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ASSESSMENT OF THE DRC'S AGRICULTURAL MARKET SYSTEMS:

VALUE CHAINS IN THE NORTH & SOUTH KIVU AND KATANGA PROVINCES

LEO
Leveraging Economic Opportunities

LEO REPORT #16

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DISCLAIMER

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ACRONYMS

AFAP	African Fertilizer and Agribusiness Partnership
ARCC	The African and Latin American Resilience to Climate Change program
CDCS	Country Development Cooperation Strategy
CIP	International Potato Center (Centro Internacional de la Papa)
COMESA	Common Market for East and Southern Africa
CRS	Catholic Relief Services
CSA	Climate-smart agriculture
DFID	Department for International Development
DRC	Democratic Republic of Congo
FAO	Food and Agriculture Organization
FC	Congolese franc
GHG	greenhouse gases
ha	hectare
IFDC	International Fertilizer Development Center
IFPRI	International Food Policy Research Institute
INERA	National Institute for Agronomic Research (Institut National pour l'Etude et la Recherche Agronomique)
INS	National Statistics Institute (Institut National de la Statistique)
IPAPE	Provincial Inspection of Agriculture, Livestock and Fisheries
IPM	integrated pest management
ITCZ	Inter-Tropical Convergence Zone
KCl	potassium chloride, potash
km	kilometers
M	meter
MFI	microfinance institution
mm	millimeter
MMG	Minerals and Metals Group (an Australian mining group)

na	not applicable
NGO	non-governmental organization
NPK	fertilizer containing nitrogen, phosphorous and potassium
NRM	natural resources management
OCC	Congolese Control Office (Office Congolais de Contrôle)
pH	measure of acidity/alkalinity
S	sulfur
SCAK	Agro-Pastoral Cooperative Society of Katanga (Société coopérative agro-pastorale du Katanga)
SENASEM	National Seed Service (Service National de Semences)
SME	small or medium enterprise
SNCC	Société Nationale de Chemin de Fer
t	ton (metric ton)
TFM	Tenke Fungurume Mining Company
UNILU	University of Lubumbashi
UPDI	Farmers' Union for Integrated Development (Union Paysanne pour le Développement Intégral)
USAID	United States Agency for International Development
VCA	value chain assessment

I. EXECUTIVE SUMMARY

Although the Democratic Republic of Congo (DRC) possesses vast, fertile lands, with more than sufficient resources to feed the country and even the continent, land under agricultural production is severely under-productive, and a large part of DRC's food supply is imported. At the same time, the large majority of the country's population is poor and suffers from malnutrition.

USAID is considering a new set of activities focused on improving livelihoods for agricultural communities in the Kivus and/or in Katanga, which are geographic priority areas under the mission's Country Development Cooperation Strategy (CDCS). Both regions are agriculturally-based economies with impoverished populations that depend heavily on imports to meet their consumption needs; however, each region faces unique challenges and therefore will require tailored solutions. A value chain assessment (VCA) was undertaken in February and March 2015 to inform the next stage of program design to address these challenges.

Six value chains in each region were assessed according to criteria that included how potential interventions could create inclusive growth (reduce poverty), improve food security, support women and youth, and be climate change robust. The effects of the conflict situation in the Kivus (and to a lesser degree in Katanga) were also an important lens used in the analysis. Using a market systems development approach, analyses of the end markets and inputs markets were completed for each of the focus products, and the findings served as an additional screen.

FOCUS VALUE CHAINS

Kivus

- Bananas
- Dry beans
- Horticulture
- Potatoes
- Small livestock
- Soy (added to original list)

Katanga

- Dry beans
- Eggs
- Farmed fish
- Horticulture
- Maize
- Soy

The two matrices at the end of this section (figure 1) provide a summary of the overall analysis.

A. KIVUS

Agriculture provides livelihoods for the vast majority of the poor populations of the Kivus. Farming systems and livelihood activities in North and South Kivu are relatively similar, with some small variations in terms of crop preferences.

1. CROSS-CUTTING FACTORS

Working in the Kivus requires a particular approach that takes into consideration a unique set of cross-cutting challenges, which are described below.

- **Conflict issues:** The ongoing conflict situation in North and South Kivu challenges any potential economic development program, especially those focused on developing sustainable income sources for the poorest populations. Many communities live in fear of ongoing rebel attacks which destroy their crops, or of being displaced altogether from their land. This deters much long-term planning and even discourages scaling and commercialization of production, as farmers who are perceived to be successful become targets for pillage. In addition, the security status of a location can shift unpredictably, so projects must remain flexible and alert. However, this should not be an overwhelming

deterrent to intervention, but rather a strong consideration in program planning. For instance, project plans must be adaptive to changing elements, with the expectation that some regions may become too dangerous to continue field work.

- **Transport challenges:** The most apparent constraint in many value chains is transport. This may be an insurmountable challenge within any project budget, but the impact of this constraint must be taken into account. As an example of how the conflict situation has affected transport costs, during the years 2012 and 2013, trucks transporting coffee in North Kivu were "taxed" (stopped forcibly with payment requested) at a rate of US $400 one-way by the M23 rebel group (with no receipt given). New technology solutions, such as mobile or satellite communications, may reduce the need for travel and the corresponding loss of goods in transit.

- **Finance:** Farmers, as well as other actors in the value chain, lack access to credit, savings and financial services such as money transfers. Some potential leverage points for intervention include providing education in numeracy, improving access to mobile-enabled finance, and building existing savings group capacity.

- **Gender roles:** In the Kivus, gender roles are entrenched in the fabric of the agricultural system, with women performing much of the planting, harvesting and trading, and men managing the finances. There is resistance to change from both genders. This factor will affect participation in programs and the continued success of any interventions.

- **NGO-heavy environment:** The well-intentioned NGO presence often alters or even disrupts functioning markets by providing free services and goods, such as seeds. This must be taken into account as the perspective of relief-oriented NGOs is often short-term, which inhibits long-term sustainability.

- **Pro-women and youth programs:** As women have an active role in all of the value chains chosen for analysis, they all scored high against this criterion. Bananas were the exception, as men play more of a role and production is often used to make liquor or wine. Youth engagement in farming is a challenge, as few opportunities were identified that would specifically entice their participation and/or benefit them exclusively.

Some of these challenges, especially those related to the conflict, can be major obstacles to the success of any intervention; these are marked with a red box in the opportunity matrix diagram (figure 1) at the end of this section. Other factors present opportunities; these potential leverage points are marked with a green box in the matrices.

2. INPUTS MARKET ANALYSIS – KIVUS

Good quality and consistent inputs for agricultural production in the Kivus are difficult for small farmers to obtain. There are no large commercial firms and very few government actors providing inputs. NGOs provide some assistance by sourcing inputs (mostly from abroad), while a small number of more successful farmers in the target value chains buy imported products from Rwanda or Ugandan through urban retail shops. However, most farmers either make-shift their own production inputs or have to do without. There is much room for improvement in the inputs market, both in terms of accessibility and also creating sustainable market systems as NGO intervention has disrupted the supply chain considerably in recent years.

3. SUMMARY OF VCA PER USAID'S DEVELOPMENT OBJECTIVES

The study team identified several key leverage points for intervention in the value chains, which will support USAID objectives. In most of the highly rated value chains, women are involved in the majority of production and commercialization roles and have a high degree of control over the sector's resources, though this varies among households. High storage capacity also contributes to greater conflict resilience and a higher rating for many of the products.

- **Beans:** As a staple product, beans provide subsistence and basic employment to millions of households. This is a staple crop and a traditionally consumed food with a high protein quantity and quality and nutrient balance. Because beans can be stored for up to three months, they are a valuable element of food security. However, like many consumable crops, beans are at risk of theft. The Kivus are highly competitive in the bean market, and the North even exports to neighboring countries, due to great demand. It should also be noted that beans are a heavy focus of many NGO interventions and this often leads to market distortion and can result in income gains that cannot be sustained.

- **Potatoes:** With fertile soils and favorable altitude conditions, Kivu-produced potatoes are relatively competitive, especially on the local market. If certain variety constraints and transit bottlenecks are overcome, there is a greater national and export market that could be pursued. Overall, the potato offers a growing market opportunity for small farmer production and commercialization, as well as increased home consumption as tastes are changing locally and the potato is becoming more of a staple food. Recent NGO work has succeeded in growing farmer incomes from this crop, although additional work needs to be done to overcome bottlenecks in the supply chain.

- **Soy:** The local market in the Kivus is growing, presenting a significant opportunity for local farmers. Soy is being increasingly demanded by local consumers, with flour processing providing increased value-addition. Notably, in other parts of the DRC, soy is not a typical product for human consumption; in Katanga for instance, soy is used mainly for animal feed. In the Kivus, however, soy is a popular part of the diet. Because soy products are high in nutritive factors and widely available, they score high for food security. As soy has to be processed, it is also relatively conflict-resistant as militias prefer to take immediately consumable items. Women play a core role in the production, sale and processing of soy. One female entrepreneur in Bukavu, for example, is successfully producing and marketing processed soy milk, as well as training other women to process soy.

- **Horticulture:** Horticulture products are widely and successfully grown at a small-scale level due to the fertile soil and appropriate climate. Improving this sector presents a great opportunity to improve the incomes of the poorest farmers. In the future, the quality of the Kivu products and their organic nature present a competitive opportunity to substitute for currently imported products. Consistency and transport issues, however, must be addressed.

- **Small livestock:** Small livestock are a source of savings and some income and (to a lesser degree) food for small farmers across the Kivus. Livestock's ability to be marketed and commercialized is limited however, especially because of the current conflict. Any activities in this area must be coordinated with other donor and NGO programs, many of which are currently active in supporting small livestock care and services such as vaccinations—although many efforts have been undermined by the conflict.

- **Bananas:** Although the banana has historically been a staple of the diet in the Kivus, the recent attack of wilt bacteria has decimated all the crops in the region. There appears to be no feasible, short-term solution that is within the scope of a donor-funded intervention.

4. END-MARKET ANALYSIS

The end-market analysis for the Kivus looked at five key market categories, as shown in table 1 below, ranging from home-consumption to exports.

- **Home-consumption:** Home-consumption was generally strong for the selected value chains, except for livestock (which are not usually consumed) and bananas (which have suffered across the Kivus from wilt bacteria).
- **Local village markets:** Most transactions of the target products occur at the village level, which is why the greatest immediate opportunity for growth in soy lies here. Soy is an emerging product in the region, as many people have started to use it as a substitute for dairy in tea or in biscuits, or in flour form as staple food; thus, small soy farmers are finding an active local market for soy products.
- **City markets:** In the provincial capitals of Bukavu and Goma, local products now face competition from often cheaper and higher-quality imported products, which reduces their competitive advantage. Opportunity is still strong in bean, potatoes and soy, however, as demand outpaces supply in many of the categories.
- **Kinshasa:** Transportation costs make most products from the Kivus uncompetitive on the national market. A market only exists for beans and some specialty products from the Kivus, but in lower volumes than existed in the past**.**
- **Export markets:** The close cross-border trading markets of Rwanda and Uganda represent a market opportunity, due to the relative ease of transport and high demand, particularly for beans and potatoes from the North.

Table 1. End Market Analysis for North and South Kivu

	Beans	Potatoes	Soy	Horticulture	Small livestock	Bananas
Home consumption	Strong	Medium	Medium	Strong	Weak	Medium
Local village markets	Strong	Strong	Medium	Strong	Weak	Medium
Urban markets (Bukavu/Goma)	N: Medium S: None	N: Strong S: Medium	Strong	Medium	Weak	Medium
Kinshasa/ national markets	N: Strong S: None	N: Weak S: None	Weak	None	Weak	None
Export (Rwanda, Uganda, etc.)	N:Strong S: Weak	N: Strong S: Weak	Medium	Weak	Weak	None

B. KATANGA

Katanga produces many different crops, of which the three most important are cassava, maize and beans. The study zone is the Katangan copper-belt, which lies within Upper Katanga District, located in the southern portion of the province.

1. MINES AND AGRICULTURE

One of the major differences between the Kivus and Katanga is the presence and impact of foreign mining companies; while in the Kivus, only two relatively small communities are affected, the influence of the mines pervades the focus area in Katanga. Mining for copper and cobalt in Katanga's copper belt takes two forms: formal-sector industrial mining and informal-sector artisanal mining.

International companies in joint ventures with the Congolese state operate the formal-sector mining operations, which take place within large concessions, little of which may be exploited at any point in time. In contrast, artisanal miners work on a smaller scale, with fewer occupational-safety constraints or environmental considerations. Tension persists regarding access to resources, jobs and security between these large mining operations, small mining operations, and local agricultural communities. Potential interventions to improve the situation include: 1) enabling open dialogue between the parties; 2) forming partnerships between the mines and local communities; 3) creating a better market-information system; and 4) deploying innovative financial-market solutions.

2. CROSS-CUTTING FACTORS – KATANGA

The study considered several cross-cutting factors in its analysis for Katanga, as detailed below. All of these factors were considered in each value chain assessment.

- **Finance:** Most Katangan farmers have difficulties obtaining finance and financial services for agriculture and for agribusiness further down the value chain. Large-scale Congolese farmers and agribusiness operators may be able to obtain credit from DRC banks for activities with relatively short payback times, perhaps up to two years, at rates of up to 2.5 percent per month. Small-scale Congolese operators in the agribusiness sector can obtain almost no bank finance. Mobile banking offers a fast, cheap and safe way of transferring money, and of potentially accessing credit and savings products in the future.

- **Transport:** For export routes, the Congo National Railway Company (SNCC) has historically connected Katanga to the rest of DRC, to Zambia and Southern Africa, and to Angola; however the railway is currently non-operational. In the meantime, the copper-belt does have a serviceable tarred road linking the region to East and Southern Africa. Domestic trucking consists of a fleet of largely old, small-sized vehicles that spends 90 percent of the time waiting in line for business and dealing with corruption.

- **Seeds:** All improved seeds identified as used in Katanga during this study were imported. Resources available to researchers at the National Institute for Agronomic Research (INERA) and the University of Lubumbashi are insufficient to create seeds that can reach Katanga's farmers on a large scale.

- **Fertilizer:** All chemical fertilizer is imported, with delays at the border adding cost and time to shipping that penalize all farmers, but hit small-scale farmers hardest.

- **Gender:** Women play a large, but largely informal role in many of the value chains. A younger generation of women can be encouraged to expand their agribusinesses and to formalize them, particularly if bank credit would play an important role in expansion.

3. SUMMARY OF VCA PER USAID'S DEVELOPMENT OBJECTIVES

The study found maize and beans to be among the highest performers per USAID's criteria.

