production of improved germplasm that has been lacking, c) additional staff within the CG to support breeding activities within the value chains, and d) development of in-situ conservation methods, and their implementation, for selected aquatic resources in key locations. The anticipated cost of this additional investment will be $1.7M in 2012 and $2.5M in 2013 and subsequent years over a long term horizon.

Leveraging agribusiness: Markets for agricultural products, and for the services and inputs needed to produce them competitively, are increasingly shifting from the hands of traditional and informal market actors to larger, more professional, and often vertically integrated market players. If supported through targeted research in a pro-poor manner, this evolutionary process can also improve market opportunities for smallholder producers and rural communities. In many of our target value chains and countries however, this process is only at a nascent stage, due to limited capacity of many private sector players, and the risks they face in making innovative investment to grow new markets. Targeted research and investment is thus needed to catalyse this process of value chain upgrading, and the current resource portfolio will only be able to address that incrementally. The types of investment needed will centre around employing agribusiness specialists to develop new business and financing models with market actors, and establishing business incubation centres within key value chains. The anticipated cost of these additional investments will be $1M in 2012 and $1.2M in 2013.

Table 3.8: Program Budget for Global Outcomes, 2011 to 2013 ($000's)

Component	Description	2011 Amount (US$)	2012 Amount (US$)	2013 Amount (US$)	Program Amount (US$)
Coordination	Program coordination and management	1,777	2,198	2,436	**6,412**
Theme 1	Technology Development	12,131	19,415	22,259	**53,805**
Theme 2	Value Chain Development	6,141	9,238	11,211	**26,589**
Theme 3	Targeting, Gender and Impact	4,795	4,326	4,217	**13,339**
	Total	**24,845**	**35,177**	**40,123**	**100,145**
Overhead	Institutional Overhead	4,885	6,863	7,814	**19,562**
	Total Program Cost	**29,730**	**42,041**	**47,937**	**119,708**

These additional investments are reflected in the Table 3.8, which outlines the Budget for Global Outcomes. Over the 3 year initial phase of the Program, this comprises a budget gap of some $20M.

PART 4: DESCRIPTIONS OF THE SELECTED VALUE CHAINS

This section contains detailed descriptions of the eight candidate value chains that form the core of CRP 3.7. Each is defined by an animal source food commodity and a country:

- Fish:
    - tilapia and African catfish in Uganda and Egypt
- Small ruminants:
    - sheep meat in Ethiopia
    - goat meat in Mali
- Dairy cattle:
    - milk in India
    - milk in Tanzania
    - milk in Nicaragua (dual purpose cattle)
- Pigs:
    - pigmeat in Vietnam
    - pigmeat in Uganda

Each value chain is described in terms of a brief profile of the value chain, the rationale and arguments as to why this value chain was selected, indicative researchable issues and supporting actions to address priority constraints along the value chain, and an indication of the nature and anticipated scale of impact. Much more detailed value chain analyses will be undertaken as an early-stage program activity but this information is provided as a guide to the types of activities that are likely to be undertaken.

FISH VALUE CHAINS IN UGANDA AND EGYPT

Why these value chains?

The focus on only two countries for value chain work in the aquaculture sector acknowledges the challenge of taking a comprehensive value chain perspective and ensuring that a sufficient critical mass of people and resources are devoted to addressing the challenges identified.

We have chosen countries in Africa for three reasons.

First, because Africa is the most food insecure continent and it has the largest and fastest growing gap between fish supply and demand. While average global fish consumption rose from 12 to 16 kg/yr between 1973 and 1997, it fell in SSA from 9 to 6.6 kg/yr (Fish to 2030).

Second, because the African aquaculture sector has the most urgent need of support to develop at scale. Although growth in aquaculture is essential if Africa is to produce enough fish to feed its people, the sector makes a much lower contribution to fish supply than the rest of the world. African aquaculture currently produces less than 2% of global aquaculture production, representing less than 5% of Africa's fish (FAOStat, 2010).

Third, because aquaculture in Asia is much more developed and well served by several national and regional research agencies. As a result, given the likely limits to available funding in the near term, our contribution to Asia is best made through sharing the results of our foundational technology research and the IPGs that arise from our in-country learning.

Our choice of focal countries within Africa was guided by an initial screening to identify those countries where a) fish consumption was high relative to total animal protein consumption, b) there was significant undernourishment in the population and c) the baseline production in the aquaculture sector indicated potential for effective intervention. Table 4.1 summarizes data for the top 8 countries ordered by aquaculture production.

Table 4.1 Aquaculture production, the importance of fish in the diet and the level of undernourishment in the population for the top eight aquaculture producers in sub-Saharan Africa.

Country	Child Stunting[1] (% of Children < 5)	Fish Consumption[2] (% of total Animal consumption)	Aquaculture Production[3] (Tonnes in 2008)
Egypt	31	38	693,815
Nigeria	41	45	143,207
Uganda	39	63	52,250
United Rep of Tanzania	44	65	11,308
Madagascar	53	33	11,081
Zambia	46	56	5,640
Ghana	29	74	5,594
Kenya	36	38	4,452

1. Source: World Health Statistics (2010); 2. Source: Speedy (2003). Global Production and Consumption of Animal Source Foods. Journal of Nutrition. 133: 4048S-4053S; 3. Source: FAOStat (Online query).

The following criteria were then applied:

1. Markets for fish are developed to a scale that offers potential to support a value chain focus.
2. Potential for aquaculture production to contribute significantly to meeting national or regional fish demand within 5-7 years.
3. Food and nutrition security assessments indicate current situation as low or at risk.
4. National and regional policy environment supports the proposed approach.
5. International development agency policy environment supports the proposed approach.
6. Development Partners also identify aquaculture value chains as a fruitful area for investment.

Using these criteria we concluded that Uganda and Egypt should be our final choices.

An additional important consideration that guided this choice is the potential for learning that comes from working in two countries at contrasting stages in their aquaculture development (Fig 4.1). These differences will require different kinds of support, thereby offering different opportunities for learning.

		Uganda ↓	Egypt ↓	
Characteristic	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**
Primary focus	Household food security	Supply to immediate local markets. Rudimentary value chains	Supply to local and regional markets. Value chains increasingly well developed.	Supply to local and regional markets and retail chains. Maturing value chains.
Scale of production	On-farm	Small-scale enterprises	Mainly small-scale enterprise, but some MEs emerging.	Medium scale enterprises becoming dominant, some consolidation occurring.
Feed and seed supply	Rudimentary, with supply and quality problems.	Rudimentary, with supply and quality problems.	Functioning, but considerable scope for improvements in quality	Systems well developed and operating at a high standard.
Production Practices	Rudimentary, few adopted norms.	Rudimentary, few adopted norms.	Broadly sound, but considerable scope for improvements.	High standard. Focus on innovation to drive down production costs.
Support services	Poor to basic, farmer to farmer learning networks emerging.	Poor to basic, industry associations emerging.	Basic services available.	Well developed.
Primary Development Benefits	Household food and nutrition security	Household food security Income generation for farmers.	Stable and affordable fish supplies for poor consumers. Employment and income through value chain participation.	Stable and affordable fish supplies for poor consumers. Employment and income through value chain participation.

Figure 4.1. A model of the various stages of aquaculture development, showing the current position of Uganda and Egypt.

Our broad objective is to work with partners to help move each country to the next stage, thereby increasing the supply of affordable nutrition to poor consumers. (Note: support for countries at Stage 1 will be provided through livelihoods focussed approaches that form part of work under CRP 1.3 on Aquatic Agricultural Systems.

In the case of Egypt, we also took into consideration the opportunity to build on existing WorldFish infrastructure and capability in the country. A more complete rationale for the choosing each country is provided below, along with a description of the work to be undertaken.

Tilapia and Catfish in Uganda

The aquaculture sector in Uganda

> "With the increasing population, there has been an increasing local demand for fish. With export demand also rising, this has led to over-fishing, a shortage of fish and an approaching collapse of the capture fish industry (see Section 2.2.3). The potential, indeed necessity, to develop aquaculture becomes ever more pressing. There is good potential for this with numerous permanent water sources in the country, soils with high water retention capacities and suitable temperatures all the year round in low altitude areas." Government of Uganda (2010)

Albeit from a low base, at an APR between 2004 and 2006 of 142%, Uganda has had among the highest aquaculture growth rates in the world in recent years. Several thousand smallholders are involved, from subsistence levels to small enterprises, growing fish in earthen ponds and stocked community water reservoirs and minor lakes; there are also a few larger farms. The most recent data are from 2005 which indicated an estimated 20,000 ponds in the country with an average size of 500 m^2. Pond sizes range from less than 100 m^2 to about 6,000 m^2. Yields in 2005 ranged between 1,500 kg per ha per year for subsistence farmers to 15,000 kg per ha per year for emerging commercial fish farmers (FAO Country Profile, 2005).

Table 4.2. Criteria for final country selection and the rational for choosing Uganda.

Criteria	Rationale for Uganda
Markets for fish are developed to a scale that offers potential to support a value chain focus.	Second largest farmed fish producer in SSA, accounting for approx 20% of the total in 2008. (Nigeria largest producer at 55%). (FAO Stat, 2010). One of the largest gaps between fish supply and demand in Africa. Per capita fish supply declined by 37% between 1973 and 1997. Catches from wild capture fisheries continue to decline. A strong fish consumption culture. Supported to date by natural catch fisheries throughout the country, this culture is key to ensuring that value chain development is focussed on meeting a demonstrated demand. The demand for fish is further supported by income and population growth in urban areas, and an increasing and food insecure rural population. (Jagger and Pender 2002).
Potential for aquaculture production to contribute significantly to meeting national or regional fish demand within 5-7 years.	Significant Growth potential. 83% Average annual growth in production from 2000-2008 (c.f. Nigeria, 26%) (FAOStat, 2010). 31 districts identified by government as suitable for fisheries and/or aquaculture development based on both natural and socio-economic factors. (FAO Country Report, 2005). Potential to support regional fish demand. Uganda borders several countries that also have a high dependence on fish (e.g. DRC, Kenya, Tanzania, see Table 4.1). This offers considerable potential for increased production to meet regional demands.
Food and nutrition security assessments indicate current situation as low or at risk.	A looming food security crisis. It is predicted that an additional 14 million Ugandans will becoming food insecure in the next 10 years (Nigeria, 7 m). This is 4th largest projected increase in the world, exceeded only by DRC, Tanzania and Afghanistan. It is also joint 2nd largest in terms of percentage increase (100% increase c.f. Nigeria at 22%) (USDA, 2010a). (USDA Global Food Security Assessment 2010 – 2020).
National and regional policy environment supports the proposed approach.	The government of Uganda seeks to make 2.5 m households food secure in the next 5 years. Increased aquaculture production is a priority for helping to achieve this by meeting the local and regional fish supply gap. The 2004 National Fisheries Policy commits to increase aquaculture production by 200% from an estimated 2,000 t in 2004 to 100,000 t by 2014. The Ministry's National Aquaculture Development Strategy also provides indicative targets to: 1. Increase small-scale aquaculture from 5000 ha to 20,000 ha by 2015; 2. Increase large-scale aquaculture from 5,000 ha to 25,000ha by 2015, and; 3. Establish functional management systems at some 80 percent of the existing aquaculture water facilities. Regional Trade Policy is developing. Cross-border trade within the East Africa region is likely to improve with the signing of the East Africa Market Protocol. This will allows free movement of people and goods between markets in Kenya, Tanzania, Uganda, Rwanda and Burundi. USAID (2010b) (East Africa Regional Food Security Update, July 2010).
International development agency policy environment supports the proposed	USAID Feed the Future Initiative. Uganda is a target country for investment to "feed and stabilize the region while improving the lives of its farmers". Aquaculture is a target for scale up investment in 2010 to develop the value chains for fisheries and value-added products that addresses both food security and market development (USAID, 2010).

approach.	NORAD Fishery and Aquaculture Investments. Identified Uganda as a high potential location for investment (NORAD, 2009).

Development Partners also identify aquaculture value chains as a fruitful area for investment.	USAID LEAD (Livelihoods and Enterprises for Agricultural Development). The LEAD program has undertaken considerable work on Ugandan fish value chains and continues to prioritize this as a focal area for intervention. Save the Children. A recent consultancy commissioned by Save the Children recommends aquaculture as a high potential area for intervention. (Save The Children USA, 2008).

Improved market prices for fish have begun to attract entrepreneurial farmers, leading to a progressive increase in pond sizes. The Government of Uganda estimate that 20 to 30 percent of smallholder subsistence ponds have been transformed into profitable small-scale production units (ref) and that there are 2000 'commercial' farmers who own nearly 5,000 ponds, with an average pond size of 1,500 m^2. Two species comprise 99% of total production; African catfish accounts for 67% of production while Nile tilapia accounts for 32%. Since growth in aquaculture production of these two species is also fastest they represent an appropriate focus for this program.

Research, supporting action and partnership

Although the level of detail that can be provided at this proposal stage is necessarily limited, and notwithstanding the need for further targeted diagnoses, several studies of fish value chains in Uganda (Save The Children, 2008; USIAD Lead, 2010), and our own stakeholder consultations (see Box 4.1, below) indicate significant constraints that can be overcome and opportunities for improvement. Principal among these, and in common with many other locations in Africa and elsewhere, is the availability of affordable, good quality, seed of improved seed and feed inputs. For the sake of clarity we treat improved strains, feed and fish production as three separate, although interlinked value chains. Tables 4.3 and 4.4 summarize the key constraints, the research and supporting actions and the partnerships needed to deliver desired outcomes along the seed and feed input value chains for both catfish and tilapia. Table 4.5 focuses on the remaining elements of the fish production value chain.

Based on our initial stakeholder consultations (Box 4.1), our sense of the priority foci for this program are indicated in bold. Further discussion will be needed, however, to refine this assessment during the early phases of the program. Throughout we will seek to identify where these chains are, or could be, linked to other agricultural value chains to mutual benefit. For example, the existing links between poultry, livestock and fish feed manufacture offers potential for developing further synergies in product development, storage, transport and distribution and marketing.

Box 4.1
Stakeholder Consultation: Entebbe and Kampala 17th-20th Aug 2010

A stakeholder consultation undertaken in Uganda helped to refine this proposal. The purpose of this consultation was to:

1. Introduce our preliminary thinking to stakeholders and test it through dialogue.
2. Gauge the level of alignment between these ideas and the interests and needs of stakeholders.
3. Seek endorsement and support by relevant government agencies.
4. Identify development, research and policy partners to work with us to co-develop these ideas into a program that will really have impact at scale.

Consultations were held with key departments in the Ministry of Agriculture, Animal Industry and Fisheries, The Aquaculture Sector Working Group of the Plan for the Modernization of Agriculture, national research partners, ASARECA, and representatives from the private sector, NGO other CG centres and donors agencies.

The feedback we received and the endorsement of our ideas by the Minister of State for Fisheries and Ministry officials confirmed the compelling case for focussing on Uganda.

Full details of the consultation can be found at: http://livestockfish.wordpress.com/

As with the rest of this program, one important dimension concerns gender. As might be expected research to date indicates highly gender differentiated roles in the aquaculture sector in Uganda - a feature that validates the rationale for an explicit gender focus given earlier in this document (see Part 2: Research Theme 3). We will adopt a gendered approach to value chain analysis in Uganda, seeking improved understanding of current roles and opportunities for creating gender equitable opportunities in the development of the value chain and in deriving an equitable share of benefits among poor consumers. To help achieve this, we will work to develop the skills of program and partner staff to identify and address gender issues, especially those arising from technological innovation and from policy change. We will use the WorldFish framework and toolbox for mainstreaming gender analysis in fisheries and aquaculture research (WorldFish, 2010).

Our in-country consultations also helped us begin to develop the partnerships needed for this program and we have had strong expressions of support (see attached letters). At this stage, however, we have indicated these as indicative in the table because further work will be needed to build on our initial partnership discussions to ensure that interests and needs are aligned and roles and responsibilities are clear and capitalize on comparative advantages. We do not see any impediment to achieving this, but wish to be realistic about the level of engagement required and believe that co-development of the work program at its inception is a key to success. Importantly, however, the roles we outline in Tables 4.3 – 4.5 draw upon those described in the recent draft Aquaculture Strategy for Uganda that was developed jointly by the Ministry of Agriculture and FAO through a widely consultative process. They also reflect our preliminary discussions.

Table 4.3 Opportunities and constraints in the seed value chains and the research and development actions to overcome them.

Constraints	Researchable Issues and Supporting Actions	Indicative partners and their roles	Outcomes
 **Lack of quality broodstock**  **Genetic Improvement**	*Researchable Issues* • State of genetic resources of Ugandan Nile tilapia and African catfish • Breeding program design (including: Synthetic founder population establishment, choice of testing environments, breeding objectives and criteria, genetic evaluation system, selection and mate allocation, monitoring of genetic gain and on farm testing of the improved strains. • Risks associated with disseminating genetically improved strains *Supporting Actions* • Gender equitable approach to build hatchery broodstock management capacity • Build and implement risk management plan for use of genetically improved strains • **Broker dialogue to determine roles and options for private and public sectors and civil society, especially for women, in dissemination of broodstock**	*Research* • Farmers, hatcheries and Producer Organizations to help ensure the breeding program is designed and implemented in a manner that addresses their needs and to partner in relevant activities, including capacity building at all levels • NARO to partner on capacity building, developing and implementing breeding program • ARIs (Bergen, CIRAD, Dartmouth College, Notre Dame, Stirling, Wageningen) to partner on research, technical backstopping and capacity building *Supporting Actions* • Ministry of Agriculture to help prioritise actions and incorporate into government planning cycle and devise and implement risk management • NAADS to collaborate on gendered approach to capacity building • Hatchery owners and managers to partner in use and management of genetically improved broodstock • USAID LEAD to partner on disseminating genetically improved broodstock to hatcheries and evaluating their contribution to increased productivity and profits • Technical services providers to support use and management of genetically improved broodstock • Bilateral donors, microfinance providers and NGOs to support program implementation	• Widespread use of productive, fast growing broodstock strains that meets present and future anticipated needs of farmers
 **Poor hatchery performance**  **Improve hatchery design and management**	*Researchable Issues* • Hatchery design and gendered staffing and management practices • **Sources of mortality and mitigation approaches**. **Seed production technologies for high potential new species (e.g. *Barbus*, *Labeo*)** • Gendered impacts of technological and management changes and mitigation responses *Supporting Actions* **Identify priority areas for hatchery development and policy changes and public sector investments that are needed to create an enabling environment for the development of the hatchery sector** **Develop and disseminate simple guidelines and implement training for fry and fingerling management**	*Research* • Farmers, hatcheries and Producer Organizations to partner on improving hatchery design, management and M&E • NARO to partner on capacity building, developing and implementing improved seed production • USAID LEAD to partner on-hatchery management research • ARIs (Stirling, Wageningen) to partner on research, technical backstopping and capacity building *Supporting Actions* • Ministry of Agriculture to help prioritise actions and incorporate into government planning cycle and devise and implement biosecurity issues associated with use of genetically improved seed and disease • NAADS to collaborate on design and implementation of a gendered approach to capacity building • Hatchery owners and managers to partner in production and management of	• Widespread use of productive, fast growing seed that meets present and future anticipated needs of farmers

	Develop and promote hatchery business management tools • Design and promote gender equitable needs based training for hatchery operatives	genetically improved seed and capacity building • USAID LEAD to partner on dissemination of genetically improved broodstock to hatcheries and evaluation of their contribution to increased productivity and profits • Technical services providers to support use of genetically improved seed by farmers • Bilateral donors, microfinance providers and NGOs to support program implementation	
 **High transport associated mortalities**  **Improve fish transport**	*Researchable Issues* • **Transport and post-transport seed mortalities and transport practices** • Protocols for farmers to assess seed quality on delivery *Supporting actions* • Broker dialogues between farmer/groups, hatcheries/nurseries and transporters • Evaluate utility of nursing networks • to improve seed transport and stocking practices • Develop training materials for sharing with stakeholders (e.g. through adoption by TSPs and incorporation into farmer field schools and other relevant capacity building fora) • **Identify infrastructure weaknesses in priority aquaculture development areas**	*Research* • Farmers, hatcheries, Producer Organizations and transporters to help identify and prioritize critical steps in fish transport, devise effective and economically efficient solutions and build capacity within the transport sector • NARO to partner on research, capacity building and implementing improvements in the seed transport sector • USAID LEAD to partner on research and implementation of improvements in seed transport • ARIs (Bergen, CIRAD, Dartford College Notre Dame, Stirling, Wageningen) to partner on research, technical backstopping and capacity building *Supporting Actions* • Ministry of Agriculture to help establish priorities for action, including where infrastructure improvements should be prioritized • Hatchery operators, seed transporters and farmers to partner in development and adoption of better seed transport and stocking practices • NAADS to collaborate on gendered approach to capacity building among hatchery operators, seed transporters and farmers • USAID LEAD to partner on development of improved seed transport and stocking practices and evaluation of their contribution to increased productivity and profits • Technical services providers to support adoption and capacity building of hatcheries, transporters and farmers	• Reduced seed losses, reduced costs and increased production
 **Weak markets for quality seed**	*Researchable Issues* • **Performance and profitability of seed from improved strains** • **Production, economic returns and farmer satisfaction from use of seed from improved strains** *Supporting actions*	*Research* • Farmers, hatcheries and Producer Organizations to help assess impacts of improved seed quality on productivity and profits, • NARO to partner on on-farm and on-station research into impacts of improved seed on production and profits • Bilateral donors (EC, DFID, NORAD) to help implement program • ARIs (Stirling, Wageningen) to partner on market research, technical backstopping *Supporting Actions*	

Strengthen demand	• **Conduct on-farm demonstrations to show impacts of genetically improved strains on production and profitability** • **Formation of business-oriented and sustainable producer organizations** • Develop and implement a hatchery accreditation scheme in close consultation with relevant stakeholders (e.g. NAROs, hatchery managers, farmer organisations, environmental impact assessment agencies). • **Identify effective and cost-efficient interventions (e.g. contract growing, access to affordable credit) that will increase the use of quality seed by farmers**	• Ministry of Agriculture to help prioritise actions and develop appropriate policy support • NAADS to collaborate on gendered approach to capacity building • Hatchery owners and managers to partner in development and adoption of industry standards for producing and transporting of quality seed • Aquaculture enterprises to facilitate contract growing • USAID LEAD to partner in development of markets for quality seed • Technical services providers to support use and management of quality seed	• Demand led-increases in development and use by farmers of quality seed from genetically improved strains

Table 4.4 Opportunities and constraints in fish feed value chain and the research and development actions to overcome them

	Researchable Issues and Supporting Actions	Potential partners and their roles	Outcomes
Inputs & Services **Lack of affordable quality feedstuffs** **Identify materials and remove barriers to their supply**	*Researchable Issues* • **Nutritional content and value of key, especially locally produced, feedstuffs** • Methods of pre-treatment to reduce anti-nutrients and increase palatability and digestibility • **Markets, both agricultural and human, for feedstuffs** • **Impacts on ecosystem services (land, water, waste dispersion and assimilation)** • Use of wastes from pig and other animal production systems as pond fertilizers *Supporting Actions* • **Identify synergies with other agricultural feed producers** • **Promote best practices in processing and storage of feedstuffs**	*Research* • Farmers and feed producers to partner in identification and use of feedstuffs • NARO and Ugandan universities and ASARECA partner NARS and universities to carry out research on feedstuffs • ARIs (Bergen, CIRAD, Stirling, Wageningen) to partner on feedstuffs related research • CG Centers to partner on research into markets for feedstuffs and on feedstuff quality and development of pre-treatment methodologies *Supporting Actions* • Ministry of Agriculture to help prioritise actions and incorporate into government planning and policy making cycles • NARO and Ugandan universities and SRO partner country NARS and universities to partner on capacity development for feedstuff producers, transporters, feed producers and farmers • Feed producers to partner in developing and using feedstuffs quality standards • USAID LEAD to partner on identification of reliable supplies of locally available, affordable and nutritious feedstuffs	• Development of affordable nutritionally and environmentally sound, aquaculture feeds

Production **Nutritionally deficient feeds and poor technical support**  **Identify nutritional requirements and improve feed quality**	*Researchable Issues* • **Effects of feed formulation on pellet stability, palatability, food conversion and profitability** • Effects of diet on nutritional value of farmed fish • **Simple least cost formulation tools through farmer field schools and other mechanisms** • **Effects of feed production technologies on feed stability, palatability, food conversion ratio, profitability** • **Development of business case for investment in feeds and feed improvements** • **Advantages and disadvantages of large-scale versus small-scale commercial and on-farm feed production (quality and supply, profits and ecosystem services)** • Effects of processing technologies on ecosystem services and global warming potential and determine ways to reduce these *Supporting Actions* • **Broker and catalyze the partnerships needed to ensure uptake of results by feed manufacturers, including farmers**	*Research* • Farmers, feed producers and Farmer Organizations to improve the quality and performance of feeds • NARO and Ugandan universities and SRO partner country NARS and universities to partner on feed formulation and processing research • ARIs (Bergen, CIRAD, Stirling and Wageningen) to partner on research, technical backstopping and capacity development on feed production and on demand for ecosystem services • CG Centers, feed platform and Ugandan pig value chain MP to partner on feed production technology and related research *Supporting Actions* • Ministry of Agriculture to help identify and implement incentives to promote adoption of new feed processing technologies • Feed mill owners and managers to partner in production of feed that meets the needs of producers and in capacity development • USAID LEAD to partner on trialling development of feeds by local mills and farmers • TSPs to develop, promote and collect data on on-farm feed manufacture	• Reliable supplies of nutritionally sound, affordable and environmentally friendly feeds that meet the needs of farmers
Transport & Processing **Feed spoilage and poor distribution networks** 	*Researchable Issues* • **Impacts of storage conditions on nutritional value of feeds and on contaminants** • **Feed transport constraints and methods to address these, including synergies with other agricultural input distribution and storage services** • **Business incentives to make the feed supply/ transport system work efficiently at scale** *Supporting Actions* • **Develop effective and cost-efficient interventions to**	*Research* • Farmers, hatcheries, Producer Organizations and transporters to help identify and prioritize critical steps in feed transport, devise effective and economically efficient solutions and build capacity within the transport sector • NARO and Ugandan universities and SRO partner country NARS and universities to partner on research on feed storage • USAID LEAD to partner on research in feed transport and storage • ARIs (CIRAD, Stirling) to partner on research and technical backstopping on feed storage *Supporting Actions* • Ministry of Agriculture to help establish and implement priorities to improve feed transport, including infrastructure improvements	• Affordable quality feeds available to all producers

Improve feed distribution and storage	**facilitate access to quality affordable feeds** • Develop storage guidelines for farmers • Create gender equitable employment opportunities	• Feed producers, transporters, farmers and Producer Organizations to help develop and adopt better feed transport and storage practices to improve quality and reduce costs • NAADS to collaborate on gendered approach to capacity development among feed transporters and farmers • USAID LEAD to partner on brokering improvements in feed availability • Technical services providers to support transporters and farmers on best practices for feed transport and storage	
 **Poorly developed feed markets**  **Improved institutions and information**	*Researchable Issues* • Current and future market demand for aquaculture feeds • **Simple tools that allow farmers to determine the role of feeds in production and profits** • Roles of private and public sector and civil society in developing markets for feeds *Supporting Actions* • **Develop Producer Organizations in value chain areas to reduce costs of feed purchases** • **Develop extension materials on feed management for farmers and POs**	*Research* • Farmers, hatcheries, Producer Organizations and transporters to help identify constraints to feed use • NARO and Ugandan universities to partner on research on feed markets • USAID LEAD to partner on research in feed markets • ARIs (Stirling) to partner on research into aquaculture feed markets *Supporting Actions* • Farmers and Producer Organizations to help develop capacity to purchase and distribute feeds, thereby reducing costs • NAADS, TSPs, USAID LEAD and NGOs to co-develop and promote best practices on use of feeds	• Strong demand for quality and profitable feeds by farmers

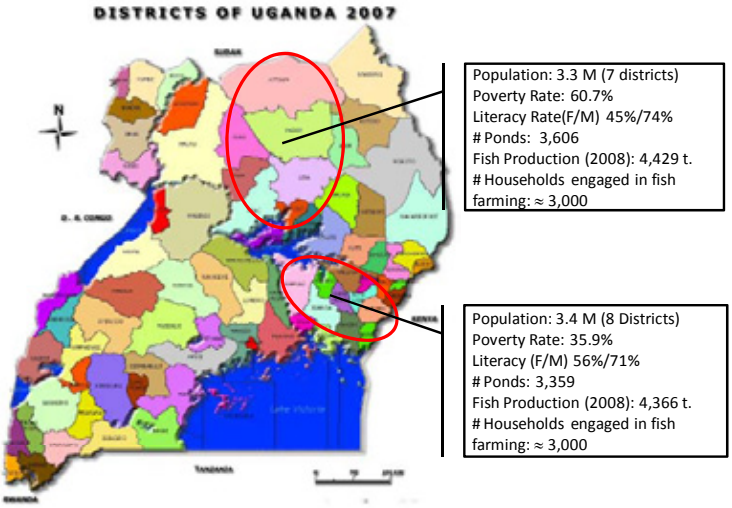
Table 4.5 Opportunities and constraints in tilapia and catfish production value chain in Uganda and the research and development actions to overcome them

	Researchable Issues and Supporting Actions	Indicative partners and their roles	Outcomes
 **Lack of quality and availability**  **Improve access to quality business and technical advice, affordable credit, seed and feed and fertilizer**	*See seed and feed value chains above*	*See seed and feed value chains above*	• Farmers able to access quality seed, feed and technical advice that meets their needs
 **Low productivity, poor production practices and marginal profitability**  **Improve**	*Researchable Issues* • Fertilization regimes • System-specific business plans • **Species and production system-specific feeding and fertilization regimes to maximize productivity and profits** • Impacts of production intensification on gender and household power relations • **Feasibility and pro-poor and gender equitable benefits from contract growing** *Supporting Actions* • **Develop record keeping, technical capacity and business skills among producers** • **Develop soft skills (e.g. communication, business, negotiation, gender awareness) among CG staff** • **Develop technical, communications and business**	*Research* • Farmers, feed producers and Farmer Organizations to seek gender equitable methods (including contract growing) to increase production and productivity • NARO and Ugandan universities and SRO partner country NARS and universities to partner on developing productive and profitable technologies • ARIs (Bergen, CIRAD, Stirling and Wageningen) to partner on research, technical backstopping and capacity development *Supporting Actions* • Farmers and POs to help identify capacity building needs, develop capacity building materials and participate in capacity building programs, and to participate in technology development • Ministry of Agriculture to help identify and implement incentives	• Increased farmed fish production and consumption by the poor

production practices	**skills among NAADS staff and TSPs** • **Develop research skills among NARO and university staff** • **Develop capacity development material for use by NAADS and TCPs**	to adoption of productive and profitable technologies • NAADS and TCPs to participate in development of staff communication and gender awareness skills • TSPs, USAID LEAD and NGOs to partner on gendered technology development and dissemination to farmers	
 **Low quality and limited value adding**  **Improve quality and seek equitable value added opportunities**	*Researchable Issues* • **Impacts of harvesting and transport on post harvest quality, food safety and price** • **Impact of cost-effective cold chain on returns throughout the value chain** • **Options for post harvest processing to improve storage or add value** *Supporting Actions* • Develop and deliver training on fish transport • **Seek synergies with other food , especially livestock, in transport and cold chains** • **Design and implement improvements to road and other infrastructure** • Create gender equitable employment opportunities	*Research* • Farmers, hatcheries, Producer Organizations and transporters to help identify and prioritize critical steps in fish transport, devise effective and economically efficient solutions and build capacity within the transport sector • NARO and Ugandan universities and SRO partner country NARS and universities to partner on research on fish processing and cold chain development *Supporting Actions* • Ministry of Agriculture to help establish and implement priorities to improve feed transport, including road and other infrastructure improvements • Transporters, farmers and Producer Organizations to help develop and adopt better fish transport practices to improve quality, food safety and reduce post-harvest losses and prices • NAADS to collaborate on capacity development among fish transporters • USAID LEAD to partner on brokering improvements in fish transport systems • Technical services providers to support farmers on development of best practices for harvesting and post-harvest handling	• Increased quantities of affordable and nutritionally sound fish and fish products in markets
 **Poorly developed markets** 	*Researchable Issues* • **Present and likely future demand for different farmed fish products among poor consumers** • **New markets for novel products** • **Mechanisms to increase communication between customers and producers to test the hypothesis that farmers will use the information to better target production to market demand** • **Use of ICT to reduce knowledge imbalances and improve value chain efficiency** • **The role of POs in marketing** • Drivers of competition among local, national and	*Research* • Farmers, consumers and Producer Organizations NARO and Ugandan universities to collaborate on fish market research • NGOs to partner on market research and development • ARIs (Stirling) to partner on research into marketing of aquaculture products	• Strong demand for - and increased access to - farmed fish products by poor and vulnerable consumers

Awareness raising among poor consumers	regional markets for farmed fish • Impacts of increased fish supply on consumption by vulnerable groups, including women and children *Supporting Actions* • **Develop capacity to conduct market research** • Develop capacity to collect human health and nutrition data	*Supporting Actions* • Farmers, Producer Organizations and traders to collaborate on development of marketing skills, use of ICT and collection of data • NAADS, TSPs, USAID LEAD and NGOs to support farmers in adoption of ICT	

Geographic Focus



Biophysical analysis shows that fish farming can be undertaken across most of Uganda (FAO Country Report, 2005). Our in-country consultations, however, have helped us identify two contrasting areas as the focus for this program (Fig 4.2). The northern area is one of considerable focus for rehabilitation following the recent period of conflict. Infrastructure investments are now being made and the Ugandan government has identified this as a priority region for aquaculture development. The region is characterized by a very high un-met demand for fish both locally and for cross border trade with southern Sudan. In contrast, the south eastern region has better infrastructure and somewhat lower poverty rates. The market demand for fish from this area comes from local markets the urban markets of Kampala and Entebbe and cross border demand from Kenya. It is also a government priority area for aquaculture development.