- **Maize:** As Katanga's second staple (after cassava), maize provides subsistence and basic employment to millions of households. In addition, there are thousands of poor maize retailers and hundreds of laborers employed in the supply chain. Maize is the major source of calories and protein in the copper belt, particularly in urban areas. Maize stores well enough to last 12 months until the next harvest. DFID's ELAN project is currently facilitating maize seed multiplication and joint ventures between a large farmer (supplying land, inputs, tilling services) and small farmers (providing labor). Women are involved in up to 80 percent of small-scale production and retailing of maize, although less at the wholesale level, and they derive income from these functions. Despite maize's agronomic potential, Katanga mostly imports maize and maize flour because its many small farms are uncompetitive with Zambian production.

- **Beans:** As the third staple, beans provide subsistence and basic employment to millions of copper-belt households. They also provide amino acids that complement those in maize, providing balanced protein. Women are involved in up to 80 percent of small-scale production and retailing of beans, although, again, less at the wholesale level, and they derive income from these functions. As with maize, small Katangan copper-belt producers are uncompetitive with imports.

- **Soy:** While processing possibilities exist for human consumption and animal nutrition, the scale is low and the jobs in question for the poor are relatively few. On the positive side, soy is a high-calorie, almost perfect-protein food and it stores very well. However, this recently introduced food has not become a standard part of the Katangan diet, so demand for human consumption is low. The limited production mostly goes to animal feed, and relatively few Katangans currently benefit directly from its high nutritional content. In the copper-belt, small-scale producers are uncompetitive and large-scale producers produce little; no industrial processing exists, resulting in low demand and thin markets that are poorly integrated, discouraging commercialization. Therefore, while soy scores highly on some factors, the low consumption and low performance on end-market competitiveness make it an unlikely choice for USAID intervention unless industrial development is envisaged.

The end market analysis table below (table 2) summarizes this aspect of the analysis for all of the value chains.

Table 2. End Market Analysis for Katanga

	Maize	Bean	Soy	Eggs	Farmed fish	Beef cattle	Horticulture
Own consumption	Strong Staple food	Strong Staple food	Low	Medium	Low: expensive calories	Low: expensive calories	Low
Local market	Medium Staple food	Medium Staple food	Low	Medium	Low	Medium	High

C. CLIMATE CHANGE

Agricultural commodities are sensitive to a range of climate risk factors that may have deleterious effects on production, storage, processing and transport. This section of the report provides a cursory overview of such risk factors and scores selected commodities based on three components of climate vulnerability:

1. *exposure* of commodities to a wide range of climate shocks and stresses (droughts, floods, changes in seasonal temperature and precipitation);
2. *sensitivity* of commodities (i.e., tolerance) to such shocks and stresses, most importantly heat waves, dry spells, erratic distribution of rainfall, high winds, severe storms, etc.; and
3. *adaptive capacity* of individuals to draw upon key assets (production inputs, knowledge of improved farming methods and storage/processing technology, market transport, etc.) to adjust and recover from a myriad of climate risk factors.

Scoring is inherently subjective due to a lack of site-specific data on climate variability and the absence of contextual information at the community level on adaptive response patterns and adjustments needed by smallholder producers to surmount a broad range of climate risk factors.

There is a notable paucity of observational data from weather stations in the DRC (and Central Africa in general), posing unique challenges in the reconstruction of climate analogues and outlooks of future climate trends for the region. The USAID DRC mission may therefore consider taking action to fill gaps in data analysis and to build a stronger evidence-base of current and future climate trends in order to make informed decisions on mission programming with a more robust climate lens.

1. CLIMATE SCREENING OF SELECTED AGRICULTURAL COMMODITIES

Using the criteria of climate exposure, sensitivity, and adaptive capacity, selected agricultural commodities for this study were scored for their overall resilience as high, medium, or low. Potatoes and goats rank high for the Kivu provinces due to their overall resilience in withstanding a range of climate stresses during production, their relative ease of storage and processing (potatoes only), and their capacity to withstand loss or spoilage during transport under conditions of damage to transport systems, particularly roads and bridges, due to extreme flooding, storms, and landslides. Commodities that score low in the Kivu provinces due to high sensitivity to changes in rainfall and temperature and extreme events (drought, flooding, intense rainfall) are bananas, horticultural vegetables, and pigs. These commodities are also highly perishable with low storage capacity unless processed, and have a greater risk of loss during episodes of destruction or disruption of main transport supply routes.

In Katanga, only soy beans score high in terms of their resilience to withstand a range of climate stresses, as well as their general ease of storage and transport. Eggs, beef and dairy cattle, farmed fish, and horticultural vegetables all received low scores due to their relative sensitivity to changes in temperature and precipitation and their high perishability when unable to reach market via transport routes washed out by intense flash flooding and storms.

Table 3. Climate Score Summary for Selected Agricultural Commodities in North and South Kivu

	Climate Exposure, Sensitivity			Adaptive Capacity	Resilience Score
	Production Capacity	Storage/Processing Capacity	Transport Capacity		
Potatoes	High-Medium	High	High	Low	High
Dry Beans	Low	High	High	Medium-Low	Medium
Soy Beans	High	Medium-High	High	Medium-Low	High
Bananas	Low	Low	Low	Low	Low
Small Animals					
Goats **Sheep** **Pigs**	High Medium-Low Low	N/A N/A N/A	High High Medium-Low	Medium Medium Medium	High Medium Low
Horticulture Vegetables	Medium	Low	Low	Medium-Low	Medium

Table 4. Climate Score Summary for Selected Agricultural Commodities in Katanga

	Climate Exposure, Sensitivity			Adaptive Capacity	Resilience Score
	Production Capacity	Storage/Processing Capacity	Transport Capacity		
Maize	Medium-Low	Medium	Low	Medium-Low	Medium
Dry Beans	Low	High	High	Medium-Low	Medium
Soy Beans	High	Medium-High	High	Medium-Low	High
Eggs	Low	Medium	Low	Medium-Low	Medium
Cattle					
Beef **Dairy**	Low Low	N/A N/A	Medium Low	Medium Medium	Medium
Farmed Fish	Low	Low	Low	Medium-Low	Medium
Horticulture Vegetables	Low	Low	Low	Medium-Low	Medium

2. CLIMATE-RESILIENT AGRICULTURAL VALUE CHAINS

Agricultural commodities selected for this study will require 'climate smart' approaches to production, storage, processing, and transport to ensure economic gains accrue to targeted farming communities in the study zones. Such practices will need to intensify crop production by increasing efficiencies in soil and water management, enhancing the storage capacity of carbon in soils, trees, and vegetation, and maximizing productivity on less land, thereby reducing pressure and encroachment onto new forest lands and biomes rich in biodiversity.

Two agricultural practices in particular should be considered in promoting agricultural value chains: intercropping and agroforestry. Both practices are essential to attenuate rates of deforestation and to reduce extensive farming practices that continue to encroach onto new lands and fragile areas of high biodiversity and forest cover. While no tree crops have been identified on the list of agricultural commodities under consideration,

the intercropping of trees with cereals, legumes and other crops is urgently needed to reduce deforestation, slow down agricultural expansion into ecologically sensitive landscapes, and mitigate carbon and forest cover loss and the attendant rise of greenhouse gas (GHG) emissions in the Congo Basin region.

Agroforestry practices that mix tree crops with cereals and legumes can boost crop productivity by providing shading and lower soil temperatures, while simultaneously increasing soil moisture and nutrients in the form leaf litter and detritus as natural mulching on soils.

Cropping in mountain areas should adopt contour planting with crop rotations of peanuts, potatoes, soy, beans, sweet potatoes, cassava, and maize. Bananas, which are highly susceptible to damage when exposed to high winds and hail at high altitudes in the Kivu provinces, are more productive when mixed with coffee.

Other climate-smart agriculture (CSA) practices to consider include:

- **Conservation agriculture:** Promoting sound natural resources management (NRM) practices such as minimum tillage, continuous ground cover, mulching, crop rotation, and contour terracing will help to retain soil moisture, slow erosion, and reduce periodic stress to drought-sensitive crops such as maize.
- **Agroforestry:** Introducing tree planting and nurseries, tree crops for shading (grevilla, pterocarpus, acacia, cedrilla, moringa) will lower soil temperatures and increase soil moisture.
- **Intercropping:** Introducing mixed cropping, such as banana, cereals and legumes, particularly on denuded landscapes, will help increase carbon storage in soils.
- **Crop diversification:** Diversifying food and cash crops (coffee, cocoa) will help to buffer against losses resulting from increasing climate variability and the unpredictability of growing seasons.
- **Improved seed varieties:** Promoting the use of short-cycle varieties adapted to heat and water stress, particularly maize, beans and horticultural garden crops, will increase resilience.
- **Agricultural water management:** Promoting improved water management methods and technologies such as rainwater catchment (reservoirs, water retention ponds) and low-cost, scalable drip irrigation systems will extend water resources for off-season crops during the dry season or periods of drought.
- **Intensive animal fattening:** Developing intensive livestock and small animal breeding and fattening, coupled with community-based micro-credit savings and loans programs, will reduce grazing pressure in sensitive areas.
- **Integrated pest management (IPM):** Supporting integrated pest management and monitoring systems will help to control against new, emerging pest and plant diseases under changing climate conditions (i.e., the 'new normal').

3. CLIMATE-RELATED INFORMATION

The climate screening undertaken in this initial phase of research on agricultural value chains reflects a dearth of climate information and the lack of a reliable observational baseline for reconstructing historical climate trends and modeling future climate change scenarios in the DRC. The donor community could contribute significantly to reducing this information gap by carrying out a series of climate research and assessment activities. Next steps might include:

- **Archive retrieval and analysis of climate records:** INERA has archived records of weather station data from their regional network of research centers, housed at their central field station in Yangambi (Orientale Province) and in the library headquarters in Kinshasa. There is a wealth of historical data dating back to the colonial era on rainfall, temperature, etc., which remains in hard copy only. These records should be digitized and fully exploited to help reconstruct climate records from the past 50+ years. Assistance is needed by INERA and other meteorological research applications centers (METTELSAT, University of Kinshasa, etc.) in the retrieval and analysis of these records to better document decadal trends in climate variability dating back to the early 20th century. Individuals interviewed for this study also indicate that private-sector industrial firms in mining, agriculture, etc., have kept detailed climate records for their own production interests dating back well into the colonial era. These, along with INERA and other possible records should be inventoried and accessed, if possible, for full climatological study.

- **Climate change vulnerability assessment at provincial levels:** The reconstruction and analysis of historical climate records could be complemented by more detailed local, site-specific understandings of climate risks and the nature of climate variability over several decades at provincial and district levels (such as the zones for this study). This would increase understanding of the local vulnerabilities of people, places, livelihoods, commodities, and institutions to climate threats. Such research could replicate and build upon the experience of the African and Latin American Resilience to Climate Change (ARCC) program—such as studies in Uganda, Senegal, Malawi, and elsewhere in Africa—that examine not only the nature of climate exposure and sensitivity, but more importantly, the adaptive capacity of communities to respond to and recover from a range of climate shocks and stresses.

- **Crop phenology and crop suitability studies:** The vulnerability assessments would also ideally include crop phenology studies that identify changing climate conditions that may affect critical stages of crop growth in the near- and long-term future. This would include emerging threats of pests and plant disease, given anticipated changes in temperature and precipitation. Crop phenology analysis can be supplemented by crop suitability mapping which models areas of suitability for specific crops under various timeframes, given future climate change scenarios. This analysis, while of lower priority or value in addressing the current and near-term preoccupations of smallholder producers, could nonetheless signal important policy considerations and actions to be undertaken by the Congolese government in preparing for possible scenarios of crops that may not be viable in certain regions under future climate conditions. The example of robusta coffee (from the ARCC study) that will not be a viable crop at high elevations in Uganda, is an instructive case study that merits replication of crop suitability mapping in other areas of Africa.

- **Climate proofing of program activities:** This study represents a positive first step toward screening program activities with a climate lens. As noted, DRC and the Central Africa region are expected to experience less severe climate stress and fewer climate-related risks relative to other regions of the continent. Nonetheless, individuals interviewed and a desk review of the literature confirm that inter-annual and seasonal variability of local climate conditions is changing and becoming more unpredictable. Therefore, adopting a proactive, precautionary optic which screens program activities for potential climate risks will minimize unforeseen costs and consequences of poorly planned activities, consistent with a 'no regrets' approach to climate resilience programming that takes sustainable environmental stewardship into account.

Figure 1. Opportunity Matrices for North and South Kivu, and for Katanga

South & North Kivu – Opportunity Matrix

Factor/ Product	Soy	Beans	Potato	Horticulture	Small livestock	Bananas
End market competitiveness	High	High	High	Medium	Low	Obstacle
Inclusive growth	High	High	High	High	Medium	High
Food security/ nutrition	High	High	Medium	High	Low	High
Conflict-neutral and resilient	High	Medium	High	Medium	Obstacle	Low
Pro-women	High	High	High	High	High	Medium
Pro-youth	Medium	Medium	High	High	Medium	Medium
Climate change robust	High	Medium	High	Medium	Medium	Low
Benefit cost analysis	High	Medium	Medium	Medium	Low	Obstacle

Katanga – Opportunity Matrix

Factor/ Product	Horti-culture	Farmed fish	Maize	Beans	Eggs	Soya beans	Beef cattle
End-market competitive-ness	Medium	High	Low/High	High	Medium	High	High
Inclusive growth	High	Low	High	High	Medium	Medium	Low
Food security/ nutrition	High	Low	High	High	Medium	Medium	Low
Conflict-neutral and resilient	Low	High	High	High	High	High	Medium
Pro-women	High	Low	High	High	Medium	High	Low
Pro-youth	Low	Low	Medium	Medium	Low	Low	Low
Climate-change robust	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Benefit cost analysis	High	High	High	Medium	Medium	Medium	Medium

Major opportunity Major obstacle

II. INTRODUCTION & METHODOLOGY

Although the DRC possesses vast, fertile lands, with more than sufficient resources to feed the country and even the continent, land under agricultural production is severely under-productive, and a large part of DRC's food supply is imported. At the same time, the large majority of the DRC's population is poor and suffers from malnutrition. Two regions in particular, North and South Kivu and Katanga, have suffered greatly in recent years.

USAID is developing a new set of activities focused on improving agricultural production in the Kivus and in Katanga with several key objectives including reducing poverty, nutrition and health, food security, and inclusive economic growth. This assessment will serve to inform USAID as it begins to plan its activities.

As the Kivus and Katanga present different challenges, these two regions were assessed by separate teams of consultants. However, the methodology used was parallel and comparable in depth. In Katanga, the assessment focused on maize, soy beans, dry beans, eggs, farmed fish and horticulture. In the Kivus, the focus was on potatoes, dry beans, soy, bananas, small livestock and horticulture.