We believe these areas provide not only the greatest potential for impact but also that the contrasts between them offer excellent opportunities for learning. The north is one of the poorest and least accessible regions of the country but it is one where local and regional demand for fish is very high. In contrast, the southeast region has good connection to urban centres and there is existing interest by the private sector in investing in fish farming. There is considerable potential for growth in fish production in both regions but the differing contexts should provide greater insights with regard to effective development pathways elsewhere.

Potential for Impact

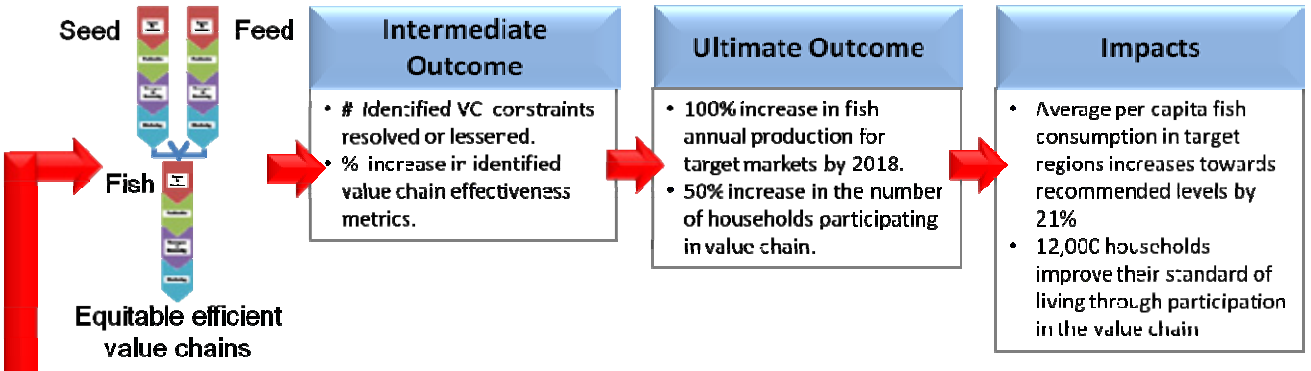
Production levels from each of our two target regions in 2008 were of the order of 4,500 tonnes. Because annual average growth rates are slowing as value chain barriers have developed we assume baseline (do nothing) growth rates of 3%. Under these assumptions expected production by 2018 would total just over 11,000 tonnes for the two regions combined. If the proposed program is successful, we believe it is possible to double annual production by 2018 to 22,000 tonnes. This will require annual average growth rates of approximately 13.5% - a challenging but achievable target, assuming that the partnerships we have identified are well structured and effective.

Overall, this growth would yield an additional 11,000 tonnes of fish per year over baseline (do nothing) levels, distributed evenly between the two regions. Assuming that 75% of additional production is supplied to consumers within the northern area, with the remainder traded across Uganda's northern border it would provide an additional 1.5 kg of fish per person per year. Assuming higher (50%) levels of trade in the southeast, increased annual consumption here would be of the order of 1 kg per person. These values represent a 25% and a 17% increase in per capita consumption for the populations in northern and southeastern areas, respectively. This of course ignores the contributions traded fish would make to nutrition outside the target regions.

We estimate that approximately 3,000 households participate in fish production in each of the regions and believe it is possible to increase this total by 50% by 2017. Improving the livelihoods of both current farmers and these 3,000 new entrants would, therefore, reach 9,000 households. In addition, we anticipate benefits to a further 3,000 participants participating in the upstream and downstream linkages in the target value chains.

The figure below summarises the pathway from the target outcomes identified in Tables 4.3 – 5 for each component of the value chains through to the impact on food security.

Although these calculations are necessarily crude, and will need to be further refined during the early phase of this work, we believe they offer a realistic picture of the local returns to investment. The impacts of wider capacity building efforts and uptake and scale-out beyond the target region would add to the total benefits that can be expected from this work, but we have made no effort to quantify this.



Value Chain Outcomes

VC Component	Seed	Feed	Fish Production
Inputs and Services	Widespread use of productive, fast growing broodstock strains that meets present and future anticipated needs of farmers	Development of affordable, nutritionally and environmentally sound aquaculture feeds	Farmers able to access quality seed, feed and technical advice that meets their needs
Production	Widespread use of productive, fast growing seed that meets present and future anticipated needs of farmers	Reliable supplies of nutritionally sound, affordable and environmentally friendly feeds that meet the needs of farmers	Increased farmed fish production and consumption by the poor
Processing	Reduced seed losses, reduced costs and increased production	Affordable quality feeds available to all producers	Increased quantities of affordable and nutritionally sound fish and fish products in markets
Marketing	Demand led-increases in development and use by farmers of quality seed from genetically improved strains	Strong demand for quality and profitable feeds by farmers	Strong demand for - and increased access to - farmed fish products by poor and vulnerable consumers

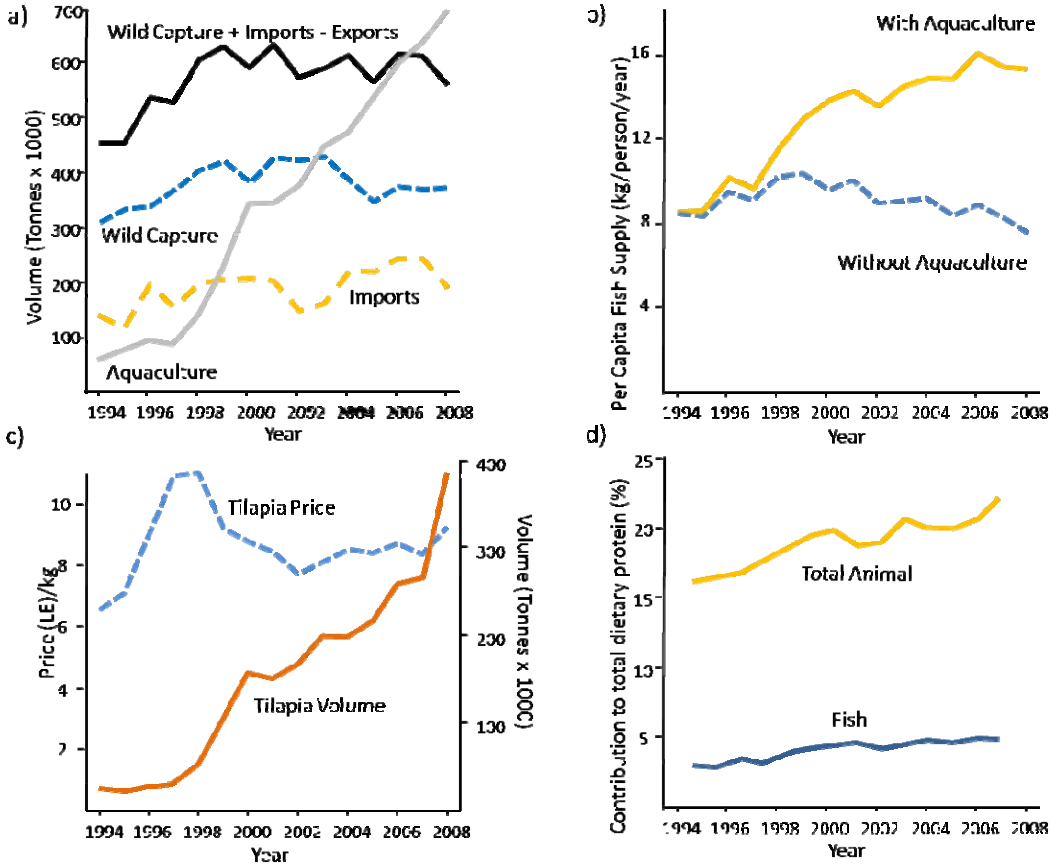
Tilapia in Egypt

The aquaculture sector in Egypt

Egyptian aquaculture has grown rapidly over the past decade and is an important component of national food supply. Valued at some LE 4.0 billion at first sale, all of which supplies domestic markets, farmed fish now contribute over 65% of total national fisheries production, up from 15% in 1994. Aquaculture production increased from 57,000 tonnes in 1994 to 694,000 tonnes in 2008, an average 21% growth annually. In contrast, wild capture supplies have been stable or declining since 1998, fish imports have remained relatively stable and exports have been minimal (Fig 4.3a). During the same 1994 to 2008 period the Egyptian population grew by 36%, from 60.1 million to 81.7 million.

Despite the large population increase, the stagnation of wild fish production and the stable trend in imports, per capita fish supply increased from 8.5 kg to 15.4 kg/person/yr during this period (Fig 4.3b). In the absence of aquaculture, but with other supplies remaining the same, this figure would have fallen to 7.6 kg by 2008.

Growth in aquaculture production also affected the affordability of fish for consumers. With tilapia for example, which constitutes over 50% of all farmed fish by weight, a trend of increasing price from 1994 to 1998 was reversed over the next four years. Since then prices have risen slowly, but remain well short of the peak in 1997. Thus, fish farming has increased fish supply for consumers and maintained affordable prices (Fig 4.3c). This has contributed to a doubling between 1994 and 2008 of the contribution that fish protein makes to total protein in the Egyptian diet (Fig 4.3d). Prices for tilapia remain well below those for chicken meat; in urban markets they were 35% lower in 2007 and 42% lower in rural markets.



Despite this impressive growth and current value, however, aquaculture production will need to rise further in coming years to meet growing demand for fish. Even more will be required for fish to continue to be available to people with lower incomes. To meet projected national needs for the next 10-15 years, aquaculture production of some 1.0 - 1.6 million tonnes will be required. Analysis of the sector indicates that this growth will need to primarily be based on the expansion of tilapia aquaculture in semi-intensive to

intensive ponds (WorldFish, 2007). To meet this production growth target significant challenges in terms of resources, technology, investment and sector organisation must be met. At present the sector's growth is slowing and, together with increasing pressure on land and water resources in the Nile Delta, the principle area of production, improvements in production efficiency are essential if growth is to continue.

Table 4.6. Criteria for final country selection and the rational for choosing Egypt.

Criteria	Egypt
Markets for fish are developed to a scale that offers potential to support a value chain focus.	Largest farmed fish producer in Africa (650,000 t), accounting for approximately 70% of production. Large increase in projected demand. If consumption is maintained at the 2002 level of more than 14 kg per capita, domestic demand would be 1,148,300 t and 1,369,900 t in 2010 and 2025 respectively. This would require increases of 20.5% and 43.7% above 2002 supply levels. A strong fish consumption culture. The expansion of aquaculture has succeeded in reducing and stabilizing the cost of fish in Egypt allowing accessibility to the poorer rural population to healthy and affordable animal protein.
Potential for aquaculture production to contribute significantly to meeting national or regional fish demand within 5-7 years.	Required growth achievable, but only through sustainable intensification of production. The average annual growth required for aquaculture to double in output in 10 years would be 7.2%. According to national statistics, this compares with 24.4% over the last 10 yrs, 16.1% over the last 5, and 12.0% over the last 2 years. This suggests that doubling is not unreasonable, but the sector will need specific attention to reduce costs and increase resource use efficiencies. (Egyptian Aquaculture Strategy, 2008).
Food and nutrition security assessments indicate current situation as low or at risk.	Egypt is a low-income, food-deficit country, with 19.6% of the population – almost 14.2 million people – living below the lower poverty line on less than US$1/day. Malnutrition and undernutrition is common. In 2008 29% of children under 5 were 'stunted', 6% were 'underweight' and 7% were 'wasted' (Egyptian Ministry of Agriculture and Land Reclamation, 2010). "Stark geographical disparities exist between the region of Upper Egypt, desert areas in Sinai and the Red Sea – which are some of the country's poorest areas with high levels of food insecurity and malnutrition" WFP (2010).
National and regional policy environment supports the proposed approach.	The General Authority for Fish Resources Development (GAFRD) has set a goal of 1.1 million metric tons of farmed fish, equivalent to around 75 percent of total fish production, by 2012. It hopes to increase average annual production of freshwater fish farms to 5 tons per acre, up from an average of 1-3 tons per acre (2.5 – 7 metric tons per hectare). Development of the 2008 Egyptian Aquaculture Strategy was supported by WorldFish. This proposal aligns fully with the country strategy. Egypt has a regional role to in capacity building and sharing lessons as a member of the African Union and COMESA, and as the continent's leader in aquaculture. WorldFish facilities at Abbassa and the training programs it provides are a key element in this capacity building capability.
International development agency policy environment supports the proposed approach.	Egypt is not currently a priority country for many development agencies, but some see it as of considerable strategic importance. Canadian CIDA, have small and medium enterprise development as one of two thematic program pillars in their Country Development Programming Framework (CDPF) for Egypt (2001-2011). USAID support to Egypt is greater than for all other countries except Israel. IFAD supports Egypt with a priorities to both "encourage private sector development and enhance agricultural competitiveness", and "promote innovative research and extension systems that respond to the need of small farmers and rural women".
Development Partners also identify aquaculture value chains as a fruitful area for investment.	The Netherlands Government invested in development of SME aquaculture through the agribusiness sector between 2005 and 2009. FAO and JICA have funded a large number of regional and national capacity building courses at the WorldFish Abbassa Center and at public and private sector partner training facilities. The private sector has invested in the development of high quality, low fishmeal and fish oil feeds

	The EC and Government of Egypt have invested in the development of genetically improved strains of tilapia and African catfish, the former now being ready for large-scale multiplication and dissemination to farmers.

Research, supporting action and partnership

The importance and future challenges of the aquaculture sector are widely recognised in Egypt and have attracted considerable response at public and private sector level. A series of workshops and consultations since 2005 has examined the sector, discussed the specific constraints and challenges, and made technical recommendations on issues to be addressed to support successful growth. A comprehensive stakeholder consultation in 2007 facilitated by WorldFish at the request of the Ministry of Agriculture culminated in a detailed sectoral analysis and series of recommendations to support sectoral growth (WorldFish, 2007). These recommendations focussed on four essential components that are required for positive development of the sector: (i) production efficiency; (ii) market development; (iii) policy and institutions; and (iv) research, development and capacity building.

Since that time we have worked with the Ministry of Agriculture, the Agricultural Research Council, The General Authority for Fisheries Research and Development and the private sector to gain support to help implement these recommendations. This CRP provides an ideal context for the CGIAR to more fully engage in and support this effort through an enhanced research and capacity building effort that builds on these relationships.

There is limited information at this stage on market chains, volumes and margins, and also on the respective market power. This will have to be built up more strongly for future understanding of the sector's potential. It appears that traditional local and city market structures still represent the bulk of trading, mainly operating through traditional wholesalers. However, contract buying from some fish farms or producer groups has been reported, which is consistent with aquaculture-linked market changes seen in other countries. A large quantity of tilapia is transported to the main national market of El-Obour for auction and further distribution throughout Greater Cairo. Its capacity is estimated from 100 to 150 t per day (~ 30,000-50,000 t per year). This was reported to be similar to the estimated quantities entering the Greater Cairo area from all other sources directly to traders, retailers and hotels (Feidi, 2004).

There is also a substantial research agenda concerning access to fish and food choice by poor consumers and the constraints and issues surrounding this. Our hypothesis is that a value chain approach to supporting development of the sector can drive positive development impacts for poor consumers. Testing this will require research effort to better understand the relationships between increases in production, availability and price for poor consumers, the food choices they make and resultant health and nutrition outcomes. The gender dimensions of these topics are of considerable importance and will receive particular attention. Here, linkages with CRP will be explored and elaborated at an early opportunity.

In the tables below, we summarize the conclusions from our research and consultations to date on the research foci for this work, using the value chain framework adopted throughout this CRP.

Table 4.7 Opportunities and constraints in the seed value chains and the research and development actions to overcome them.

Constraints	Researchable Issues and Supporting Actions	Indicative partners and their roles	Outcomes
 **Broodstock performance**  **Genetic Improvement**	*Researchable Issues* • **Breeding program evaluation and adaptation (including: breeding objectives and criteria, genetic evaluation system, selection and mate allocation, monitoring of genetic gain and on farm testing of the improved strains).** • Risks associated with disseminating genetically improved strains *Supporting Actions* • **Develop industry wide breed improvement strategy** • Gender equitable approach to build hatchery broodstock management capacity • **Broker dialogue to determine roles and options for private and public sectors in dissemination of broodstock.**	*Research* • Farmers, hatcheries and Producer Organizations to help ensure the breeding program is designed and implemented in a manner that addresses their needs and to partner in relevant activities, including capacity building at all levels • Private sector to partner on capacity building, developing and implementing breeding program • CLAR to help develop genetically improved strains. • ARIs (Bergen, CIRAD, Dartmouth College, Notre Dame, Stirling, Wageningen) to partner on research, technical backstopping and capacity strengthening *Supporting Actions* • Ministry of Agriculture to help prioritise actions and incorporate into government planning cycle and devise and implement risk management • Hatchery owners and managers to partner in use and management of genetically improved broodstock • Technical services providers to support use and management of genetically improved broodstock • Bilateral donors, microfinance providers and NGOs to support program implementation	• Widespread use of productive, fast growing broodstock strains that meets present and future anticipated needs of farmers
 **Hatchery performance**  **Improve hatchery design and management**	*Researchable Issues* • Hatchery design and gendered staffing and management practices • Sources of mortality and mitigation approaches. • Gendered impacts of technological and management changes and mitigation responses *Supporting Actions* **Facilitate new models for hatchery development and policy changes and public sector investments that are needed to improve the quality and service level of the hatchery sector** **Develop and disseminate best practice guidelines and quality standards.** Backstop training for fry and fingerling management • Develop and promote hatchery business management tools	*Research* • Farmers, hatcheries and Producer Organizations to partner on improving hatchery design, management and M&E • Private sector to partner on capacity building, developing and implementing improved seed production • ARIs (Stirling, Wageningen) to partner on research, technical backstopping and capacity building *Supporting Actions* • Ministry of Agriculture to help prioritise actions and incorporate into government planning cycle and devise and implement biosecurity issues associated with use of genetically improved seed and disease • Hatchery owners and managers to partner in production and management of genetically improved seed and capacity building • Technical services providers to support use of genetically improved seed by farmers • Bilateral donors, microfinance providers and NGOs to support program implementation	• Widespread use of productive, fast growing seed that meets present and future anticipated needs of farmers

	• Design and promote gender equitable needs based training for hatchery operatives		
 **High transport associated mortalities and deterioration in seed quality**  **Improve fish transport**	*Researchable Issues* • **Transport and post-transport seed mortalities and transport practices** • Protocols for farmers to assess seed quality on delivery • Performance of stocked seed as a function of size, health and strain *Supporting actions* • Broker dialogues between farmer/groups, hatcheries/nurseries and transporters • **Identify infrastructure weaknesses in priority aquaculture development areas** • **Identify infrastructure weaknesses in priority aquaculture development areas**	*Research* • Farmers, hatcheries, Producer Organizations and transporters to help identify and prioritize critical steps in fish transport, devise effective and economically efficient solutions and build capacity within the transport sector • ARIs (Bergen, CIRAD, Dartford College Notre Dame, Stirling, Wageningen) to partner on research, technical backstopping and capacity building *Supporting Actions* • Hatchery operators, seed transporters and farmers to partner in development and adoption of better seed transport and stocking practices • Technical services providers to support adoption and capacity building of hatcheries, transporters and farmers	• Reduced seed losses, reduced costs and increased production
 **Business case for genetically improved seed widely appreciated**  **Improve evidence and marketing**	*Researchable Issues* • **Performance and profitability associated with use of seed from improved strains** • **Production, economic returns and farmer satisfaction from use of seed from improved strains** *Supporting actions* • **Conduct on-farm demonstrations to show impacts of genetically improved strains on production, productivity and profitability** • **Develop traceability systems and standards** • Develop and implement a hatchery accreditation scheme in close consultation with relevant stakeholders (e.g. Ministry of Agriculture, hatchery managers, farmer organisations).	*Research* • Farmers, hatcheries and producer organizations to help assess impacts of improved seed quality on productivity and profits, • CLAR to partner on on-farm and on-station research into impacts of genetically improved seed on production and profits • Bilateral donors to help implement program • ARIs (Stirling, Wageningen) to partner on market research, technical backstopping *Supporting Actions* • Ministry of Agriculture to help prioritise actions and develop appropriate policy support • Hatchery owners and managers to partner in development and adoption of industry standards for producing and transporting of quality seed • Technical services providers to support use and management of quality seed	• Demand led-increases in development and use by farmers of quality seed from genetically improved strains

Table 4.8 Opportunities and constraints in fish feed value chain and the research and development actions to overcome them

	Researchable Issues and Supporting Actions	Potential partners and their roles	Outcomes
 **Reliance on imported feed - stuffs, with large ecological foot-print**  **Improved LCA values and traceability**	*Researchable Issues* • **LCA analysis of feed industry, identification of reliable supplies of affordable and nutritious local feed ingredients** • Competition between feed producers and poor consumers for feed ingredients and effects on prices • **Tailored feeds for key production stages** • **Quality control and testing approaches** • **Development, costing and adoption of traceability processes in feed manufacture** • **Benefits of probiotics** *Supporting Actions* • Disseminate results to industry, producers and policy makers •	*Research* • ARIs (Bergen, CIRAD, Stirling and Wageningen) to partner on research, technical backstopping and capacity development on feed production • CLAR and other Egyptian agriculture research centers to collaborate on research into locally produced feedstuffs *Supporting Actions* • Ministry of Agriculture to help prioritise actions and incorporate into government planning and policy making cycles • Capacity enhancement of public and private sector trainers • Development and adoption of environmental criteria for feed production	Development of environmentally sound aquaculture feeds, based on local ingredients, that meet international standards of traceability
 **Expensive, energy-intensive feeds**  **Profitable, nutritionally sound and**	*Researchable Issues* • **Effects of diet on nutritional value of farmed fish** • **Effects of feed production technologies on feed stability, palatability, food conversion ratio, profitability** *Supporting Actions* • **Broker and catalyze the partnerships needed to ensure uptake of results by feed manufacturers, including farmers**	*Research* • Farmers, feed producers, Farmer Organizations and CLAR to collaborate to improve the quality and performance of feeds • ARIs (Bergen, CIRAD, Stirling and Wageningen) to partner on research, technical backstopping and capacity development on feed production *Supporting Actions* • Ministry of Agriculture to help identify and implement incentives to promote adoption of new feed processing technologies • Feed mill owners and managers to partner in production of feed that meets the needs of producers and in capacity development • TSPs to develop, promote and collect data on on-farm feed manufacture	• Reliable supplies of nutritionally sound, affordable and environmentally friendly feeds that meet the needs of farmers

environmentally friendly feeds			
 **Inefficient feed distribution chains**  **Improved feed distribution and storage**	*Researchable Issues* • Impacts of transport on feed costs and performance • Impacts of storage conditions on nutritional value of feeds and on contaminants *Supporting Actions* • Disseminate best practice guidelines	*Research* • CLAR and Egyptian universities and to partner on research on feed storage • ARIs (CIRAD, Stirling) to partner on research and technical backstopping on feed storage *Supporting Actions* • Ministry of Agriculture to help establish and implement priorities to improve feed transport, including infrastructure improvements • Feed producers, transporters, farmers and Producer Organizations to help develop and adopt better feed transport and storage practices to improve quality and reduce costs • Technical services providers to support transporters and farmers on best practices for feed transport and storage	• Affordable quality feeds available to all producers
 **Poorly developed feed markets**  **Improved understanding by producers of feed quality issues**	*Researchable Issues* • **Current and future market demand for aquaculture feeds** • **Impacts of feed formulations and production methods on feed performance and environmental impacts** *Supporting Actions* • **Develop Producer Organizations in value chain areas to reduce costs of feed purchases** • **Develop extension materials on feed management for farmers and POs**	*Research* • CLAR, Egyptian universities and private sector feed companies to partner on research on feed markets • ARIs (Stirling) to partner on research into aquaculture feed markets *Supporting Actions* • Farmers and Producer Organizations to help develop capacity to purchase and distribute feeds, thereby reducing costs • NAADS, TSPs, and NGOs to co-develop and promote best practices on use of feeds	• Strong demand for quality and profitable feeds by farmers

Table 4.9 Opportunities and constraints in tilapia production value chain in Egypt and the research and development actions to overcome them

	Researchable Issues and Supporting Actions	Indicative partners and their roles	Outcomes
 **Lack of quality and availability**  **Improved access to quality business and technical advice, affordable credit, seed, feed and fertilizer**	*See seed and feed value chains above*	*See seed and feed value chains above*	• Farmers able to access quality seed, feed and technical advice that meets their needs
 **Low productivity, poor production practices and marginal profitability**  **Improved**	*Researchable Issues* • **Production system-specific feeding regimes to maximize productivity and profits in the production of fish that target pro-poor markets** • **Improved land use and water management** • **Integration with crop production** • **Development of recirculation aquaculture systems and their associated impacts on LCA** • **Aquaculture waste treatment/use** *Supporting Actions* • **Develop record keeping, technical capacity and business skills among producers** • **Develop soft skills (e.g. communication, business, negotiation, gender awareness) among CG staff**	*Research* • Farmers, feed producers and Farmer Organizations to seek gender equitable methods (including contract growing) to increase production and productivity • CLAR and Egyptian universities to partner on developing productive and profitable technologies ARIs (Bergen, CIRAD, Stirling and Wageningen) to partner on research, technical backstopping and capacity development *Supporting Actions* • Farmers and POs to help identify capacity building needs, develop capacity building materials and participate in capacity building programs, and to participate in technology development • Ministry of Agriculture to help identify and implement incentives to adoption of productive and profitable technologies	• Increased farmed fish production and availability to the poor

productivity, profitability and production and reduced ecological footprint		• NAADS and TCPs to participate in development of staff communication and gender awareness skills • TSPs, USAID LEAD and NGOs to partner on gendered technology development and dissemination to farmers	
 **Variable quality of limited range of products**  **Improve quality and seek equitable value added opportunities**	*Researchable Issues* • **Impacts of harvesting and transport on post harvest quality, food safety and price** • **Impact of cost-effective cold chain on returns throughout the value chain** • **Options for post harvest processing to improve storage or add value** *Supporting Actions* • Develop and deliver training on fish transport • **Seek synergies with other food , especially livestock, in transport and cold chains** • **Design and implement improvements to road and other infrastructure** • Create gender equitable employment opportunities	*Research* • Farmers, hatcheries, producer organizations and transporters to help identify and prioritize critical steps in fish transport, devise effective and economically efficient solutions and develop capacity within the transport sector • CLAR and Egyptian universities to partner on research on fish processing and cold chain development *Supporting Actions* • Ministry of Agriculture to help establish and implement priorities to improve feed transport, including road and other infrastructure improvements • Transporters, farmers and Producer Organizations to help develop and adopt better fish transport practices to improve quality, food safety and reduce post-harvest losses and prices • With NARs develop capacity among fish transporters • Technical services providers to support farmers on development of best practices for harvesting and post-harvest handling	• Increased quantities of affordable and nutritionally sound fish and fish products in markets
 **Poorly developed markets** 	*Researchable Issues* • **Impacts of increased fish supply on consumption by vulnerable groups, including women and children** • **Present and likely future demand for different farmed fish products among poor consumers** • **The role of gender in demand patterns among poor consumers and barriers to consumption as part of a balanced diet** • **New markets for novel products that are attractive and affordable to poor consumers** • **Mechanisms to increase communication between customers and producers to test the hypothesis that farmers will use the information to better target production to market demand**	*Research* • Farmers, consumers and Producer Organizations, ARC and Egyptian universities to collaborate on fish market research • NGOs and health sector to partner on market research and development • ARIs (Stirling) to partner on research into marketing of aquaculture products	• Strong demand for - and increased access to – nutritionally sound farmed fish products by poor and vulnerable consumers

Awareness raising among poor consumers	• **Use of ICT to reduce knowledge imbalances and improve value chain efficiency** • **The role of POs in marketing** • Drivers of competition among local, national and regional markets for farmed fish *Supporting Actions* • **Develop capacity to conduct market research** • **Develop capacity to collect human health and nutrition data**	*Supporting Actions* • Farmers, Producer Organizations and traders to collaborate on development of marketing skills, use of ICT and collection of data	

Geographic Focus

The key to increasing tilapia production in Egypt lies primarily in supporting farmers in existing growing regions, although there is some potential to expand to new areas. Most tilapia production is concentrated in the Nile delta, close to the Northern Lakes, with some in Fayoum. In 2004[8] about 96% of total production was in the delta, while Fayoum accounted for 3.3%, farms south of Fayoum 0.3%, and farms near Cairo around 0.1%. In the delta area Kafr-El Sheikh governorate produced most tilapia followed by Damietta and Sharkia, at 88,079 t, 36,319 t and 30,186 t respectively. About 89% of tilapia production derived from earthen ponds, the remaining 11% being from intensive production in cages and tanks. These regions and production systems will be the focus for work on the production elements of the fish value chains. With respect to downstream linkages, however, the major markets in Egypt, both urban and rural will be the focus.

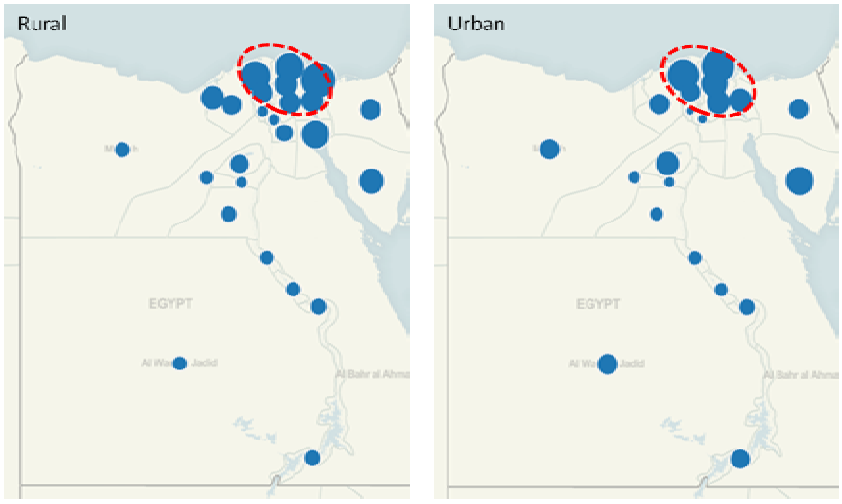


Figure 4.4 Map showing the main tilapia producing region and the the relative contribution (by weight) of fish to the diet of rural and urban populations in each Egyptian Governorate (Source Galal, 2007).

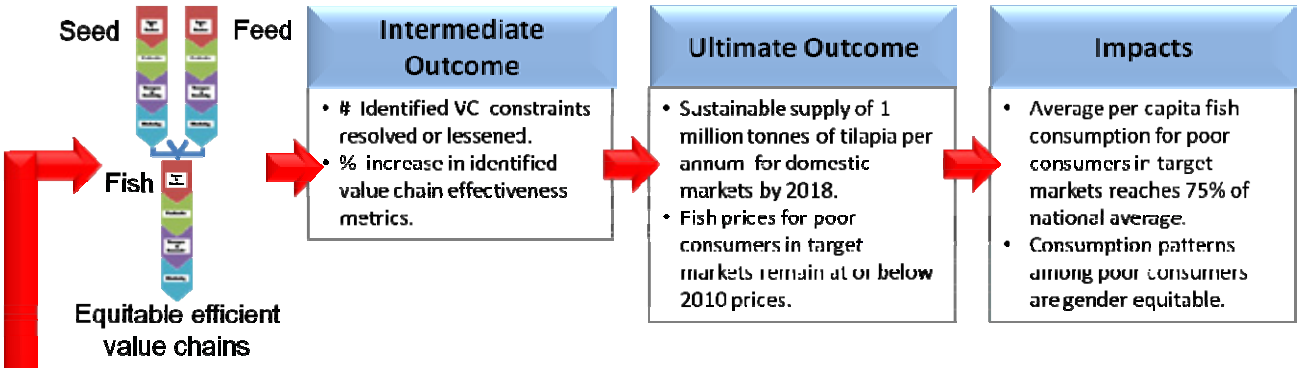
Potential for Impact

Annual average production growth rates for tilapia between 2003 and 2008 were approximately 16%. In the absence of further investment in innovation, this growth is unlikely to be maintained. Optimistically, one might expect an average of about 5% growth annually until 2017, which would yield an additional 213,000 tonnes over 2008 levels. Through support to this program we believe a combination of upgrading farmers to produce at the level of the current best producers, expanding areas under production and technical innovation could increase annual average production growth rates to 10%, yielding an additional 615,000 tonnes by 2017. At current population growth rates, and assuming all other sources of fish supply remain static, this increase in tilapia alone would bring per capita fish supply from 15.4% in 2008 to 18.6% in 2017.

Given trends observed elsewhere, we would also expect this increase in production to stabilize or reduce prices for consumers. Since low grade tilapia is the principle source of fish for the poorest sector of society in many regions this could have significant role in ensuring adequate levels of fish consumption. Significant research will be needed however to understand links between production increases food consumption and ultimately health and nutrition impacts among the poor in target markets. Establishing baselines and structured approaches for monitoring and evaluating outcomes will be a vital early investment for this CRP.

The figure below summarises the pathway from the target outcomes identified in Tables 4.7-4.9 for each component of the value chains through to the impact on food security.

[8] *Data obtained from the General Authority for Fisheries Resources Development (GAFRD) statistics*



Value Chain Outcomes

VC Component	Seed	Feed	Fish Production
Inputs and Services	Widespread use of productive, fast growing broodstock strains that meets present and future anticipated needs of farmers	Development of affordable, nutritionally improved and environmentally sound aquaculture feeds.	Farmers able to access quality seed, feed and technical advice that meets their needs
Production	Widespread use of productive, fast growing seed that meets present and future anticipated needs of farmers	Reliable supplies of nutritionally sound, affordable and environmentally friendly feeds that meet the needs of farmers	Increased farmed fish production and consumption by the poor
Processing	Reduced costs and increased production	Affordable quality feeds available to all producers	Increased quantities of affordable and nutritionally sound fish and fish products in markets
Marketing	Demand led-increases in development and use by farmers of quality seed from genetically improved strains	Strong demand for quality and profitable feeds by farmers	Strong demand for - and increased access to - farmed fish products by poor and vulnerable consumers

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SHEEP MEAT VALUE CHAIN IN ETHIOPIA

Ethiopia is home to 77 million people; 32 million are classified as poor living on less than US $1 per day. With a population of 48 million small ruminants (FAOStat 2010) Ethiopia has one of the largest populations in sub-Saharan Africa (Table 4.6). Sheep (24 million) are the second most important species in Ethiopia (CSA 2008a).

Sheep are mostly kept by smallholders and the rural poor, including women headed households. They contribute substantially to the livelihoods of Ethiopian smallholder households as a source of income, food (meat and milk), and non-food products like manure, skins and wool. They also serve as a means of risk mitigation during crop failures, property security, monetary saving and investment in addition to many other socioeconomic and cultural functions (Tibbo 2006). At the farm level, sheep contribute up to 63% to the net cash income derived from livestock production in the crop-livestock production system. In the lowlands, sheep together with other livestock are a mainstay of pastoral livelihoods (Negassa and Jabbar 2008).

The annual meat production from small ruminants is relatively small compared to the number of heads (Table 1). The average annual off-take rate and carcass weight per slaughtered animal for the years 2000-2007 were estimated at 32.5% and 10.1 kg, respectively (FAO, 2009); the lowest among sub-Saharan African countries. Negassa and Jabbar (2008) reported an even lower sheep off take rate of only 7% in the Ethiopian highlands.

Table 4.6: Sheep and goat populations in selected sub-Saharan countries in 2009

Country	Sheep and goat population (000s)	Production of sheep and goat meat (1000 tons)
Sudan	93,931	334
Ethiopia	47,827	124
Kenya	23,395	124
Mali	18,538	78
Uganda	9,972	35
Cameroon	8,200	32
Mozambique	5,219	26
Congo, Democratic Republic	4,935	21
Malawi	2,906	18
Burundi	1,900	2

Reasons attributed for the apparent low productivity are: absence of well planned/appropriate breeding programs, lack of technical capacity, inadequate and poor quality feeds, diseases leading to high lamb mortality, and underdeveloped markets in terms of infrastructure and market information. As the market systems are typically informal, individual producers have little bargaining power. Furthermore, sheep and goats generally receive little policy or investment attention.

Although technologies to address many of the most common constraints are in hand, a key constraint is the lack of models of suitable and acceptable organizational strategies for producer groups that could facilitate access to services and markets. Research is therefore required to develop and test input and market service delivery options and models, as well as the institutional and organizational arrangements that would provide sustainable delivery and uptake of the available health management, feeding and genetic improvement technologies through effective public-private partnerships in which governmental support services and private partners are integral part of value addition process.

Why this value chain?

Demand and prices for sheep and goat meat show an increasing trend due to urbanization and increased income in the cities and increased demand from the Gulf countries. From 2000 to 2008 the price of live

sheep and sheep meat increased by 157%; the increase for live goats and goat meat was slightly lower at 107% (FAOStat 2010)[9].

A structural model of the Ethiopian livestock sector estimates the total consumption of sheep and goat meat at 91,200 and 91,600 tons in 2010 which exceeds the estimated sheep and goat meat production (124,000 tons, see Table 1) by 47%. The same model predicts a per capita annual growth rate in sheep and goat meat consumption from 2010 to 2020 by 3.4% and 1.3%, and an overall change of 41% and 14%, respectively (Fadiga and Amare 2010).

It is evident that the increasing demand for sheep meat cannot be met with the current inefficient production and marketing systems. Although Ethiopian sheep breeds are well adapted to the existing production environments, their full production potential is obviously not being realized due to a combination of constraints. Many of these constraints have already been studied and technologies to overcome some of them have been developed. However, their uptake and wider adoption remains low, thus further research and dissemination of the knowledge and technologies are still required.

In our view this situation provides good opportunities to increase sheep meat production and ensure that this will benefit poor rural producers, both men and women. Table 4.7 summarizes the reasons for proposing the sheep meat value chain as a focus value chain for our proposal

Table 4.7: Criteria and rationale for choosing Ethiopia

Criteria	Rationale for choosing Ethiopia
Growth and market opportunity	• Huge and increasing demand for sheep meat within and outside the country reflected in increasing prices • Ethiopia's strategic location promoting exports to Middle East markets • Current annual livestock and meat export potential is estimated at US$ 136 million; however, the realized export earning over the past 15 years to 2003 averaged only to US$ 2.5 million. • Abattoirs in Ethiopia operate only at 40% of their capacity (information from Elfora) • High potential to raise the low flock productivity and off-take rate in smallholder flocks
Pro-poor potential	• The majority of rural poor in Ethiopia depend on sheep (and goat) production • Both men and women are involved in sheep production with different tasks and decision making power • Good income opportunity for women headed households • Many market agents along the value chain (input/livestock traders, meat processors and transporters etc.) provide potential as well as challenge for cooperation
Researchable supply constraints	• Negative selection of breeding rams for lamb growth as fast growing lambs are sold first and inbreeding due to small flock sizes • Shortage and fluctuation in quantity and quality of feed supply • Poor animal hygiene and diseases (high lamb/kid mortality, PPR, CCPP) • Lack of business enterprise production strategy • Lack of sustainable organizational structures for breeder and producer groups in order to facilitate their access to affordable breeding animals, animal health care and efficient market services • Poor market infrastructure and institutional arrangements (underdeveloped marketing system) resulting in high price difference between rural and urban markets, high number of middlemen and thus small producer margins • Poor input supply system and limited support services (extension and credit systems) • Insufficient supply of abattoirs with sheep meat (number, weight, age and body condition) • Ineffective knowledge management systems, in particular knowledge sharing between producers and scientists, to enhance uptake of proven technologies
Enabling	• Increasing international interest and support from donors for developing the livestock

[9] ILRI data

environment	sector in Ethiopia (a number of livestock development projects funded by USAID) • Various projects / initiatives on-going or planned and competent organizations / institutions • Commitment by Government of Ethiopia to improve policy environment • Ongoing improvement of paved road network which will enhance market access
Existing momentum	• ILRI and ICARDA, together with their key partners, bring in a rich combination of technical and practical experiences on developing country and low-input mixed crop-livestock systems, and a history of having successfully worked together in related research, on which to build on • Very few other global organizations combine development with innovative and adaptive research. • Both Centers have experience with value chain development in small ruminants and other livestock production systems. • A number of ILRI and ICARDA partner organizations are already active in Ethiopia or are partners in new project proposals, such as the Ethiopian NARS, BOKU- Vienna, University of Goettingen, and EMBRAPA. • ILRI provides an excellent infrastructure and is partner in complementary project like IPMS[10]; two projects, SPS-LMM and ESGPIP[11] funded by USAID provide opportunities for linkages and knowledge sharing

Research and supporting actions

Further discussion with stakeholders along the value chain are required to refine and prioritize the major barriers and opportunities for increasing sheep flock productivity and meat production and supporting research and development actions. The constraints listed in Table 4.7 are based on the experiences of an ongoing ICARDA/ILRI/BOKU Community-based Sheep Breeding project and the ILRI IPMS (Improving Production and Market Success of Ethiopian Farmers) project.

In common with many other livestock production systems in the developing world and constraints identified in other key value chains, major constraints at input and production level include lack of access to breeding rams with proven genetic attributes (breeding value), inadequate feeding at critical production stages and poor healthcare, inefficient healthcare services (disease control and prevention measures), lack of access to inputs and supportive institutional/organizational and knowledge systems. This preliminary analysis underlines the need for the platform research approach described in an earlier section of this proposal that will allow the program to search for technology solutions across the proposed value chains.

Not surprisingly, the share of the retail value captured by sheep producers is small and could be increased by developing and organizing the sheep markets in all important aspects – market access, structure, and transparency in transactions and price information. One root of the problem is the failure of producers to coordinate and collaborate with each other to increase their bargaining power by supplying more attractive quantities to the buyers at the time of peak demand. But it is difficult for such collective action to spontaneously occur in these traditional rural communities. Innovations in rural organizations and cooperation among different market players (producers, traders, fatteners, abattoirs, and retailers) are needed. Table 4.8 summarizes the key development challenges, knowledge gaps and areas of intervention envisaged for the value chains in pilot areas of Ethiopia.

Variable product quality of both live animals and meat are additional drawbacks to satisfying qualities that are demanded by the domestic and export markets; although both offer better prices they are also increasingly demanding higher product safety and quality consistency. For example, the export markets which mainly trade in sheep carcasses demand more rigorous meat inspection systems, thus cold chains are

[10] IPMS = Improving Productivity and Market Success of Ethiopian farmers

[11] SPS-LMM = Ethiopian Sanitary and Phytosanitary Standards and Livestock and Meat Marketing Program; ESGPIP = Ethiopian Sheep and Goat Productivity Improvement Project

prerequisites to accessing such markets. Combined, these constraints limit the sheep producers' capacity to maximally benefit from their sheep and to further invest in this industry.

Studies by IPMS and the community-based sheep breeding project across different regions in Ethiopia showed that women share responsibilities with men in the production of sheep and are mainly responsible for feeding, maintaining hygiene and day to day management. Children are often responsible for supervising the grazing during rainy season. However, men dominate the marketing of sheep and control the income from sales. It was found that the workload of women and children may increase due to market-oriented development of the commodity, but men tend to benefit more in terms of income obtained.

Table 4.8: Opportunities and constraints in the sheep meat value chain in Ethiopia and the research and development actions to overcome them

Value chain components	Developmental challenge	Researchable Issues and Supporting Actions	Indicative partners[12]	Outcomes
Inputs & Services	• How to organize efficient and sustainable input services for smallholders (independent from development projects in the long term)? • How to organize long-term functional and affordable animal health delivery services for remote areas?	***Researchable Issues*** • What is the most efficient strategy/ model for organizing input delivery systems for smallholder: - Required partnerships (government, private partners, development projects) - Required investments by smallholders (micro-credits) - Required supporting training /extension program for smallholders - Supportive, policies, organizational and institutional arrangements for improved sheep production • Differences in men's and women's and poor and rich households' access to inputs, preference for inputs, use of inputs, roles in input supply. ***Supporting Actions*** • Assess current institutions and policies; identify gender sensitive and equitable options to better support breeding programs, resource management and marketing • Undertake actor analyses and evaluate the existing animal health services (vaccines, and drugs), delivery systems (including private) and design efficient and affordable delivery options systems to cover in particular women and the poor, including training community basic veterinary workers and linking them with governmental veterinary services • Assess the existing forage species, their potential in the various production systems and design forage seed/seed material delivery systems and the agronomic practices that would ensure sustained yields • Design adequate training programs for male and female sheep owners • Facilitate linkages to micro-credit and other financial	***Research*** • NARS-Ethiopia • IPMS • ESGPIP ***Supporting Actions, in particular organizing input delivery:*** • Private veterinarians or governmental services • Seed companies • Feed enterprises • Micro-credit schemes	• Inputs and services (including vaccination campaigns) accessible and delivered in time to male and female smallholders • Increased knowledge of male and female smallholders about useful inputs and services • Functional institutions and conducive policy environment

[12] Compare Table 4.9

		services operated through other partners with a focus on women and poor		
Production	• How do we increase sheep meat production and flock productivity to meet current and future market needs? • How to avoid inbreeding and negative selection of rams? • How to overcome seasonal or continuous gaps in feed quantity and quality? • Which preventive measures and treatments are essential to increase productivity?	***Researchable Issues*** • What design of breeding programs and strategies would be appropriate for the existing and emerging production systems/environment (incl. appropriate data recording and feedback system)? • What are the best strategies to reduce mortality, particular in young animals and avoid decreased productivity caused by diseases? • How to design optimized feeding systems? • Are there options to introduce forages and the economics of their production? • Are there differences among men's and women's motivation to engage in the enterprise, in anticipated benefits, roles in production, skills/capacity needs, sources of knowledge/technology, influence of policies and institutions? • Are there any aspects of production that are hard for women or socially discouraged? • What changes are required in sheep management systems to overcome specific constraints that women face, e.g. herding? • How will improved resource use and sheep productivity affect household livelihoods, especially women and children taking into consideration the spillover into other parts of the farming system? ***Supporting Actions*** • Implementing best bet breeding programs, incl. performance recording, selection strategies to enable sustained genetic improvement in the key breeding objective traits, while maintaining reasonable levels of genetic diversity, including minimizing inbreeding and its effects at herd and at population level. • Developing and facilitating institutional (e.g. by-laws and guidelines) and organizational arrangements through farmer group approaches and collective action	***Research*** • NARS-Ethiopia • BOKU-Vienna • INTA • CIRAD • IPMS • ESGPIP ***Supporting Actions*** • MoARD-Ethiopia • IPMS • ESGPIP[13]	• Access to breeding rams with higher breeding value • Decreased inbreeding index • Flocks more homogenous in desirable traits • Improved market weight and body condition • Reduced mortality • Increased offtake rate • Increased meat consumption in the households

[13] The project was supposed to end in 2010 but it may be extended for one or two more years

		• Optimize animal health and disease control, through
		  - investigating the epidemiology of parasites and pathogens, and designing preventive/control strategies in accordance.
		  - promoting simple preventive measures such as access to adequate feed, clean water, clean housing, spraying/dipping
		• Optimize feeding systems and increase feed resources, in particular
		  - Testing forages varieties (food-feed varieties) and integrate them into cropping systems
		  - Optimizing use of currently available feed resources, (strategic supplementation, feed preservation, purchase of most limiting nutrients).
		  - Promoting feed processing options (simple hand chopping; village based motor-driven choppers; commercial but decentralized feed processing units)
		  - Planting fodder trees in private and community managed plots		

Transport & Processing	• How to deliver reliable quantities of more homogenous, safe and quality products (meat or live animals) from smallholder systems? • How to increase the supply of quality skins (slaughter at both private places and abattoirs)	***Researchable Issues*** • Is a carcass grading system required and what would be an appropriate grading and pricing system? • Does the market prefer/segregate carcass parts or cuts and if so, how can this be mainstreamed in the breeding strategy and pricing system? • How to reduce meat quality losses caused by transport and inadequate handling of animals? • How to avoid darkening of meat from highland sheep impeding their export? • What are the causes of most common pre and post mortem skin defects? • Is there any difference in quality of products supplied by men and women? • Are there differences in access to transport and processing services? ***Supporting Actions*** • Establish grading / quality systems for carcasses if appropriate • Capacity building on transport, handling and	***Research*** • NARS-Ethiopia • IPMS • SPS-LMM ***Supporting Actions*** • MoARD-Ethiopia and SPS-LMM for sanitary regulations, e.g. meat inspection • Abattoirs (Elfora) • Butchers (meat shops)	• Meat quality criteria defined with traders and consumers • Higher quality carcasses and skins produced • Higher prices and incomes for sheep producers

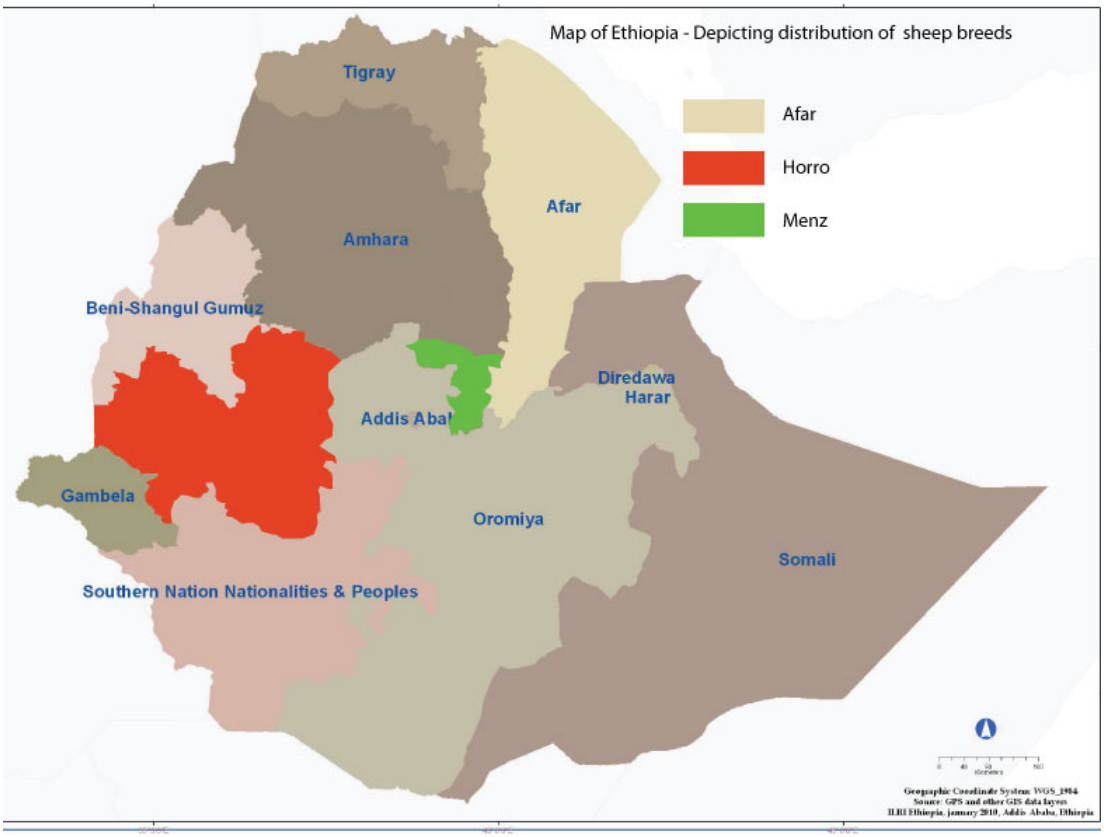
		slaughter of sheep with all involved stakeholders • Study factors causing pre- and post mortem skin defects and design handling and processing strategies to improve skin quality accordingly • Design of traceability system for sheep meat (longer term)		
Marketing	• How to organize markets (both demand and supply) for equitable benefits along the chain? • How to ensure access for the Ethiopian people to safe meat at an affordable price?	***Researchable Issues*** • Market/Consumer demands: what do markets pay for (breed, region, specific liveweight or size, quality)? • Market structures: relations/transactions between local, regional and export markets including transboundary trade issues (e.g. food safety) to be addressed for increasing exports • Market access: is it preferable to organize the farmers for accessing markets or to improve marketing systems and infrastructure (e.g. infrastructure of markets)? • Market transparency: what market information is available / needed, and how could it be better disseminated (information systems)? • Differences in men's and women's access to markets and market information • Intra-household decision making on sales (where, when, how many) and control of benefits • Are there any aspects of trading that are difficult or socially discouraged for women and poor? • How can women owning sheep better participate in, and benefit from small ruminant markets? ***Supporting Actions*** • Analyze the market structure, constraints and opportunities for sheep and mutton, covering all agents and actors involved in sheep marketing including traders, middlemen, transporters and exporters. • Evaluate and test options for coordinating and transporting bulk group sales of animals. • Test marketing arrangements through breeders cooperatives • Assess the performance of different marketing services including provision of market information,	***Research*** • NARS-Ethiopia • IPMS ***Supporting Actions*** • MoARD-Ethiopia and USAID-SPS-LMM for regulatory framework • ELFORA-Ethiopia (abattoirs) and trade organizations for defining product standards and arranging marketing channel	• Increased margins for smallholders in the value chain • Sales of sheep with appropriate weight and size according to market demands • Organized marketing of sheep at good prices • Sheep owners well informed about marketing opportunities • Abattoirs operate near their full capacity

		facilitation of market linkages, provision of marketing facilities, transport of sheep and mutton and identify ways of improving them • Identify and respond to demand-driven market opportunities for value addition, through improved product quality • Facilitate linkages to market information systems operated by other partners. • Gender-disaggregated analysis of market and services access		
Crosscutting issues	• How to organize a value chain to considerably increase the output – what are essential components and partnerships?	***Researchable Issues*** • Impact of value chain development on workloads and on control over the income within the household • Who benefits from new technologies in households and communities (equity)? • What are incentives for various key actors (farmers, input providers, traders and animal health providers etc.) to invest in small ruminants? And how can these actors cooperate? • Is it feasible to design (a) common model(s) for value chain development through analysis of the lessons learnt from the diverse value chains, in particular comparing the SR value chains in Mali and Ethiopia? ***Supporting Actions*** • Characterization of complete value chains and production systems in the target locations (own surveys and other studies) at the start • Develop indicators of success • Capacity building at all stages • Compare the approaches applied for the different value chains • Develop an easy monitoring system for home consumption of meat	***Research*** • NARS-Ethiopia, • IPMS • Boku, Vienna ***Supporting Actions*** • MoARD-Ethiopia • IPMS • ESGPIP	• Contribution of sheep production to livelihoods increased considering tangible and intangible benefits

Geographic focus

Diverse sheep breeds and ecotypes are kept in different regions and ecologies – from the mountainous highlands to the arid pastoral lowland areas. Nine indigenous sheep breeds have been identified by phenotypic and molecular characterization methods (Gizaw et al 2007). The community based sheep breeding programs is being implemented in four areas in Ethiopia, namely Horro, Bonga, Menz and Afar. . Based on the project related studies and the experience during the last four years we are proposing to initiate sheep production value chains for Horro, Menz and Afar sheep in their home areas of the same name.

Human population in Menz area is estimated at 324,720. However, the breed is being used out of its original home region by an estimated 2 million people and is widely distributed. Horro sheep are reared by about 6,874,480 people. Population of Afar sheep is estimated at 2,499,640 and is kept by 1.4 million Afar people and other neighbouring communities (CSA 2008b).



Map of Ethiopia depicting Horro, Menz and Afar region

The arguments to select Horro and Menz area as pilot sites for value chain development include:

- Horro, Menz and Afar sheep are the most populous breeds in Ethiopia (population is estimated at more than 2 million for each breed) with a wide area coverage
- Pilot community based breeding programs have been established in two communities of each region that can be used as learning and demonstration sites
- Regional research centres with well educated and interested staff are found in Menz and Horro region
- Reasonably good information is available on the breeds and the production systems as base for future research and development work[14]

[14] The Community based Sheep Breeding Project focuses on genetic improvement and related aspects. Initially other constraints such as feed availability and quality and animal healthcare and access to efficient markets that are equally important were not addressed. Acknowledging the importance of these constraints for achieving impact, during its last year the project has started to introduce interventions addressing some of these constraints

- The three areas are comparatively easy accessible.
- Afar and Menz sheep are major contributors to the households' incomes: Menz is a highly degraded highland area mostly not suitable for other crop and livestock production. Thus, there is trend towards specialization in sheep production and this will help us to achieve impact. Afar sheep are kept in the lowlands by pastoralists, livestock production being the mainstay of the population. Horro region is characterized by crop-livestock production systems with more diverse farming activities; nevertheless the communities also depend to a relatively large extent on sheep for livelihood and as security measure against crop failure.

Based on an ILRI classification of recommendation domains within Africa (Omolo et al 2009) the three sites represent three different domains: Horro is located in an area mainly characterized as having high agricultural potential, good market access and low potential density, while Menz area shows low agricultural potential, good market access and high population density and Afar low agricultural potential and population density with partly good and partly poor market access. Thus, this diversity will enable across site learning and a more precise definition of recommendation domains for certain technologies.

Potential for impact

The general principles of the value chain approach that we intend to apply in this Program and the envisaged impact pathway were explained earlier in the proposal. A key principle is to enhance the competitiveness of all value chain components, combining research and development activities in strategic partnerships. This is considered as the most promising option to achieve the envisaged impact – higher sheep meat production levels and increased living standards of the involved households. The pathway to impact will be through increasing off-take rates from sheep flocks and easier access for smallholders to markets with higher producer margins, resulting in higher incomes for rural households and thus enabling the required investment in sheep production to further enhance production levels.

However, developing a comprehensive strategy and a model approach for organizing the sheep meat value chain will be a challenge – one that has not been achieved for smallholder systems in developing countries up to now. Research and development projects tend to focus on individual components of the value chain or specific technologies only. Our approach aims at integrating research and development efforts to provide solutions and strategies to overcome the existing system deficiencies *along the whole value chain* in a comprehensive and synergistic manner. The level and scale of impact will depend on our ability to build the essential partnerships along the value chain and attract investments from development partners.

Based on simulation models for the breeding program (Tadele et al 2010) and current productivity levels it is expected that by 2017 the number of weaned lambs per ewe can be increased by 10% and yearling weight can be improved by about 20% (from about 24 kg to 27 kg per year on average across the three regions) which would result in an increased annual production per ewe by 20% (an increase of about 7 kg per ewe and year). Flock sizes per household are relatively small: 15.2 productive ewes in Menz, 5.6 in Horro and 10 in Afar.

The number of households that will benefit from the focus on this value chain, and thereby the percent increase in sheep meat production, will ultimately depend on the investment that can be made by the Program and its partners. About 1.46 million households keep Horro, Menz or Afar sheep in Ethiopia. If we assume that 5% of these are impacted by this Program, through activities that strengthen the sheep value chain, this means that some 70,000 households will enjoy enhanced livelihoods, and this will in result in production of an additional 5,000 tonnes of sheep meat annually.

In contrast to the dairy, pig and fish value chains we expect only a small increase in home sheep meat consumption of the rural households: sheep meat is not consumed on a regular basis in rural communities. Instead the increased sheep meat production will benefit urban consumers and export markets. The major impact of developing the value chain on livelihoods of rural smallholders and poor households is expected to be achieved through increased income from sales.

Intermediate Outcomes

- Priority VC constraints lessened or resolved
- Partnerships with major stakeholders established and additional investments aligned
- Flock productivity increased by 20%

Ultimate Outcome

- 1000 sheep meat producing households in three pilot regions directly participating in the program
- Increased meat production (plus 72 t) in 1000 households which is efficiently marketed

Impacts

- 5000 tonnes additional sheep meat produced annually
- 70,000 households involved in the value chain program improve their standard of living

Components	Value chain outcomes
Inputs and services	• Inputs and services (including vaccination campaigns) accessible and delivered in time to male and female smallholders • Increased knowledge of male and female smallholders about useful inputs and services • Functional institutions and conducive policy environment
Production	• Access to breeding rams with higher breeding value • Decreased inbreeding index • Reduced mortality • Increased offtake rate • Improved market weight and body condition • Increased consumption of ASP in the households through increased income
Processing	• Meat quality criteria defined with traders and consumers • Higher quality carcasses and skins produced • Higher prices and incomes for sheep producers
Marketing	• Increased margins for smallholders in the value chain • Sales of sheep with appropriate weight and size according to market demands • Organized marketing of sheep at good prices • Sheep owners well informed about marketing opportunities • Abattoirs operate near their full capacity

Summary of indicators along the impact pathway that we believe can achieve these impacts.

Table 4.9: Stakeholders in Ethiopia and their possible role

Stakeholder	Type	Role	Remark
ELFORA Agro-industries P.L.C.	Private	Could create market outlet for the community sheep and export of mutton, live animal and skins	Consulted
Luna	Private Abattoir in Modjo	Exports small ruminant meat to the Middle east; ILRI has been working with Luna in IPMS and have developed t a strong linkage	To be consulted
Improving Productivity and Market Success of Ethiopian farmers (IPMS)	ILRI project	Cooperate on the whole sheep value chain development	Consulted
Ethiopian Institute of Agricultural Research (EIAR)	Government	Implement the field research activities in Afar	Consulted
Amhara Regional Agricultural Research Institute	Regional Agricultural Research Center,	Implement the field research activities in Menz	Consulted

	Government		
Oromia Agricultural Research Institute	Regional Agricultural Research Center, Government	Implement the field research activities in Horro	Consulted
USAID - Ethiopian Sanitary and Phytosanitary Standards and Livestock and Meat Marketing Program (SPS-LMM)	NGO	Cooperate on marketing of mutton, sheep, skin	To be consulted
USAID - Ethiopian Sheep and Goat Productivity Improvement Project (ESGPIP)	NGO	Cooperate on breeding at field level	To be consulted
Pastoral Community Development Program	Government-project	Research and tailored training in Afar	To be consulted
Ministry of Agriculture and Rural Development (MoARD)	Government	Support the field activities in all the project sites	Consulted
Netherlands Development Organization (SNV Ethiopia)	NGO	Experience sharing on value chain development	Synergies to be discussed and agreed upon

SHEEP AND GOAT MEAT VALUE CHAINS IN MALI

Agriculture, livestock and fishery represent 33% of Mali's GDP and agricultural activities employ almost 70% of the nation's labour force. More than 77% of the country's rural people live below the poverty line and about 4.6 million of poor people are livestock keepers. Per capita GDP of US$ 470 positions Mali as one of the world's 10 poorest nations.

The small ruminant population has been estimated at 11.3 million and 15.8 million head for sheep and goats, respectively. Extensive pure pastoral systems with large flock sizes are found in marginal arid areas where low rainfall does not allow successful cropping. Extensive sheep and goat productions systems are also practiced in semi-arid areas (400-600 mm of rainfall) by sedentary rain-fed mixed crop-livestock farmers. A third sheep and goat production system is found in the interior Delta of Niger River. In this sub-system, small ruminants are moved out to the upland Sahelian pastures lands during the rainy season and return to flooded 'bourgou' pastures areas during the dry season.

All these pastoral low-input systems rely on family labour and on livestock mobility to adapt to seasonal feed and water shortages. On the other hand, sedentary mixed crop-livestock systems are either based on millet or irrigated rice production where sheep and goats are grazed on natural pastures with limited mobility.

In sub-humid zones of Mali, sedentary Djallonke sheep and goats production is associated with both food (sorghum, millet, maize, rain-fed rice, roots) and cash crops (cotton, groundnut) productions. Sheep and goats are kept as an 'insurance' or 'emergency cash' resource (McDermott et al 2010). They produce manure for fertilising crops as well as meat (and sometimes milk) for home consumption, and can be sold for cash income. The high demand of rams for the *Tabaski* festival for both domestic consumption and for export to neighbouring countries has stimulated the development of more commercially-oriented intensified sheep production systems in semi-arid or urban and peri-urban areas in Mali. Financially profitable investment in sheep fattening operations is involving an increasing number of farmers, including women, to diversify their income using home grown crop residues and purchased concentrates. In 2008, 129,000 fattened rams were produced through 'Ministere de l'Elevage et de l'Environnement' loan schemes (DNPIA 2009).

Prominent constraints to smallholder farmers keeping sheep and goats include insecure access to feeds (encroachment of cropping into grazing lands, land degradation) and water and exposure to risks (drought, animal diseases, price volatility) which translate into poor productivity (Pica-Ciamarra 2005) and disincentives for further investment in livestock production. High pre-weaning mortality is a significant problem for herd growth and Peste de Petits Ruminants (PPR) is a threat in many areas (McDermott et al 2010). Wilson (1983) reports that on average 32% of kids die before the age of 5 months. Uptake of technical and organisational innovations which have been designed to address these constraints has been low because of the inadequate 'push' from the market in terms of the inputs and services required to support their adoption. Difficult access to animal health services is a persistent problem of small ruminant producers. In addition, limited small ruminant producers bargaining power, high transactions costs, and imperfections in financial and animal input/outputs markets prevent benefits along livestock value chain to trickle down to poor livestock keepers which in turn has an adverse effect on adoption of innovations.

Why this value chain?

The vast majority of poor farmers in Mali keep small ruminants as a main source of livelihoods. Hence, sheep and goats assets are key opportunities for smallholder small ruminant producers to not only engage in income generating activities enabling them to escape the poverty trap but also to consume animal source food they could not afford to buy. At the national level, sheep and goats contribute to 22% of meat supply in Mali. Between 2001 and 2008, domestic goat meat supply has increased more than three-fold from 580 to 1961 MT with a concomitant increases in goat meat prices that reflect a vibrant livestock sub-sector in Mali with high pro-poor potential if gains along the value chains are benefitting the majority of smallholder farmers small ruminant producers and other small ruminant value chains actors. In 2009, about 500,300 sheep and 15,000 goats worth US$36.6 million were exported to neighbouring countries. The majority of sheep are exported to Senegal (80%) and to Ivory Cost (10%) (DNPIA 2009) to meet the increasing demand of

Tabaski rams in these countries. Other countries such as Algeria, Benin and Guinea are supplied with sheep by Mali. Libya had in the past expressed his interest to import about 150,000 sheep annually but this has not yet materialized.