A. VALUE CHAIN APPROACH

In the past, donor and NGO interventions in the agricultural sector have often emphasized improving the production and consumption of agricultural products, with the goal of swiftly addressing food security issues and delivering short-term income gains to agricultural households. However, much of this development has been undertaken without adequate consideration of the dynamics of interrelated market systems,[1] leading to an inefficient use of resources and a lack of enduring impact.

This assessment was carried out in three weeks by two teams of three consultants each, one focused on the Kivus and the second on the Katanga region. Interviews were held with stakeholders at each level of the value chain (see textbox on right). See annex 2 for the value chain questionnaire that was used as a guide to drive the field research.

The team performed a full value chain assessment for each target product. In particular, the assessment included analyses of the inputs market and the end markets, in addition to the value chain itself. At each step, cross-cutting supporting services were assessed, including transport and finance. Screens were also used to assess the effects of gender issues, the existence of conflict, and security challenges.

STAKEHOLDERS CONSULTED

- Producers: cooperatives, commercial farmers and individuals
- Processors
- Traders
- NGOs
- Customary Chiefs, groupement heads
- Bulk local buyers (hotel, school)
- Transporters (truck, plane, foot)
- Provincial government
- Input providers
- Mining community

[1] For more on market systems development, see Campbell, Ruth. (2014). "A Framework for Inclusive Market Systems Development." USAID.

Within each region's assessment, the report includes a value chain map to illustrate the market players and the dynamics that exist. Further understanding of the inter-relationships and the power structure among these players will be integral to future program design. A full list of contacts interviewed as well as other relevant actors is documented as annex 4 to this report**.**

B. RESEARCH METHODOLOGY

The overall objective of the assessment was to identify potential bottlenecks and opportunities to the feasibility of promoting specific agricultural commodity value chains in the Katanga and Kivu provinces. As an initial phase of inquiry, the assessment involved the following data collection and analysis phases:

1. **Desktop research:** A preliminary desk review of pertinent studies and reports on the target value chain in the DRC; as well as the supporting enabling environment
2. **Field visit and key informant interviews:** The team visited Kinshasa as well as conducted field visits to the two regions. The climate change expert spent a 10-day period conducting primary data collection in Kinshasa from March 3-13. Each of the Kivu and Katanga consultants spent 12-14 days in their respective provinces. They interviewed relevant private sector, government, donor, research, and civil society stakeholders. The data gathering was driven by a detailed questionnaire which both teams used as a guide. See Annex 4: List of Contacts & Meetings.
3. **Data analysis:** A feasibility matrix was designed to rank the list of agricultural commodities for each province, using USAID objective criteria. The scores were integrated into the final evaluation and ranking of commodities based on the multiple criteria used for the market study.
4. **Mission debrief and final report:** Scores and evaluation of the commodities, including the climate screening analysis, were then presented to USAID mission staff in the form of a PowerPoint presentation on March 12th and 13th. This final report is based on the presentation of findings and feedback received from USAID.

C. LIMITATIONS ON DATA COLLECTED

Reports and statistics were assembled whenever possible to support the value chain assessment. However, it should be noted that the availability of quantitative data was extremely limited. Statistics were often from several years—or even decade—in the past.

D. EVALUATION CRITERIA: USAID GOALS

USAID has a defined set of development goals which it seeks to achieve through application of a value chain approach. The agency aims to work in three to six agricultural commodity sectors. The findings from this assessment will inform that selection process. Selection will largely be based on whether feasible interventions in the sector are likely to achieve USAID's goals as they are defined below.

1. GENERATING INCLUSIVE GROWTH

A sector which generates inclusive growth is defined as resulting in increased sustainable incomes for the poorest populations, allowing them to rise out of poverty. This can include either creating new sustainable products for people to sell, raising incomes from existing product sales, or else creating new job opportunities which can bring in additional income. As an example, "inclusive growth" could result from introducing new

value-added activities for those working in the poorest portions of the value chain, such as supporting a new processing function. Incomes from existing operations could also be improved, for instance by making improved inputs both available and more affordable. Overall, there must also be a perceived positive benefit-to-cost ratio for farmers to invest their resources (time, land, etc.) into the product, with a manageable amount of risk.

2. FOOD SECURITY IMPROVED

The definition of food security is based upon USAID and FAO's accepted definitions (see Annex 1. Definitions of Food Security). To contribute positively to food security, the value chain is assessed based on the following factors:

- **Food availability** is achieved when "sufficient quantities of food are consistently available" to a target population.[2] This can be supplied through household production (home-consumption), purchased from local, urban or import markets, or through the receipt of food assistance. Food availability implies that the value chain provides "physical access" to sufficient and nutritious food, defined as adequate (timely and without significant losses along the way) and sustainable (through all seasons and year to year) transport of food to the consumer; as well as "economic access" to sufficient and nutritious food, meaning at an affordable and stable price.

- **Food utilization** depends in large measure on knowledge within the household of proper food storage and processing techniques, basic principles of nutrition and proper childcare (feeding of infants and children under the age of 18).

- **Nutritious food** is defined as containing sufficient calories, protein, a balance of nutrients and high quality protein (based on an amino acid score). Note that elements of "nutrition" are embedded as necessary factors into the definitions of both access elements as well as within the utilization element (see table 5).

Table 5. Nutrition Content of Agricultural Commodities in the DRC

Nutrition per 100g	Calories	Fat (g)	Protein (g)	Nutrient balance: Completeness	Protein quality: amino acid score
Potato, boiled in skin, w/o salt	78	0	3	60	na
Cassava, raw	160	0	1	27	52
Maize flour	364	5	9	28	na
Soy flour, full-fat, raw	436	21	35	60	118
Beans (kidney), cooked w/o salt	127	0	9	55	89
Beans (yellow), cooked w/o salt	144	1	9	54	104
Beans (white), cooked w/o salt	139	0	10	56	104
Beans (navy), cooked w/o salt	140	1	8	55	91
Beef liver, pan-fried	175	5	27	64	151
Beef, bottom round, lean fat, trimmed to 1/8", braised	247	12	33	36	94

[2] Definition of food security from www.fao.org

Hamburger 85 percent lean, cooked	232	14	25	37	74
Eggs, hard-boiled	155	11	13	43	132
Tilapia, cooked, dry heat	128	3	26	37	124
Onion, yellow, sautéed	132	11	1	21	25
Cabbage, boiled w/o salt	23	0	1	77	59
Pak-choi, boiled, w/o salt	12	0	0	85	67
Eggplant, boiled w/o salt	35	0	1	54	63
Carrots, boiled w/o salt	35	0	1	75	na
Tomatoes, stewed	79	3	2	58	62

Notes:

1. A completeness score between 0 and 100 is a relative indication of how complete the food is with respect to dietary fiber, protein, vitamins, minerals, as well as nutrients commonly overconsumed in the West.
2. The amino acid score (0 – 100) is a basic measure of protein quality, unadjusted for digestibility or preparation method.

Source: Nutrition Data[3]

3. CONFLICT RESILIENT AND NEUTRAL

This factor refers both to whether the target population's current or potential value chain activities for a particular commodity are resilient to risks due to the region's conflict issues; or whether the value chain activities actively exacerbate risk or increases exposure related to the conflict. Resilience is defined as "the capacity of communities in complex socio-ecological systems to learn, cope and adapt in the face of shocks and stresses."[4]

4. PRO-WOMEN

Women have often been the victims of sexual violence and other forms of repression in the DRC, especially during the recent conflict in the East. Although women contribute a large part of the household's agricultural labor, men generally make the major financial decisions in the household (women do often handle education and other smaller household purchases). Furthermore, women are challenged in being able to own their own land, often having to defer to a male member of the household to officially hold land which the women plan to farm. Value chain interventions should take into account how women's roles will be affected, and more generally, the effect of proposed activities on household gender dynamics.

Pro-women interventions are defined as achieving one or more of the following:

- Increasing women's incomes directly and/or empowering them to increase their influence in household financial management;
- Enabling women to secure and control valuable assets for their own family or business use;

[3] The information in Nutrition Data's database comes from the USDA's National Nutrient Database for Standard Reference and is supplemented by listings provided by restaurants and food manufacturers. The source for each individual food item is listed in the footnotes of that food's Nutrition Facts page. In addition to food composition data, Nutrition Data also provides a variety of proprietary tools to analyze and interpret that data. These interpretations represent Nutrition Data's opinion and are based on calculations derived from Daily Reference Values (DRVs), Reference Daily Intakes (RDIs), published research, and recommendations of the US FDA.

[4] See *Development Digest: Key takeaways from "Is Market Systems Development Inherently a Resilience Approach?"* Market Systems Blog. Microlinks.

- Providing new skills training or other education opportunities for women;
- Improving women's health;
- Empowering women socio-politically at the household, community or national levels;
- Providing support to women who are victims of sexual violence or other forms of abuse; and
- Otherwise raising women's confidence and standing in the community.

Lastly, a value chain sector must not endanger women in any extraordinary way, or put them in situations that would put them at considerable risk.

5. BENEFITS YOUTH

Youth in the Kivus and in Katanga often lack employment opportunities and suffer other development challenges such as a lack of access to health and adequate food. In poor, rural areas, the families and household assets (land, etc.) are often not able to support the livelihoods of young people, who therefore either migrate to cities (where they add to the urban unemployment toll), or are lured into joining rebel militia groups which give them a sense of purpose and some income. In this way, there is reportedly a drain of youth away from the farm, and the elderly and less capable are left to tend to agriculture.

If agriculture could become more productive and profitable, youth may be influenced to remain on the farm and contribute to the growth and prosperity of the sector. However, there must also be an effort to create higher-value jobs so society is not caught in a "poverty trap" by creating low-value, poverty-reinforcing employment. In theory, a limited number of more productive young farmers would, through multiplier effects, generate a diversity of jobs elsewhere in the economy creating sustainable youth employment. Therefore, a balance of quantity versus quality of jobs for youth must be sought.

A value chain which benefits youth will:

- Provide higher-value employment opportunities for youth;
- Provide new skills training or other education opportunities for youth; and
- Increase incentives for youth to work in agriculture.

6. CLIMATE-CHANGE ROBUST

Climate change robustness is defined as:

- A relatively low level of exposure to climate effects for value chain activities;
- A low level of sensitivity and/or high tolerance of key assets in the value chain to the effects of climate stress or shocks; and
- A high adaptive capacity of key value chain actors and assets to climate stress or shock.

7. SYNCHRONIZATION OR OVERLAP WITH EXISTING PROGRAMS

USAID should also consider the prevalence of other development partners and programs working in the value chain and how proposed USAID assistance will complement such work. It is important that USAID programs do not overlap with other donor programs. Particularly in the Kivus, there are active NGO and donor interventions in all of the selected chains.

8. END-MARKET COMPETITIVENESS

End market competitiveness is important as locally-produced products that cannot compete with competitive suppliers (such as imports) cannot be expected to achieve long-term improved livelihoods. Using Porters' Five Forces as the basis for analysis, end-market competitiveness includes assessing the following factors:

- **Existing market rivals:** defining current end-markets ranging from self-consumption to village-level, regional urban, national urban, and international levels.
- **Competitive positioning of DRC products:** how products compare to competitors in terms of key factors including price, quality and market access. Suppliers producing either the same product or a substitute are examined. These can be local, regional or global level competitors.
- **Bargaining power of buyers:** determines what leverage buyers have in the market of a product. This can also relate to producers themselves as consumers.
- **Bargaining power of suppliers:** assesses the ability of suppliers to manage inventories, move the price in their favor, or other leverage powers they may possess.
- **Market trends:** assessment of the future opportunities, problems and competition, and changes in domestic demand over time.
- **High-potential market segments:** identification of the segments of the market system that offer the greatest opportunities for the value chain.

In the case of the DRC, imported products are a major source of competition for local agricultural producers. In the Kivus, upwards of 80 percent of all products are imported, including a significant amount of agricultural products. Most urban consumers rely on imports from regional suppliers in South Africa (meat and vegetables) and European exporters, as well as vegetables and frozen fish coming from as far away as China and Vietnam.

9. SPECIAL ATTENTION TO THE MINING SECTOR

In both Katanga and (to a lesser degree) in the Kivus, the DRC's mineral resources provide livelihoods to both foreign mining companies and local communities. Local communities benefit from the foreign mining ventures by being directly employed, selling their agricultural products, and/or from other development programs implemented by the companies. However, in these communities "artisanal mining" has flourished for generations, providing income to the communities; this tradition is now being challenged as foreign mining companies seek to secure their rights to the land to mine. Many of the communities that were the focus of this assessment are affected in this way by the mining sector. In the Kivus, there were just two communities, one in the South and one in the North, which were considered in this assessment. As mining is more widespread in Katanga, the dynamics and challenges of the mining sector were a more central part of the analysis.

This dynamic presents both opportunities and threats to the communities where USAID proposes to execute its agricultural value chain activities. The assessment gives special attention to how each value chain's activities affect this dynamic between the formal-sector mining companies and the local communities.

III. COMPARISON OF KIVUS & KATANGA

The impoverished populations in the copper-belt of Katanga and in the Kivus both gain their livelihoods largely from agriculture and also depend heavily on imports to meet their consumption needs; however, each region faces unique challenges which are discussed below. This section provides a discussion of similarities and differences between Katanga and the Kivus, in terms of the value chains assessed and the implications for implementing USAID's interventions in these regions.

A. MINING PRESENCE

One of the major differences between the Kivus and the copper-belt of Katanga is the presence and impact of foreign mining companies. In the Kivus, only two relatively small communities are affected. But the influence of the mines pervades the focus areas in Katanga—copper and cobalt mines, including both formal-sector, industrial-scale mining, and informal-sector artisanal mining, which provide important alternative employment opportunities to family farming throughout the region. Because of the minor, isolated presence, interventions in the mining communities in the Kivus would therefore have a limited impact on the population and would not reach significant scale. On the other hand, mining is a key factor in most communities in the Katangan copper belt.

In Katanga, mining companies are already implementing some direct agricultural support programs: they are acting as catalysts small-scale farmer intensification of crops. The existing agricultural programs in the Kivus (implemented by Banro) focus mostly on providing social services, infrastructure and equipment, and to a lesser degree on animal support programs, but have found much less success in terms of positive impact in the local community.

B. CONFLICT SITUATION

The ongoing conflict in the Kivus will challenge any new program to be implemented in the region. While there are some disturbances in the Northwest of Katanga, there is little insecurity within the copper-belt area, which was the focus of this study. The conflict situation in the Kivus is a major potential obstacle in intervening in any of the value chains. In fact, this factor may trump all others in program design, therefore making implementation difficult to synchronize with parallel programs operating in Katanga.