A number of competitive advantages justify the selection of Mali for pilot testing of the development of small ruminant value chains as a means through which poor smallholder farmers can come out of poverty. First, Mali presents a diversity of agro-ecological zones (arid, semi-arid and sub-humid zones) thus presenting different production systems, in which small ruminants are not only important, but where the breed/population differences, resource endowments, husbandry practices can be differentially and profitably exploited. Besides, the existing different biophysical constraints, and market orientation and constraints are similar to what is experienced in many arid and humid environments elsewhere in the Africa and Asia. Consequently, the lessons learnt from the planned small ruminant projects in Mali would be easily out-scalable elsewhere in sub-Saharan countries with similar biophysical and economic conditions. Second, in the West African context, Mali small ruminant value chains play a prominent role reflected in the number of live sheep and goats exported from Mali to its neighbouring countries (Table 4.10). This is evidence that any positive or negative transformation in the Mali small ruminant value chains will have significant impact in the supply of mutton into its neighbouring countries.

Table 4.10: Criteria and rationale for choosing Mali

<table>
<tr><th>Criteria</th><th>Rationale for Mali</th></tr>
<tr><td>Growth and market opportunity</td><td>High demand for sheep and goat meat due to increased income and population growth both in Mali and countries importing live sheep and goats from Mali. The annual growth rate of per capita meat consumption in Mali has been estimated at 0.8% between 1992 and 2002 (DNPIA, 2005).

Supply and price of sheep and goat meat have increased tremendously over the last decade (Table 3) in Mali. Nominal prices of small ruminant meat have increased from US$ 1208 to 4457 per tonne from 2001 to 2008 which indicates an average annual increase of 33.6% of goat meat prices in Mali.

Mali is the main supplier of Tabaski rams to Senegal and Ivory Cost and both domestic and export demands of these animals are increasing. Steady growth in demand of sheep and goat meat in neighbouring countries will be beneficial to Malians poor farmers keeping sheep and goat.

Other neighbouring countries such as Libya and Algeria have also expressed interest in getting supplies of sheep from Mali.

Trends in the supply and prices of goat meat from 2001 to 2008 in Mali
<table>
<tr><th></th><th>2001</th><th>2002</th><th>2003</th><th>2004</th><th>2005</th><th>2006</th><th>2007</th><th>2008</th></tr>
<tr><td>Goat Live Weight (MT)</td><td>579.8</td><td>717.4</td><td>817.3</td><td>900.3</td><td>902.1</td><td>947.5</td><td>1650.7</td><td>1961.2</td></tr>
<tr><td>Goat meat price ($/MT)</td><td>1207.9</td><td>1494.5</td><td>1702.7</td><td>1875.7</td><td>1879.4</td><td>2871.3</td><td>3761.1</td><td>4457.2</td></tr>
</table>
</td></tr>
<tr><td>Pro-poor potential</td><td>Mali is home of 15.8 million goats and 11.3 millions sheep belonging to 4.6 million poor livestock farmers. Increased sheep and goat production and productivity will translate into both enhanced cash income and consumption of animal source food in the form or meat and milk. Sheep and goats are the most important household assets with saving and insurance functions. They play crucial risk mitigation role in the face of drought, crop failures, and illness and to (re)invest in crop production following drought or other hazards. It has been reported that 27% total offtake in sheep and 34% of total offtake in goats were in the form of slaughter for domestic consumption in agropastoral systems in Mali (Wilson 1986). It is therefore apparent that keeping small ruminant is a unique opportunity for poor farmers to consume meat, a commodity that would have been unaffordable if they had to buy it.</td></tr>
<tr><td>Researchable supply constraints</td><td>Design/adapt productivity-enhancing interventions through the reduction of high pre-weaning mortalities and abortion rates in ewes and better control of other killer diseases such as PPR.

Design and implementation of sustainable best-bet sheep and goats breeding programs; Design</td></tr>
</table>

	strategies to ease access by sheep producers to stock of higher genetic merit and that match specific environments. Reduce feed insecurity. Promote uptake of technologies for increased availability of feed resources of better quality and for better use of existing feeds (production of high yielding fodder species, feed storage and conservation); Improve farmers access to purchased feed resources; Institutionalizing multi-dimensional approaches to improving food-feed crops and improving their input markets; Develop community-based strategies to improve the management of natural resources (water, land and vegetation) for intensifying crop and small ruminant production; Improving the knowledge base through institutional capacity building Design sustainable pro-poor input and support services delivery systems (veterinary inputs and services, feed, seeds, knowledge, information, credit). Analyse sheep and goats marketing systems in Mali (Describe markets in terms of size, functions, structures, infrastructures, and financial and social capital endowments; analyse capacity, strengths and weaknesses of market agents, their functions, describe market information systems; and identify the institutional constraints that hinder sheep and goat market efficiency). Conduct a quantitative value chain analysis and trace the distribution of marketing margins along the sheep and goat value chains and propose ways to improve the overall performance of the system of commercialization. Adapt business development services models to small ruminant values chains
Enabling environment	Mali is one of the few countries in West Africa which has developed a sound policy and legal frameworks in the form of the Mali '*Charte Pastorale*: Livestock Charter' that recognizes the right of transhumant pastoralists and protects livestock mobility which is key livestock management feature in Mali. The Government of Mali, with the support of donors such as AfDB, USAID, Belgium Government, is allocating significant resources in many aspects of the livestock sector development dealing with market information systems, risk management and natural resource management. ECOWAS and CILSS are encouraging conducive policies to promote regional livestock trade in West Africa with a prominent role played by Mali as a central supplier of live animals into other West African countries. With the support of EU, CILSS is planning to implement a regional project that seeks promoting livestock trade in West Africa. The USAID-funded Agribusiness and Trade Promotion program is also playing also a key role in strengthening the institutional and financial capacities of actors of livestock value chains. A number of projects (CILSS, PROGEBE) are also investing in upgrading cross-border market infrastructures and livestock transport systems. The Livestock Market Information System (LMIS) being set up and operationalized with USAID funds is likely to have significant impact in market information exchange and transparency. The Bill and Melinda Gates Foundation is contemplating heavy investments to support the development of sheep and goats value chains in Mali in the near future.
Existing momentum	ILRI has developed in the past long standing partnership with many research and development organisations in Mali. Fundamental work carried out by ILRI (then ILCA) in the mid 1980s and 1990s on livestock production systems have generated a significant body of knowledge on the productivity of small ruminant breeds, feeding systems and health constraints in Mali.

Key potential partners for the design and implementation of the Small ruminant value chains project in Mali include:

Research organisations: IER, CIRAD
NGOs: VSF-Belgium, SNV
Government of Mali: Ministry of Livestock and Fishery, DNPIA
Special projects: PADESO, PROGEBE, USAID funded projects: MLPI, ATP
FAO

Information gained during various consultations with a number of stakeholders in Mali has been used to shape models of target small ruminant value chains in Mali which will be pilot tested within the framework of CRP3.7. First, there has been a consensus that the CRP3.7 should focus on both sheep and goat value chains in semi-arid areas and in wetter sub-humid zones of Mali. We are proposing to select Office du Niger area and Nara districts in semi-arid areas and the Bougouni (Sikasso) districts in sub-humid zones as pilot sites for the development of small ruminant value chains in Mali.

Research and development efforts to support small ruminant value chains in Mali will be designed taking into consideration differences in challenges and opportunities in the two agro-ecological zones. Strategies for the development of sheep and goat values chains in the Office du Niger and Nara areas will be articulated on the following elements: (1) sourcing of males (young or mature males) from extensive sheep productions systems neighbouring the Office du Niger irrigation system; (2) support to group of farmers (mostly women associations) to engage in sheep fattening operations based on the exploitation of local feed resources (cereal brans, crop residues) and purchased feeds), (3) establishment of business hubs to facilitate access by livestock producers to feed resources, improved breeds, veterinary inputs, credits, information and to create opportunities for the development of innovative contractual arrangements between various actors of the small ruminant value chains and collective actions for access to input and output markets (4) targeting of Muslim celebrations (*Tabaski* and End of Ramadan) and other family ceremonies for marketing. In both the Nara and Office du Niger areas, many households keeping breeding sheep flocks are already engaged in fattening operations using rams drawn from their own flocks. The whole production cycle including breeding, growing out of young and finishing phase could be planned within the same household in sub-humid zones of Bougouni. Here also, the establishment of hubs of services will be critical to facilitate access to veterinary inputs and services, credits and information. Critical interventions in all pilot sites will address high mortalities rates, better access to improved breeds, the promotion of better feeding strategies based on food-feed crops (cowpea, groundnut) and the improvement in sheep and goat marketing systems.

Research and supporting actions

Table 4.11 summarises key development challenges and proposed research and support interventions on which the small ruminant value chain in Mali will focus. Based on value chain approach, this Program will make efforts to improve access to inputs and services, and output markets by farmers with the view to promote uptake of sheep and goats productivity-enhancing technological innovations. At the production level, the small ruminant value chains in Mali will look at alternative solutions to bridge the gaps in small ruminant productivity in Mali by existing and generating new knowledge useful for the design of feeding, breeding and health care innovations which would address biophysical constraints related to high mortality rates, seasonal feed shortages and availability of improved sheep and goat genetic material

Significant productivity gaps in sheep and goats due to differences in management have been reported in agropastoral systems in Mali (Wilson 1986). Using mortality rates, parturition intervals and dam post partum weight, Wilson (1986) estimated that female goats reared under good feeding systems in the rice irrigated systems produced each year 17.1 kg of live weight of weaned kids as compared to 12.1 kg in millet system characterized by poor feeding systems and health conditions. Similarly, ewes produced 24.7 and 32.1 kg of live weight of kids per year in millet and rice systems, respectively. The productivity ratio of the productivity in best over that of worst flocks was 1.73 in the rice systems and 1.55 in the millet system. It is therefore apparent that significant productivity gains of more than 50% could be achieved under this

Program if improved management (better nutrition and health care) are promoted and adopted by small ruminant producers.

As detailed in previous chapters, strategies to improve sheep and goat feeding systems in Mali will rely on (1) producing more feed of better quality , (2) making best use of existing feed resources and (3) the promotion of transfer of feed resources from areas of feed surplus to places experiencing feed deficit. Food-feed crops such as cowpea and groundnut already play a critical role in the supply of high quality feed to small ruminants. This Program will endeavour to identify superior cultivars of food-feed crops (cowpea, groundnut) and promote their widespread dissemination though appropriate seed production and distribution mechanisms. Research and supportive interventions aimed at improving sheep and goat feeding systems will also focus the optimization of the use of available feed resources through smart association of cereal and legume crop residues and the processing of rice straw. There is a high potential to add value to huge quantities of rice straw available in the Office du Niger processing to produce multi-nutrients blocks made out of rice straw, molasses and minerals to support intensified sheep production systems.

A large sheep and goat breed diversity exist in Mali today. These animal genetic resources are well adapted to the agro-ecological conditions (heat, vector-borne diseases, seasonality in feed and water supplies) and production systems (mobility, demand of *Tabaski* rams) in which they are kept and are the basis of the sheep industry supplying live animals for both consumption and breeding to many countries in the sub-region. They provide a good fit to the needs of diverse production systems and market demands in Mali and in the sub-region. The challenge in CRP3.7 is to analyse past formal institutional sheep breeding programs to better understand causes of failures and success, to characterise sheep production systems including farmers breeding systems with the view to designing and testing in a participatory manner best-bet sheep genetic improvement strategies and interventions including both straight breeding and cross-breeding schemes. An inclusive process of participatory development of breeding and sustainable management strategies building on existing systems and farmers experiences and for sheep in Mali will be developed during the course of this Program taking into account the potential for application of novel whole genomic breeding methods.

Women are key actors in sheep and goat production. Most of small ruminant assets are owned and managed by women: the mainstreaming of gender is seen as a crucial strategy to ensure sustainable and significant impact of this project. The analysis of specific constraints and needs of women and children, the main source of workforce allocated to sheep and goat production, will be key to the design of strategies that would empower women and ensure they will have easier access to financial and support services required for the uptake of productivity enhancing technologies and a equitable share of gains generated along the small ruminant value chains. The active participation of women in innovation platforms/business hubs which will be established in project pilot sites, and the strengthening of their technical, organisational (women marketing associations) and institutional capacities are some of the strategies enabling the mainstreaming of gender in the small ruminant value chains.

Table 4.11: Opportunities and constraints in sheep and goat value chain in Mali and the research and development actions to overcome them

Value chain components	Developmental challenge	Researchable Issues and Supporting Actions	Indicative partners	Outcomes
Inputs & Services	*Key developmental challenges* ▪ How to design and establish a model of sustainable delivery of input and services provision for sheep and goats keepers with special emphasis to women small ruminant producers in project pilot sites.	*Researchable Issues* ▪ Analyse strengths and weaknesses of public and private veterinary input and services delivery systems for both disease control and prevention. ▪ Analyse existing systems of feed supply dissemination of improved breeding stocks, fodder seed production and distribution systems. ▪ Analyse existing formal and informal credit systems for actors (producers, traders, service providers) in the Small ruminant value chains *Supporting Actions* ▪ Work with partners to establish and operate business development services at the project pilot sites for sheep and goats ▪ Promote the establishment of, and strengthen technical, institutional and financial capacities of local public and private veterinary service providers in the project pilot sites to ensure delivery of better quality services ▪ Facilitate access to credit by small ruminants producers, providers of input and support services and strengthen their organisational and institutional capacities ▪ Promote businesses oriented feed processing and trade enterprises	*Research* ▪ The department of 'Economie des Filieres, Ecofil' of the Institut d'Economie Rurale, the Malian national agricultural research organisation will be a leading on all studies on input and service delivery systems. ▪ ILRI will also make efforts to engage with US universities (Syracruse University) supporting the USAID project: Mali Livestock and Pastoralist Initiative (MLPI) *Supporting Actions* ▪ On-going Livestock development projects such as : PADESO, USAID MLPI, CILSS intra-regional livestock trade project, ▪ Veterinaires Sans Frontieres-Belgium	▪ The number of sheep and goat farmers that have access to veterinary services (vaccine, drugs) has increased and therefore more sheep and goat are vaccinated and treated each year ▪ A significant number of farmers have better access to and are using fodder seeds. ▪ Input and service providers that are relevant to sheep and goat producers have improved their knowledge, skills, and financial capacities and have upgraded their businesses ▪ Small entrepreneurs processing and selling livestock feed have been set up

Production	*Key developmental challenges* ▪ How to increase production, productivity and value of sheep and goats produced by poor farmers for both home consumption and sales through the smart combination of productivity enhancing technologies: 1. better health care to reduce mortality rates, 2. improved feeding strategies and 3. better access to breeding stock of superior genetic merit.	*Researchable Issues* ▪ Review causes of death and conduct complementary epidemiological studies in order to design strategies to reduce mortality rates in young animals and high abortion rates in ewes ▪ Develop more effective PPR vaccines (Thermostable PPR vaccine). ▪ Assessment of forage resources and feed markets for matching feed resources with sheep and goat requirements to identify deficit and options to meet the shortfall in intensifying crop-livestock systems ▪ Screening, breeding and dissemination of high yielding food-feed crops (dual purpose cowpea, groundnut) ▪ Test innovative technologies to make better use of crop residues in The Office du Niger (Production of rice straw-based compact feed blocks with the incorporation of other nutrients, sugar cane, make better use of bourgou, optimize associative effects of cereal and legumes residues) ▪ Analyse past formal institutional sheep breeding programmes, characterise sheep production systems including farmers breeding systems with the view to designing and testing best-bet sheep genetic improvement strategies and interventions including both straight breeding and cross-breeding	*Research* ▪ The Livestock Research Department of IER ▪ Labouratoire Central Veterinaries (LCV) of Mali will get involved ▪ CIRAD ▪ ICRISAT	▪ Sheep and goat flock sizes have increased as a result of reduced death rates and this has translated into increased offtake rates and income for farmers ▪ Improved breeding males and females are more readily available to poor farmers ▪ The number of rams fattened each year has increased significantly. ▪ Sheep and goat productivity rates have increased as a result of improved weight gains in sheep and goats due to adoption of fodder crop innovations.

		schemes. *Supporting Actions* ▪ Develop community based strategies to improve management of natural resource (water, land, vegetation). ▪ Develop an information system on feed and water availability across the year based on assessment … ▪ Support the development of local institutional and organisational capacities through producers and women associations and collective action for sheep and goat marketing and acquisition of inputs and services. ▪ Facilitate the establishment of business development services for improved access to knowledge services, physical inputs and credit.	*Supporting Actions* ▪ Ministry of Livestock Services and Direction Nationale des Productions et Industries Animales (DNPIA) ▪ Bamako feed factories ▪ USAID-funded MLPI in the process of developing methods and extension activities for nutritional analyses of supplemental feeds and establishing early warning capabilities for monitoring surface water and feed resources. ▪ VSF-Belgium for support to local women organisation ▪ USAID funded Agribusiness Trade Promotion Programme to support collective action and stakeholder capacities	
Transport & Processing	*Key developmental challenges* ▪ How to reduce transport and handling costs in national and cross-border small ruminant trade •	*Researchable Issues* ▪ Analyse sheep and goat marketing channels for the formulation of recommendations to reduce transport and handling costs. *Supporting Actions* ▪ Develop and maintain road infrastructures ▪ Support availability of multifunctional trucks and influence changes in truck and spare part import taxes ▪ Support the application of ECOWAS policies on regional trade which eliminates illicit taxes	*Research* Ecofil of IER *Supporting Actions* ▪ CILSS intra-regional livestock programme ▪ USAID-funded ATP ▪ Livestock Traders Associations at the national and regional levels	Income of farmers and traders has improved as a result of reduction in sheep and goat transport cost.

Marketing	*Key developmental challenges* ▪ How to reduce marketing transaction costs and imperfections in order to improve the efficiency of sheep and goat marketing systems. ▪ How to ensure that gains along the sheep and goat value chains are equitably distributed to all actors. ▪ ▪ How to promote the participation of women in the marketing of sheep and goats ▪ How to promote exports of Malian sheep and goats into northern neighbouring and Arabic countries	*Researchable Issues* ▪ Analyse sheep and goats marketing systems (describe markets size, functions, structures, infrastructures; analyse capacity, strengths and weaknesses of market agents, their functions, describe market information systems; and identify the institutional constraints that hinder sheep and goat market efficiency) ▪ Capture lessons learned from collective marketing experiences and facilitate the establishment of sustainable sheep and goat marketing associations *Supporting Actions* ▪ A livestock marketing information system is put in place and is operational ▪ Promote mechanism to improve access to credit by sheep and goat traders ▪ Upgrade national and regional market infrastructures. ▪ Organise regional small ruminants fairs to promote commercial linkages between sellers and buyers from different countries	*Research* Ecofil of IER *Supporting Actions* ▪ USAID-funded MLPI that has established a sound Livestock Market Information System using ICT. ▪ On-going project: PADESO ▪ Local livestock keepers associations ▪ VSF-Belgium	▪ Information on livestock markets (prices, opportunities, constraints) easily available to all actors of the value chains ▪ Increase in the volume and value of sheep and goats traded at the national and regional levels ▪ Increase in the profit margins made by sheep and goat farmers engaged in breeding, growing out and fattening operations ▪ Income of actors along the SRVC have increased
Crosscutting issues	*Key developmental challenges* ▪ How to create incentives for increased investment sheep and goat production, marketing and processing systems through reforms in national and regional policy and institutional frameworks. ▪ How to disseminate lessons leant and	*Researchable Issues* ▪ What are the necessary reforms in institutional frameworks to promote strong, efficient and sustainable small ruminant farmers/traders associations ▪ Update analyses on tariff and non-tariff barriers to small ruminant intra-	*Research* IER CIRAD	

	knowledge and information among various partners	regional trade ▪ Study existing knowledge management systems *Supporting Actions* ▪ Support establishment and/or strengthen capacities of existing small ruminants producers and traders associations ▪ Establish information and knowledge exchange networks	*Supporting Actions* ▪ VSF-Belgium ▪ SNV	

Geographic focus

This project has selected pilot sites in both semi-arid and sub humid zones of Mali so that lessons leant could be applicable to many countries in sub-Saharan Africa. These are the Office du Niger (Segou region) and Nara/Nioro districts in semi arid areas, and Bougouni district in sub humid zones.

The Office du Niger is characterized by the establishment, during 1930s, of a large irrigation scheme that has endowed the area with tremendous resources (water, crop residues: rice straw, sugarcane tops, rice bran) which could form the basis for more intensified crop-livestock production systems. The high human density found in this area is also conducive to enhanced access to various services by value chain agents. The annual production of rice straw is estimated at 300,000 tons of which a large percentage is burnt to clear rice field before planting. There is a high potential to add value to these raw material through processing to produce multi-nutrients blocks made out of rice straw, molasses and minerals which could be used in large scale intensified sheep production systems. There are good prospects for such a technical innovation as evidenced by the existing high demand for rice straw in feed deficit areas in Northern Mali and from Bamako urban-periurban livestock production systems. In addition, there is an on-going favourable political environment as the Government of Mali has included in its agenda the support of youth to engage in commercial production of rice bales for export. ILRI experience in compacting sorghum stover with the incorporation of minerals could be replicated in Mali using rice straw. Compact blocks have the additional advantages of significantly reducing transport costs.

The soundness of the choice of Bougouni in Southern Mali is grounded on the fact that existing and expected development projects in this area will likely create conducive environment for leveraging research funds of the Small ruminant value chains with development efforts to ensure large scale impact of CRP3.7 in Mali. Indeed, the 'Project on sustainable management of Endemic ruminant livestock' funded by AfDB and GEF is operating in the Bougouni areas. This project seeks to develop economic incentives and promote market opportunities for Djallonke sheep and goats for their sustainable management. The same breeds and production systems are targeted by CRP3.7 in Mali. In addition, the Alliance for Green Revolution in Africa (AGRA) has selected Southern Mali as one of their 'breadbasket' zone where investment will be made to promote production of staple food. These two development-oriented projects constitute unique opportunities for concerted research for development interventions targeting small ruminant value chains in Southern Mali.

Potential for impact

It is assumed that if 5% of the population of sheep and goats are kept under improved management systems making use of productivity-enhancing packages, meat from these animals in Mali will increase by 5,000 tonnes each year, equivalent to the annual quantity of small ruminant meat exported yearly from Mali. The more than 150,000 households keeping these small ruminant resources will not only benefit from both increased income but they will also improve their diet and therefore their health through increased consumption of sheep and goat meat. New opportunities for employment for actors along the value chains (supply of feeds and veterinary inputs, transport, processing) will be brought about by this significant additional meat production from small ruminants. The development of small ruminant value chains in Mali will require considerable public and private investments to support access to inputs and output markets and to ensure that the programme activities and outputs are translated into outcomes and impacts for the benefit of the poor. One of the pillars of the program's approach to impact pathway is the development of firm partnerships with public and private development organizations with clear identification of the roles and responsibilities of each partner. The co-development of new technologies, new institutional arrangements and policy measures to support the value chains in the project sites seem to be an effective avenue to ensure the programme outputs are used beyond the programme site boundaries to reach a larger number of poor smallholder sheep and goat producers. In Mali, ILRI is in the process of identifying strategic development partners with vested interest in the value chains who

are prepared to engage in complementary investments. In this regard, ILRI is carrying out consultations with research (the Institut d'Economie Rurale) and development organizations (Veterinaires Sans Frontiere Belgium, donor-funded projects such as PADESO, PROGEBE , CILSS, AUSAID-funded projects -MPLI) with track records in livestock development, to build the required partnership for the implementation of this small ruminant programme in Mali.

Intermediate Outcomes

- Inputs and services easily accessible to more producers
- Overall flock productivity increased by 50%

Ultimate Outcome

- 150,000 producers participate in the program
- 5000 tonnes of additional sheep/goat meat produced

Impacts

- Increased income and employment for poor producers and other value chain actors
- Increased per capita meat consumption in rural and urban areas

Components	Value chain outcomes
Inputs & Services	▪ The number of sheep and goat producers that have access to veterinary services and inputs (vaccine, drugs) has increased ▪ The population of sheep and goat being vaccinated and treated has increased significantly ▪ A significant number of small ruminant producers have better access to and using fodder seeds has increased. ▪ Number of Input and service providers relevant to sheep and goat producers have improved their knowledge, skills, and financial capacities and have upgraded their businesses ▪ Number and size of small entrepreneurs processing and selling feed have increased
Production	▪ Number of animals weaned per year has increased as a result of reduced death rates and this has translated into increased offtake rates and income for farmers ▪ Improved breeding males and females are more readily available to poor farmers ▪ The number of rams fattened each year has increased significantly. ▪ Number of farmers using improved food-feed crops or having adopted technologies optimizing feed resources has increased
Transport & Processing	▪ Income of sheep and goat producers and traders has improved as a result of reduction in transport and transaction costs.
Marketing	▪ Number of small ruminant producers, traders and processors, having timely access to information on livestock markets (prices, opportunities, constraints) has increased actors of the value chains ▪ Increase in the volume and value of sheep and goats traded at the national and regional levels ▪ Increase in the profit margins made by sheep and goat producers engaged in breeding, growing out and fattening operations ▪ Income of actors along the value chain have increased

Summary of indicators along the impact pathway that we believe can achieve these impacts.

DAIRY VALUE CHAIN IN INDIA

India is home to one third of the world's undernourished children. This persistent undernutrition has devastating effect on human development and economic growth in the country, resulting in economic losses of an estimated US$ 2.5 billion annually. With over 50% of the population being vegetarian, milk is a key source of dietary protein and other essential nutrients and plays a key role in the mitigation of undernutrition. Unfortunately a significant gap exists between demand for and supply of milk despite milk production contributing about 18% to agricultural GDP and being - by value - the single most important agricultural commodity. About 70% of the milk is produced by small, marginal and landless farmers keeping up to 3 adult dairy animals. Even households supplying private dairies have an average herd-size of only about 10 animals. For 70 million rural households, 40% of whom are landless, milk production is an important part of their livelihoods. About 70% of labour in dairying is provided by women and engagement in dairying has been shown to provide pathways out of poverty. Improving the dairy sector in India will therefore benefit producers by providing livelihoods and consumers by providing milk at affordable prices.

Table 4.12: Criteria and rationale for choosing dairy value chain in India

Criteria	Rationale for India
Growth and market opportunity	In the past two decades per capita milk consumption in India increased from 150 to 250 gram per day, with a predicted consumption of 370 gram daily in 2020. Current growth rate in milk production is only 3.8% compared to 4.5% in the 90s and a projected growth in demand in the coming decade of 4 to 5%. A demand-supply gap has existed for at least the past three years resulting in price increases of 21% on a year to year basis. This is severely affecting the ability of rural and urban poor to buy milk. In India, where over 50% of the population is vegetarian, milk is a key source of dietary protein and other essential nutrients. Thus this demand-supply gap has severe consequences for millions of poor in a country with an already chronic level of malnutrition. Government of India (GoI) responded by allowing tax-free imports of in March 2010 of 30 000 tonnes of milk powder and 15 000 tonnes of butter oil, commodities which until then attracted 60 and 30% import duty respectively.
Pro-poor potential	Recent (2004-2005) estimates (Tendulkar Committee) about poverty suggest that 42% of the rural population live below the poverty line of 447 Indian Rupees per capita per month (about 10 US $) and 26% of the urban population (urban BPL is 579 Indian Rupees per capita per month or approximately 12.6 US $) resulting in 407 million poor. With a vegetarian population of over 50%, milk and milk products are a crucial source of protein and other nutrients in India. Despite wide-spread malnutrition amongst young children in India, it has not been shown that increasing sales of milk further weakens their nutritional situation. Rather, the increased regular income in relatively small amounts offers households the opportunity of improving their access to nutritious food. Female household members are generally responsible for feeding and management of livestock within the homestead. Increased milk production along with improved training on basic nutrition, especially nutrition of women and children, and food safety could have a significant impact on food and nutrition security.
Researchable supply constraints	Of the 180 million bovines, only about 12% are cross bred with average milk yields (corrected to 365 day lactations) of 6.44 kg per day. Forty one percent are local cattle with average milk yields of only 1.97 kg. Forty seven of milch animal are buffaloes yielding on average 4.40 kg of milk daily. The average milk yield across all bovine animals is 3.6 kg per day. In the years 2002-2007 growth in the dairy sector was due more to an increase in herd-size, (about 7% p.a.) rather than milk production per animal Actual yield increases were negligible (under 1% p.a.) for both buffaloes and cows. Feed is the major financial input into dairy accounting for an estimated 70% of the production cost and is a major constraint to increasing production. In India, reduced access to grazing and rising opportunity costs for producing fodder crops has led to considerable increases in feed prices. Thus, in many parts of the country, the price of

	cereal residues, i. e. straws and stovers, currently the major feed resource, accounting for almost half of all livestock feed, is now half the price of grain by weight. Concentrate availability is limited because of the priority in most of the country of allocating land to food crops and by-product concentrates such as brans and oil cakes are exported in significant quantities. Improving feed supply through green fodder and forage production has largely failed because of severe constraints in the availability of arable land and irrigation water. Even in areas where land and water are available attempts to increase fodder supply have generally failed because access to quality forage seeds is a major impediment. On the other hand, various feed resources remain underutilised and few opportunities for improving feed rations through supplementation or processing are implemented. Knowledge and extension on feeding remains inadequate. Poor genetics of breeding animals is another constraint to improving dairy productivity. (As stated above, only 12% of dairy cattle are cross bred). Even where artificial insemination (AI) is being used, less than 15% of the breeding bulls have been tested. Furthermore, conception rates after AI are only about 40% when the service is supplied by government agencies although conception rates are higher when supplied by Non Government Organisation (NGO)s. Private AI services are in their infancy and often impaired by government policies. The introduction of exotic semen for cross-breeding is hardly regulated, leading to low fertility and survival rates of higher grade dairy animals. Breeding programs for buffaloes have not been very effective. Animal health services are very variable regionally within India with a large number of producers having little or no access to veterinary services. Even where veterinary services exist they often have inadequate facilities and a lack of operational funds. Only in limited areas have private suppliers been able to successfully establish the delivery of animal health services. Similarly livestock extension services are usually nonexistent or very limited. Animal diseases such as foot and mouth disease, brucellosis and haemorrhagic septicaemia cause large economic losses. In general the key services necessary to improve dairy animal productivity and management are found to be fragmented, uncoordinated and non-integrated. Services are rarely tailored to the need of smallholders. Their high transaction cost is a further element discouraging participation of poor producers in dairy value chains. Economically and institutionally viable models for integrated service delivery in the dairy sector are virtually absent or operating at an insufficient scale. With the exception of the large urban centres, almost 80% of the milk marketed is traded through the informal sector. Government policies hardly consider the importance of the informal trade. Most milk is consumed as liquid milk – only about 20% of the milk produced is processed. Cooling facilities are limited and restricted to the organised sector, leading to considerable food safety issues.
Enabling environment	The high number of smallholders and landless people engaged in dairy together with the significantly increasing demand for milk and other dairy products and the existing supply gaps has put dairy high on the development agenda in India. An ambitious 15-year National Dairy Development plan has been prepared by the National Dairy Development Board, supported by a request to the World Bank from Government of India for a 1 Billion US$ loan, and which recognises the potential role of the private sector (feed, AI, processing etc) and marketing structures other than dairy cooperatives. The Government of India (GoI) has asked for CG involvement in this new program. Therefore the probability of this Program influencing a major development program and leveraging significant development funds is very high. In addition, both private sector and co-operative dairies are showing renewed interest in investing in improved collection, processing and distribution systems after many years of stagnation.
Existing momentum	The choice of the dairy value chain in India was based on the above described importance of milk in food security, the importance to poor consumers and poor rural producers and ILRI's comparative advantage in research infrastructure, staffing and wide ranging established partnerships in India. ILRI has already carried out research on aspects of the

dairy value chain in the state of Assam, supported by the World Bank, which had led to changes in policy on the informal market sector and has developed several large projects that address technical constraints to dairy development in the feed, health and breeding sectors. These projects are being implemented in close collaboration with other CG Centers (ICRISAT, CIMMYT, IRRI), the national agricultural research system (Indian Council of Agricultural Research) and several State Agricultural Universities), private enterprises (feed manufacturers, fodder traders, seed industry) and NGO's (Sir Ratan Tata Trust, BAIF, BASIX, RDT).

Research and supporting actions

ILRI's institutional and technical research experience and projects with its wide range of public and private partners in India and beyond will be harnessed and focus onto the dairy value chains. This comprises well developed research on key constraints in input and services through innovation platforms and hub structures, well tested approaches to mitigating key technical constraints in animal feeding, health and genetics and knowledge management strategies that bring those aspects together and that can deliver to target beneficiaries and other pertinent actors.

Gender dimensions

Milk and milk products is a key component of the diet in most Indian households. It is consumed in tea and also taken as a drink by children, old people and the infirm. However, the supply-demand gap and resultant price increases are resulting in reduced ability of poor households to access it. Within households women make decisions about the purchase and consumption of milk.

Women have a major role in dairying, accounting for most of the employment in dairy production (World Bank, 1991). Their activities range from care of animals, grazing, fodder collection, cleaning of animal sheds to processing milk and livestock products. Indoor jobs, such as milking, feeding, and cleaning, are done by women in 90% of families while management of male animals and fodder production are done by men.

Although women play a significant role in dairy management and production, the vast majority of the dairy cooperative membership is made up of men, leaving only 14% to women. Nevertheless in recent years a number of NGOs have facilitated the formation of women's self-help groups focussed on dairy. Gender-targeted strategies will be used to reach women, who have a key role in so many aspects of the dairy value chain,

Table 4.13: Opportunities and constraints in dairy value chain in India and the research and development actions to overcome them

Value chain components	Developmental challenge	Researchable Issues	Indicative partners	Outcomes
Inputs & Services	• Ensure smallholder participation and competitiveness in dairy value chains	• Develop equitable business models that better link all actors in the value chain • Effects of national trade policies on dairy markets	• ICAR • NDDB • MoA and Ministry of Trade	Sustainable producer business models reduce constraints of labour and feed access on smallholder dairy farms and increase their participation along the value chain. Sustainable business models improve service delivery and reduce transaction costs for input provisions and delivery of services.
	• Lack of appropriate input provision and input markets	• Develop new sustainable business models for livestock service delivery to reduce transaction costs • Business models to decentralise and localise input supply through partnerships with private rural retailers and livestock input suppliers • Establishment of service delivery platform at state level to strengthen stakeholder co-operation in service delivery in dairy	• NGOs • Rural coop and retailers • extension services KVKs • state governments • private veterinarians • finance institutions	
	• Unreliable and unsatisfactory artificial insemination services	• Development of sustainable models of delivery of AI to smallholders	• NGOs, , • Government, breeding centres • inseminators	
	• Inadequate availability and lack of quality control of commercial concentrate feeds	• Improve availability and utilisation of locally sourced feed supplements • Development of low-cost commercial feed • Commercial feed quality control system to prevent adulterations	• Fodder traders and feed processors • Animal nutrition Institutes of ICAR	

Production	*Key developmental challenges* • Mitigate feed scarcity in an economically and environmentally sustainable way	*Researchable Issues* • Increase available feed quantity through improved food-feed crops from multidimensional crop improvement, niche forage and specialized forage production and use of by-products from bio-energy production • Make better use of on farm feed resources through feed and fodder preservation techniques, supplementation strategies and strategic feed resource allocation *Supporting Actions* • Engage with crop improvement Centres to include feed and fodder traits into crop improvement and develop hubs for phenotyping for such traits • Engage with government program, private enterprise initiatives to ensure distribution of improved varieties	*Research* • National and international crop improvement Crop improvement Centres • Development agencies and natural resource management • Seed industries, fodder traders and feed manufacturers *Supporting Actions* • Mobilize and focus ongoing partnerships on new dairy value chains	More milk with less animals, through better feeding and higher animal productivity Smallholders use breed, feed and health management options that can on average double milk production per animal
	• Poor animal breeding and lack of widespread availability of improved genetics	• Development of innovative institutional arrangements for the delivery of improved genetics at farm and village level	• ICAR • NGOs • AI suppliers, biotech institutes, breed organisation	
	• Develop integrated service packages for the delivery of animal health interventions together with feed and breed interventions to increase animal productivity.	• Quantification of economic losses due to disease at national state and household levels • Develop cost effective and sustainable disease prevention and treatment strategies	• ICAR • State governments • Private vets	

Transport & Processing	*Key developmental challenges* • Reliable and cost efficient milk collection	*Researchable Issues* • Quantification and time-line of direct and indirect effects of improved infrastructure - comparing impact on	*Research* • private and cooperative dairy marketing institution	

		various household types and intra-household effects • Analysis of exiting business models as a basis for more efficient and localised milk collection		Employment creation in more efficient and inclusive dairy value chains
	• Processing of crop residues or biofuel industry by –products (blocks, pellets, bales)	• Current constraints and potential of under-used feed materials, economics of feed blocks and machinery design • Facilitate fodder markets and develop decentralized feed processing enterprises	• Feed block manufacturers, machinery manufacturers and dealers • Concentrate producers • Fodder traders	
	• Lack of value adding of liquid milk at local level for dairy product s local provision	• Economic viability and microenterprise development of cottage industries for women • Development of franchising schemes with the dairy industry for decentralised and localised production and marketing outlets through village level entrepreneurs.	• Government self-employment and poverty reduction schemes • *NGOs* • Dairy industries	
Marketing	*Key developmental challenges* • Improving the effectiveness and efficiency of the informal milk market • Creation of linkages between the informal and formal milk market sectors • improving the milk quality and safety in the informal milk market • Ensure appropriate supply of milk ad milk products to different market types • improving the contribution of meat to the income of smallholder dairy producers • Creation on policies conducive to modern	*Researchable Issues* • Describing and analyse the informal value chains to identify key bottlenecks and opportunities. • Pilot testing of priority interventions. • Pilot changes to market models to improve their efficiency • Development of risk-based approaches to food safety • Market research to understand market segmentation, by geography, demography, income group etc to inform	*Research* • Private retail organisations • Dairy processors • State government dairy departments • Central government • Meat processors • Quality control institutions • Dairy cooperatives, private dairy producers • NARS • Public health institutions	More efficient, inclusive and safe milk markets drives sustainable dairy growth in the country

	retail and logistics • Impact of price policies in production growth	policy and investment decisions. • Establish market models for meat animals (buffalo). • Welfare economics to understand benefit distribution to inform development of pro-poor food security policies.		
Crosscutting issues	*List key developmental challenges* • Develop new approaches to deliver technical interventions, such as innovation platforms, hubs systems • Ensure multi-stakeholders knowledge sharing and cross- learning on dairy VC and link up with policy making national platform • Use of ICT in dairy value chain to facilitate: o input provision, innovation dissemination producer linkages with VC actors and stakeholders' decision making for famers • Gender issues in dairy value chains • Environmental issues in dairy VC	*Researchable Issues* • Ways of overcoming Institutional barriers and coordination problems in the dissemination of information to stakeholders and dairy farmers and forms of cooperation in dairy VC • How to overcome communication barrier and development of communities of knowledge for highly effective policy development and implementation • Testing which technologies are most appropriate, which impact in terms of time and cost savings and improved decision making for farmers and service providers • Role and benefit of women in Dairy VC • Emission reduction through better feeding and manure management • Smallholders capacity to pay for environmental costs	*Research* • Private sector, public sector institutions involved in dairy production and marketing • NGOs, NARS and extension services involved in developing and disseminating technical information on dairy management • NDDB, MoAs at national and state level • APAARI, NDDB, ICAR, ICT for Dev. platforms in India	Government policies, extension services, and input supplies are aware of the specific needs of smallholder producers Knowledge management in dairy value chains and use of ICT deliver technical interventions more effectively and sustainably

Geographic focus

India is a huge and diverse country. Many of the individual states are larger in area and have a higher population than many countries in Africa. It varies immensely in climate, covering high, cold Himalayan mountains, temperate regions, humid and semi-humid tropical areas to arid deserts. There is also a huge diversity in ethnicity and social structures, language, wealth distribution and political structures. To take account of at least some of this variation we propose to work in one pilot site each in three geographically contrasting dairy value chains. The exact locations will be decided in consultation with the Government of India and the National Dairy Development Board to ensure maximum synergy with the National Dairy Development Plan and to maximise the leverage of development resources from central and state governments, donors (e.g. World Bank Loan for dairy development) and the private sector. Since agriculture is a devolved to the states, the interest and commitment from the relevant state governments and animal husbandry departments will be crucial Potential target states are:

- Andhra Pradesh in a dryland area. There is a general policy thrust to develop agriculture and livestock in dryland areas in India. There is investment by private dairy companies, several of which have expressed interest in working with the CG Centres.
- Eastern Gangetic Plain. Lack of investment in the semi-humid Eastern Gangetic Plain has hampered dairy development but there is now renewed interest from both government and the private sector in diary development. CRP 1.2 will also be working here.
- Assam. This is a milk deficit state in a humid region in which ILRI has been working for several years and has built good working relationships with government and the NGO sector.

Potential for impact

The potential impact of increasing the efficiency of the dairy value chain in India has to be seen in view of the 70 million rural households relying on dairy animals. However, the difficulties in replicating the considerable success of co-operative dairy systems in individual states on a national scale highlight the challenges in reaching these households. The selection of the specific value chains and geographic locations for this project is aimed at investigating and overcoming the various constraints currently limiting dairy development. The initial number of direct beneficiaries will depend on the final selection of the specific value chains to be targeted, but we envisage a minimum of 5,000 dairy producers to be involved with each value chain during the life-span of the project. In addition, a similar number of poor consumers and households involved with the pre-production and post-production stages of the value chain will be directly affected by the project activities.

The objective of doubling per animal milk productivity will be achieved by interventions at all stages of the value chain. The improved quality and cost-efficiency of inputs and services will lead to an increase in their use. The integration of producers into producer communities will enable a better utilisation of available resources and an increased investment into dairy production. The gains in efficiency and quality of milk collection, processing and marketing, as well as the improvements in the policy framework will encourage various stakeholders in the value chain to profitably increase their involvement in the dairy sector. In particular, attractive and reliable marketing opportunities will be the basis for small-scale dairy producers to intensify their dairy production and to increase their market integration.

Doubling dairy animal productivity will lead to considerable income increases for the poorest households, especially if the efficiency of input delivery and of milk marketing is improved simultaneously. Improved awareness of nutritional requirements of children together with increased household milk supply will contribute to a reduction in child undernutrition. Improved milk supply to markets and more efficient marketing systems will allow poor consumers to increase the share of milk and milk products in their diets without exposing themselves to increased health risks. The growth of the value chain will create additional employment opportunities, both in the formal and the informal sectors. Updated policies will allow the informal sector to grow through supporting improvements in food safety and environmental impacts while retaining its efficiency advantage.

In previous and ongoing projects, which will contribute substantially to the proposed dairy value chain work and from which the proposed work is derived, ILRI used Outcome Mapping exercises to identify entry points into the value chain, intermediate output targets, important actors, partners and boundary partners.

Components	Value Chain Outcomes
	• Existing policies understood and used for supporting small holder participation in dairy value chains • Actor matrix linkages used to identify missing links and entry points for establishing • Input and service supplies discuss, design and try new business models with emphasis on decentralized inputs & supplies • Innovation Platforms and hubs established for linking input and service suppliers, producers and customers
	• Best fit feed intervention for pilot VC identified and addressed by seed supplier, fodder/forage growers and fodder traders • Decentralized feed processing options implemented by entrepreneurs, village self help groups and dairy cooperatives • Extension and other developments agents agreed on service packages comprising complementing feeding, health and AI/breed interventions
	• Prevailing transport and processing conditions analyzed for opportunities constraints • Feed manufacturers/fodder traders use feed resource scenarios, transport/infrastructure, feed processing cost information and economic return from dairying estimates for feed interventions • Business plans developed and used for design of milk processing options
	• Informal milk market value chains are described and analyzed and used for pilot schemes testing improved marketing options • Incentive systems for improved milk quality developed and tested in pilot sites • Suitable ICT models selected and tested in pilot site

DAIRY VALUE CHAIN IN TANZANIA

The vast majority (about 80%) of Tanzania's 43 million people depend on agriculture, mainly mixed farming. Livestock contributes about 30% of agricultural GDP, mostly derived from over 18 million heads of mostly indigenous East African zebu cattle, the third largest in Africa after Ethiopia and Sudan. Improved dairy cattle comprise a relatively small number, 560,000. Cattle supply virtually all the milk though there is a small but steadily growing population of dairy goats mainly in Arusha-Kilimanjaro and Morogoro regions.

Milk supply has increased 130% over the last decade to about 1.6 billion litres (NBS, 2009), implying a per-capita milk consumption/availability of approximately 39 litres per annum. Average producer prices have also fallen dramatically over the period from about US$ 0.4 in 2000 in some areas to about US$ 0.12 currently, implying a more stabilized market and better distribution. Arusha and Kilimanjaro regions supply about two-thirds of the milk. Other significant producing regions are Tanga, Mwanza, Kagera, and Dar es Salaam.

Demand has been rising sharply as projected a decade ago by MOAC/SUA/ILRI (1998), driven mainly by human population that is growing fast at 3.3% per annum and high economic growth rate of about 7% per annum over the last decade. The gap between demand and local supply is predicted to continue to widen in the medium term to 2020 (see projections below). The market continues to be dominated by raw liquid milk, which comprise over 95% of the marketed milk currently. Less than 1% of households consume processed milk according to a recent household budget survey (HBS) report (NBS 2007). Urban livestock farming is common in major cities, likely because of long distance from main production centres. The largest consumption centre, Dar es Salaam, is considered to have the largest number of dairy cattle kept within urban boundaries in East Africa, given the large gap previously observed in supply from outside the city and per-capita milk consumption among city residents (MOAC/SUA/ILRI 1998). The unmet demand in Tanzania presents important opportunity for improving the welfare of producers and their market agents, through income and employment generated in dairy production, processing and marketing.

Why this value chain?

Growth in the dairy industry has been ranked by ASARECA and IFPRI as the most important agricultural sub-sector in the ECA region in terms of potential GDP gains (Omamo et al 2006). And there is large milk productivity gaps in each production system and genotype going by minimum and maximum production levels reported in the literature (Mwacharo et al 2009). The potential for growth in the dairy sector in Tanzania may take similar trends with neighbouring Kenya where, with similar conditions, growth has been much faster and total production is now than six times Tanzania's production. The major difference lies in a longer history of public investment in improved genotypes and private sector led growth that has characterised dairying in Kenya. The rapid rise in demand and a liberalised economy now provide Tanzania with similar impetus for growth.

The dominance of small-scale production and marketing system in Tanzania is not only typical of dairy systems in East Africa but many parts of the developing world as well. However, dominant product types vary from mainly liquid milk in East Africa, to butter in Ethiopia, soft cheese in West Africa and milk sweets in India. The main constraints of limited feed availability and poor quality cut across dairy systems in all these regions. Lessons from dairy research and development in Tanzania can therefore be widely applicable.

Table 4.14: Criteria and rationale for choosing Tanzania

Criteria	Rationale for Tanzania
Growth and market opportunity	Demand for dairy products in Tanzania is driven by the large human population currently estimated at 43 million that is growing at 3.3% annually, urbanisation at 5% annually and increasing income from high economic growth rate – annual real GDP growth is currently about 4% (NBS 2008). Milk supply has hardly kept pace with growth in demand. The momentum for growth was adversely affected in early 1990's when public support for both milk marketing and livestock services declined, leaving a wide gap. Private sector growth has been unable to fill this gap, even in the most productive regions, despite a flurry of activities by various actors, including small traders, private entrepreneurs, farmer groups and NGO's, each innovating mechanisms for collecting and retailing milk and for providing inputs and animal reproduction and health services. While the latest FAOSTAT indicates per-capita milk consumption in Tanzania has remained unchanged at about 24 litres over the past decade, national sources in Tanzania estimate that milk availability/ consumption has increased significantly to about 39 litres per capita annually (NBS 2007), up from 24 and 28 litres per capita estimated in 1998 by FAOSTAT and MOAC/SUA/ILRI, respectively. The source of the difference is in estimates of annual production[15]. Regardless of the different estimates, Tanzania still has very low average per-capita milk consumption levels compared to some neighbouring countries[16], and well below levels seen among some segments of Tanzanian society, especially in urban areas. The rapid increase in the numbers of the more productive improved dairy cattle population, which is now estimated at about 560,000 heads (up from only about 240,000 heads a decade ago), indicates that production is already responding to meet the rising demand. Only an insignificant amount of some 25 million litres, less than 5% of production, is processed annually by private units, meaning the local milk supply is dominated by unprocessed milk. The most common processed milk product is fermented, locally known as *mtindi* and UHT , both comprising 77% of marketed processed milk products (NIRAS 2010). Consumption of packed milk is very low even in urban areas. The 2007 HBS estimates that less than 1% of households consume processed milk, with Dar es Salaam having the highest rate at 1.5%. Rising demand in urban areas has provided an incentive for imports to fill part of the small market for processed and packaged milk, mainly UHT, but figures on imports vary with various sources. Imports of dairy products in liquid milk equivalent between 2004 and 2009 averaged at 26,000 million litres per annum, growing 9.41%, and accounting for about 48% of the processed milk market (NIRAS 2010). Most imports comprise of UHT milk and cream, concentrated or sweetened. Major sources of imported dairy products are Kenya, South Africa and United Arab Emirates. Imports from within the region are likely to increase given the EAC Customs Union that now allows free trade without tariffs. Figure 1 shows projections for local milk supply and demand in Tanzania to the year 2020, based on modest increases in real GDP growth. The demand projections are based on current consumption levels, projected for urbanisation at 5% annually, population growth rate declining to 2.6% by 2020, an overall income elasticity of demand for dairy products generally of 0.8, and the indicated rates of real growth in GDP. Under the assumption of a modest 2% annual real GDP growth, milk consumption can be expected to rise by over 60% over 13 years to 2020, to reach nearly 2.5 billion litres annually. That rise would reflect an average per capita consumption level of still only about 56 litres annually in urban areas, and 37 litres in rural areas. Considering that income growth is a little faster than assumed, demand could easily rise more rapidly than these modest projections. For comparison, Figure 1 also shows the projected rise in demand under 3% annual real GDP growth.

[15] For example, in 2007, FAOStats and NBS estimated milk production in Tanzania at 953 million and 1.43 billion litres, respectively.

[16] Per capita availability of milk in Kenya is currently estimated at over 100 kg annually.

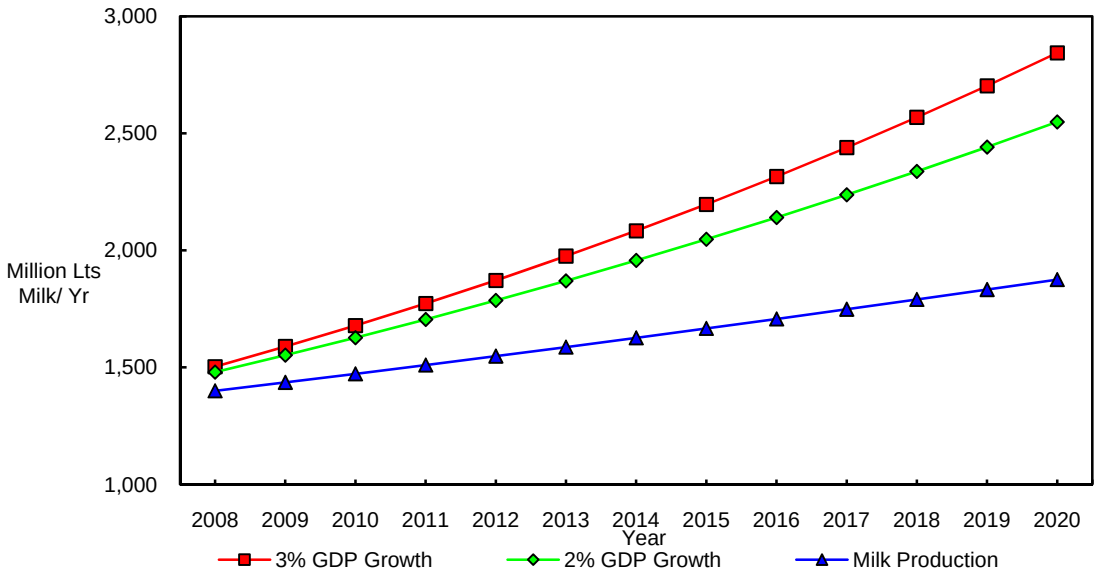


Figure1. Projections in dairy supply and demand to 2020 for Tanzania

Milk production trends were also projected and are illustrated in Figure 1. Production projections assume no change in per animal productivity or herd structure, and are based on extrapolating current herd changes. The traditional zebu herd is projected to increase at a rate of 1.4% annually and dairy herd, estimated to be growing at 5%. The latter growth rate is assumed to decline modestly to 4.6 by 2020. These projections suggest an increase of some 41% in milk production, with the dairy herd share rising from 34% to 43%. Under this supply projection and the demand scenario of 2% GDP growth, there could be shortfall of some 673 million litres of milk annually, or about 26% of demand. Under the same GDP scenario, an overall herd productivity increase of 4.5% annually would be necessary to enable supply to keep pace with demand.

These projections suggest that, under current trends, production is very likely to fall short of demand. National economic performance continues to respond positively to recent structural reforms, implying the shortfall is likely to be substantial These trends present an important opportunity for improving the welfare of current and potential smallholder dairy producers in Tanzania and their market agents, through income and employment generated in dairy production, processing and marketing.

Pro-poor potential

Though successful economic liberalization and institutional reform in recent years have led to a recovery of the Tanzanian economy since 2000 with a high GDP growth, this has not impacted rural areas significantly and about 37% of rural Tanzanians are still classified poor and undernourished (NBS, 2010). The 2008 World Bank Development Report cites evidence that investment in agriculture is critical to the process of ensuring a decline in poverty, and that the poor's involvement in markets offers pathways out of poverty at the household level. Dairying is widely considered to be one of the most promising agricultural pathways out of poverty, not only for producers but for consumers and the informal actors who dominate the marketing chain as well; hence the ranking of growth in the sector as the most important agricultural sub-sector in the region in terms of potential GDP gains in the medium term (Omamo et al 2006).

Small-scale dairy production and marketing benefits the poor in many ways, especially where increasing demand enhances those opportunities as in Tanzania. These include opportunities for intensification and enhanced productivity leading to livelihoods improvement, including through employment, besides nutrition benefits for the poor. It has been estimated that dairy farming generates about 50 full-time wage-labour opportunities per 1,000 litres of milk produced on a daily basis, and up to 20 full-time jobs (17 direct, 3 indirect) per 1,000 litres of milk handled on a daily basis by informal traders (Omore et al 2004; SDP, 2005).

Milk-borne public health concerns that are usually the basis for discouraging the dominant informal milk markets that serve the poor. But these can be addressed without endangering the health of

consumers (Omore et al, 2009). Evidence from neighbouring Kenya indicates that interventions to improve such markets accrue widespread and substantial benefits. Recent Impact analysis of an intervention to pro-actively engage small-scale milk traders through a training and certification quality assurance scheme demonstrated benefits to the Kenyan economy amounting to US$ 33 million annually (Kaitibie et al 2010). The benefits accrued mainly to producers through reduction in margins, but with milk traders and consumers benefitting as well.

Researchable supply constraints

The possibility of utilising large areas of Tanzania's land mass that is suitable for livestock production is limited by tsetse infestation. Most marketed dairy production takes place in Arusha and Kilimanjaro, Tanga and Dar es Salaam Mwanza regions where there is relatively low disease challenge. The main constraint in production in these areas is the severe constraint posed by feed resources, including the high degree of seasonality (MOAC/SUA/ILRI, 1998; Nkya et al 2007). Limited quantity and quality of feed is considered to be the main reason for the low production of only 5-10 and 0.5 litres/day for lactating improved dairy and zebu cow, respectively. There is also a shortage of replacement start-up stock, especially in the Arusha-Kilimanjaro region where dairy is dominant. Linked to this may be the poor performance of AI and heifer breeding services. Heifer-in-trust schemes promoted by Heifer International and other agencies are playing a limited role in filling this gap among poor households. Most of Tanzania is lowland and humid implying most exotic breeds from temperate climates are not appropriate. But efforts at genetic improvements for adaptation to the tropical environment like the Mpwapwa were not adopted (Kyomo and Kifaro 2005). Whereas for some systems such as in the Arusha-Kilimanjaro highlands, it may be prudent to move from indigenous to crossbreeds and finally to exotic breeds and improved husbandry, in other more extensive areas, costs and benefits analysis may dictate that producers should upgrade their indigenous stocks to crossbred animals rather than to purebred exotic cattle.

It might be worth casting the net wider to look at more productive tropical breeds found elsewhere like the Gir, a zebu breed, originally from India but now found in many places like Brazil where further improvements have occurred with milk yield averaging 3500 kg per lactation, about ten times the lactation yield of the East African Zebu. The Sahiwal is another dairy (and meat) breed that could be explored for multiplication and distribution because it is also well adapted to humid tropical conditions. Sahiwal cows average 2,270 kg of milk per lactation, while suckling a calf. While exploring options for improved cattle, niches for dairy goats should also not be overlooked. Dairy goats have for a long time been seen by stakeholders in Tanzania as offering increased dairy productivity in areas of intensive land use and for resource-poor households, but little is known about their performance and viability in Tanzanian production systems. Presently various breeds including Saanen, Toggenburg, Anglo-Nubian, Alpine and their crosses are being actively promoted by various dairy development projects such as HPI, Farm Africa and various church groups. Anecdotal information is that there is high demand and many households seeking dairy goats do so because they want to replace the cow milk they consume at home and to sell their offspring. Others see dairy goats as a suitable low-cost and low-risk alternative to cattle dairy production for resource-poor households in areas of intensive land use, particularly where access to feed resources is limited.

While other more productive genotypes adapted to the tropical environment is being explored, the potential for productivity gains from existing breeds should not be ignored. This potential is considered to be substantial in all production systems, especially for improved dairy cattle. Figure 2 and Table 1 presents percentage differences based on various literature sources in East Africa (including Tanzania) of maximum and minimum production levels within and between both genotypes and animal husbandry

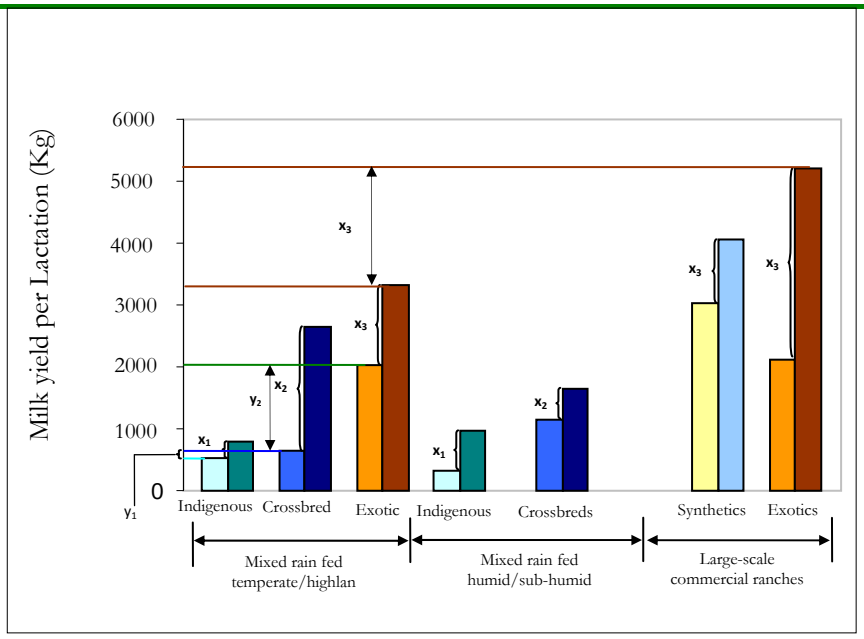


Figure 2 Differences in milk production by different genotypes in dairy cattle production systems found in different regions of East Africa. Source: Mwacharo et al 2009

Key for both Figure 2 and Table 1 below):
Light coloured bars = Minimum production; Dark coloured bars = Maximum production
xi = Yield gaps due to "animal husbandry practices"
yi = Gap in productivity due to "genotype"
z = Gap in productivity due to "differences in the production system"

Table 1. Percent (%) differences in maximum and minimum milk production levels within and between genotypes representing the yield gaps due to animal husbandry and genotype in East Africa

Differences (%) in productivity due to animal husbandry			**Differences (%) in productivity due to genotype**		
Indigenous breeds	**Crossbreeds**	**Exotics**	**Indigenous vs Crossbreeds**	**Indigenous vs Exotic**	**Crossbreeds vs Exotic**
32.7 (X_1)	75.8 (X_2)	38.9 (X_3)	17.9 (Y_1)	73.9 (Y_2)	68.2 (Y_3)

Source: Mwacharo et al 2009

The under-exploited genetic potential is mainly attributed to limiting feed resources, which if addressed could triple milk yields in crossbred genotypes (Figure 2). For example, *Brachiaria* grasses improved by CIAT have shown both high biomass production, good nutritional quality, and increased drought resistance. Dual purpose legumes like cowpea are not widely used, and the current application of feed conservation technologies is very limited. Furthermore, the large potential for existing zebu cattle population with potential for increased milk off-take has not been adequately explored. Information is needed on biophysical and market factors, dairy technology adoption patterns, herd structures and dynamics, socio-cultural factors and relative economic advantages/ competitiveness of various levels of dairy intensification. The epidemiological picture is unclear though important disease challenge is reported in many areas, contributing to milk deficits in some areas where human populations are high. Experience with vaccination against East Coast fever in northern Tanzania indicates that technological solutions can result in dramatic reductions in disease incidence. The vaccine hitherto considered undeliverable in pastoral communities due to poor infrastructure has been successfully delivered and has reduced mortality from 30-50% to only 2% in over 100,000 vaccinated calves in the area. However, the extent to which private sector solutions can address these constraints is unclear.

As shown above, demand and supply projections suggest excellent opportunities exist for significant growth in smallholder dairying. But the structure of milk marketing and the dominant raw milk market underpins the nature of constraints faced in the marketing chain. Beyond quality and market access improvements, it is unclear what specific interventions are needed to grow the formal sector given that capacity utilisation of current processing capacity of about 350,100 litres per day below 25% (RLDC 2009; NIRAS 2010). The continued dominance of the informal milk market in spite of several decades of policies and investments efforts to promote pasteurised milk marketing and consumption is linked fundamentally to the strong preference by consumers for fresh milk. Given that milk processors cannot generally compete on a cost basis with the raw milk market, if new dairy development efforts are to be viable in the long-run, they must explore the possibilities of working through market mechanisms which provide consumers with their preferred product at the lowest cost. The challenge is to address quality and safety challenges in the process. Expanding examples of commercialised supply of training and certification through accredited business development service providers that has been successfully tested as a mechanism for addressing food quality and safety concerns and differentiating the milk sold is one option for promoting market access is one option for promoting the long-terms interests of smallholder farmers, market agents and consumers. Additional information is required to better understand viability of alternative market channels, especially in relation to market margins and cost structure, barriers to entry, including credit, competition from imports, and role of transaction costs in determining farmer participation in markets.

The role of dairy farmer groups is seen in Tanzania to be very small, yet experience elsewhere has shown that they may be critical to assisting the sustained participation of smallholder producers, by providing both milk market outlets and access to services. Expansion of their role is likely to be necessary for continued dairy development. There is uncertainty as to the gaps in delivery of services (input supply, credit and extension services) that can be filled by the private sector, and the impact this is having on growth of dairying by smallholders. Slow changes in land tenure policy reform is also seen to as a constraint to access to credit and long-term investment, but is not specifically a dairy or livestock issue.

The main challenge for both research and development will be how to identify and alleviate these technological constraints to upgrading and expanding the dairy value chains.

Enabling environment

The policy direction is to increase consumption of milk supplied from local sources. Recent investment in institutional development, such as the Dairy Policy and Act and subsequent formation of the Tanzania Dairy Board, is beginning to provide a conducive environment for broader dairy rector regulation and development. The Board, formed in 2006, provides a platform for stakeholder engagement and active participation in dairy sector development. Key stakeholder associations that participate in the Board are: Tanzania Milk Processors Association (TAMPA) and Tanzania Milk Producers Association (TAMPRODA). After its formation, TDB took over coordination of consumer education to promote milk consumption and dairying that include publicity campaigns held annually around the country during the June Milk Week, among other activities.

Several bilateral and multi-lateral donors and NGOs are currently engaged in dairy development in Tanzania. The recently launched Eastern Africa Agricultural Productivity Project (EAAPP), a regional project funded by the IDA to nurture centres of excellence that has dairy as one of the commodities targeted for improvement within collaborative arrangements and partnerships spanning four countries in the region, namely Tanzania, Ethiopia, Kenya and Uganda and involving ASARECA in communication and some coordination. Tanzania and Norway are committed to participate in the development and implementation of the REDD (Reduced Emissions from Deforestations and Forest Degradation) initiatives in Tanzania to combat deforestation and the challenges of climate change. Livestock offers the main opportunity for improving livelihoods in extensive areas where productivity losses associated with climate change risks are high.

Existing momentum

ILRI has been involved in several past dairy research projects in Tanzania. Over the last one and a half decades, ILRI has worked with dairy research and development institutions to appraise the dairy sector (MOAC/SUA/ILRI, 1998). This was shortly thereafter followed by research into market mechanisms, efficiency, processing and public health risks in peri-urban dairy product markets (Omore et al, 2009). ILRI was also invited severally over the period to stakeholder policy consultations that led to the formulation of the current Dairy Industry Act in 2004. Currently, the Tanzania Dairy Board (TDB;) assisted by a local NGO, the Austroproject Association, is piloting a commercialised supply of training

and certification milk quality assurance scheme with support from ASARECA and ILRI. CIAT has also been engaged recently initiated steps to build up expertise on tropical forage research in the region, and Tanzania is among the target countries.

Ongoing donor investments targeted at dairy development include those implemented by Heifer Project International (HPI) and Farm Africa that have been involved in promoting access by poor households to improved dairy cattle and goats, respectively, for over a decade. Others include: SNV (capacity building); SDC (milk market promotion and support to Rural Livelihood Development Company); and, BRAC (AI services, http://www.brac.net/content/about-brac-tanzania). The United Nations, through UNDP and FAO, are also reported to be engaged in promotion of value chains approach to the development of various agricultural commodity systems. Locations of Tanzania have also been recently identified by AGRA as "breadbaskets" among other locations in various countries in Africa.

Planned engagements include The Royal Norwegian Embassy (RNE) and SUA who are planning to have dairy value chain and policy research included in the next phase of its new four-year-period programme that will put emphasis on scaling-up and dissemination of best practises from previous programmes in a value-chain-perspective and actively collaborate with public and private sectors as well as non-governmental organisations in the process his will be the successor project to the just ended Programme for Agricultural and Natural Resources Transformation for Improved Livelihood (PANTIL). The on-going East Africa Dairy Development Project (EADD) in Kenya, Uganda and Rwanda by consortia including HPI and ILRI, is considering including Tanzania in its next phase anticipated in 2012.