C. NGO PRESENCE

As a consequence of the long, ongoing conflict, international NGOs have a deep presence in the Kivus and affect the functioning of all aspects of the markets. NGOs have a relatively minor presence in the Katanga copper-belt region, with ELAN being one of the few potentially overlapping programs to consider.

A reliance on donor aid for livelihoods presents several obstacles in the Kivus that are not relevant in Katanga. First, the NGO presence distorts functioning markets, putting some services such as inputs out of business by offering free alternatives. By paying higher prices for local goods, NGOs can crowd out local de-

mand. Therefore, when designing programs, USAID should consider two factors: 1) how to synchronize activities to not overlap with other aid programs, and 2) how to target longer-term market opportunities, which would not include the presence of the NGOs.

D. IMPORTS AND CURRENCY VALUATION

Both the Kivus and Katanga depend heavily on imports for consumption. Despite extreme poverty and low local economic production, the regions pay for these imports using mining revenues in the case of the Katanga and with donor funds in the case of the Kivus.

In Katanga, for instance, this so-called Dutch disease, the overvaluation of the FC due to ore exports, renders DRC's production of non-mineral tradable commodities uncompetitive and large quantities of agricultural commodities flow into the country across the border. (This is worsened by the Zambian government's provision of significant and sustained fertilizer subsidies, which has ensured that Zambia has over 300,000 hectares of irrigated land that produce maize, beans, soy and horticultural produce year-round.) This is the starting point for considering how to improve the competitive profile of Katangan agriculture.

E. GENDER ROLES AND VIOLENCE

Gender roles within the target value chains are comparable in the two regions, with women taking a leading role in farming and trading.

In both provinces, young men often leave their rural villages to seek employment or other life opportunities elsewhere. In Katanga, this largely consists of migration to work in the mines (particularly from Kolwezi's hinterland), or to a lesser extent to urban areas. In the Kivus, young men also often leave their families to go to urban areas seeking employment or to join militia which offer income and a sense of purpose, a trend that is not observed in Katanga.

Due to the ongoing conflicts which disrupt household and village harmony, violence against women in the Kivus is particularly severe and rampant, affecting women's ability to perform their roles. For this reason, gender relations are much more turbulent in the Kivus and require an extra level of consideration.

F. LAND ISSUES

Both the copper-belt in Katanga and the Kivu regions contain a large number of small-scale farmers, though Katanga has a greater number of larger, commercial operations. Small-scale farmers in Katanga have on average 0.5 hectares (team expert estimate). Overpopulation in the Kivus is shrinking average farm sizes: statistics from the Provincial Inspection of Agriculture, Livestock and Fisheries (IPAPE) show that more 86 percent of farms in South Kivu cultivate less than 0.45 hectares, with the average size of a domestic farm in South Kivu between 0.3 and 0.4 hectares.[5] This limits land scalability and commercialization.

[5] Mastaki, J.L. (2006). Le rôle des goulots d`étranglement de la commercialisation dans l`adoption des innovations agricoles chez les producteurs vivriers du Sud-Kivu (Est de la R.D.Congo). Thèse de doctorat : Faculté des Sciences Agronomiques de Gembloux (Belgique).

G. TRANSPORT

The transport situation observed is different and more challenging in the Kivus than in Katanga.

- **Katanga roads:** Perhaps due to mining company interventions, paved roads connect part of the region both internally and across the border. Much of the copper-belt's infrastructure, including roads, was built by the once powerful Gécamines parastatal. There is a functional paved road from Kasumbalesa to 35 km east of Kolwezi with several connecting tarred roads. Principally to export mineral ores, Katanga has a single road-transport backbone: a tarred road running the length of the copper-belt linking its three main cities—Lubumbashi, Likasi and Kolwezi (which have a total population of 2.2 million). The tarred road extends south from Lubumbashi to Kasumbalesa, the major border crossing to Zambia, and onwards to multiple destinations in East and Southern Africa. In the future, rehabilitation of the rail link (underway) may offer cheaper transport for bulk commodities to and from East and Southern Africa, as well as Angola.

- **Roads and water transport in the Kivus:** There are practically no paved roads in the Kivus, with mudslides occurring regularly, which block all traffic and shipment. Furthermore, the danger from militia limits accessibility in some areas and causes great risk and cost to transporters of goods. There are a few isolated roads connecting the two mining areas to export routes but these have proven to be of little value in connecting any local trade. While there is some water transport, these are small-scale and inconsistent, and only used as an alternative to land since the roads are difficult and often impassable.

Overall, the status of transport in the Kivus is a potential major obstacle, with the security situation being possibly the ultimate deal-breaker, a factor which does not challenge transport in the Katangan copper-belt.

H. PRODUCT SELECTION

Three out of the six products (bean, soy and horticulture) were examined in both the Kivus and Katanga.

- **Soy:** Soy is becoming part of the diet in the Kivus, consumed as a dairy substitute in tea and as a staple for cooking as soy flour, largely due to NGO interventions. Katangans, however, generally do not consume soy; it is used more as a feed ingredient for non-ruminant animals (fish, pigs and poultry).

- **Beans:** Beans are the third most important crop in Katanga, after cassava and maize, but they do not have as important a place in agricultural production as they do in the Kivus. Particularly in North Kivu, the markets for bean production and distribution (and export) are well-developed. Both Katanga and the Kivus face challenges with regards to seed inputs.

- **Horticulture:** Similar products (such as tomatoes, onions and cabbage) are produced in both regions. Also similarly, there is a greater emphasis on commercial sales versus home consumption. The main difference is that the Kivus face more transport challenges, a factor that is crucial for these perishable items.

- **Livestock:** While there is some opportunity for beef cattle in Katanga, this is merely a specialty category in the Kivus, largely due to conflict-related theft, despite the fact the Kivus have a history of cattle-raising. For this reason, the Kivu livestock assessment was focused on small livestock such as goats and chickens, which are less susceptible to theft. In the Kivus, there is also a tradition of dairy production which could be explored for revival.

Recommendations for value chain improvement, however, were different for each region; therefore cross-regional programs in any of these products may not be very effective.

I. GOVERNMENT POLICY AND PROGRAMS

Agricultural support and government programs are largely decentralized with the provincial governments holding a great degree of control in terms of policy, certification, and implementation of development programs.

In practice, little government support reaches most small-scale farmers in the Kivus. In Katanga, the provincial government has a stronger hand in the agricultural sphere: one of its main policies is to require mining companies to grow 500 hectares of maize and/or cassava.

However, overall there is relatively less support from government than in other comparable countries. Government rarely offers subsidies to promote agriculture or agribusiness; if present, these come from donor-funded projects. In addition to taxes to national and provincial government, informal payments to government officials are not unusual, reaching a peak at border crossings. Zambia, in contrast, as mentioned above provides subsidies to its agricultural sector; this makes it even more difficult for DRC products to be competitive.

The weakness of the national institutions makes it difficult to support programs at that level. The new Agricultural Code promises some improvements, although it also introduces new challenges, such as restrictions on foreign ownership which are deterring new investment (though many foreign investors in Katanga still find ways around these restrictions).

J. IMPLICATIONS FOR PROGRAM DESIGN

Overall, the most promising opportunities for cross-support of programs in both Katanga and in the Kivus are likely to be within the bean value chain, particularly the facilitation of input availability to small-scale farmers. Cross-cutting interventions to provide finance (e.g., via mobile money) may offer more practical solutions for impact in both regions. However, transport and security challenges in the Kivus may still make such programs difficult to execute effectively.

In Katanga, innovative mining companies have shown that they can act as catalysts for small-farmer intensification of these crops. These companies may make crucial partners. In the Kivus, this is less of an emphasis due to the small-scale presence of the mines.

IV. KIVUS: CROSS-CUTTING ANALYSIS

North and South Kivu continue to suffer the effects of the various wars and insecurities that have dominated eastern DRC since 1996. The economy of the two provinces is dominated by agriculture, which contributes more than 65 percent of GDP in South Kivu and over 30 percent in North Kivu (lower in recent years due to the long-term conflict in that province), and contributes to over 70 percent of employment.[6] Poverty rates in South Kivu and North Kivu remain high: the National Institute of Statistics (INS) report of 2014 shows 60 percent and 53 percent of the populations of South and North Kivu, respectively, as poor, and the proportion of poor women is higher than that of men. Food insecurity and youth unemployment in these two provinces are very high. In view of the agricultural potential in the two provinces, productivity remains low. This section examines the different problems and opportunities that exist at each stage of the value chain for the selected commodities.

A. GEOGRAPHY

The geographical areas of this study in North and South Kivu provide an exceptional range of diversity of biomes, ecosystems, and habitats. These include dry rainforests (Muhly), open woodland forests (Miombo), grassland savannah, and cloud and gallery forests. A network of protected areas conserves portions of the diverse ecology of the two Kivu provinces. This forms part of the DRC's tropical rainforest landscape which is said to store eight percent of global forest carbon.[7]

In 1969 the Kivu region was divided into two provinces, North and South Kivu. The provincial landscapes are highly complex and heterogeneous, ranging from high volcanic mountain peaks above 5,000m in the Albertine Rift to woodland savanna and sparsely-vegetated lowland plains at 800 meters (Mercy Corps 2014).

Extreme population pressure is a ubiquitous feature across the regional landscape of the two provinces. Population density is the highest in the DRC, with 71 inhabitants per square kilometer in South Kivu and 97 inhabitants per square kilometer in North Kivu.[8] South Kivu covers 65,070 km^2 while North Kivu is slightly smaller at 59,483 km^2. Total population for the provinces surpassed 10 million in 2010 and is now estimated at approximately 12 million.[9]

The provinces are characterized by a bimodal pattern of two rainy seasons, occurring from March-May and September-December, followed by two short dry seasons in June-August and January-February. Seasonality is determined by the Inter-Tropical Convergence Zone (ITCZ) which oscillates north and south across the Equator and Tropic of Capricorn during the year.

1. NORTH KIVU PROVINCE

North Kivu is comprised of six territories, of which Rutshuru, Masisi, and Walikale constitute the study zone. Goma, the provincial capital, had an estimated population of 1,000,000 inhabitants in 2012, and is located on

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[6] Institut National de la Statistique (INS), République du Congo.

[7] http://www.adaptationlearning.net/congo-kinshasa/profile

[8] http://en.wikipedia.org/wiki/South_Kivu; http://en.wikipedia.org/wiki/North_Kivu

[9] Adam Smith International, DFID ELAN report, 2015

the northern shore of Lake Kivu. It is located less than 20 km south of the crater of the active Nyiragongo Volcano which erupted in 2002, forcing the mass migration of large numbers of inhabitants into the South Kivu province. Goma was also severely affected by the events of the Rwandan Genocide in 1994 and the subsequent First and Second Congo Wars, displacing large numbers of people. Most recently, in 2012, the city was overtaken by the M23 rebel forces, only to be liberated soon after by DRC government troops.

The geographical landscape of North Kivu is widely varied, including a significant range in habitat from woodland savanna to lowland and montane forests. It is characterized primarily by tropical rainforest according to the Köppen climate classification system, in which 12 months of the year have average precipitation of at least 60 mm.[10] It ranges in altitude from 800m to over 2,500m, and the northern portion of the province is home to the Virunga National Park, a World Heritage Site cherished for its high biological endemism, including endangered mountain gorillas. North Kivu is comprised primarily of dry tropical forest and savanna on the eastern edge, and wet tropical rainforest to the west.

High population densities in North Kivu may be attributed in part, to highly fertile soils which are now quickly degrading due to overuse and poor farming practices. Rainfall averages just over 1,550 mm annually and temperatures range from 2 °C to 26 °C for much of the year (table 6). Altitude averages nearly 2,000 m and ranges from about 560 m to just over 5,000 m, making the region mostly free of malaria.[11] A more detailed analysis of climate characteristics for all three study zones is included in the climate section of this report.

Table 6. Rainfall, Temperature, and Altitude in the Study Zones

Province, District	Average Annual Rainfall (mm/year)			Average Annual Temperature (°C)			Altitude (meters)		
	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
North Kivu	825	1553	2342	2	21	26	558	1189	5119
South Kivu	997	1631	2458	9	21	25	530	1247	3464
Upper Katanga	794	1116	1345	17	21	25	600	1230	1923

Source : Ministere de l'Agriculture, RDC 2009. Etude du secteur agricole. Rapport bilan diagnostic et note d'orientation.

2. SOUTH KIVU PROVINCE

Eight territories constitute South Kivu, including three in the study zone: Kabare, Kalehe, and Walungu. Bukavu, the provincial capital, reported an estimated 620,000 inhabitants in 2008, and has seen a rapid rise in population over several decades. This includes a spike and massive influx of refugees from Goma during the volcanic eruption at Nyiragongo in January 2002.

Similar to North Kivu, South Kivu is characterized by mostly lush equatorial vegetation and terrain stretching from high mountainous and plateau areas reaching nearly 3,500 m along the western shore of Lake Kivu, and

[10] http://en.wikipedia.org/wiki/K percentC3 percentB6ppen_climate_classification

[11] http://www.leeds.ac.uk/demographic.disentrapment

descending westward down to a less densely populated lowland plateau at approximately 500 m and equatorial forest area. Like North Kivu, soils are largely volcanic and rainfall is in abundance, allowing for two extended growing seasons, primarily from September to December, and March through May.

The province has a temperate climate similar to North Kivu, but has more of a tropical savanna and warm-summer Mediterranean climate according to the Köppen climate classification system. Average monthly temperature is the same as in North Kivu at 21 °C, but with slightly less range from cold to warm (9 °C – 25 °C). Rainfall is also comparable to that of North Kivu, averaging just over 1,600 mm annually, with a minimum average of nearly 1,000 mm and a maximum of almost 2,460 mm (table 6, above). In Bukavu, temperatures average 19.9 °C, with a high of 20.5 °C in September and low of 19.5 °C in July. Rainfall averages nearly 1400 mm annually, with over 160 mm falling, on average, in March, April, and November, and a low of just under 20 mm in July.[12]

B. ENABLING ENVIRONMENT & KEY STAKEHOLDERS

The obstructive and weak enabling environment in the Kivus restricts growth and competitiveness in all six product areas. This is due both to the ongoing conflict and instability, as well as to the government's lack of support at all levels from national to local. These disruptive elements continue to inhibit the Kivus' ability to compete with foreign products in any of the targeted agricultural value chains, and a considerable trade imbalance continues.

This section describes the set of factors driving the enabling environment in which the focus value chains operate including a description of the key stakeholders and their roles. Figure 2 shows the main actors including the formal government, the traditional governing structures, the central value chain participants, supporting services, and foreign actors including NGOs, donors and other large patrons, e.g., mines.