Research and supporting actions

Recognizing that further discussion will be needed to refine these, indicative actions are described in Table 4.15, below.

Table 4.15: Indicative research areas and supporting actions in Tanzania value chain

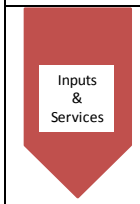
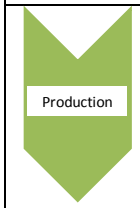
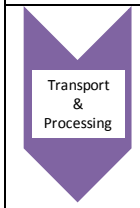
Research area	Supporting action
1. Increasing productivity of existing dairy systems	
• Identify adoptable strategies to alleviate under-nutrition of dairy animals and reduce the seasonal variation in feed availability • Investigating existing constraints and options for breeding strategies (new genotype, AI, bull services, etc) • Evaluate constraints & potential to dairy goat dissemination including evaluation of determinants of adoption and economic viability, including areas having both dairy goats and cattle; analysis of alternative multiplication/breeding schemes, based on extensive project experience in dairy goat dissemination; and, evaluation of resource use efficiency in comparison to cattle and local goats. • Update existing information on viability of alternative milk marketing mechanisms and optimal mix between informal and formal marketing systems. This includes identifying reasons for low capacity utilisation of existing chilling/processing plants	• Promote dairy farmer group development with emphasis on milk collection, and provision of feeds and reproductive and health services. Farmer groups may have an advantage over both informal milk traders and private processors in that, while offering farmers reliable milk outlets, they are well placed to simultaneously provide inputs and services such as AI. • Federation of individual farmer groups to provide economies of scale in distribution and service and input provision. If/when a genuine federation of groups is attained, processing of milk by that federation could be considered. • Promote milk distribution outlets in urban areas through simple bulk channels, including kiosks, dairy bars, etc. This could be linked to either private entrepreneurs or federations of farmer groups but informed by research into which market channels will be viable in the longer run. • Establish a platform for the co-ordination of dairy development. Many institutes perform their roles in isolation, whether in research, in dairy development, or in dairy marketing. The Tanzania Dairy Board may be one avenue and a convener

	• Pro-active engagement to empower small-scale traders to acquire skills in milk quality control and entrepreneurship • Enhance on-going efforts towards consumer education regarding milk quality, hygiene and consumption, particularly in urban areas. Through their demands and preferences expressed as choice of purchases, consumers are best-placed to induce better quality control in informal markets and the development of the formal market.
2. Increasing marketed off-take & dairy herd expansion in extensive systems • Identification of relatively extensive production regions with potential for increased milk off-take, and identification of the conditions necessary for exploiting that potential This includes: a) an *ex ante* analysis of dairy potential in terms of agro-ecological, spatial, and market factors, disease challenge, distance, infrastructure, and collection system development on dairy potential, b) an *ex post* analysis of dairy technology potential including analysis of adoption patterns of components of dairy technology packages • Update existing information on milk demand patterns and seasonality including product differentiation, and secondary urban markets. • Impact assessment of the contribution of dairy system development to households particularly the poor. This includes: a) intra-household impact assessment, dealing particularly with child nutrition, and the gender implications of market-oriented dairying, and b) direct and indirect economic impact assessment including linkages of the dairy sector to the rest of agricultural and non-agricultural sectors.	• Given the relatively small exotic dairy herd population, priority for milk market development should be given to increasing the offtake from existing traditional herds, or importing and promoting more productive tropical breeds that can withstand tropical conditions (e.g. the Gir or Sahiwal). As farmers become better equipped to deal with the disease challenge, cross-breeding of existing cattle should be encouraged. • Expand heifer and dairy goat loans schemes to smallholders, perhaps through establishment of multiplication schemes. • Promote the provision of AI services by private livestock service providers and smallholder farmer organisations that currently do not provide the service. Appropriate training is required to improve farmer acceptance of technicians and AI.

Gender dimensions

Successive surveys of gender participation in dairy production and marketing in eastern Africa has repeatedly shown that women control significant proportion of the income derived from dairy production, even though men may own the production assets. But direct participation by women in marketing declines relative to that of men as marketed output increases and the milk is sold to large bulking points, such as dairy cooperatives. Women are more likely to receive money from milk sold to individual customers and private traders than from dairy cooperatives. Therefore, women producers would be expected to benefit from promotion of small-scale milk marketing.

Table 4.16: Opportunities and constraints in dairy value chain in Tanzania and the research and development actions to overcome them

Value chain components	Developmental challenge	Researchable Issues and Supporting Actions	Indicative partners	Outcomes
	*Key developmental challenges* • Sub-optimal inputs and services needed to exploit genetic potential of existing dairy herds • Constraints to feed production and marketing • Optimal strategies for delivery of animal health services	*Researchable Issues* • Identify viable collective action and/or private sector solutions to provision of inputs and services *Supporting Actions* • Promote dairy farmer group development	*Research* • SUA, GoT, ILRI, CIAT *Supporting Actions* • GOT, Various national and international NGOs	Enhanced use of inputs and services Increased productivity (reduced morbidity and mortality)
	*Key developmental challenges* • Under-nutrition of dairy animals seasonal variation in feed availability • Low marketed dairy production and off-take in extensive systems	*Researchable Issues* • Identify adoptable strategies to alleviate under-nutrition • Introduce other tropical dairy breeds (e.g. Gir and Sahiwal) *Supporting Actions* • Promote dairy farmer group development	*Research* • SUA, GoT, CIAT ILRI • *Supporting Actions* GOT, Various national and international NGOs	Increased productivity in intensive systems and increased milk off-take in extensive systems
	*Key developmental challenges* • Poor infrastructure, the development of which can greatly ease milk collection and marketing • Under-utilised capacity for existing chilling/processing plants • Under developed business service provision	*Researchable Issues* *Supporting Actions* • Infrastructure development to ease milk collection and marketing • Promote dairy farmer group development • Maximize utilisation of existing chilling/processing capacity	*Research* • SUA, GoT, ILRI, CIAT *Supporting Actions* GOT, TDB, Processors, Various national and international NGOs	Increased marketed milk off-take from all systems

Marketing	*Key developmental challenges* • Near-absence dairy farmer groups with emphasis on milk collection, and provision of feeds and reproductive and health services. • Transformation of informal milk markets towards formality	*Researchable Issues* • Determine viability of alternative milk marketing mechanisms and optimal mix between informal and formal marketing systems. *Supporting Actions* • Pro-active engagement to empower small-scale traders to acquire skills in milk quality control and entrepreneurship	*Research* • SUA, GoT, ILRI, CIAT *Supporting Actions* • GOT,TDB, Processors, Various national and international NGOs	Increased proportion of formally marketed milk
Crosscutting issues	*Key developmental challenges* • Low direct participation by women in marketing relative to that of men as marketed output increases	*Researchable Issues* • Understanding reasons behind gaps in achieving gender equity *Supporting Actions* • Gender mainstreaming	*Research* • SUA, GoT, ILRI, CIAT *Supporting Actions* • GOT, various national and international NGOs	Improved gender equity

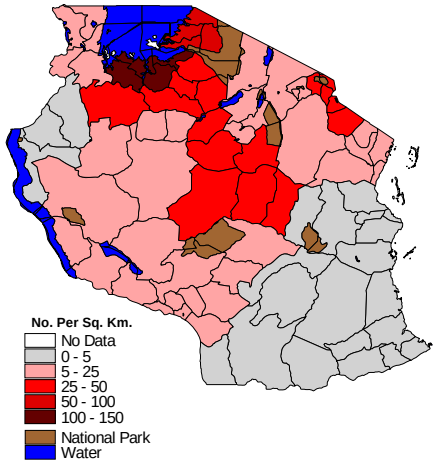
Geographic focus

For increasing productivity in existing dairy systems

Priority area to focus activities directed at increasing productivity in existing dairy systems are as follows, in order of priority given the current density of improved dairy cattle: Northern highlands (Arusha, Kilimajaro), Southern highlands (Mbeya, Iringa), Coast (Tanga), and Lake Zone (Kagera). Alhough with increasing numbers of dairy cattle, dairying in Dar-es-Salaam is considered low priority because it is unlikely to be a primary source of livelihood for those involved.

For increasing marketed off-take and herd expansion

Extensive areas with the highest density cattle are Lake Zone (Mwanza, Mara), Central Tanzania (Dodoma, Singida) and per-urban Dar es Salaam. Previous and on-going efforts to increase marketed off-take from these areas by, *inter-alia*, Austro-project and RLDC, respectively, need to be reviewed before new initiatives are taken.



Map of Cattle Density in Tanzania (all breeds)

Potential for impact

The main strategy for translating the dairy value chain development activities and outputs towards outcomes and impacts for the poor is to by, first, channelling the research directly into improving value chains with development partners, and second, on working with the private sector, at all levels (e.g. service providers for feed, AI, health and processors). Serving as knowledge partner for development partners implementing large-scale interventions comprising new integrated services, provides direct access to immediate promotion/scaling out and uptake of best-bet strategies and technology packages. Playing an active role in M&E also provides an avenue for learning and feedback. Impacts are envisaged through increased per-capita milk consumption by over 60% in 2020 if the target of overall herd productivity increase of 4.5% annually is attained. Impacts on livelihoods can be extrapolated from the ongoing East Africa Dairy Development Project (EADD) where a doubling of income for 179,000 households is envisaged and is on track to being achieved over a 10 year period. Potential impacts may also be extrapolated from the study by Kaitibie et al (2010) where one policy intervention generated benefits to the Kenyan economy amounting to US$ 33 million annually.

Summary of indicators along the impact pathway that we believe can achieve these impacts.

Intermediate Outcome

- 10 identified VC constraints resolved or lessened.
- % increase in identified value chain effectiveness metrics.

Ultimate Outcome

- At least a 50% increase in dairy annual production for target markets by 2020.
- 100% increase in households participating in value chain.

Impacts

- Average per capita dairy consumption in target regions increases towards recommended levels by 60%
- 90,000 households double their dairy income by 2020

Components	Value chain outcomes
Inputs & Services	• Increased private sector participation in inputs and services provision • Increased number of farmer groups engaged in provision of inputs an services • Increased access to desired inputs and services for breeding, feed, and animal health • Improved feed quality and increased quantity of feed (forage and concentrates) • Increased access to affordable animal health care
Production	• Reduced seasonality in milk supply • Increased milk off-take from existing herds in extensive areas • Increased feed options available • New more adaptable breeds introduced and accessible • Reduced yield gap for cows with under-exploited genetic potential • Reduced disease risk and mortality, especially ECF
Transport & Processing	• Increased volume and proportion of processed milk • Increased number of small-scale milk traders selling more milk • Reduced transport and transaction costs
Marketing	• Increased number of farmer groups engaged in milk marketing • Reduced transactions costs • Participating milk business enjoying price premiums from improved milk quality • Higher milk volumes sold to more and profitable outlets • More women participating in larger milk businesses and farmer organisations

DAIRY VALUE CHAIN IN HONDURAS AND NICARAGUA

In Central America, dairy products are an important dietary component for consumers from all social strata. The potential to increase the consumption of dairy products is high, with domestic consumption growth rates in Honduras and Nicaragua of 6.7 and 11.7%, respectively. Average per capita consumption in Latin America is currently 100 kg Litres of Milk Equivalent (LME) per year versus 265 kg LME for USA (FEPALE, 2006). In lower income strata in Central America– representing the majority of the population – the per capita consumption is far below the Latin American average.

Population growth and on-going urbanization create favourable conditions for expanding markets. In 2030, the Central American population will be 56 million, compared to 35 million in 2005. Moreover, 65% of the population will live in cities of more than 50,000 inhabitants, compared to the current 40%. Most urban consumers have access to electricity and hence refrigeration facilities. Population expansion will be accompanied by a growing diversity of consumer preferences for a great variety of dairy products. Strengthening small industries to enter market niches for products with higher added value would change the business panorama of the value chain for small producers.

Why this value chain?

The majority of the poor in Latin America live in tropical lowlands or hillsides. About 50% of this population, mostly rural dwellers, is still considered poor (UNDP 2003). Within the rural sector, dual-purpose livestock systems (meat and milk) constitute a principal economic activity of small producers. About 400,000 small-scale producers in Central America own livestock, with more than 75% of income being generated by milk sales. Nicaragua and Honduras, with more than 200,000 poor smallholder livestock producers, are key players for developing the dairy sector in the region.

After the poultry sector, milk production and marketing, and the dairy-products industry constitute the fastest growing livestock sub-sector in the region and continue offering valuable opportunities for small producers. Interventions to increase small-farm productivity should therefore be based on milk production, the creation of value-added products in the dairy industry and the improvement of linkages along this increasingly dynamic value chain.

However, several factors limit the participation of small-scale farmers in dairy value chains. The quality of milk produced by small farmers is usually poor, due to a lack of adequate on-farm infrastructure, inappropriate milking practices, and collective investment in cooling systems on the farm and for transportation. In addition, links of individual farmers to associations and from these to buyers remain weak. The lack of strong links along the value chain inhibits not only the flow of information on what constitutes product quality and how to achieve it but also the establishment of quality-based incentive systems that benefit both producers and buyers. This suggests a need for tools to improve small-scale producer efficiency, links between actors in the value chain and increasing the level of added value generated by the dairy sector overall.

Production constraints

Constraints include low and unstable productivity, poor milking hygiene and bulk milk collection. They are related to low productivity and poor quality milk, and often to high production costs. Some producers receive low prices because of a lack of storage capacity, especially in times of high production (rainy season). In addition, milk quality is often low due to long periods between milking and cooling, which takes place in large milk collection centres in nearby towns. Usually cooling starts after 2-3 hours, but during the rainy season when roads deteriorate this can take up to 5 hours, further increasing bacterial count and acidity.

Supply constraints

In spite of an annual average growth rate of 4.2%, second only to poultry as a source of animal protein (FAOStat 2009), milk production is not sufficient to meet growing domestic demand. This situation is further exacerbated by high seasonal fluctuations in milk availability with markedly reduced production levels during the dry period (Fujisaka et al 2005).

Initiatives are needed to improve productivity, hygiene and general quality in milk producing farms, particularly among the smaller producers. Improved forage-based systems are key (Peters *et al*, 2003), providing year-round sufficient quantities of high quality feed based on a combination of high quality grasses and legumes in a diversified resilient landscape often including shrubs and trees, and combined with conservation technologies (hay, silage). Genetic improvement of animals and improved herd and farm management are also essential

Market/institutional constraints

Constraints to the marketing of raw milk largely explain the wide presence of micro-processors, some on the farms themselves, to produce fresh cheese and cream sold in local markets. This contrasts with the increasingly stringent food safety standards which demand differential responses of milk producers especially to reach more profitable formal markets in urban centres. An analysis of the value chain (e.g. the case of informal cheese exports from Nicaragua to El Salvador) is needed to determine which proportions of the revenues are going to the different actors (farmers, intermediaries, retailers), to be able to focus interventions on improving the economic situation and thus conditions at producers' level, improving overall quality, hygiene and profitability.

In milk collection, solutions are needed to improve milk collection processes and food safety measurements in collaboration with industry partners and to improve quality control and food safety standards from production to local and regional markets.

Table 4.17: Criteria and rationale for choosing Nicaragua and Honduras

Criteria	Rationale
Growth and market opportunity	**Import substitution** Nicaragua: import: US$ 17.7 million Honduras: import US$ 58 million **Effects on income** In Central America the dairy sector generates more than 540,000 direct jobs, usually with higher wages than in other livestock activities (FECALAC 2006). The sector also generates about 1,600,000 indirect jobs in the area of supplies, equipment, and services that form part of the dairy cluster. Pomareda (2005) estimates total jobs created by dairy production, industry and distribution in Central America (five countries) at about 11 million, with more than half of them are in rural areas. **Distribution** The distribution of dairy products follows different channels depending on the scale, type and quality of products. The most extended market represents 60% of total milk production (mainly by smallholder farmers) and consists mainly of raw milk and fresh white cheese with a short shelf life due to low (hygienic) quality. About 20% of these fresh cheeses produced in Nicaragua is exported to El Salvador. Pasteurized milk (including UHT), white and matured cheeses of several varieties and cream, all requiring refrigeration, are marketed in the larger cities and represent about 40% of total regional production. Supermarkets and local stores are the main channel for delivery. They all have access to distribution services from industries or collectors of industrial products. In Honduras, a network of small dairy processing units (CRELs) guarantees storage capacity and good hygienic conditions and at the same time provides services to dairy farmers (e.g. veterinary products, feed supplements). **Trade** The main dairy product traded is white fresh or semidry cheese, followed by pasteurized milk, including some long-life presentations. They account for 65% of total dairy exports, primarily within the region. Most dairy exports from Nicaragua are destined to Guatemala and El Salvador.

Value of exports of dairy products (thousands US$)

Country	2005	2006	2007	2008	Main products
Costa Rica	29,465	36,327	47,580	57,650	Fluid milk and cheese
El Salvador	4,381	5,084	6,764	7,894	Fresh and dry cheese
Guatemala	3,215	3,509	3,643	2,984	Fresh and dry cheese
Honduras	10,504	10,878	11,462	18,410	Fresh and dry cheese
Nicaragua	32,008	57,663	89,847	116,239	Fresh and dry cheese

Consumption

The poorest 50 percent of the population (CEPAL 2004) consume small amounts of dairy products (in fluid milk equivalents), primarily fresh raw milk and white s of local origin. The higher value dairy products are consumed primarily by the urban middle and higher and rural middle class. There are therefore two challenges: to supply low cost, high quality dairy products for the poor, while at the same time capturing the market for high value added dairy products consumed by a smaller segment of the population with higher income (Pomareda 2005).

Market development

Local Markets. Largest increases in demand will come from urban consumers, however, the rural population itself comprises a relevant market, with the basic dairy products (raw milk, fresh cheese, and cream) being an important part of the diet. Social programs such as the "Vaso de Leche" (a glass of milk for every student attending public schools) in Honduras is an example of this and helps to boost local demand.

Regional markets. The regional market consists specifically of the urban population of the Caribbean Basin countries obtaining products from small retailers and supermarkets, and to food industries that

	use milk, cheese, cream, and other dairy products, and is estimated to represent a population of 150 million consumers. Trade agreements also create opportunities for high value dairy products entering high income niche markets, where differentiated products can be sold successfully, for instance, Central American dairy exports to the US markets are essentially fresh and semi-mature cheeses targeted at the Central American immigrant market in major US cities. To obtain sustained access to these markets, however, significant changes in both policies and public and private institutions will be needed. **Nutritional contribution to diet** Dairy (milk, cheese) is the most important source of animal protein in both Honduras en Nicaragua including the poorest category. The challenge is providing them with nutritious less expensive dairy products, especially for children, while ensuring adequate food safety and product quality.
Pro-poor potential	Nicaragua and Honduras have currently 120,000 and 100,000 poor livestock keepers, respectively. Most dairy farms in Central America are small and scattered, although there are some dairy clusters in a selected number of zones. The typical dairy oriented farm carries, on average, 5 to 10 milking cows that produce between 15 and 50 kg of milk per day. Milk production is 3-5 kg per cow per day. Income comes from milk production (75%) and sale of weaned male calves and culled cows (25%), compared to 95% of income coming from milk in specialized dairy systems. This dual-purpose system is more risk averse and allows farmers more flexibility when either the milk or beef price fluctuates by feeding calves more milk when price is low, such as often during the rainy season. Milk production contributes between 5.9% and 9.2% of the agricultural gross domestic product (AGDP) and between 0.9% and 1.9% of the gross domestic product (GDP). When contributions from the dairy-products industry and other activities of the cluster are included, these figures triple. Furthermore, in the 'dairy basins' of each country, the importance of dairy activities is much more significant than what the aggregate figures for each country suggest.
Researchable supply constraints	**Production constraints.** As mentioned before, constraints are low and unstable productivity, seasonal feed constraints poor milking hygiene, and bulk milk collection. Supply constraints. In spite of an annual average growth rate of 4.2%, as a source of animal protein only second to poultry (FAOStat 2009), milk production is not sufficient to meet growing domestic demand. Initiatives are needed to improve productivity, quality, hygiene and general quality in milk producing farms, particularly among the smaller producers. **Market/Institutional constraints.** An analysis of the value chain (e.g. the case of informal cheese exports from Nicaragua to El Salvador) is needed to determine which proportions of the revenues are going to the different actors (farmers, intermediaries, retailers), to be able to focus interventions on improving the economic situation and thus conditions at producers' level, improving overall quality, hygiene and profitability.
Enabling environment	Technological policies for cattle production are provided in four major areas: pasture improvement including use of multipurpose forages and sylvopastoral systems, genetics, reproductive technology and farm management. Integrated pasture systems with sylvopastoral components will also contribute to mitigation to climate change (e.g. carbon sequestration), conservation of biodiversity (including reducing pressure on natural forests) and improve water use. **Animal health and food safety policies.** The efforts of the national veterinary services have centered on the development of technical capacity and human capital In recent years there has been more interaction with the private sector and attention to market access. There is a need for integrated animal health management - better use of veterinary medicine – to comply with safety standards. **Commercial Policies.** Countries in general have agreed to lower tariffs in bilateral trade agreements, particularly with the US. Yet in the case of Central America, one of the greatest problems is the not-harmonized external tariffs for dairy products. Bilateral trade between these countries is important, yet it is limited by different tariffs and other regulations regarding extra-regional imports. **Environmental Policies and Ecosystem services.** Livestock production has long been an important cause of natural habitat and biodiversity loss in Latin America (Pagiola et al 2006). In Central America deforestation as a result of the establishment of pastures is expected to continue as a result of growing demands for livestock products and low productivity. Therefore, immediate dissemination of efficient and environmentally friendly, i.e. eco-efficient (CIAT 2009) farm technologies, such as the establishment of improved pastures, legumes and integration of sylvopastoral practices reducing emissions and increasing carbon fixation, is required to improve competitiveness in local and regional

	economies, while leaving a minimal ecological footprint.
Existing momentum	Dual-purpose cattle systems constitute a principal economic activity for around 400,000 small producers in Central America, with more than 75% of income generated by milk sales. Significant progress toward poverty alleviation and improved diets for consumers can be made through intensification of these systems. The specific arguments can be summarized as follows: **Cash flow for small producers.** Dairy is often the most important provider of cash for small producers, utilizing productive systems strongly based on domestic resources (land and labour) and offers a route for capitalisation and escape poverty. **Potential for high value dairy products.** Currently small producers cannot compete in commodity oriented systems due to their inability to take advantage of economies of scale associated with large intensive operations. They must therefore engage in vertical integration aimed at producing and marketing value added products with local identity based on high-quality raw milk (Pomareda 2007). **Taking advantage of expanding markets.** Population growth and on-going urbanization accompanied by a growing diversity of consumer preferences for a great variety of dairy products create favourable conditions. **Gradual trade liberalization.** In the trade agreements with the US the participating countries have negotiated between 10 and 15 years of decreasing protection for the dairy sector. The remaining time should be utilized to develop differentiated high value products and to gain market access both locally and with partner countries. **Needs and opportunities for private investment.** In order to increase competitiveness and to improve productivity and added value, small producers and industry enterprises will need an injection of capital and knowledge. **Multiplier effects and scaling up**. One important aspect of promoting milk production and small scale high quality dairy industries is the multiplier effect for local economies, through employment generation and the development of small businesses for input supply and services. **Increased integration with formal market chains for fresh milk** There exists a high seasonal variability in production of fresh milk affecting both utilization of production capacities and availability to consumers. The linkage of improved production technologies such as drought adapted forages and forage management connected with milk quality standards and organized collection and support services provide a unique opportunity to improve income generation across the value chain, while enhancing product quality to consumers. **Small and medium-scale industrialization: search for value added products** Thousands of small processing units generate products based on raw material of limited quality. In contrast, most of the available quality milk is collected in bulk by a few plants, which can then generate products of guaranteed safety. The opportunity lies in identifying, motivating, and supporting a segment of these small-scale industries to grow and become involved in the principles of quality.

Research and supporting action

The three main principles to improve small-scale dairy production across Central America are: (1) a value chain approach from producer to local, national and international markets addressing constraints and capitalizing on opportunities; (2) a focus on specific regions where dairy has an important potential to mobilize the local economy; and (3) a focus emphasizing learning across different biophysical and socio-economic environments and defining specific options for local, national and regional policies and programs.

Potential interventions include:

- Improved forage, pasture and sylvopastoral systems that are resilient to climate change to increase productivity (including growth of animals) and assure stable milk production throughout the year, and including improving economic efficiency by reducing production costs
- Improve milk quality and hygiene through better processing techniques
- Strengthen farmers' organizations, at the production, processing and marketing level (including promotion of niche products and Protected Designation of Origin).

Gender

Roles of women and men vary according to the different components of the dairy value chain. Whereas in general the crop-livestock sector has a mostly masculine character (10-20% of farms are owned/managed by women), women play a important role especially in processing and management of resources. In small farms (with some dairy cattle) they are sometimes also involved in feeding and milking, but in general they engage mainly in processing of milk (e.g. fresh cheese, *cuajada*) for household consumption and local/regional markets. In larger dairy farms with more products the men are usually engaged in production and marketing, whereas the women control inputs, do the financial administration and participate in decision processes on production and marketing.

Geographic focus

Nicaragua and Honduras are among the poorest countries in the region; about 50% of the population live below poverty line. Livestock production and in particular dairy is one of the most important agricultural activities, with the majority in smallholder systems. The main emphasis of the value chain will be Nicaragua, but with potential scaling into Honduras. The systems studied are of relevance to the Central American region and beyond: if successful the research and development efforts will have an impact on national dairy value chains. The major action sites with the highest potential for impact in Nicaragua include the South Pacific Region of Nicaragua (Rivas), Matiguas, Muy Muy, RAAN (Siuna), Las Segovias and Chinandega. For Honduras, Olancho and Yoro have been identified for scaling.

Potential for impact

With the increasing population, changing demographics and external trade opportunities, there is an increasing internal and external market for dairy products. While direct impacts are expected from improved production and income generation for the 220,000 poor livestock producers in Nicaragua and Honduras, beneficiaries will be much greater including the large number people linked to the dairy chain and rural and urban consumers facing a shortage of dairy products. In Central America the dairy sector generates more than 540,000 direct jobs, usually with higher wages than in other livestock activities (FECALAC 2006). The sector also generates about 1,600,000 indirect jobs in the area of supplies, equipment and services that form part of the dairy cluster. Pomareda (2005) estimates total jobs created by dairy production, industry and distribution in Central America (five countries) at about 11 million, with more than half of them are in rural areas.

Table 4.18: Opportunities and constraints and the research and development actions to overcome them

Value chain components	Developmental challenge	Researchable Issues and Supporting Actions	Indicative partners	Outcomes
Inputs & Services	• How to organize efficient and sustainable input services for smallholders including ➢ Animal health ➢ Milk hygiene	*Researchable Issues* • Conduct gap analysis to identify upgrading needs in terms of technological changes needed to meet public and buyer standards • Strengthen local dairy clusters by Identifying key support services *Supporting Actions* • Develop a business development plan and budget for upgrading needs • Facilitate integration between small farmers, small dairy enterprise and buyer to establish agreements for physical and process upgrading • Develop local platforms for collective action and link these to relevant organizations.	*Research* • CATIE • SIDE • INTA • **DICTA** *Supporting Actions* • Nitlapan • CANISLAC • SwissContact • GTZ/DED, UNAG, URACCAN	• Inputs and services are accessible to smallholder farmers • Farmers organized and linked to service providers, and development and research • Conducive policy environments
Production	How to enhance resilient productivity at farm level including ➢ to overcome seasonal or continuous gaps in feed quantity and quality ➢ to improve milk hygiene ➢ to develop sustainable production systems resilient to climate change	*Researchable Issues* • Develop improved forage options and facilitate the access of small scale dairy producers to improved forage alternatives to increase and sustain milk production. • Develop methodologies for balanced rations at smallholder level *Supporting Actions* • Train technicians and producers in methodologies for balancing rations. • Facilitate the development of farmer led seed supply systems. • Connect small producers with service providers to assist in the formation of rural enterprises. • Prepare manuals on milking	*Research* • CATIE • INTA • **DICTA** • SIDE *Supporting Actions* • GTZ/DED, UNAG, URACCAN	• High quality feed year round • Reduced seasonality of milk production addressing seasonal supply constraints • Improved milk quality and quality • Better linkage of smallholder producers to formal market • Higher standard of products from informal market • Enhanced sustainability of smallholder crop-livestock system and improved resilience to climate change an environmental shocks

		techniques, milk handling and conservation, and hygienic milking.		
Transport & Processing	How to provide consumers year round with high quality dairy products, and maximize productivity of smallholder livestock producers	*Researchable Issues* • Develop low-cost traceability systems for collection points capable of assessing the milk quality of individual producers and promote the use of payment systems based on milk quality. *Supporting Actions* • Link small scale producers to ➢ Modern conservation and transport systems for raw milk. ➢ Quality enhancing processing systems ➢ Modern distribution and sales systems for dairy products • Facilitate mechanism to comply with food safety regulations • Provide policy support for value of official recognition of certifications made by private animal health services	*Research* • SIDE • CATIE *Supporting Actions* • INTA • **DICTA** • GTZ/DED, UNAG, URACCAN	Higher productivity of smallholder livestock producers High quality dairy products available to consumers years round
Marketing	How to link smallholder producers to the formal market for dairy products and how to provide higher quality products in the informal market, enhancing availability of high quality dairy products to consumers year round	*Researchable Issues* • Implement processes of new product development • Testing of simple but robust monitoring and evaluation tools that allow to assess the health of the chain on an on-going basis *Supporting Actions* • Development of a shared business vision between actors in the chain • Strengthening of the small dairy firm as a "social intermediary" that provides both business value to buyers	*Research* • SIDE • CATIE • INTA • DICTA *Supporting Actions* • CANISLAC • CONAGAN • SwissContact GTZ/DED, UNAG, URACCAN	Higher availability of high quality dairy products Higher productivity of smallholder dairy enterprises Functional value chain linking formal and informal markets

		but also social value to producers and local communities • Building clear and transparent governance into the chain for rule setting, enforcement and conflict management		
Crosscutting issues	• How does the transformation of the dairy value chain affect gender relations	Assessment effects of transformation of dairy value chain on gender equity		Gender equity in dairy value chain enhanced

Summary of indicators along the impact pathway that we believe can achieve these impacts.

Intermediate Outcome

- improved productivity

Better linkage of small

- producers to formal and improvement of informal markers

Ultimate Outcome

- 50% increase in dairy annual production for target value chains by 2021.
- 10% households participating

Impact

- Availability of dairy products to consumers in the region
- 20,000 households improve their standard of living through participation in the value chain

VC Component	Value chain outcomes			
Inputs and Services	Accessible to smallholder farmers	Farmers organized and linked to service providers		
Production	High quality feed year round and Reduced seasonality of milk production	Improved milk quality and quality	Better linkage of smallholder producers to formal market	Enhanced sustainability and resilience of smallholder crop-livestock systems
Processing	Higher productivity of smallholder livestock producers	High quality dairy products available to consumers years round		
Marketing	Higher availability of high quality dairy products	Higher productivity of smallholder dairy enterprises	Functional value chain linking formal and informal markets	

PIGMEAT VALUE CHAIN IN VIETNAM

The livestock sector contributes over 21% of agricultural GDP (6% of national GDP), of which pig production accounts for 71% of livestock output. The recent increase in livestock production has been driven by rising domestic demand, particularly in urban areas where per capita incomes have risen fastest. In general, meat demand has been rising among a growing population of consumers that is increasingly urbanized, having more income and thereby able to shift their diets from starch-based to a more diversified diet with more meat, fish, and dairy products. Between 2000 and 2005, consumption of livestock products increased by 7.8% per annum; alongside, share of pig meat in total meat production was also rising.

Considering the fundamental characteristics of climate and labour, Vietnam has a comparative advantage in the pig sector (World Bank 2006). This is reflected in the historical dominance of the pig sector in livestock production (see Table 4.19); this trend is expected to remain, as growth trends suggest.

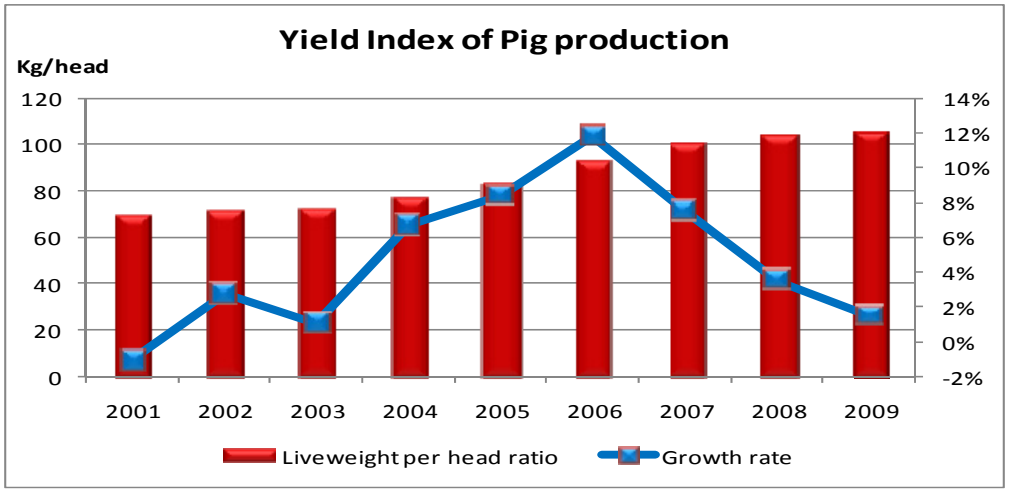
Table 4.19: Composition of livestock output, in % of total volume of output

Year	*Pig*	*Chicken*	*Cattle*	*Others*	*Total*
1990	65	11	14	10	100
2000	68	14	9	9	100
2005	72	12	8	8	100
2009	62	13	11	14	100

Source of data: FAOStat 2009.

Pig production has been rising in absolute terms, both in numbers and in liveweight; over the period 2001-2009, pig numbers have been rising faster than liveweight output. Yield (in terms of kg liveweight per head) is also increasing in absolute terms; however, annual growth rates in yield started to decline in 2006 and continue to do so up to the present (see Figure xx), although overall the growth trend is still on the upward.

Yield index of pig production, 2001-2009.



Source of data: Vietnam Statistical Yearbook 2009, GSO.

Pig production in Vietnam is mainly characterized by small-scale, widely scattered farms (Lapar et al 2003). The size distribution of pig farms is dominated by the very small scale household-based producers with 1-5 sows (84% of all households raising pigs in 2006, down from 92% in 2001. Pig raising households account for 65% of all agricultural households (based on 2006 GSO survey of agriculture).

Still, smallholders remain the dominant contributors to supply (about 80% of total pig output annually). There are indications that household-based pig production is scaling up which is consistent with economic growth that Vietnam has achieved during the last decade after *Doi Mo*^{i}*i* reforms (i.e., 7-8% annually).

Pig farms with more than 100 heads of pigs at any given time are officially registered: only 548 such pig farms were recorded in 2003, mostly in the Southeast region (76%) and some in the deltas (13% in the Red River delta, 5% in the Mekong River delta) (GSO 2003; Giao 2004) where large urban centres are located. These pig farms collectively account for about 20% of total annual pig production (ILRI 2007).

Issues for R4D

The main research for development issues confronting Vietnam's pig sector in the current context include productivity and associated NRM implications of intensification, market access for inputs and outputs, food safety, value chain performance, and the appropriate institutional and policy adjustments required to jumpstart the change process in order achieve development goals.

Why this value chain?

Table 4.19: Criteria and rationale for choosing Vietnam

Criteria	Rationale for Vietnam
Growth and market opportunity	Domestic market: Pork is the dominant meat consumed by Vietnamese consumers (about 75% of meat consumption (ILRI-CAP consumer survey report); per capita pork consumption is estimated at 22 kg (based on survey results; expected to grow by 21% over the period 2005-2020 (IFPRI IMPACT model projections updated in 2009, unpublished results) Import substitution: Vietnam is generally self-sufficient in pork, except in particular years (e.g. 2008) when animal disease outbreaks resulted in shortages in supply due to culling and deaths, in which case, imported pork from the US fill the gap in supply requirements, making Vietnam a net importer of pork in the global pork trade for the first time; this situation is projected to remain during the period 2008-2017 (FAPRI 2008), although IFPRI IMPACT model projections show Vietnam to be a net pork exporter during the period 2000-2020. Income and urbanisation: with Vietnam's rapid economic growth in recent years (6-7% per year), increased income and urbanization will drive consumption of more protein (meat, milk and dairy products, eggs); the demand for fresh pork as the dominant meat in the Vietnamese diet will remain, and this cuts across all income levels. There is also a growing demand for quality and safety attributes among higher income consumers, particularly in urban areas; these include attributes such as leanness, free from harmful residues and from animal diseases, and guarantee of hygienic slaughtering and processing. Regional and global exports: Vietnam has been exporting suckling pigs regionally, particularly to China/Hong Kong; previously, pork was exported to Russia under a special bilateral agreement. Among Southeast Asian countries, Vietnam's volume of pork exports is the largest; projection estimates suggest that Vietnam will remain the largest pork exporter among countries in the region. On the other hand, Vietnam's competitiveness in the global pork market remains weak; Vietnam's cost of production is relatively high compared to other pork exporting countries, e.g. US, Canada, Brazil, that it will be difficult for Vietnamese pork at this stage of pig sector development to be competitive in the export market. Vietnam also needs to ensure compliance with OIE requirements for disease free zones, e.g. FMD, in order for them to be a significant player in international trade of pigs/pork. There could be a niche for continuing to supply a niche market for suckling pigs to China and neighbouring countries. Nutritional contribution to diet: Vietnamese consumers derive about 10% of their calorie intake from livestock, one of the highest in Southeast Asia, and this is projected to increase by 32% during the period 2005-2020 (IFPRI IMPACT model estimates, unpublished results). With pork the dominant meat in the Vietnamese diet, this implies that pork contributes significantly to the overall calorie intake from livestock of Vietnamese consumers.

Pro-poor potential	Numbers of poor livestock keepers: Smallholder pig producers (e.g. those having less than 10 heads) account for at least 80% of pig production in Vietnam. In 2006 household survey, 83% of households had less than 5 pigs (Tisdell 2009). High density of pigs is also associated with high poverty (FAO-PPLPI, 2006), that is, regions with high poverty incidence also have the highest pig densities. Potential role of smallholder: Currently, smallholders (or households with less than 10 heads of pigs) account for at least 85% of pig production in Vietnam. Smallholder pig production generates employment (about 4 million full-time jobs along the pork supply chain, valued at $3.3 billion or 5.5% of Vietnam's GDP in 2007) (estimates from ILRI survey of household based pig producers, 2008). Household labour constitutes the main labour inputs in household based pig production; Women labour accounts for 1.5 times the labour use in household based pig production. Recent ILRI estimates also show value added of at least 12,500 VND (or roughly $0.66) per kg liveweight of output from household-based pig production. Ability to participate and potential to intensify: Pig raising is and will continue to be part of a suite of activities in mixed crop-livestock systems in Vietnam. Intensification will happen and is already happening at different levels across the regions of the country, likely driven by the opportunities from increasing demand and also improved infrastructure that allows easy access to both input and output markets. Productivity and efficiency issues remain critical constraints to a sustainable intensification process, particularly in the context of limited household landholdings and increasing wages in the manufacturing sector.
Researchable supply constraints	Production constraints: Feed cost accounts for the largest share of total cost of pig production (e.g. at least 65% of total feed cost); most of feed ingredients used in processed feeds are imported. Animal diseases remain an important production threat; recent experience with PRRS (blue ear disease) has seen thousands of pigs culled resulting in shortages of pork supply, not just in areas where outbreaks occurred, but also in areas, particularly urban centres, that depend to a large extent on imports of pork from other regions having surplus production, because of the ban on animal movement. There has already been widespread dissemination and even uptake of improved pig breeds in Vietnam that potential gains in genetic improvement may not be as substantial or even necessary. What is required is to ensure that existing local breeds that are being used in crossbreeding with exotic stock to generate crosses that are widely used in household based systems are maintained by the state breeding centres for sustainable propagation. Appropriate and effective breeding strategies will also need to be co-developed and jointly implemented with key stakeholders including their target beneficiaries. Market/Institutional constraints: Inefficiency in delivery of extension and vet services remain an important supply constraint to productivity and efficiency in pig production in Vietnam; this is particularly important in hard to reach regions, e.g. mountainous areas where accessibility and lack of appropriate incentives deter extension and vet officers from working there; the sorry state of the majority of markets and slaughtering facilities in the country also potentially poses food safety and public health risks; Improvement in delivery of animal health services in terms of quality and improved accessibility - Improving quality would require re-training of vet officers in order to update and/or upgrade their skills and introduce new approaches; also equipping them with appropriate tools and equipment. Improving accessibility would require increasing the reach of delivery of vet services; this implies need for increased institutional support for vet services either to hire more vets and/or to provide appropriate incentives to improve the efficiency of existing vet officers; Also improving delivery of effective extension on appropriate pig husbandry in general; the private sector has been dominant in the feed sector, both in production, processing, and distribution; what may be necessary are stricter rules and penalties for compliance with feed quality standards to ensure that consumers are getting their money's worth from purchased feed. In terms of vet services, there are private providers, but these are usually serving the larger farms; household-based pig producers are

	generally reliant on the supply of publicly-provided vet services. There may be scope to explore to what extent these producers may be willing to pay for services that they demand to address their animal health concerns. The national research systems will also need to review and re-program their research agenda in order to effectively respond to current needs and this may require tacit and continued support from the national government. Gendered constraints: Women contribute a substantial amount of labour in pig raising, so that technology interventions need to consider this aspect in the technology development and dissemination process. In many cases, women have not been actively sought to participate in extension programs because of their limitations to spend time away from home due to their household and child care responsibilities, even if they could have benefited from such exposure.
Enabling environment	Alignment with national and regional priorities and policies – Vietnam's Livestock Development Strategy to 2020 recognizes the importance of livestock in the country's overall agricultural development strategy, and pig sector development features prominently in this strategy. While the long-term vision of the strategy targets the development of a modern pig sector that involves transforming small-scale production units into large-scale, intensive production systems, it also recognizes the need for specific measures to support the small-scale producers in this transition process, including putting in place safety nets and other social measures to cushion the negative impacts on those that will be marginalized in this process. Other relevant factors – transformation of the food retail distribution system and growing interest from private sector to invest in meat processing in anticipation of growing market for fresh and processed meat products in Vietnam, and these have spurred growing private investments in the feed sector, supply of veterinary drugs, and in meat processing equipment.
Existing momentum	Existing or planned development or research investments – Vietnam is currently implementing a WB-funded Livestock Competitiveness and Food Safety Project (LIFSAP) that is aimed developing safe livestock production and targeting household-based pig and poultry systems. The project will develop livestock production zones and will support upgrading of slaughtering facilities and markets. This project could potentially be an important vehicle for providing the appropriate 'software' (knowledge base, empirical evidence) that will allow the effective operation of the 'hardware' or infrastructure being put in place. CGIAR track record and established partnerships – ILRI's previous and ongoing partnerships with national partners and development practitioners (e.g. CASREN-Vietnam component on institutional arrangements for technology uptake with MARD and Vietnam Academy of Agricultural Sciences, FAO-PPLPI project on contract farming with Hanoi Agricultural University and IFPRI, EU-DURAS project on improving pork quality and smallholder linkage with pork supply chain with Rural Development Center-IPSARD and CIRAD, ACIAR pig competitiveness project with Center for Agricultural Policy-IPSARD, Oxfam, IFPRI and University of Queensland), National Institute of Animal Science (currently in GEF-Asia project). Others?

Research and supporting action

Recognizing that further discussion will be needed to refine these in order to tailor fit the context of the target project sites, indicative actions include a stakeholder consultation during program inception to bring all stakeholders and partners together to discuss and agree on the specific research agenda. Some proposed areas for research are outlined in Table 4.20 on opportunities and constraints.

Gender dimensions will be actively integrated in various aspects of the research and development activities. It is recognized that a gendered lens could enhance the effectiveness of interventions to improve chain performance, by addressing issues that affect women's effective participation in and contribution to the pork supply chain.

Table 4.20: Opportunities and constraints and the research and development actions to overcome them

Value chain components	Developmental challenge	Researchable Issues and Supporting Actions	Indicative partners	Outcomes
Inputs & Services	*Key developmental challenges* *Feed* • Productivity of smallholder swine production is constrained by lack of access to and high costs of purchased feeds • Smallholder swine producers do not fully utilize crop residues as feed for intensifying swine production • Productivity of smallholder swine production is constrained by seasonal shortages of feed resources produced on-farm • Smallholder swine producers lack access to agro-industrial processing by-products as low-cost feed resources • *Breed* • Productivity of smallholder swine producers is constrained by lack of access to or inadequate supply of good quality, appropriate breeds • The widespread introduction of exotic pig breeds in the race to	*Researchable Issues* • Develop a wide range of options for balanced feed rations based primarily on locally produced feed resources, crop residues, and agro-industrial processing by-products • Develop easily adopted or adapted technologies for conserving (drying, ensilage, etc.) and storing feed resources produced on-farm • Evaluate alternative models for feed input service provision to smallholders in an action research *Supporting Actions* • Train decentralized, small-scale feed millers and mixers in production of balanced feed rations • Develop barter/consignment models with decentralized feed producers to increase affordability of feeds to smallholder swine producers • Policy advocacy *Researchable issues* • Select appropriate local pig breeds that have desirable traits for smallholder pig systems, e.g. Mong Cai, Ban, and evaluate their performance (technical and	*Research* • CIAT (utilization of cassava roots and leaves, starch processing by-products) • CIP (use of dual-purpose sweet potato varieties, ensilage of feeds and residues) • ILRI and CIP (Life-Sim: simulation model for feed ration planning) • NIAH (livestock production, feeding strategies, demonstration feeding trials) • Hue University of Agriculture and Forestry (HUAF) -- ensilage and feeding trials (cassava roots and leaves) *Supporting Actions* • Private sector companies (working with cassava starch factories on waste management for livestock feeding) • Development projects (such as IFAD, other donors) working with implementing partners in local government extension services (for farmer adaptation and scale-out)	Increased availability of low-cost, locally produced, nutritionally balanced feed resources enables smallholders to increase productivity (faster growth/off-take and/or increased herd size) of swine production. Increased availability of appropriate breeds to smallholder pig raisers, thereby improving access to affordable pig stock

	increase carcass yields and produce carcasses with low fat-lean meat ratio puts at risk the continued viability of genetic diversity for pigs and its attendant benefits to smallholder pig production <u>*Veterinary and extension services*</u> • Smallholder pig raisers generally lack or have limited access to veterinary and extension services	economic) under various breeding schemes • Evaluate models for village breeding programs linked with marketing and distribution networks for pig stock in an action research *Supporting actions* • Identify and select private sector partners for breeder supply network • Link with suitable ongoing research (e.g. GEF-Asia project in Vietnam, Hohenheim University projects in Northern Vietnam) and development projects *Researchable issues* • Evaluate models for cost-effective delivery of veterinary and extension services in an action research • Evaluate existing institutional set up for publicly-provided veterinary services, and identify gaps/areas for private-sector provision or development of other alternative forms of veterinary service delivery *Supporting actions* • Link with ongoing development projects that involve training of veterinary service providers or community-based animal health workers and extension officers • Policy advocacy	*Research* • NIAH (breed selection, on-farm evaluation of breeding strategies) • ARIs (upstream research on methods and analytical approaches for breed selection) *Supporting Actions* • IDE (development of breeder supply network) • Development projects (IFAD, other donors) working with implementing partners in local government extension services (for farmer adaptation and scale-out) *Research* • IDE, local government unit (DARD), private sectgor (action research to evaluate cost-effective delivery of veterinary and extension services) • Dept. of Animal Health and other associated line agencies under the Ministry of Agriculture and Rural Development *Supporting actions* • Development projects (LIFSAP) working with implementing partners in local government veterinary and extension services	Increased access by smallholder pig raisers to veterinary and extension service providers in the target sites Increased uptake of effective animal health practices by smallholder pig raisers in the target sites

Production	*Key developmental challenges* *Feed* • Low quality local feeds result in slow growth • Pregnant and lactating sows and weaners (especially in remote areas) fed locally produced, high fibre feeds lack sufficient digestible protein for survival and rapid growth • Widespread use of industrially processed feeds contribute to increased nitrogen and phosphate in pig waste that are environmental pollutants if not properly managed • Increasing pig numbers generate increasing volume of animal waste that could potentially result to environmental waste problems of magnitude proportion if not properly managed	*Researchable Issues* • Develop feed rations that incorporate easily digestible legume protein in balance with low-cost supplements • Develop simple, low-cost processing technologies that decrease fibre and increase availability of legume protein feed resources • Develop improved diet composition and feeding practices that will reduce waste volume and nutrient concentration in the waste • Evaluate uptake of identified feeding rations by smallholder pig raisers in an action research *Supporting Actions* • Linkage with development projects and/or partners that could provide the facilities and/or cost-share the investment in required facilities and/or inputs where needed • Policy advocacy	*Research* • CIAT (stylo and other legume feeds for monogastrics) • CIP (protein extraction from leaves) • NIAH (on-farm feed technology trials) *Supporting Actions* • Linkages with development projects and NGOs for adaptive research • Extension of technologies through training and demonstration trials with local extension services	Increased, survival, growth, and disease resistance of sows and piglets leads to increased income and food security for smallholder livestock producers.. Reduced volume and improved quality of environmental waste from pig production

	Breed • There is a shortage of good quality replacement gilt for F1 breeding sows • Unhygienic and uncontrolled breeding practices result in low quality breeding stock	*Researchable Issues* • Develop and evaluate breeding strategies that are appropriate for smallholder pig raisers • Identify traits that are preferred by smallholders and evaluate the feasibility of integrating these in breeding strategies • Develop appropriate decision support tools for breeding strategies *Supporting Actions* • State breeding centers will need to ensure that pure local breed stock are kept and bred under controlled conditions in order to maintain good quality breeding stock for sustained propagation • Develop and effective performance monitoring system for various breeds (including the appropriate database to be used with decision support tools in breeding strategies) • Capacity building at national research system in the use of these tools and the monitoring system • Policy advocacy	*Research* • NIAH (testing and evaluation of breeding strategies) • ARIs (methodologies for trait selection and evaluation, decision support tools) *Supporting Actions* • FAO • Ministry of Agriculture and Rural Development and relevant line ministries	Increased supply of replacement gilts/breeding stock with appropriate breeds (F1 crosses from exotic and local breeds, for example Yorkshire or Landrace with Mong Cai) Enhanced capacity at national research systems to implement appropriate and sustainable breeding strategies and plan
	Animal health • Animal diseases present significant risk to smallholder pig raisers, compromising the viability of their livelihoods from pig production and marketing • •	*Researchable Issues* • Develop and test effective and efficient disease surveillance systems that are suitable to smallholder context • Develop and test appropriate diagnostic tools to assist	*Research* • NIVR (development and testing of diagnostic tools, disease surveillance systems) • Dept. of Animal Health (application of diagnostic tools, disease surveillance systems) • ARIs (advanced methodologies and	Increased uptake by smallholder pig raisers of appropriate and effective animal health practices Improved productivity by smallholder pig raisers from reduced

		smallholders in quick and less costly diagnosis for disease control • Develop and test effectiveness of appropriate vaccines that are accessible and affordable to smallholders • **Analyse drivers of disease outbreaks and implications for effective control strategy** *Supporting Actions* • Training of veterinary officers in the application of diagnostic tools and disease surveillance systems • Develop a database of disease outbreaks that can be geo-referenced and used for early warning predictions and scenario analysis • Policy advocacy	tools for assessing disease risk) *Supporting Actions* • Dept. of Animal Health (database of disease outbreaks) • OIE's SEA-FMD	incidence of pig diseases
Transport & Processing	*Key developmental challenges* • Food safety is compromised by lack of hygienic facilities and practices at points of slaughter and retail sale	*Researchable Issues* • Risk assessment at slaughterhouse and transport *Supporting Actions* • Training of chain actors involved in transporting and processing of pork in best practices of meat processing and handling • Risk communication strategy • Policy advocacy	*Research* • NIVR • National Institute of Public Health *Supporting Actions* • Dept. of Animal Health • Vietnam Food Administration, MOH	Reduced incidence of food-borne and water-borne diseases associated with pork consumption

Marketing	*Key developmental challenges* • Smallholder participation in pork supply chains is constrained by their inability to meet volume and quality requirements demanded by the market. • Smallholder pig raisers face high transaction costs in pig and pork marketing due to inefficient market systems	*Researchable Issues* • Assess demand for specific pork quality attributes including food safety attributes. • Evaluate smallholder competitiveness in supplying pork that meets quality (and food safety) requirement by consumers. • Identify feasible options for upgrading pork supply chains that link smallholder pig raisers with preferred market outlets for pork by different types of consumers. • Evaluate marketing information flows and identify appropriate options to improve access by smallholders to appropriate and timely market information, and test pragmatic ways to operationalize these options in a pilot *Supporting Actions* • Develop a price information database and make this accessible in pragmatic ways to smallholder pig producers • Policy advocacy	*Research* • Hanoi Agricultural University, NIAH, and NIVR (for baseline assessment surveys, demand studies, competitiveness studies) • Dept. of Animal Health • Dept. of Trade *Supporting Actions* • local government units • pig producer associations and/or cooperatives in target study sites • IDE, Oxfam	Increased income from pig/pork marketing Increased availability of safe and hygienic pork in traditional market outlets
Crosscutting issues	*List key developmental challenges* • Women contribute significant labour inputs to pig production and marketing, however, they are rarely sought to participate in various initiatives such as training, consultations, etc; as such they miss opportunities to learn and also to provide information that	*Researchable Issues* • Identify gender-appropriate technologies and processes that could enhance uptake of these. *Supporting Actions* • Develop advocacy and communication strategy for	*Research* • NARS for technology development and testing • ARIs, national universities for research protocols and implementation *Supporting Actions*	Increased opportunities for women participation in pork supply chains Increased uptake of appropriate productivity-enhancing technologies and practices

	could be used in technology development, for example.	research results dissemination	• Oxfam, IDE for policy advocacy, stakeholder consultations	

Geographic focus

Pigs are ubiquitous all over Vietnam, especially in rural areas; almost all households raise at least one pig for household consumption or as a source of cash. Across the country, household-based pig producers are widely spread, with relatively higher proportion in the north, specifically in the Red River Delta, the North East, and the North Central Coast, relative to the South. In the latter, some concentration of households can be observed in the Mekong River Delta.

Where the incidence of poverty is relatively high, it is likely that there are relatively more household-based pig production present, with a few exceptions, as in the case of the Northwest region and the Central Highlands, both of which are characterized by relatively dense forest cover and higher sloping terrain. The poverty and household-based pig production nexus are located in the Northeast Region, the North Central Coast, and to some extent the two deltas, where some 5 million households are engaged in pig production (or about 80% of all pig-raising households) (GSO 2006).

These four regions are also home to about 69 million people (about 79% of the country's total population), of which some 11 million are poor (according to Vietnam's official definition of poverty, i.e., monthly per capita average expenditure of 280 thousand VND, or equivalent to US$0.50 per day per person, GSO 2009) (see Table 4.21, below).

Table 4.21: Population and poverty incidence in the four target regions

	Population ('000 persons)	***Number of poor ('000)***
RRD	19654.8	1592.0
NE	11207.8	2723.4
NCC	19820.2	4479.3
MRD	17695	2176.4
Total for 4 regions		10971.3
Country	86210.8	12500.6

Source of data: GSO 2009.

It is proposed that the program in Vietnam initially focus on three sites: one in the Northeast, one in the North Central Coast, and one in the Mekong River Delta. This will facilitate working on pig systems under different local context, thereby ensuring wider applicability of lessons learned and their implications to development and policy actions. The selection of the specific sites will be made through a participatory process involving key stakeholders and partners, in order to ensure buy-in from these diverse groups of potential users of research outputs.

Criteria for site selection: high incidence of poverty, household-based pig production is an important component of development strategy, good or potential to improve market access for inputs and outputs, and potential to link with large-scale development projects ongoing or being planned.

Potential for impact

The proposed program is envisioned to generate some quantifiable impacts including increased productivity leading to improved livelihoods from pig production for households engaged in pig raising in the proposed project sites.

Under current practices, recent ILRI estimates show that household-based pig production can generate some 4 million full-time equivalent jobs across a range of actors in the pork supply chain. The proposed program should aim to at least sustain that level nationally, and with higher productivity targets achieved through uptake of productivity-enhancing technologies and/or improved access to critical inputs and services and output markets, a 20% increase in full-time equivalent labour will likely be generated at project sites. The projected productivity gains from uptake of technologies and effective advocacy for policy changes will likely generate higher incomes to household pig producers in the project sites; at least 10% of these households

engaged in pig raising in the four target regions (approximately 500,000 households) will likely to be direct beneficiaries. It is also envisioned that with higher productivity gained from project interventions, that per capita consumption of pork, either purchased from the market or from consumption of own-produced pigs, will increase by at least 10% (or an additional 2 kg per capita per year, at least).

Increased productivity of smallholder pig systems will have direct benefits to rural livelihoods through increased eco-efficiencies of production systems. In contrast to large-scale factory farms where manure may be a serious pollution problem, increased availability of manure is a valuable resource for mixed (crop/livestock) farming systems, as it helps to increase productivity and sustainability of crop production. Compared to use of chemical fertilizers, use of manure can lower production costs, thereby increasing competitiveness. Increased availability of manure for intensified pig production also provides opportunities for clean and renewable household energy resources, as biogas.

Impact pathway

The program is envisaged to generate impact at scale. The impact pathway can be described as follows: research outputs are generated from the project, from which outcomes from the use of those outputs are documented, and subsequently lead to impact that could be defined in terms of change in behaviour or resolution of the research issue being addressed. In the context of the pig value chain in Vietnam, the program will generate research outputs and processes at the project sites that will include for example new knowledge, new technologies, new institutional arrangements, etc. These will engender best practices, new and better ways of doing things that will subsequently lead to the achievement of the desired impact. The project can account for impacts at the project site through direct engagement in R4D activities with partners and stakeholders where the program is physically implementing these.

The second level of impact will be generated from spillover effects to other non-project sites within the country. These impacts are envisioned to be achieved by scaling out the learning from the project sites through an effective strategy, where the various development partners will act as conduits of knowledge, processes, and other learning from the project sites, and apply the learning in their own programs and development initiatives outside the project sites. This will necessarily involve an effective communication and advocacy strategy in combination with the partnership strategy. It will involve targeting and choosing boundary partners that will have the highest likelihood of generating the scaling out of learning from the project sites. An example would be the potential of the program to add value to a large-scale development project; e.g. the World Bank's Livestock Competitiveness and Food Safety Project (LIFSAP), or IFAD's various development projects directly implemented by provincial partners all over the country.

The third level of impact will rely on the regional and international public goods that the project will be able to generate. Through an effective communication and advocacy strategy combined with the appropriate partnerships, these regional and international public goods can generate impact at regional (e.g. in similar context in Laos, Cambodia, and other parts of the Mekong region) and global scale (e.g. in pig systems in the humid tropics of Africa and Asia).

An outcome mapping approach will be used to track and monitor the identified indicators of outcomes that could lead to impact through documented behavioural changes of boundary partners.

Summary of indicators along the impact pathway that we believe can achieve these impacts.

Intermediate Outcome

- Priority VC constraints resolved or relaxed.
- At least 30% increase in farm-level productivity
- evidence and mechanism for scaling out are in place

Ultimate Outcome

- At least 30% Increase in marketable surplus from household pig production
- At least 10% of pig raising households are project participants in three project sites

Impacts

- Increased availability and consumption of pork by poor consumers
- increased income from & employment in pork value chain for smallholders.

VC Component	Value chain outcomes
Inputs and Services	• Increased access by smallholders to good quality and cost-effective inputs such as appropriate feeds and breeds. • Improved access by smallholders to efficient and cost-effective veterinary and extension services • Increased availability of cost-effective feeding options. • More efficient markets for inputs and services in place.
Production	• Improved productivity from adoption of good quality, cost-effective feeding options • Increased survival, growth, and disease resistance of sows and piglets. • Enhanced production cost-efficiency from adoption of suitable pig breeds. • Reduced incidence of pig diseases (e.g. PRRS, classical swine fever, diarrhoea, cysticercosis, among others. • Improved uptake by smallholders of appropriate pig husbandry and animal health practices
Transport & Processing	• Reduced incidence of food-borne and water-borne diseases associated with pork consumption. • Increased public and private sector investment in upgrading of slaughtering and market facilities. • Better trained slaughterhouse operators, carcass transporters, and other pork supply chain actors.
Marketing	• Increased availability of safe and hygienic pork supplied by smallholders or household producers. • More efficient marketing system and arrangements in place and accessible to smallholder pig producers. • Increased share of pork retail price accruing to smallholder pig producers. • Higher proportion of women participation in pork supply chain, and improved income opportunities for women from these activities.

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SMALLHOLDER PIG PRODUCTION AND MARKETING VALUE CHAIN IN UGANDA

The Ugandan pig sector

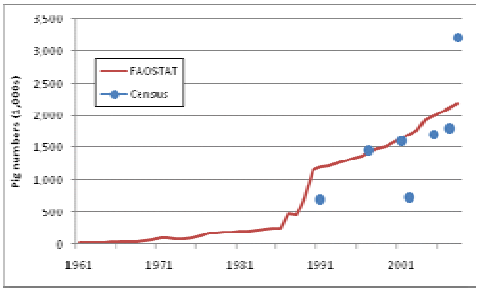
According to recent FAO statistics, pork is second only to beef in terms of meat production in Uganda (Table 4.22). Since imports and exports of meat products are negligible, this ranking also reflects the relative importance currently of pork in terms of meat consumption.

Table 4.22: Meat production in Uganda

Type	Amount (1,000 tonnes)
Beef	96.8
Pigmeat	77.4
Chicken meat	44.1
Goat meat	24.6
Sheep meat	5.3

Source: FAOSTAT | © FAO Statistics Division 2010 | 14 September 2010

Pork has only become important in Uganda over the past two decades; pig numbers have grown rapidly following the Idi Amin years as pig keeping has become an increasingly common strategy for rural households and pork has become a popular food in the 'pork joints' of Kampala and other towns. Whereas pork accounted for only 1-2% of the 11-12 kg/yr per capita meat consumption in the 1960s, it now accounts for at least a third of the current 10 kg/yr (FAOSTAT). The recent livestock sample-based census conducted in 2008 recorded 3.2 million pigs, a remarkable doubling of the numbers from recent years and much higher than those reported in FAOSTAT.



Pig numbers in Uganda, 1961-2008 (Source: FAOSTAT | © FAO Statistics Division 2010 | 14 September 2010; MAAIF/UBOS 2009)

Little information is available regarding the structure and composition of the pig sector in Uganda. According to key informants, the majority of pigs are kept by smallholder households under extensive systems (an earlier estimate cites 80%; Lekule and Kyvsgaard (2003)) with small numbers of peri-urban small-scale, semi-intensive farms and a few larger modern, intensive farms producing for commercial sale. The 2008 Livestock Census reports 1.1 million households, or 17% of all households, keep pigs (on average 2 pigs).

The typical smallholder pig system is free-range or tethered with little or no housing (Waiswa 2005). Animals are apparently the survivors from introductions during the 1960s and of no distinct breed. Village herds are possibly inbred. In addition to what the pigs scavenge, they are provided with household scraps and bran. During the crop growing season, pigs are often tethered to avoid crop damage. They are kept for sale and only rarely slaughtered for household consumption (Ampaire and Rothschild 2010). Households like the fact that they require few, if any, inputs and yet generate a significant amount of income when sold. Poorly organized markets and disease risk, especially of African Swine Fever (ASF) (Costard et al 2009) are credited with discouraging intensification of production. Pigs serve no other cultural or livelihood roles besides being a productive asset that can be sold when needed. Gifting of piglets is reportedly a popular strategy for politicians, the government and NGOs.

Pigs from village systems are usually sold directly to butchers or through middlemen for slaughter in local informal systems. Pigs are among the most important live-animal commodities that farmers produce for sale (Nyapendi et al 2004).

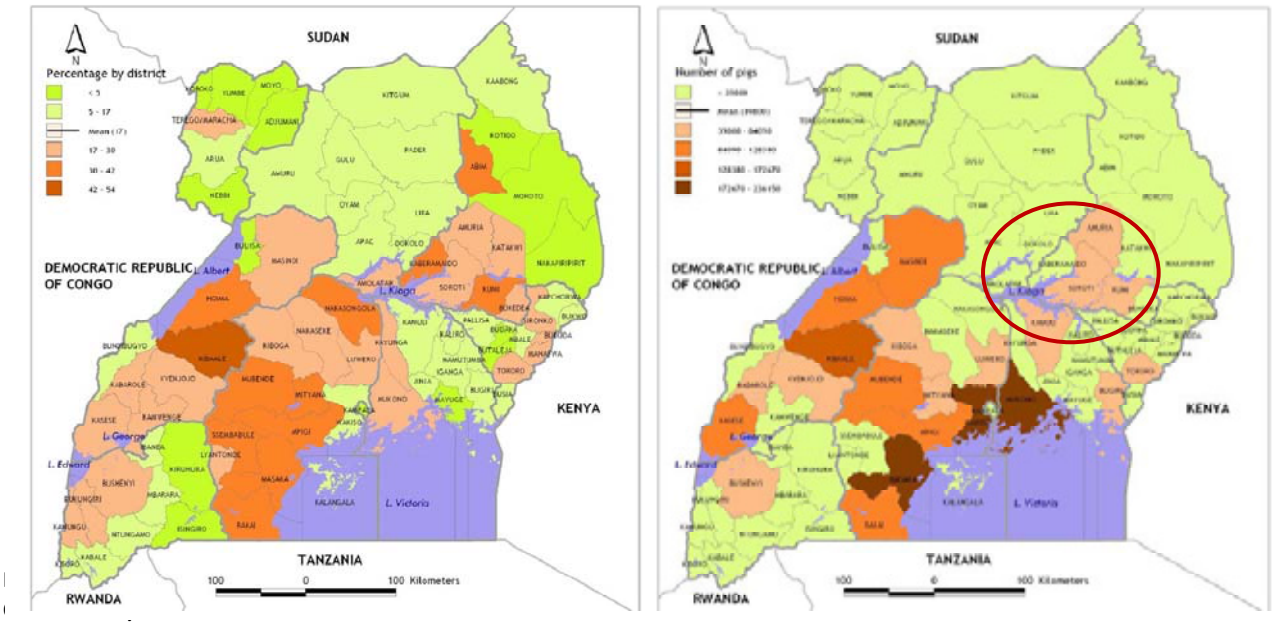
Peri-urban small-scale producers keep larger herds under managed production cycles for commercial sale. Basic housing and locally produced feeds are typically used (Muwonge et al 2010). Management practices vary depending on the degree of specialization of the farmer. Farmers market their pigs to local butchers, 'pork joints' or other restaurants.