1. CORE VALUE CHAIN—SMALL FARMERS, COOPERATIVES AND CONSUMERS

Agriculture provides livelihoods for the vast majority of the poor populations of the Kivus; in South Kivu, 73 percent of the population reported agriculture as their main source of income, with 11 percent reporting commerce as a distant second.[13] For the poorest sectors, this percentage is closer to 90 percent. Farming systems and livelihood activities in North and South Kivu are relatively similar with some small variations in terms of crop preferences.

The vast majority of inhabitants in both provinces live on the margins of poverty, eking out an existence on small landholdings where they carry out subsistence farming, hunting, small animal husbandry (goats, sheep, pigs, poultry, rabbits, guinea fowl, ducks, guinea pigs), limited cattle production and some fishing, and mining. Most smallholders practice swidden agriculture using slash-and-burn methods in which fallow periods have declined significantly to around two years at present.[14] Pressures to access land for farming or other purposes are severe in the Kivus and a constant source of violent conflict. Average size smallholdings are only about a half hectare of land due to the confluence of many factors, including strong demographic pressure, soil erosion and loss of fertility, land grabbing and speculation, and a history of intense ethnic conflict in the region.

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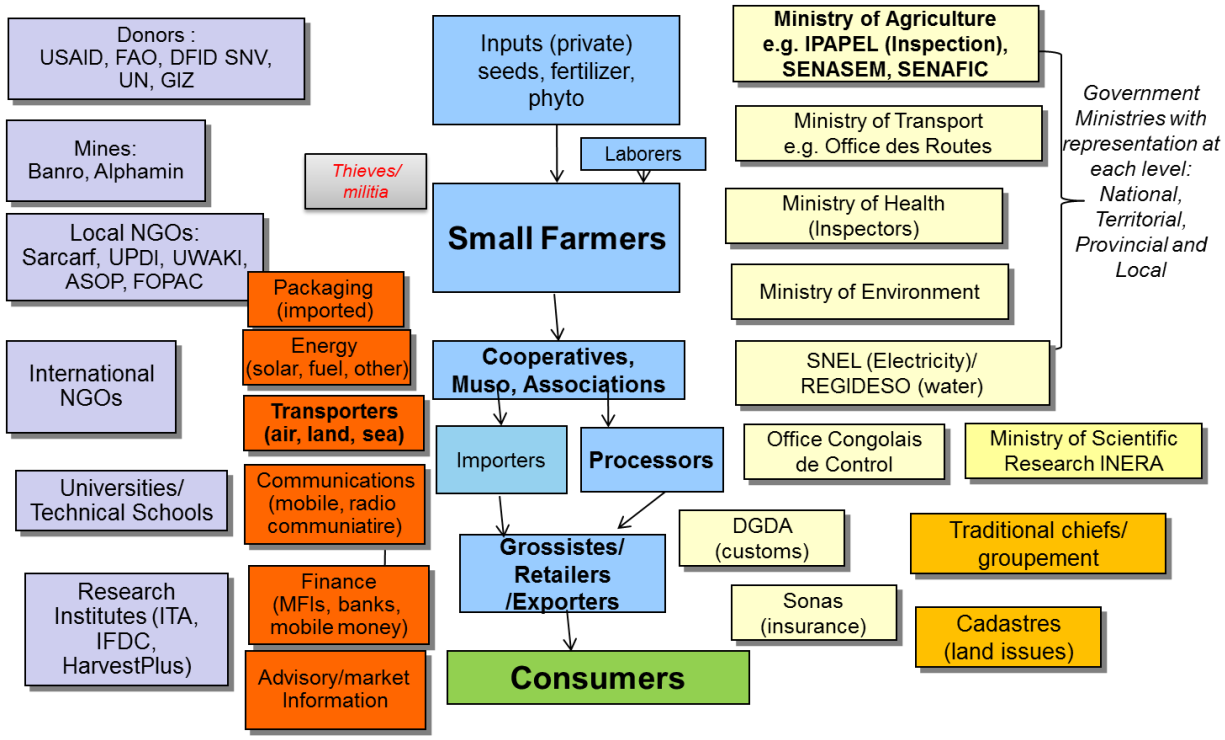
[12] http://en.climate-data.org/location/4604/

[13] World Bank, 2010, Poverty Reduction Strategy.

[14] Fallow periods are believed to have shrunk from about five years previously to about two years today. Based on limited key informant interviews and observations drawn from the general literature.

Figure 2. Agricultural Stakeholder Map—North and South Kivu



Notes:
Pale yellow—formal government; light orange—traditional governing structures; blue—central value chain participants; dark orange—supporting services; purple—foreign actors including NGOs, donors and other large patrons, e.g., mines.

A wide range of staple crops are grown, including cassava, rice, beans, Irish potatoes, taro, maize, sorghum, millet, bananas, plantains, sweet potatoes, soya, groundnuts, sugar cane, and vegetables. Most systems entail mixed cropping of beans and legumes with cassava and cereal crops, and are cultivated in both highland and lowland areas, with garden crops grown near small streams and water courses.

Small artisanal brewing of banana beer is widespread as an income earning activity. Cash crop production on an industrial scale entails tea and coffee plantations, although large commercial enterprises have declined significantly with political instability and civil conflict in the region. Oil palm is grown as a cash crop, extracted by simple hand methods, and traded widely in local village markets in the east.

Other activities include artisanal logging (some clandestine and illegal), subsistence hunting and bush-meat trade (particularly near illegal mining camps), river fishing, and fish farms (in the Walikale area, although they have fallen into disrepair). Today, only a small fraction of the population raises cattle or cows which were decimated through war and cattle raiding. Farmers are highly risk averse and avoid raising livestock, which are easily stolen or killed by raiding bands of thieves and rebel factions. Finally, both artisanal and larger scale industrial mining are practiced throughout the Kivu provinces.

2. TRADERS—WHOLESALERS, EXPORTERS, RETAILERS

From harvest to end consumption, several key intermediaries drive the local market, serving various end markets. These include small-scale wholesalers (mostly women) to whom farmers sell directly or through farmer cooperatives. Some farmers also go directly to the village or even the urban market to sell their wares themselves as well. For some products, a *collector* contributes an intermediate service. Transport is provided by various forms—bicycle, truck or on foot, by either individuals or through services delivered via transport organizations. Storage is rented from the farmers' cooperative, association or *muso* (another less-organized farmer group) or from private depot owners. The transport and storage stage of the value chain can be the most costly, risky and loss-ridden, as is expounded in the constraints section below.

3. IMPORTERS—POWERFUL MERCHANTS WHO INFLUENCE GOVERNMENT

Bigger commercial importers also serve the market and present a significant competitive challenge to local traders, though they often work together to serve certain markets. As consumption in the Kivus (and the DRC in general) depends largely on imports, networks of large merchants who trade in these products wield considerable influence over the government and control a large part of the economy. These commercial agents are largely responsible for procuring and distributing the imports upon which consumers in the Kivus depend to survive. These merchants are also responsible for most imports that feed wealthy Congolese and foreigners, including the extraction industry and the NGO and relief sectors. These companies have a vested interest in maintaining their import networks as their ongoing business depends on the continued growth of the overall market, rather than in growing a home base of agricultural production that may bring the poor out of poverty.

4. GOVERNMENT

The state budget allocated to the agricultural sector is very low and in reality falls short of the official 10 percent. In the DRC, agricultural governance and policy is largely decentralized, and much of the responsibility is in the hands of the provincial government, which has not yet developed a clear vision for agricultural development in the Kivus. Therefore, there is very little formal government influence in the region. Agricultural policy issues that form the base of the enabling environment are discussed below.

- **Taxes:** Several agricultural support agencies within the Ministry of Agriculture exact taxes in several ways. Farmers pay taxes to the local government; cooperatives also pay a moderate tax. Various points in the supply chain are taxed where collection is most accessible such as 1) through certification of seeds and inputs for sale, 2) for inspection of goods at various stages, or 3) during the transit of goods. "Inspectors" and various other tax collection agents often vie for positions to extract rents from the agricultural supply chain.

- **Trade policy:** Foreign trade in the Kivus is an important contributor to food security (Caballero et al., 2001) and tariffs and related instruments can bridge the gap between production and food consumption needs, mitigating supply variations. In particular, the cross-border trade with Rwanda is integral to the food supply of the Kivu populations.

- **Investment environment:** Foreign or large-scale investment is limited to the extractive industries in the Kivus. Although there is a history of large-scale farming on plantations during colonization, this has declined dramatically. And though some large-scale farms (such as tea plantations) still exist, the environ-

ment for foreign investment is largely perceived as too risky. The recent introduction of a National Agricultural Code which limits foreign ownership of agricultural concessions to no more than 49 percent has essentially deterred new potential foreign investment in agriculture.

5. TRADITIONAL GOVERNANCE

The customary chiefs are important actors in the economy across the DRC and especially in the Kivus. In practice, the traditional chiefs and *groupement* organizations are more likely than the official government to perform many governance roles such as mediation of land disputes or participation in certain development programs. The former Belgian colonial state instituted a system that allowed the chiefs to maintain their power and made them essentially partners in the process of colonization. At present, the chiefs not only distribute land but also control markets and have certain tax-collecting powers. In return, they offer services and protection to their subjects; however, the nature and effectiveness of these services varies greatly. Each chiefdom is comprised of multiple *groupements* which each have their own leaders, who often vie for resources and jockey for power with the chiefs. Cadastres are entities that exist to deal with land issues that often arise.

6. DONORS AND INTERNATIONAL NGOS

The economy of the Kivus depends largely on the assistance and related operations of international donors and NGOs, from the UN relief efforts to USAID, DFID and FAO's agricultural programs. These are often at odds, as relief efforts can counter market-based solutions that longer-term interventions are based upon. Because of the level of destruction and the long-term nature of the conflict in the area, these donors and NGOs hold a more significant and core standing in the system than in other developing countries. Local NGOs are partnered with and supported by these entities.

7. UNIVERSITIES & RESEARCH INSTITUTES

Technical and biological innovation could potentially be driven by agricultural research centers; however, the continuing deterioration of these institutions and the low capacity of staff in the DRC at both local and national levels, are two major problems that hinder the Congolese agricultural sector. Agricultural research in the DRC is currently mainly undertaken by INERA. In the 1970s, the National Seed Service (SENASEM) also contributed to research, along with a network of state-owned farms. However, today SENASEM does not provide any development support to the agricultural sector. Because these institutions lack financial and human resources, much of their operations have been abandoned, and in many cases only a few research initiatives exist for those who have managed to obtain outside funding. Market information or extension services appear to be largely defunct, except as supplied by donors and NGOs.

8. SUPPORTING SERVICES

Such services are extremely limited in the Kivus. Communications are largely by mobile phones, though connectivity is limited in rural areas. Electricity is spotty in urban areas and virtually non-existent in rural areas, although there are a few instances of solar panels being installed. Other supporting services such as market information are very limited.

9. MILITIA AND CONFLICT GROUPS

Threats from armed groups continue to harass farmers, including the Forces Démocratiques de Liberation de Rwanda (FDLR), and other groups such as the local Mayi Mayi—community-based militia groups who were

originally formed to defend their local territory against other armed groups but often become threats themselves. There are widespread reports of night attacks and thefts from militia seeking to feed themselves. On a more systematic level, some groups exact a tax on the local population in return for "protection." They are very often implicated in illegal resource extraction and extortion, including the extraction of agricultural products. The national army is also seen as more of a threat to farmers than a source of protection or service. Many of these groups are even believed to be controlled by political actors in Bukavu and Kinshasa.[15]

C. RELIANCE ON IMPORTS FOR SUBSISTENCE

The Kivus import upwards of 80 percent of the food consumed. This trade imbalance is supported by revenues from the extractive industry, as well as the preponderance of NGO and relief efforts. For instance, in 2011, North Kivu province reportedly exported goods and services valued at $84 million and imported goods valued at $278 million.[16] While this dynamic may seem like a ripe opportunity to address poverty by supporting local agricultural production, the challenge is great due to many constraints and market failures.

The table below shows the level of importation of food that was necessary for the population in Bukavu to subsist as of 2010. For an average 1,027 calorie per day diet, more than half of the food calories (593.5) come from food imported from Rwanda, while 339 calories came from North Kivu and just 92 calories were produced in the region.

Table 7. Calorific Contribution of Staple Foods by Origin (kcal per person per day)

Produits (tonnes)	Approvisionnement total de Bukavu*	Population en 2010**	Approvisionnement	Norme pour 100g ***	Calories totales	Calories Rwanda	Calories Nord-Kivu	Calories Sud-Kivu
	Qnté (T)	Nombre	g/pers/jr	Kcal	Kcal/pers/jr	kcal/pers/jr	kcal/pers/jr	kcal/pers/jr
Mais	10015	717328	155,13	363	563,1	372,8	175,9	14,5
Manioc	2293	717328	35,52	338	120,0	27,9	38,1	54,1
Haricot	3164	717328	49,01	341	167,1	51,3	114,4	1,4
Pomme de terre	1419	717328	21,98	67	14,7	12,1	2,7	0,0
Sorgho	911	717328	14,11	361	50,9	37,1	7,0	6,6
Arachides grain	1045	717328	16,19	567	91,8	63,4	6,8	21,6
Patate douce	97	717328	1,50	101	1,5	1,5	0,0	0,0
Riz	20	717328	0,31	360	1,1	0,8	0,0	0,3
Banane plantain	24	717328	0,37	75	0,3	0,1	0,0	0,2
Viandes de bœuf	619	717328	9,59	150	14,4	12,2	0,0	2,2
Viandes de porc	55	717328	0,85	220	1,9	1,7	0,0	0,2
TOTAL	19662				1027	593,5	338,9	92,4

Source : (*) Pointage des flux aux mois de mai, juin et juillet 2010, (**) statistiques de la Mairie de la ville de Bukavu, (***) FAO (2003).

[15] ELAN RDC, Political Economy and Conflict Analysis, South Kivu, December 2014

[16] ASI, 2015

D. INPUTS MARKET ANALYSIS

Good quality and consistent inputs for agricultural production in the Kivus are difficult for small farmers to obtain. There are no large commercial actors and very few government schemes providing inputs. NGOs provide some assistance by sourcing inputs (mostly from abroad), while a small number of more successful farmers in the target value chains buy imported products from Rwanda or Ugandan through urban retail shops. However, most farmers either make-shift their own production inputs or have to do without. There is much room for improvement in the inputs market, both in terms of accessibility and also creating a sustainable market system, as NGO interventions have disrupted the supply chain considerably in recent years.

1. SEEDS

Foundation and breeder seeds of suitable varieties are not widely available, disseminated or marketed in the Kivus. For that reason, the varieties of agricultural products produced are often of low or inconsistent quality. For example, in South Kivu consumers report that the locally-sourced variety of potato rots in just one to two days, versus potatoes from the North or imported from Rwanda which last on average five to seven days.

Good bean seeds

Degenerated bean seeds

Most farmers source seeds in the following ways:

- Re-use their own seeds, which causes degeneration.
- Buy from local village shops, which are not certified.
- Source from NGOs—donor projects, NGOs and other stakeholders are working in several of the major product areas to improve the availability and quality of seeds, relying mostly on imported products.

Several other stakeholders are working to improve seed varieties for the Kivu region with varied success. INERA is working to improve seed quality and availability (see the bean VCA section for more on the bean seed pilot study).[17] HarvestPlus is also working to improve bean quality by raising the iron content. Bukavu-based NGO UPDI (Farmers' Union for Integrated Development) is also working with local universities to develop new potato seed varieties, such as piloting new seeds from Peru.

The International Fertilizer Development Center's (IFDC) CATALIST project is introducing a network of input suppliers led by ADVS (l'Association de Distributeurs de Vivres et Semences) which, contrary to its name, is not an organization but a private distributor selling to agricultural organizations and retailers, as well as directly to farmers.

The constraints which obstruct the seed market can be summarized as follows:

- **Cost and availability.** Overall the cost of seeds is an obstacle for most small farmers, causing them to resort to using degenerated seeds or seeds of questionable sources.
- **NGOs disrupting the market.** Despite good intentions, by providing highly subsidized seeds to farmers, the NGO community is unintentionally upending the long-term viability of the inputs market in several ways. First of all, when farmers receive free seeds, they will begin to expect in the future that seeds

[17] Strengthening Local Seed Systems within the Bean Value Chain: Experience of Agricultural Innovation Platforms in the Democratic Republic of Congo, Institut National pour l'Etude et la Recherche Agronomiques (INERA-MULUNGU) DS Bukavu.

will always be given to them at no charge, thereby reinforcing an "*attentiste*" mentality where they are dependent upon this assistance. And secondly, any existing local markets for seeds are disappearing as local providers cannot compete on price with NGOs' free products. Beans are a particular focus of NGOs, so this value chain suffers this pitfall more than others. One program, HarvestPlus, is said to be implementing a more market-based approach.

- **Lack of certification.** To ensure the quality of seeds, most agricultural markets rely upon certification practices to optimize seed inputs. There is little to no reliable certification currently underway in the Kivus. SENASEM, which is charged with certification, uses poor standards to certify; reportedly, many of the "certified" seeds which are sold at a premium were in fact sourced from nearby market stands.

- **Lack of traceability.** In more advanced markets, seed verification and optimization relies on traceability. There are no reliable systems in the Kivus to ensure that certified seeds remain intact through delivery.

2. FERTILIZERS AND PHYTO-SANITARY PRODUCTS

Like the seed market, the fertilizer and phyto-sanitary markets have been disrupted in recent years by the conflict and the dissolution of the supply chain. As a result, no large or international suppliers reach the Kivus. Large international suppliers, such as Savannah, a French company, which supplies plant products, do not reach the Kivus due to transport costs, lack of consumer purchasing power, and political barriers (such as the regulatory issues cited below). Urban retail shops, such as agro-dealer Pharmacie Lobiko in Bukavu, supply chemical fertilizers which are imported from Rwanda and Uganda; however, these are expensive and typically beyond the budget of small farmers.

Natural fertilizers (such as compost) and inter-cropping are also used, although some challenges to availability have hindered their use.

NGOs are also working to support this area in terms of providing products and training. The DRC, and specifically the Kivus, are the focus for the IFDC's CATALIST-2[18] project, which works to upgrade agro-dealer networks and infrastructure supporting agricultural systems.

Constraints to overcome in using fertilizers and phyto-sanitary products are as follows:

- **Lack of education on how to use chemical fertilizers.** Currently, some NGOs are implementing necessary training, however, farmers often do not know the basics and require instructions for use of inputs such as "Don't put your hand in the bucket to distribute" and "Don't store near animals."

- **Chemicals too costly.** Phyto products and fertilizers are simply too costly for the small scale at which farmers in Kivu operate.

- **Lack of compost due to reduction of livestock**. Natural fertilizer made of compost is often used by farmers who source it from their livestock. However, as livestock populations have been reduced, this is not as available.

[18] See www.ifdc.org/projects/current2/east_southern_africa_division/catalist-2

- **Bananas, once used to inter-crop, are now not available**. One soy producer cooperative used to inter-crop with bananas, which prevented diseases and raised yields; however, since the wilt bacteria decimated their banana crop, they can no longer apply this practice.

- **Restrictive, unpredictable regulations**. Reportedly, the national government of the DRC banned a certain phyto-sanitary product because one of the inspectors read a story on the Internet which claimed that the chemical did some harm. This stopped the supply of this chemical indefinitely and frustrated the supplier (Savannah, a French company with offices in Kinshasa).

The next section describes potential interventions to overcome or mitigate these constraints.

3. OPPORTUNITIES FOR INPUTS MARKET INTERVENTION

Despite the significant challenges to agricultural systems in the Kivus, there are some windows of opportunity to assist small farmers:

- **Market comparative advantage in "organic" processes**. Local products are said to taste better than Rwandan products, for instance, because they are produced without chemicals. In this case, the inability for farmers to access chemicals has led to an unexpected market advantage.

- **Work with regional partner experts to develop resilient crop varieties and agricultural practices.** For instance, ARC Relief in Bukavu, has engaged with the International Potato Center (CIP) based in Nairobi to help develop potato varieties to improve yields for farmers in Kivu. CIP's potato seed and integrated crop management related work is managed from their Nairobi office and works across the region in Kenya, Uganda, and Ethiopia and to a lesser extent in Rwanda, Burundi and DRC.

- **Finance**. Access to credit via microfinance or even mobile money savings schemes could enable sales of inputs for small farmers.

- **Link farmer groups with urban retail shops**. Organizing farmers so that bulk purchasing is enabled would reduce cost and increase access.

- **Soil regeneration and re-forestation**. Another consideration at this stage is replacing/re-planting trees which were removed as agriculture expanded with increased population. This would limit deforestation and mitigate changes in weather patterns and retain biodiversity.

- **Reinforce training on inputs use**. Education on products and techniques remains low, and has worsened as availability has declined in recent years. Several NGOs are already working in this area; therefore it would be advisable to collaborate, support and possibly expand their efforts.

- **Increase transparency and effectiveness of SENASEM**. Introducing traceability mechanisms and/or other communications technologies could be explored to increase the effectiveness of both SENASEM's regulatory and support roles.

- **Work with inputs traders**. The inputs that are currently supplied to the market are sourced from Rwanda and Uganda by professional traders (such as one called *Bico*). These entities could be consulted to expand their reach and the affordability of their products.

4. EQUIPMENT INPUTS

Farmers also lack access to modern tools and equipment due to a lack of finance and weak market organization. With farming at a very small scale, it is often not cost-effective to purchase costly tools or machines such as tractors. Therefore most farmers use obsolete tools and technologies and are generally limited to basic instruments such as the hoe, machete and spade.

There have been some efforts to provide machinery, though they have not been successful. In 2010, for instance, the government launched a program that was intended to provide tractors to agents who would rent them to small farmers. This program failed for several reasons: the tractors were allocated to private "patrons" of the state who did not execute the program effectively and did not make the machines available to those who needed the equipment; it is unclear exactly what transpired but the tractors did not appear when needed; and most farmers in the Kivus manage less than a hectare of land and therefore do not really have use for tractor services.

E. LAND ISSUES

Land issues are a major challenge in the Kivus with various forces causing potential issues:

- **Customary versus formal land status.** The traditional chiefs (called Mwami, "head-chief" or "King"), who exercise authority over their subjects, held land "in trust" for the people they governed and allocated land to those households under their jurisdiction. There is often some dispute between traditional and formal land rights. The Chiefs, traditionally, are said to own all the land in their chiefdoms and are known to overturn land deals purportedly performed by their subjects with outside parties.

- **Power aspirations.** Much conflict has been linked to demographics and the economic fortunes and political aspirations of certain ethnic communities. The Masisi Territory in North Kivu, for instance, has seen much violence between Hutu, Tutsi, Hunde and Nyanga militia forces vying for control over the land. In addition, during periods of conflict or instability, armed groups and other powerful actors have taken the opportunity amid the power vacuum and confusion of a struggle to acquire land (without legal grounding or any attempted justification) for rent-seeking or speculative purposes.

- **Immigrants and refugees.** The conflicts in neighboring countries and in the Kivus themselves have led to land disputes among displaced and returning migrants. This occurs both as foreign refugees take up land, and as Congolese who fled abroad return.

- **Gender rights.** Controversy over women's rights to own or transfer land leads to conflict when land is disputed, when no male inheritor is present to acquire land, or when women are widowed.

- **Conflict resolution.** At the heart of many land struggles is a lack of accepted mechanisms to settle disputes. Traditional governance systems often step in to mediate, as do certain NGOs dealing with this issue.

- **Grazing rights**. Cattle herders often move outside of their home *groupement* or *territoire* to seek new feed for their herds; this seasonal movement is a customary practice by herders around the world, but is increasingly a problem in the Kivus as land becomes scarcer and cattle are often caught grazing in other farmer' fields and damaging crops.[19]

Tackling land rights challenges is an ongoing theme in the Kivus, and while solving this challenge outright may be beyond the scope of potential USAID projects, there are some interventions that would allow project beneficiaries to mitigate the pitfalls that may arise through land issues.

- **Operate in a secure land environment.** Any development project needs to assess land ownership in target areas, relying not only on "legal" property rights but also consulting the traditional land proprietors. Lands that are the subject of a previous dispute may result in unmanageable tensions.
- **Confer with traditional chiefs.** Traditional chiefs should be consulted on the location of project activities to ensure their up-front support and agreement to honor land rights.
- **Support the tending of small ruminants.** Small ruminants that require less grazing land are preferable to cattle, given the concentrated land holdings in the Kivus.
- **Advocate for small farmers in land disputes.** Disputes over land rights are a major instigator of conflict in the region and small farmers often lose out to large land owners because they lack capacity to advocate on their own behalf. In response, aid programs such as UN Habitat have engaged in arbitrating some disputes over land rights. NGOs such as Friends of the Earth and the Federation of Congolese Agricultural Producers' Organizations (FOPAC) have also lobbied for more representation of agricultural workers in local decision making over land rights.

F. TRANSPORT

Transport generally suffers from high costs and generally poor conditions, both inland within the Kivus and connecting to other parts of the DRC and regional trading partners. This includes transport by road, sea and air.

Road challenges in North Kivu

- **Roads:** The state of the roads that deliver agricultural products is extremely poor, especially during the rainy season. Road transport is largely undertaken by the owners of private vehicles who use outdated transportation (trucks, vans, mini-buses and cars) that move people and products from the site of production to the place of consumption. This largely explains the low quantities transported and the resulting higher prices. Insecurity and poor roads therefore mean that sellers focus solely on local markets, as long distance transport is expensive if not infeasible.

[19] Land, Power and Identity Roots of Violent Conflict in Eastern DRC. Chris Huggins, November 2010

- **Sea:** Lake transportation is provided largely by "boats" and private canoes serving Idjwi and coastal villages of Kabare and Walungu territories in South Kivu and linking via Lake Kivu with the North Kivu. There is currently no public transport; however, there is an emergence of private boats connecting Goma with Bukavu and with other destinations.

- **Air:** Air transportation also exists, although the routes are less used for transport of agricultural goods than in the past. Within the South, Kavumu Airport connects the most distant territories such as Shabunda, Mwenga to the city of Bukavu. Palm oil is one of the increasingly transported agricultural products. In North Kivu, agricultural products are transported to the capital Kinshasa by air, with beef, beans, cheese being the most frequently transported products.

The conflict also challenges the transport of products. For example, during the years 2012 and 2013, trucks transporting coffee in North Kivu were taxed (stopped forcibly with payment requested) at a rate of $400 one-way by the M23 rebel group (with no receipt given). Furthermore, high taxation on the part of the government (at all levels) is reportedly the reason for the lack of profitability of the transport sector across the country, and for the slowdown in investment in this sector.[20]

G. FINANCE

Finance is essentially not available to small farmers in the Kivus. There is no access to loan capital, and savings mechanisms and other services do not exist. Furthermore, a severe lack of financial education contributes to a weak capacity to support the functioning of agricultural credit or savings systems. In the observed communities producing the selected crops, this lack of finance was particularly noticeable in the following areas:

- **Input finance, land and basic production.** Inputs such as fertilizers or phyto-sanitary products must be purchased up-front by farmers; however, they often do not have access to funds available. Cooperatives often try to assist by operating a rotating credit service or buying in bulk; however, the cooperatives observed in the Kivus lacked the capacity to perform these services.

- **Women's savings groups.** In some cases, women's savings groups exist and provide small sums to finance seed purchases or other inputs. NGOs, however, often step in to provide subsidized (or free) products.

- **Equipment finance.** Most farming in the Kivus is done using rudimentary tools, without access to modern technology. Farmers do not have access to equipment due to lack of finance (and availability of equipment, to some extent). In several cases, NGOs have stepped in to support the finance and operation of mills; however, the conflict, as well as electricity shortages, often make these mills unusable. Government programs such as the provision of tractors (described previously) have been largely unsuccessful.

- **Inventory and sales management.** Even when demand is high, farmers are often very challenged with financial management of product sales. Bulk buyers (as, for example, one of the mines) tend not to pay for product immediately upon purchase, so farmers do not receive payment right away. Therefore, they

[20] Source: interviews with transport professionals including Service Air, ADEVIVA and others.

often favor smaller collectors offering less favorable prices who pay cash on the spot. In this way, farmers are losing profits because they do not have enough operating capital to wait for payments from more lucrative buyers.