Concurrent with the increase in smallholder pig keeping and pork consumption, porcine cysticercosis (Phiri et al 2003; Waiswa 2005; Waiswa et al 2009), and prevalence of mycobacterial infections (Muwonge et al 2010) have been increasingly reported from eastern Africa.

A small number of modern piggeries have been established as development or business investments, usually located near Kampala. These farms have often faced difficulty covering their costs and competing successfully with cheaper sources of pork, and face the risk of ASF outbreaks that can decimate their herds. Since these farms are associated with better quality control, they supply the formal sector, which includes commercial butcheries, larger restaurants and hotels, and the small processing sector that has been developing.

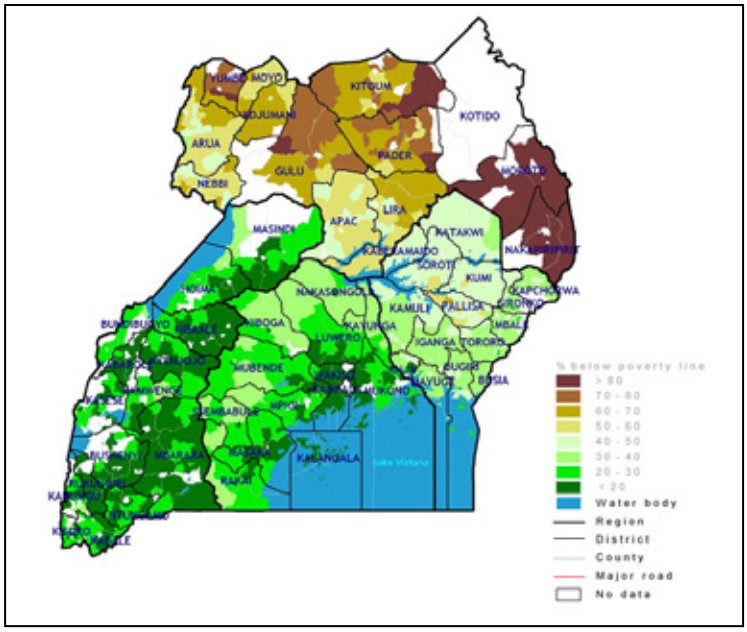
Inputs and services supporting pig production are largely informal Few commercial feed products are available specifically for pig production, there is no commercial breeding service, and availability of veterinary care and extension advice to smallholder systems is very limited. There is, however, unorganized development of small enterprises and services providing locally made feed products and other inputs. Credit services for pig production are generally unavailable to smallholders outside of localized project schemes. Market systems are largely informal with little devoted infrastructure. Overall productivity in terms of feed conversion, reproductive rates and offtake remains low.

As indicated in Figure x.2, pig keeping is practiced across all of Uganda, with concentrations around Kampala in districts along Lake Victoria and in the zone between Lakes Victoria and Albert, with another zone of lower concentration to the east in the Soroti-Mbali area (circled in the second map). The maps, below, show the distribution of the incidence of poverty within Uganda, and suggests that pig-keeping in the Soroti-Mbali area would have particular benefits for poverty reduction.



Why this value chain?

Pork is generally a minor component of diets in Africa, and pigs do not figure prominently in farming systems across the continent (Tacher et al 2000). This can be attributed to cultural reasons – both due to a lack of tradition of pig-keeping and the influence of Islam – as well as to production constraints, especially the continued threat of ASF. Despite these constraints, pig keeping has become established in many areas and its popularity as a quick turn-around, lucrative 'cash crop' among livestock activities and as a less expensive meat for urban diets continues to grow, offering substantial opportunities for income generation (Nkonya et al 2002; Nyapendi et al 2004). Given the evidence of its growth potential and the competitiveness of small-scale production and marketing systems in sub-Saharan Africa, it was considered appropriate to include a pig value chain in sub-Saharan Africa as a target for CRP 3.7 efforts. It is also considered important to provide a means for comparison and cross-learning with the pig value chain selected for South East Asia in Vietnam; smallholder production and marketing systems there are highly sophisticated and may provide valuable models.



Incidence of poverty in Uganda in 2002, by county (Source: Uganda Bureau of Statistics, accessed at: http://www.ugandaclusters.ug/PVRTY-INQLTY/map2.html

Table 4.23 shows the top five sub-Saharan African countries according to size of pig population. Of these, Uganda has high production and consumption per capita, and appears to be experiencing the most rapid growth. For this reason, and given other factors related to the high poverty rates, existing momentum and enabling environment as described in Table 4.24, we selected Uganda as the priority pig value chain for Africa; it is judged to offer the highest probability of demonstrating the pro-poor potential of smallholder pig production and marketing chains in sub-Saharan Africa. Households may particularly benefit from linkages to markets with regard to increasing household incomes, and accumulating assets (Kaaria et al 2008).

Table 4.23: Pig sector indicators in 5 sub-Saharan African countries with the highest pig populations, 2007

Country	Number of pigs (million head)	Pigmeat production (1,000 tonnes)	Pigmeat consumption (kg/person/yr)
Nigeria	6.6	209	1.4
Burkina Faso	2.8	40	2.7
Uganda	2.1	105	3.4
South Africa	1.7	174	3.5
Cameroon	1.4	18	1.0

FAOSTAT | © FAO Statistics Division 2010 | 14 September 2010

Table 4.24: Criteria and rationale for choosing Uganda

Criteria	Rationale for choosing Uganda
Growth and market opportunity	• Rapidly increasing production and consumption of pork within the country, driven not only by population growth, but also by a combination of rising incomes and changing preferences associated with urbanisation and changing production systems • Growing demand for processed products as street food and for supermarkets, and emergence of formal-sector enterprises (e.g. Fresh Cuts, Quality Cuts, My Choice) • Growing base of smallholder producers with potential for intensification
Pro-poor potential	• Growing popularity of pig keeping among smallholder households (17% of all households currently keeping pigs), with potential for intensification • Smallholder sector appears to remain more competitive than modern piggeries • Pig keeping in smallholder systems is largely considered a woman's activity • Many market agents along the value chain (input/livestock traders, meat processors and transporters etc.) provide potential for increased income and employment from adding value • Pork increasing in popularity as a low cost street food and as a meat product sold in informal markets, and as a share of the national diet
Researchable supply constraints	• Control strategies for ASF, which remains the single largest risk to production • Other swine health issues (high piglet mortality, Classical Swine Fever (**CSF**), worm infestations) • Public health concerns regarding cysticercosis • Poor feeding practices and lack of adequate supplies of appropriate feeds, either on-farm or purchased • Lack of knowledge for better use of by-products (e.g. brewer's yeast) • Limited genetic resource base and inbreeding • Poor biosecurity, with breeding practices contributing to disease transmission • Lack of awareness and incentive to adopt improved management, esp. housing • Lack of sustainable organizational structures for breeder and producer groups in order to facilitate their access to affordable breeding animals, animal health care and efficient market services • Poor or non-existent waste management systems • Lack of business and management decision support tools, e.g. when it is better to specialise in breeding, weaner or fattening operations; optimal feeding strategies for profits, business plans for infrastructure investment • Poor market infrastructure and institutional arrangements (underdeveloped marketing system) resulting in high price difference between rural and urban markets, high number of middlemen and thus small producer margins • Weak input supply system and limited support services (extension and credit systems) • Ineffective knowledge management systems, in particular knowledge sharing between producers and scientists, to enhance uptake of proven technologies
Enabling environment	• Though not identified as a priority for commercial development investment (e.g. DSIP, NLPIP), generally appreciated by policymakers as a high potential opportunity for broad-based food security and income diversification in rural areas • Numerous past and current smaller-scale development efforts targeting smallholder pig development: Danida, Heifer Project International (HPI), Volunteer Efforts for Development Concerns (VEDCO), National Agricultural Advisory and Development Services (NAADS) • Favourable business climate and policies for micro, small and medium-enterprise development
Existing momentum	• CRP 3.7 is also proposing to focus its work on the aquaculture value chain in Uganda • ILRI has long-standing collaboration with both the Ministry (MAAIF) and Makerere University, particularly on poverty mapping and trypanosomosis, East Coast fever, and

	other animal health research • CIAT has ongoing collaboration with NARO on forage research • ILRI and ICRAF are heavily involved in supporting the implementation of the East Africa Dairy Development project activities in Uganda, particularly with respect to improving feeds and their use • ILRI and ICRAF are collaborating with the BMGF-funded project on sweet potatoes (SASHA), which is promoting food-feed applications that would suit smallholder pig systems • ILRI has other ongoing research activities in Uganda: characterisation of Ankole cattle with BOKU (Austria) and Makerere University; characterisation of ASF with SLU (Sweden) and Makerere University • Several other CGIAR Centers are active and have staff based in Uganda. • Very few other global organizations combine development with innovative and adaptive research.

Research and supporting actions

As seen in the earlier maps, the emergence of pig keeping in Uganda is a recent phenomenon and, as a result, there has been little systematic research on pig production and marketing systems. Both the national agricultural research system, NARO, and Makerere University currently maintain modest programs of research in these areas (NAADS 2010). Constraints to improving the productivity and performance of smallholder pig production and marketing systems in Uganda are, therefore, not well characterized, and no attempt has been made to assess their relative importance. Perceived constraints were, hence, identified by stakeholders during consultations in Entebbe and Kampala in September 2010, and are summarized in Table 4.25.

Table 4.25: Opportunities and constraints in the pork value chain in Uganda and the research and development actions to overcome them

Value chain components	Developmental challenge	Researchable Issues and Supporting Actions	Indicative partners	Outcomes
Inputs & Services	• How to organize efficient, viable, and equitable input services for smallholders? o Management training o Feed provision o Health care o Breeding o Credit o Market information • How to strengthen innovation capacity of input and service value chain actor webs? • What strategies can be devised to ensure equal access to inputs and services by women, as well as inputs and services tailored to women farmer's needs? • Are there collective action strategies for organizing farmers and other actors in the value chain to benefit from economies of scale in purchasing inputs and services?	***Researchable Issues*** • How can input and service delivery systems be organized to better perform to increase productivity and efficiency in a gender-equitable and pro-poor manner? • Differences in men's and women's and poor and rich households' access to inputs, preference for inputs, use of inputs, roles in input supply. • What methods can be used to stimulate innovation systems within input and service value chains? ***Supporting Actions*** • Assess the policy and business environment for input and service value chains • Assess the structure, actor incentives, and performance of each major input and service value chain and identify opportunities for upgrading, improving access by and for women, and improving benefits to the poor current institutions and policies o Current access and frequency of use o Constraints to access • Design and pilot improved systems as candidates for large-scale development intervention o improved commercial feed formulations using local materials o BDS approaches for small-scale mixing and feed marketing appropriate to smallholders o Improved selection and seed systems for dual purpose food-feed crops o Novel dissemination strategies for technical advice and market information	***Research*** • NARO • NaLIRRI • Makerere University ***Supporting actions, in particular organizing input delivery:*** • NGOs & CBOs: VEDCO, Oxfam • Private or governmental animal health services • Seed companies • Feed enterprises • Micro-credit schemes	• Increased use of inputs and services, which are accessible and delivered in time to male and female smallholders • Increased knowledge of male and female smallholders about useful inputs and services • Functional institutions and conducive policy environment

Production	• How do we increase pig meat production and herd productivity to meet current and future market needs? • How to design appropriate breeding strategies, avoiding inbreeding and negative selection of boars? • How to overcome seasonal or continuous gaps in feed quantity and quality? • Which healthcare strategies are essential to increase productivity? • How do we enhance farmer and actor uptake of productivity-enhancing technologies and strategies?	***Researchable Issues*** • What basic husbandry practices and housing that significantly improves productivity can be reasonably afforded and taken up by farmers? • What are the genetic attributes of breeds currently in use; can breeding programs improve their quality or is it appropriate to introduce new breeds or cross-breeding programs better suited to existing and emerging production systems and environment? • How can ASF be better managed to reduce the risk of catastrophic losses? • How can farm biosecurity be strengthened? • What is the relative importance (disease burden) of the range of health problems affecting pig production and how can priority diseases be better managed? • How can robust and profitable feed formulations and processing technologies be designed that best take advantage of on-farm resources supplemented by purchased feeds? • Are there differences among men's and women's motivation to engage in the enterprise, in anticipated benefits, roles in production, skills/capacity needs, sources of knowledge/technology, influence of policies and institutions? • Are recommended practices and technologies suitable for women or socially discouraged? • How will resource requirements for improved pig systems compete with other uses for household livelihoods • Can pig waste be better utilised or managed? ***Supporting Actions*** • Design and implement breeding programs, incl. selection strategies to enable sustained genetic improvement in key breeding objective traits while minimizing inbreeding and its effects at herd and at population level. • Create economies of scale by developing and facilitating organizational arrangements through farmer group approaches and collective action • Optimize animal health and disease control, through	***Research*** • NARO ; NaLIRRI • Makerere University • BOKU-Vienna ***Supporting Actions*** • MAAIF • NGOs: VEDCO; Heifer Project International; Oxfam • Danida	• Access to breeding boars with higher breeding value • Decreased inbreeding index • Herds more homogenous in desirable traits • Improved market weight and body condition • Reduced mortality • Increased offtake rate

		- Identifying priority diseases - Improved ASF management strategies - promoting simple housing and preventive measures such as access to adequate feed and clean water - Devise inexpensive anthelmintic strategies • Optimize feeding systems and increase feed resources, in particular - Testing forages varieties including food-feed varieties and integrate them into cropping systems - Optimizing use of currently available feed resources, (strategic supplementation, feed preservation, purchase of most limiting nutrients). - Promoting feed processing options (simple hand chopping; village based motor-driven choppers; commercial but decentralized feed processing units)		
Transport & Processing	• How to deliver reliable quantities of safer products (meat or live animals) from smallholder systems to meet preferences for lean in urban areas and fat in rural ones? • How to increase efficiency through collective action to achieve economies of scale? • How to reduce waste? • How to increase women's participation in the post-harvest supply chain? • How to enhance equitable distribution of value added among actors within the value chain?	***Researchable Issues*** • Is a carcass grading system required and what would be an appropriate grading and pricing system? • Does the market prefer/segregate carcass parts or cuts and if so, how can this be mainstreamed in the breeding strategy and pricing system? • How to reduce boar taint? • Is there any difference in quality of products supplied by men and women? • Are there differences in access to transport and processing services? • Can trade services be improved through basic management skills? ***Supporting Actions*** • Disseminate weighing band calibrated for local pigs to help establish appropriate prices • Establish grading / quality systems for carcasses if appropriate • Apply participatory risk analysis for developing appropriate local standards for pork safety • Apply BDS approaches for stimulating small-scale	***Research*** • NARO • Uganda Industrial Research Institute • Makerere University ***Supporting Actions*** • MAAIF • NGOs: Heifer Project International • Private processing companies: Fresh Cuts; Quality Cuts; My Choice • Butchers	• Meat quality criteria defined with traders and consumers • Higher quality carcasses produced • Higher prices and incomes for pig producers • Higher employment and incomes for traders and processers

		businesses for transport and processing services • Raise awareness and develop diagnostic aids for detecting cysticercosis-infected animals and meat • Develop certification schemes for safe handling of meat products • Capacity building on transport, handling and slaughter of pigs with all involved stakeholders • Design of traceability system for pig meat (longer term)		
Marketing	• How to organize markets (both demand and supply) for equitable benefits along the chain? • How to ensure access for low-income Ugandans to safe meat at an affordable price?	***Researchable Issues*** • Market/Consumer demands: what do markets pay for (breed, region, specific liveweight or size, quality)? • Market structures: relations/transactions between local and urban; potential for regional trade • Market access: is it preferable to organize the farmers for accessing markets or to improve marketing systems and infrastructure (e.g. infrastructure of markets)? • Market transparency: what market information is available / needed, and how could it be better disseminated (information systems)? • Differences in men's and women's access to markets and market information • Intra-household decision making on sales (where, when, how many) and control of benefits • Are there any aspects of trading that are difficult or socially discouraged for women and poor? • How can women owning pigs better participate in, and benefit from markets? ***Supporting Actions*** • Analyze the market structure, constraints and opportunities for pigs and pork, covering all agents and actors involved in pig marketing including traders, retailers and consumers. • Evaluate and test options for coordinating and transporting bulk group sales of animals • Assess the performance of different marketing services including provision of market information, facilitation of market linkages, provision of marketing	***Research*** • NARO • Makerere University ***Supporting Actions*** • MAAIF • NGOs: Heifer Project International	• Increased margins for smallholders in the value chain • Sales of pigs with appropriate weight and size according to market demands • Organized marketing of pigs at fair prices • Pig owners well informed about marketing opportunities • Abattoirs operate closer to their full capacity

		facilities, transport of pigs and pigmeat and identify ways of improving them • Identify and respond to demand-driven market opportunities for value addition, through improved product quality • Facilitate linkages to market information systems operated by other partners. • Gender-disaggregated analysis of market and services access		
Crosscutting issues	• How to organize a pro-poor value chain to considerably increase the output – what are essential components and partnerships?	***Researchable Issues*** • Impact of value chain development on workloads and on control over the income within the household • Who benefits from new technologies in households and communities (equity)? • What are incentives for various key actors (farmers, input providers, traders and animal health providers etc.) to invest in pigs? And how can these actors cooperate? • Is it feasible to design (a) common model(s) for value chain development through analysis of the lessons learnt from the diverse value chains, in particular comparing the pig value chains in Vietnam? ***Supporting Actions*** • Characterization of complete value chains and production systems in the target locations (own surveys and other studies) at the start • Develop indicators of success • Capacity building at all stages • Compare the approaches applied for the different value chains • Develop an easy monitoring system for home consumption of meat	***Research*** • NARO • Makerere University ***Supporting Actions*** • MAAIF	• Contribution of pig production to livelihoods increased considering tangible and intangible benefits

Geographic focus

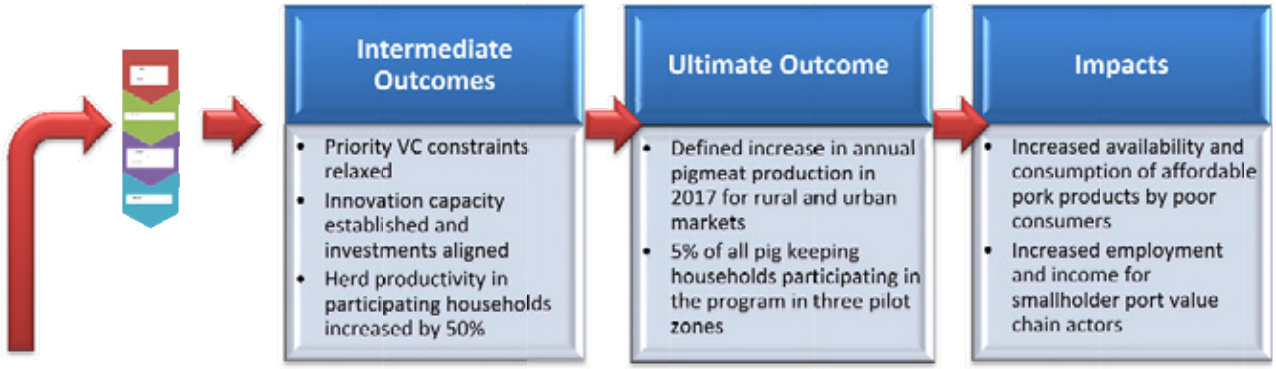
The project will focus initially in the districts with higher smallholder pig concentration ensuring a gradient of market access. Higher density of pig keeping suggests inherent comparative advantage, and facilitates interventions based on creating economies of scale. Three initial zones of focus are proposed:

- Value chains originating in the small-scale semi-intensive production units in Kampala and neighbouring districts
- Those originating in smallholder systems along the corridor between Kampala and Lake Albert
- Those originating in smallholder systems in the Soroti-Mbale area

Focal zones will be confirmed after more in-depth consultation with stakeholders and the initial situational analysis is completed.

Potential for impact

The Livestock Census 2008 revealed that over 1.1 million households keep pigs, representing 17% of all households in Uganda. The vast majority keep pigs in low input-low output free-range systems. Fixing a development target of improving significantly household production by 50% in at least 5 of these households (i.e. 50,000 households) should be achievable if the necessary development investment is mobilised. Because smallholder pig systems are often managed by women (e.g. Pickering et al 1996), at least half of the beneficiaries should be women. Associated improvements in productivity in input and service delivery and along the value chain can reduce waste and inefficiency and improve quality of the final product, thereby adding value that translates in increased employment and income; specific targets will be set after the initial assessment of the value chain. Increased production and efficiency should contribute to increased availability and access to pork products by poor consumers; more information will be needed about the structure of consumer demand for pork from smallholder systems and how it is differentiated by income group before appropriate targets for increased consumption by poor consumers can be set.



Components	Value chain outcomes
Inputs & Services	• Key inputs and services for breeding, feed, and animal health accessible to both male and female smallholders • Increased access to information about best management and production practices among male and female smallholders • Conducive policy and institutional environment established
Production	• Appropriate levels of investment in housing and better management practices • Better selection within existing breeds, lower inbreeding index and introduction of improved genetic resources • Better on-farm feed options and better use of local feedstuffs in appropriately formulated, locally produced feed rations, with seasonal variation minimized • Reduced risk of ASF and reduced incidence of helminths and cysticercosis • Improved piglet survival and offtake rates
Transport & Processing	• Improved pork safety • Reduced transport and transaction costs
Marketing	• Lower marketing margins and higher share of price captured by producers, regardless of gender • Product and quality branding increases returns to value chain actors • Market information more widely available

Summary of indicators along the impact pathway that we believe can achieve these impacts.

Table 4.26: Stakeholders in Uganda and their possible role

Stakeholder	Type	Role	Remark
Makerere University - Veterinary Sciences - Animal Production - Agricultural Economics	Public university	Conduct research activities, training	Consulted
East African Dairy Development Project (EADD)	Heifer Project International-led project, ILRI as partner	Share BDS strategies for market development	Consulted
National Agricultural Research Organisation (NARO)	Public sector NARS	Implement the field research activities	Consulted
National Livestock Resources Research Institute (NaLIRRI)	Public sector NARS (part of NARO)	Implement lab and field research activities	Consulted
Livestock Development Investment Project	Government project funded by AfDB	Infrastructure development, esp. slaughter slabs	To be consulted
Ministry of Agriculture, Animal Industry and Fisheries	Government	Support the field activities in all the	Consulted

(MAAIF)		project sites	
Danida	Donor	Fund development intervention and complementary research activities of national partners	To be consulted
Volunteer Efforts for Development Concerns (VEDCO)	NGO	Support implementation of development intervention in smallholder households	To be consulted
Heifer Project International	NGO	Support implementation of development intervention, breeding schemes	To be consulted
SNV (Netherlands NGO)	NGO	Experience sharing on value chain development	To be consulted

ANNEX 1: PROPOSAL DEVELOPMENT PROCESS

This proposal has been developed through an intensive and inclusive process spanning the 12-month period April 2010 to March 2011.

The process combined stakeholder meetings, in-country visits and a public e-consultation. The process was supported by a wiki - http://livestock-fish.wikispaces.com - to enable documents and other resources to be shared in a transparent, efficient and cost-effective manner, a blog – http://livestockfish.wordpress.com – where assumptions and questions were posed and comments received, and several online surveys (using SurveyMonkey). The process and documentation was fully open, with all documents shared with any interested parties. Presentations and video interviews about the process were also made publicly available. Advantage was taken to exploit other opportunities, such as the side event organized at FARA's Africa Agriculture Science Week, held in Ouagadougou in July 2010.

The e-consultation began in July 2010 and consisted of eight rounds of questions, each focused on a different aspect of the proposal. Five rounds were conducted during the development of the initial proposal with each round including a survey consisting of a series of statements for each of which participants were invited to indicate whether they agreed or disagreed, and combined with the opportunity to submit more open-ended comments. The focus for each of the initial five phases of the e-consultation was:

- week one: working to transform selected value chains (151 comments and responses)
- week two: deciding the focus (126 comments and responses)
- week three: how best to address gender issues (19 comments and responses)
- week four: linking technology generation to value chain development (53 comments and responses)
- week five: forging and catalyzing partnerships (39 comments and responses)

Three more phases of the e-consultation were held in February 2011 as the original proposal was being revised in response to the Consortium Board review. During these phases, our draft responses to the review were shared and put to the test in public in the e-consultation forum. The focus for these phases included:

- issue one: can livestock and fish production 'by the poor' contribute meaningfully to nutrition 'for the poor' (20 comments and responses)
- issue two: partnering with the private sector for pro-poor value chain development (9 comments and responses)
- issue three: poultry as a priority value chain for development (5 comments and responses)

In a two-month period (mid July to mid September 2010), the various e-consultation tools and resources were viewed more than 14000 times; and 410 comments and feedback to our questions and the surveys were received. Presentations and video interviews about the process were also made publicly available.

Full details of the consultations, including reports on the meetings held and all the response received during the e-consultation, can be found at http://livestock-fish.wikispaces.com and http://livestockfish.wordpress.com. The consultations were generally supportive of the approach being proposed in CRP 3.7, but raised a number of concerns and suggestions that were instrumental in strengthening the proposal, both initially and during the revision process.

The following table summarizes the process for the development of the concept note and full proposal, and for the various consultation events:

Date	Event	Notes
1 April 2010	CGIAR Consortium agreed the thematic area on sustainable rice, wheat and maize systems for ensuring global food security will be expanded to be more inclusive of other crops as well as fish and livestock	Followed on from discussions held during the GCARD 2010, Montpellier, France
April/early May	Drafting of concept note by staff from *ILRI, WorldFish, CIAT, and ICARDA*	
10 May	CRP3.7 concept note submitted to Consortium Board	
17 June	CRP3.7 concept note approved by Consortium Board and reviewers' feedback provided	
6-8 July	CGIAR Centers meeting, ILRI, Nairobi, Kenya	Review of concept note and feedback from reviewers, and planning of consultation process and full proposal development
20 July	Side event, hosted by *ILRI, WorldFish, CIAT, and ICARDA and* held during FARA Africa Agriculture Science Week, Ouagadougou, Burkina Faso	Nearly 40 people attended the session, with participants from at least 4 NARS, 2 international NGOs, 4 ARIs, 1 CG organization, 1 donor and 1 farmer organization engaging actively in the discussion
13 July to 10 September	e-consultation: see http://livestockfish.wordpress.com/	Five rounds of questions, each focusing on different aspects of the proposal
26 July	Consultations held in Bamako, Mali to explore opportunities for focusing on small ruminant value chains in Mali	
17-20 August	Consultations held in Uganda to explore opportunities for focusing on fish value chains in Uganda	
24/25 August	Stakeholders' consultation, ILRI, Addis Ababa, Ethiopia: see http://livestock-fish.wikispaces.com/addis_stakeholder_meeting	22 non-CGIAR participants came from Africa, Asia, Latin America, and Europe, representing governments, national research organizations, regional and sub-regional bodies (FARA, IBAR, ASARECA, CORAF), NGOs, the private sector, and international organizations (FAO, World Bank). 17 participants attended from 4 CGIAR Centers - CIAT, ICARDA, ILRI, and WorldFish;
9-10 September	Consultations held in Uganda to explore opportunities for focusing on pig value chains in Uganda	
Late August/early September	CRP3.7 full proposal drafted	
3-10 September	Draft of full proposal circulated for comment by CG partners and external reviewers	
17 September	Full proposal submitted to Consortium Board	

2 February 2011	Consortium Board review comments received	
9 February to 5 March	e-consultation: see http://livestockfish.wordpress.com/	Three rounds of questions, each focusing on different responses to the review
1-3 March	CGIAR Centers meeting, ILRI, Nairobi, Kenya	Responses to the Consortium Board review comments finalized
5 March 2011	Revised proposal submitted to Consortium Board	

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ACRONYMS AND ABBREVIATIONS

AfDB	African Development Bank
AGDP	Agricultural Gross Domestic Product
AGRA	Alliance for a Green Revolution in Africa
AI	Artificial Insemination
APAARI	Asia Pacific Association of Agricultural Research Institutions
ARI	Agricultural Research Institute
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASF	African Swine Fever
AU-IBAR	African Union-Interafrican Bureau for Animal Resources
BOKU	University of Natural Resources and Life Sciences
CANISLAC	Cámara Nicaragüense del Sector Lácteo (Nicaraguan Dairy Sector Chamber)
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza
CBO	community-based organization
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Center for Tropical Agriculture
CIFOR	Centre for International Forestry Research
CILSS	Comite Inter-états de Lutte conte la Sécheresse dans le Sahel
CIMMYT	International Maize and Wheat Improvement Centre
CIP	International Potato Centre
CIRAD	Agricultural Research for Development
CORAF	West and Central African Council for Agricultural Research and Development
CREL	Centro de Recolección y Enfriamiento de Leche (small dairy milk processing unit)
CRP	CGIAR Research Program
CSA	Central Statistical Agency
CSISA	Cereal System Initiative for South Asia
DED	Deutscher Entwicklungsdienst
DICTA	Dirección de Ciencia y Tecnología Agropecuaria, Secretaria de Agricultura y Ganadería
DNA	deoxyribonucleic acid
DNPIA	Direction nationale des productions et industries animales
EAAPP	Eastern Africa Agricultural Productivity Project
EADD	East Africa Dairy Development
ECOWAS	Economic Community of West African States
ESGPIP	Ethiopia Sheep and Goat Productivity Improvement Program
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	FAO Statistical Database
FEPALE	Federación Panamericana de Lechería
GCARD	Global Conference on Agricultural Research and Development
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIFT	Genetically Improved Farmed Tilapia
GoT	Government of Tanzania
GSO	General Statistics Office
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
IAR4D	International Agricultural Research for Development
ICAR	Indian Council for Agricultural Research
ICARDA	International Centre for Agricultural Research in the Dry Areas
ICRAF	World Agroforestry Centre
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and Communication Technology
IER	Institut d'Economie Rurale
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture

ILRI	International Livestock Research Institute
INTA	Instituto Nicaragüense de Tecnología Agropecuaria
IPMS	Improving Productivity and Market Success of Ethiopian Farmers
IPSARD	Institute of Policy and Strategy for Agricultural and Rural Development
IWMI	International Water Management Institute
LEAD	Livelihoods and Enterprises for Agricultural Development
LIFSAP	Livestock Competitiveness and Food Safety Project
LME	Litres of milk equivalent
M&E	monitoring and evaluation
MAAIF	Ministry of Agriculture, Animal Industries and Fisheries
MLFD	Ministry of Livestock and Fisheries Development
MLPI	Mali Livestock and Pastoralist Initiative
MOAC	Ministry of Agriculture and Cooperatives
MoARD	Ministry of Agriculture and Rural Development
MSME	micro, small and medium enterprise
MT	metric tonnes
MTP	Medium-Term Plan
NAADS	National Agricultural Advisory Services
NaLIRRI	National Livestock Resources Research Institute
NARO	National Agricultural Research Organization
NARS	National Agricultural Research Systems
NBS	National Bureau of Statistics
NDDB	National Dairy Development Board
NGO	non-governmental organization
NIAH	National Institute of Animal Health
NITLAPAN	Institute specializing in research on and the creation and publicizing of new local rural and urban development models and methodologies, Nicaragua
NIVR	National Institute of Veterinary Research
NORAD	Norwegian Agency for Development Cooperation
OIE	World Organization for Animal Health
PADESO	Projet de développement de l'élevage au Sahel Ouest
PANTIL	Programme for Agricultural and Natural Resources Transformation for Improved Livelihood
PGC	Program Governance Committee
PM&E	process monitoring and evaluation
PMC	Program Management Committee
PPR	peste des petits ruminants
PROGEBE	Projet de gestion durable du bétail endémique en Afrique de l'Ouest
PRRS	Porcine Reproductive and Respiratory Syndrome
QTL	Quantitative Trait Loci
R4D	research for development
REDD	Reduced Emissions from Deforestation and Forest Degradation
RLDC	Rural Livelihood Development Company
RNE	Royal Norwegian Embassy
RRD	Red River Delta
SDP	Smallholder Dairy Project
SIDE	Servicios Internacionales para el Desarrollo Empresarial
SNP	single nucleotide polymorphism
SNV	Netherlands Development Organization
SPF	Science and Partnership Forum
SPS-LMM	Sanitary & Phytosanitary Standards and Livestock & Meat Marketing Program
SRVC	Small ruminant value chain
SUA	Sokoine University of Agriculture
TAMPA	Tanzania Milk Processors Association
TAMPRODA	Tanzania Milk Producers Association
TDB	Tanzania Dairy Board
TSP	technical service provider

UHT	Ultra-heat treated
UNAG	Unión Nacional de Agricultores y Ganaderos
UNDP	United Nations Development Program
UNICEF	United Nations Children's Fund
URACCAN	Universidad de las Regiones Autonomas de la Costa Caribe Nicaragüense
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
VC	Value chain
VEDCO	Volunteer Efforts for Development Concerns
VND	Vietnamese Dong
VSF	Vétérinaires sans Frontières
WARDA	Africa Rice Centre
WB	World Bank