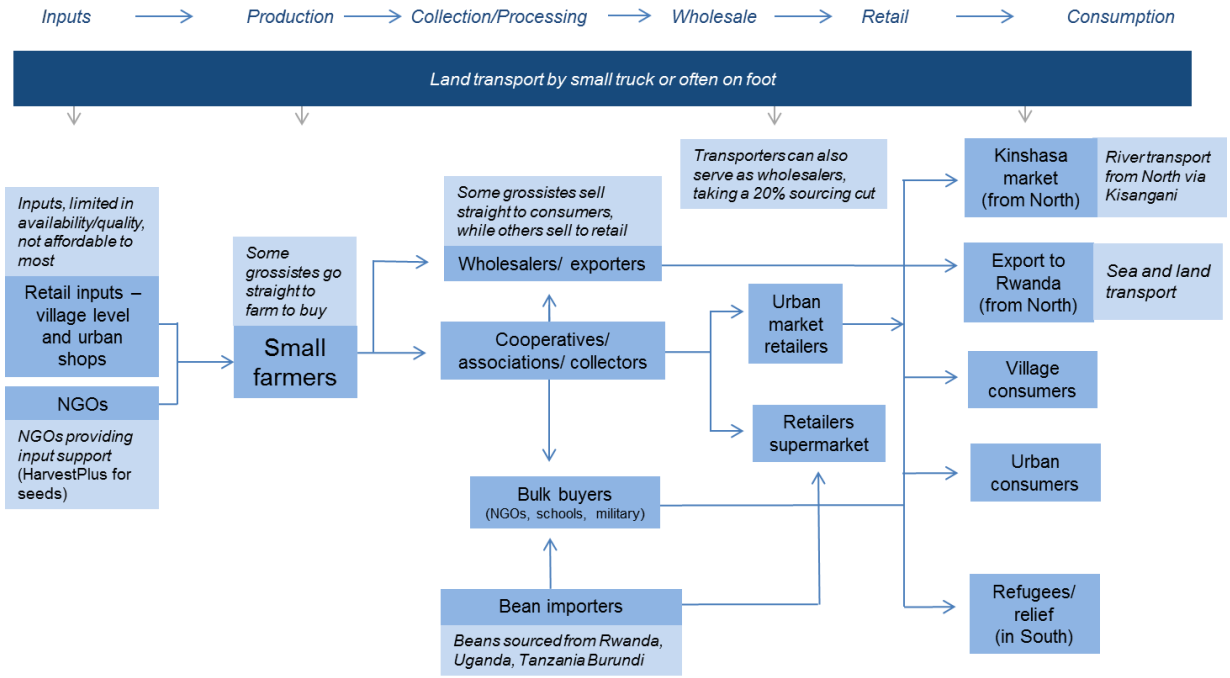
- **Transaction services (e.g., mobile banking).** One of the many dangers in the value chain is that farmers and traders who travel to deliver their goods often have to carry cash, risking theft. Technologies such as mobile-enabled finance may offer future solutions to this problem. However, at the moment a lack of connectivity and pay-out agents in rural areas prevent this service from functioning. In addition, the mobile money services as of March 2015 are said to be too expensive (reportedly 10 percent plus) for even urban consumers to utilize.
- **Emergencies and life purchases.** Traditionally, and to this day, livestock are the most common financial savings tool which farmers in the Kivu use to pay for emergency costs or other large life purchases such as dowries. However, with livestock in danger due to the conflict, this method is often risky.

V. KIVUS: BEANS VCA

Dry beans are one of the staple food and income sources for the North and South Kivu regions. Several varieties of different colors, qualities and tastes are produced. While most of the beans grown in the South are consumed within the region, the North has an active export flow to the South, as well as to national markets (e.g., Kinshasa) and regional export destinations.

Of the estimated 1.5 million farming households in both North and South Kivu, there are approximately 100,000 commercial bean farmers (40,000 in Masisi and Rutshuru[21] and 60,000 in Kabaré [22]), with many more producing beans for consumption within the household. Due to prolonged conflict and insecurity in the Kivus, overall bean production in DRC dropped from its 1994 peak of 180,000 metric tons to 107,000 metric tons in 2002, and is still recovering to reach these previous levels. Total DRC output was estimated at 140,000 metric tons per annum in 2011, with production concentrated in North Kivu (70 percent of DRC output, about 98,000 metric tons) around Misasi and Rutshuru, and in Kabaré in South Kivu (5 percent of DRC output, about 7 metric tons).[23]

Figure 3. Bean Value Chain—North and South Kivu



A. BEAN VALUE CHAIN ACTORS

Small farmers form the core actors of the value chain, as no large-scale bean operations exist in the Kivus. NGOs play a pivotal role in providing support from the input stage through production, marketing and also as bulk buyers. Farmer cooperatives (and lesser organized *musos* or associations) operate on a limited scale

[21] Oxfam, EMMA, 2013

[22] Chefferie de Kabaré, Cultures vivrieres 2010-2011.

[23] ASI, 2014

with the heavy-handed support of NGOs. Transport and storage services are the major supporting function enabling the value chain to operate, as other advisory or support services (such as finance or market information) do not exist. Export routes are also facilitated by relatively small actors (*grossistes*) selling close to regional destinations.

B. COMPETITIVE POSITIONING

The Kivus produce around 75 percent of the DRC's bean output, making this an opportunity for both income growth and food supply. In the case of beans, the North and South have different competitive profiles, which are summarized in table 8 below.[24]

In addition to feeding its own population, North Kivu historically supplies beans to the South where production is lower. Imports also come from Rwanda and to a lesser extent from Tanzania (for the *pigeon vert* variety). The dynamics of the key market segments are analyzed by assessing the bargaining power of buyers versus suppliers, and by identifying future threats or trends which will affect market competitiveness. These market rivals form the competitive landscape for the assessment of the North and South Kivu bean suppliers to the identified target markets.

Table 8. Competitive Position of Bean Products of Various Origins

Origination	Advantages	Major barriers to entry (disadvantages)	Markets served (within study)
South Kivu	• Low price point • Organically grown	• Low production • Poor quality seeds • High transport costs • High risk of theft/attack • Inconsistent delivery	• South Kivu (urban/local)
North Kivu	• Low price point • Developed transit market via Goma/lake • Organically grown	• High transport costs • High risk of theft/attack • Inconsistent delivery	• South Kivu (urban) • North Kivu (urban/local) • Kinshasa • Exports
Rwanda	• Consistent supply • Trade route developing via Goma • Higher quality product	• Longer shipping • Import hassle • Known to use more chemicals	• North Kivu (urban) • South Kivu (urban)
Tanzania	• Varieties in demand (*pigeon vert*, white) • Trade route to Goma/ Kinshasa established	• Longer shipping • Import hassle	• North Kivu (urban) • South Kivu (urban) • Kinshasa

[24] Adam Smith International, DRC Market Systems Analysis, 2103.

C. END MARKET ANALYSIS

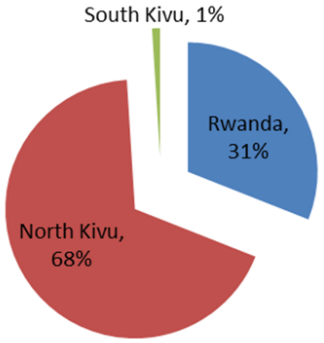
The analysis is broken down into various end-market segments and a competitiveness rating for both the North and the South is assigned, based on the competitive positioning laid out in table 8 above.

Table 9. End-Market Analysis for Beans in North and South Kivu

	Both North and South		North Kivu			South Kivu		
Supply to	Self-consumption	Local market	Kinshasa	Uganda, Rwanda, Bukavu	Urban market (Goma)	Kinshasa	Uganda, Rwanda	Urban market (Bukavu)
Competitiveness	*Strong* Base food, "meat of the poor"	*Strong* Base food, "meat of the poor"	*Medium* Cultural preference for local, prices higher than competitors	*Strong* Price competitive	*Strong* Existing & growing market	*None* Small volumes produced	*None* Currently import from North Kivu and Rwanda	*Weak* Due to high transport costs

- **North/South Kivu self-consumption and local village markets**. **Ratings: North Kivu: STRONG, South Kivu: STRONG**. The high cost of transport makes local or nearby urban consumption the most competitive end markets for bean producers. As shown in figure 4, as of 2010 most of the beans consumed in South Kivu were sourced from North Kivu and from Rwanda with a smaller amount grown locally. However, since this information was gathered in 2010, NGO intervention has actually raised the level of production in the South so this one percent figure has likely risen. In North Kivu, the population consumes its own production as well as a sizable amount (exact data not available) that derives from the nearby cross-border trade with Rwanda. As overall supply is low and demand is high, sellers have the pricing power when they offer their products. However, the lack of consistent supply chains reduces the North's access to market, which is then filled by imports.

Figure 4. Sources of Beans Consumed in Bukavu



Source: primary research collected for doctoral dissertation, Dr. Stany Vwima, 2014. Data collected in 2010.

- **National market (Kinshasa)**. **Ratings: North Kivu: MEDIUM, South Kivu: NONE**. North Kivu supplies a significant portion of the staple beans to the Kinshasa market, with a strong transport corridor developed from Goma to the capital. Supply is said to be the limiting factor for expansion, as demand continues to increase with population growth. The *pigeon vert* variety of beans is imported from Tanzania and primarily shipped to Kinshasa. The FEWS NET/FAO/WFP Joint Cross Border Market and Trade Initiative reported that overall dry bean imports from Uganda to the DRC have increased in the last three years, with the volume reported in the first quarter of 2015 to be 153 percent higher than the previous three-year average due to high demand in eastern DRC. This trade route is seasonal and volumes decline

approximately 60 percent when the harvest season begins in the DRC.[25] Also of note, there is a cultural preference for the Kivu-grown ("local") beans versus imports; although disrupted supply over the years due to conflict and poor transport has allowed competitive beans to take market share.

- **Urban provincial market (Bukavu). Ratings: North Kivu: STRONG, South Kivu: WEAK (but growing).** As shown in figure 4, in 2010 most of the beans consumed in Bukavu were shipped from North Kivu or imported from Rwanda. However, this has reportedly changed in the last five years as NGOs have worked to improve the bean value chain in the South. Urban demand is high and therefore increased supply of beans of all sources will likely be consumed at competitive prices.

- **Urban provincial market (Goma). Ratings: North Kivu: STRONG, South Kivu: NONE.** Beans demanded in Goma are either produced in the North or imported from nearby Rwanda. As the Rwandan border is within a few kilometers of central Goma, transport (which is the highest and most inconsistent factor in the value chain), importing from Rwanda is often the most reasonable market to access.

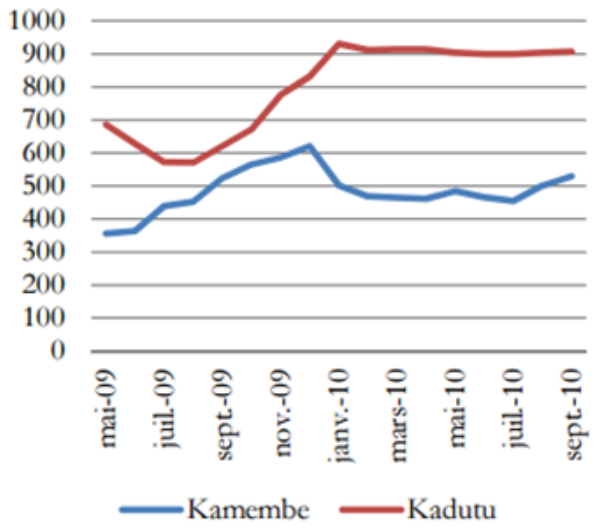
- **Export/cross-border trade markets Ratings: North Kivu: STRONG, South Kivu: None**. Cross-border trade (both imports and exports of beans) occurs between the North and Tanzania, Rwanda, Uganda, and Burundi. Particularly the lower income groups, for whom beans represent an important protein source, are major consumers of Kivu beans in all the target countries.

There are several constraints to understand in the operation of the bean market, with the most important being market distortions and price volatility.

- **NGO market distortions.** The assistance of NGOs has changed the market, especially in the last decade as the region has calmed (relatively) from the conflict. As a staple food, beans were especially targeted for assistance, with free inputs and technical assistance being given out in the short term. However, when this assistance's term is complete, the future sustainable operation of the markets is uncertain.

- **Price volatility**. In recent years, the prices of all products have varied greatly. Figure 5 shows the swing of bean prices in 2009-2010 in the cross-border trade between South Kivu (Kadutu market) and Rwanda (Kamembe market). Also note the higher price in South Kivu versus Rwanda, reflecting transport and other surcharges incurred along the way. This leaves consumers open to risk and prevents longer-term planning.

Figure 5. Average Monthly Price for Cross-Border Trade of Beans 2009-10 (FC/kg)



Source: Rwanda Ministry of Agriculture

[25] East Africa Cross-border Trade Bulletin, FSDWG God Security & Nutrition Working Group, The FEWS NET/FAO/WFP Joint Cross Border Market and Trade Initiative, January 2015.

D. INPUTS MARKET ANALYSIS

The inputs market serving the Kivus has been heavily disrupted and in many cases is non-existent. Since the Kivus are blessed with highly fertile soil, where beans are relatively easy to cultivate, this allows the bean crops to be profitable with very few to no inputs (i.e., irrigation, fertilizers, pesticides etc.). However, the yields could be significantly improved if inputs were available. Elsewhere in the neighboring Great Lakes region, bean crops using better soil management and fertilizer practices reap yields of 1.5 to 3.5 metric tons/ha,[26] compared to 0.6 to 1.5 metric tons per hectare for the Kivus.[27]

1. BEAN SEEDS

Suitable varieties of foundation and breeder seeds are not widely available, disseminated or marketed in the Kivus. The seed production and multiplication that occurs is largely performed by NGOs acting in a semi-commercial manner, with some providing subsidized or even free seeds. Farmers also often re-use seeds from their previous harvests, or purchase low-grade seeds or seeds of questionable origin from wholesale or retail markets. This inconsistent sourcing is a major cause of crop degeneration and the decline of bean quality and yields.

INERA is working to improve seed quality and availability. The institute recently tested an Agricultural Innovation System approach to the seed systems to improve the bean value chain with 74 pilot farmers in the South and North Kivu provinces. The pilot increased access to seeds of marketable varieties between 2009 and 2012 from less than 10 percent to about 42 percent, while the price of bean per ton at the farm level increased by 120 percent, and seed purity increased from 70 to 95 percent over the same period.[28] HarvestPlus is also working to improve the nutritional content of bean varieties by raising the iron content.

Major constraints to note in this area include the following:

- **Lack of certification**. To ensure the quality of seeds, most agricultural markets rely upon certification practices to optimize seed inputs. There is little to no reliable certification currently underway in the Kivus. The state-run seed service, SENASEM, is largely non-operational at the moment, due to a lack of funding.
- **NGOs disrupting the market**. By providing highly subsidized seeds to farmers, the NGO community is unintentionally upending the long-term viability of the inputs market by reinforcing a dependency culture through free seed distribution, and by crowding out local providers, who cannot compete with donor-subsidized products.

2. FERTILIZER AND PHYTO-SANITARY PRODUCTS

Some bean farmers within the target populations were observed to use limited amounts of chemical fertilizers, which are available on the local market; however, most still used "organic" fertilizers, often from the compost of the household livestock. Phytosanitary products are not used by the vast majority of bean farmers. Major constraints include the following:

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[26] These are inter-cropped bush varieties enabled by CIAT, the international agricultural research institute that is part of CGIAR, the Consultative Group on International Agricultural Research. CIAT is managing bean research projects in the East from Bukavu in S. Kivu, including the introduction of bio-fortified "Gorilla Beans" that are rich in zinc and iron.

[27] ASI, 2014.

[28] Strengthening Local Seed Systems within the Bean Value Chain: Experience of Agricultural Innovation Platforms in the Democratic Republic of Congo, Institut National pour l'Etude et la Recherche Agronomiques (INERA-MULUNGU) DS Bukavu.

- **Compost limited with reduced livestock.** As livestock populations are in danger, farmers who depend on the input of compost for organic fertilizer find they have nothing to substitute.

- **High cost of product, high transport costs.** In general, these products cost too much and are not locally available for farmers to reasonably purchase. Very few international (or other) products make it into the local markets for distribution.

HARVESTPLUS WORKS TO IMPROVE THE IRON CONTENT OF BEANS

"Beans that are bred to be high in iron can contribute to a reduction in iron deficiency in regions of Africa where daily bean consumption is high. Beans are consumed mainly in the eastern provinces of North and South Kivu in the DRC at an estimated 300 grams per capita per day (in contrast to consumption in Rwanda which is just 200 grams per capita per day). Prevalence of anemia among preschool children in the DRC is 36 percent in North Kivu and 47 percent in South Kivu.…which is due to iron deficiency in the diet. The breeding strategy combines high iron with other desirable agronomic traits. Breeding for high iron has built upon early investments made during proof of concept studies. Consequently, beans are projected to be the second bio-fortified crop to be officially released by the program pending the results of nutritional efficacy trials. HarvestPlus estimates, under an optimistic scenario, that 10 years after release, two million people in D.R. Congo and three million Rwandans would consume high iron beans each year."

Source: HarvestPlus Bean Strategy

E. PRODUCTION ASSESSMENT

Beans are either cultivated in monoculture (in farms with a higher level of commercialization) or intercropped with other products, with some farmers growing four to six crops simultaneously. Several bean varieties may also be produced within one farm. There are two primary cropping cycles per year for beans in Eastern DRC, which occur from June to August, and early September through the end of the year, thus representing continuous planting and harvesting periods.

Largely due to the on-going presence of rebels and resulting insecurity, there are very limited support services available. There is no access to financial services or mechanization. Any research and extension (business development services) are conducted entirely by NGOs financed by donor programs.

Labor on the farm is performed mostly by members of the householder (reportedly 80 percent by women, 10 percent by children, and 10 percent by men). There is a limited amount of paid manual labor which earns on average 1,500 francs per day (about US $1.60) which includes working in the field and transporting the products to a central location.

There are several constraints to consider in this stage when designing interventions:

- **Low yields**. Yields are generally very low, when compared to the global and even the sub-Saharan African average. This is due to poor seed and other inputs as described above. In addition, agricultural practices are limited, with most farmers using primitive tools and little modern technology.

- **Overpopulation and land shortage**. Largely because of population growth, much of the land is being over-cropped and each farmer's average land size has shrunk. Statistics from IPAPE show that more than 86 percent of farms in South Kivu cultivate less than 0.45 hectares, with the average size of a domestic farm in South Kivu between 0.3 and 0.4 hectares.[29]

- **Lack of market information.** Farmers lack access to a multitude of potentially helpful supporting services, from production assistance to market information on trends and prices. Though some advanced research is being undertaken, for instance by INERA as described in the example above, widespread dissemination of technical information to farmers does not occur.[30]

- **Poor handling and storage.** Storage facilities are limited, with risks related to theft as well as disease. Many handling facilities do not have drying stations and do not triage or separate beans of good and bad quality. One of the primary roles of cooperatives is to provide storage, and NGOs often supply needed technical support to these operations.

- **Dependence on child labor**. An estimated 5-10 percent of labor on the farms is performed by children in the household, which is often a priority over education, as it is deemed necessary for subsistence.

F. PROCESSING ASSESSMENT

Beans from the Kivus are not a processed product for target end markets.

G. CONSUMPTION ASSESSMENT

Beans are a staple and a source of protein for the target populations in the Kivus, often referred to as the "meat of the poor."[31] They are the basis of most of the poor population's diet, often mixed with available vegetables or rice. Furthermore, the high storability of beans, which can last up to three years, makes them highly attractive for households to hold and manage their food consumption, as well as possible income generation throughout the year.

Beans are one of the top products in North Kivu for both home consumption and sale. NGO ConDev's survey of smallholder farmers in North Kivu in September 2014 found that beans were third to cassava and maize in terms of the overall number of farmers growing the crop, with 88 percent of farmers growing beans. As a cash crop, beans are second only to cassava, with 40 percent of farmers reportedly selling beans.

H. TRANSPORT, TRADERS & *GROSSISTES*

While the production level of the bean market operates mostly informally and through small-scale farms, moderately large-scale wholesalers ('*grossistes*") often perform the aggregation, coordination, transport and marketing functions, capturing up to 40 percent of the total price of the final product.

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[29] Mastaki, J.L. (2006). Le rôle des goulots d`étranglement de la commercialisation dans l`adoption des innovations agricoles chez les producteurs vivriers du Sud-Kivu (Est de la R.D.Congo). Thèse de doctorat : Faculté des Sciences Agronomiques de Gembloux (Belgique).

[30] Strengthening Local Seed Systems within the Bean Value Chain: Experience of Agricultural Innovation Platforms in the Democratic Republic of Congo, Institut National pour l'Etude et la Recherche Agronomiques (INERA-MULUNGU) DS Bukavu.

[31] Adam Smith International, Market Systems Analysis Report, August 2013

1. MARKETS

Beans produced in South Kivu are almost all consumed either at the village level or in Bukavu, and rarely beyond. In fact, a large part of consumption is sourced from North Kivu and arrives either by boat or by truck on land (as described in the section below).

In Goma, the collection of agricultural goods and their distribution is managed by several small trade associations whose members organize the buying process on the village markets, transport to Goma, store goods (very short term) and sell on to retailers, and to national (Kinshasa) and regional exporters (mainly Rwanda and Uganda). Beans constitute around 40-50 percent (an estimated 200 metric tons/week) of an average Goma wholesalers' business. In Bukavu, the market is much smaller, with bean wholesalers only selling 9-10 metric tons of beans per week.

The Biréré wholesale market at Goma is a hub for bean aggregation in North Kivu, including cross-border trade with Uganda, Rwanda, Burundi and Tanzania, in addition to domestic production. The Goma-based wholesale network supplies transportation services covering the 60-100 km between production areas. From the Goma market, beans are retailed for local consumption or prepared for onward boat transport via Lake Kivu transport to Bukavu or onto Kinshasa. Small quantities of locally produced beans are exported from this market.

The intermediate markets of Masisi and Rutshuru (Le Petit Nord); and to a lesser extent in Beni (Le Grand Nord) form the secondary level spokes of the North Kivu bean market. Farmers and highly mobile small- and medium-scale traders transport beans from the Masisi-Rutshuru production area to Goma, either directly or via local wholesale markets, where they are aggregated.

Wholesalers in Goma pay US$2 (US$1.1 in Bukavu) per sack to the depot owner and an additional US $2 per sack for storage. Wholesale depots are mostly male-owned but at least 50-80 percent of wholesalers in Goma and Bukavu (numbering 300-400) are women.

2. TRANSPORTERS

The main transport associations are ADEVEVI (Association des Dépositaires et Vendeurs des Vivres), ATVPA (Association des transporteurs et Vendeurs des Produits Agricoles) and UPRVEPA (Union des Producteurs et Vendeurs des Produits Agricoles). Together they have more than 6,200 members and manage more than 900 food depots, each with a capacity of 1-3 metric tons in Goma. UPRVEPA also maintains a considerable number of food depots in the village markets (primarily in Rutshuru). Another association, AFVL, specializes in legumes. Two other organizations, AVEPAD and Union des Bas Peuple, focus on the cross-border trade with Rwanda in both directions.

There are an estimated 800 plus vehicle owner-operators based in Goma, who own around 1,600-2,400 light-weight (10 metric tons, 80 percent) to medium-weight (20 metric tons, 10 percent) vehicles; these make daily trips to Masisi or Rutshuru to carry bean products. These road-transport services may employ a total of around 6,000 to 10,000 people.

There are some US $160 per annum of local taxes, licenses, and "patents" (which are considerably less in Bukavu)—which comes in the form of various inspections from local and regional agencies. One of the primary roles of the above associations is to serves as a center-point for government to collect taxes, which can be both burdensome and unpredictable.

There are several constraints to consider in this stage when designing interventions:

- **High road costs and risks from bandits and tax-collectors.** Estimated transport fees vary from US $6-US $20 per 100 kg of goods from production areas to Goma, and US $7- US $15 from Goma to Bukavu by boat. The risks for transporters are very high and vehicle convoys are regularly attacked, often resulting in death or injury. Unofficial "taxes" can vary from US $10 to US $1,000 per vehicle per road-block. The roads are in bad condition and vehicle maintenance costs are high. Allocation of value-addition reveals high logistics costs as seen in table 10. While the allocation of value per market actor varies considerably by end market, the following calculation demonstrates an example from the Bukavu market. Note that the largest contributor of value addition is the *grossiste*, as this actor is responsible for both transport and storage, which are major cost components of the value chain. The example in table 10 is from a street market, whereas a higher-end retail supermarket may mark-up the price by 50 percent or more.

Table 10. Price (Value-add) per kg

Farm price	400	35%
Collector price	549	13%
Grossiste price	1006	40%
Retailer (urban market)	1143	12%

Source: IPAPE Provincial Statistics 2009 for percentage allocations, market research 2015 for current prices.

- **Inadequate storage facilities**. Although beans can be stored for up to three years, producers prefer to sell quickly due to a lack of long-term bulk storage facilities (according to ASI Kivu Market Systems Analysis).

- **Payment systems are risky**. Although cash remains the most common method to pay for goods, in-kind agreements often are used to lower the risk associated with carrying cash. Mobile money is being used by only a small number of market participants and only identified on an anecdotal basis.

- **Lack of enforceable contracts**. The bean trade operates largely on trust, with contracts difficult to enforce. Transit networks often operate through related parties within a network who share an ethnic or linguistic connection. The breakdown of trust is a frequent challenge and a source of loss for *grossistes*, many of whom are individual women operating their small businesses in local or urban markets.

I. RETAIL

At the retail stage, beans are sold in several forms, including:

- **Individual (mostly female) vendors in the local or urban market**. Women often rent a stall from a *grossiste* and sell their wares, returning the inventory in the evening. Some *grossistes* also play the role of retailer in the market.
- **NGOs and relief groups**. These bulk buyers deal directly with *grossistes* and even cooperatives to source product.
- **Supermarket**. Beans are sold at a premium of up to 100 percent in urban supermarkets.

Prices and quality vary considerably in the different retail outlets, due mainly to transport constraints and established market relationship patterns.

Table 11. Performance of the Bean Value Chain against USAID Objectives

Criteria	Rating	Justification
Generating inclusive growth	High	As a staple product, beans provide subsistence and basic employment to millions of households. In addition, there are thousands of poor bean wholesalers and retailers, and hundreds of laborers employed in the supply chain.
Food security improved	High	Beans are a staple crop and a traditionally consumed food with a high protein quantity and quality and nutrient balance. Because beans can be stored up to three years, they are a valuable element of food security.
Conflict-resilient and neutral	Medium	Beans, like many consumable crops, are at risk of theft. However, beans may also be stored for lengths of time in hidden, safe places which can provide resilience to intruders.
Pro-women	High	Women are involved in up to 80 percent of production and commercialization of beans and have a high degree of control over the sector's resources, although this varies among households (ASI, 2014). The conflict situation however is influencing men to increasingly enter the sector and assume the wholesale function because it involves vehicle hire and travel in conflict zones.
Benefits youth	Medium	Beans provide millions of household livelihoods; however, the largely low-skilled nature of jobs is not ideal. Because there is no processing function, there is little opportunity for future, significant value-addition.
Climate-change robust	Medium	Production is more sensitive than storage which is relatively resistant. Adaptive capacity to diseases is low, though overall resilience scores medium.
Synchronization or overlap with existing programs	Medium	Beans are the heavy focus of many NGO interventions due to their role as a staple crop. However, this often leads to market distortion and can result in gains that are unsustainable in the long term.
End market competitiveness	High	The Kivus are highly competitive and the North even exports to neighboring countries. Due to high transport costs, self- and local consumption of bean crops is the most abundant end market. Furthermore, the cultural preference for Kivu beans throughout the DRC (all the way to Kinshasa) is favorable to the growth of the market.

J. POVERTY REDUCTION POTENTIAL

Of the studied value chains, beans represent the greatest potential poverty reduction. This is due to their role as a staple food, the existing infrastructure and tradition of bean farming, as well as the low perishability compared to other products. High storage capability allows beans to be safely hidden from pillagers, and also allows an inventory to be kept to stabilize food availability and incomes. Beans can therefore provide the base for a household or community to emerge from poverty.

Beans have a wide reach in the Kivus for potential poverty reduction. Of the estimated 1.5 million farming households in the region, more than 100,000 of these are commercial bean farmers with many more producing beans for self-consumption.[32] In addition, there are thousands of other households who gain their livelihoods from the supply chain as bean wholesalers, retailers and laborers.

[32] Service National des Statistiques Agricoles (SNSA), L'Agriculture Congolaise en Quelgues Chifres, 2012.

Table 12 shows income scenarios for three bean-farming households, and how beans comprise just one component of diverse revenue streams. This demonstrates how costs and revenues are inextricably linked, and therefore it is difficult to extract the profitability of individual products.

Table 12. Household Income and Profitability Calculations (US $) for Three Bean-Producing Households in the Kivus

Household	Price/kg	Annual bean sales (kg)	Revenue from beans	Other sales (kg)	Avg price/kg from other sales	Revenue from other sales	Annual costs	Income	% income from beans
Masisi, Monoculture and other crops	0.45	3,000	1,350	12,000	0.29	3,480	3,770	1,060	28%
Rutshuru, Pigeon vert, intercropping	0.8	2,500	2,000	6,000	0.29	1,740	2,780	960	53%
Kabaré, Mélange, intercropping	1.03	240	568.	2,260	0.3	678	357	889	25%

Source: ASI, DRC Market Systems Analysis 2013.

K. BENEFIT–COST ANALYSIS OF POTENTIAL INTERVENTIONS

Because beans are already a widespread, integrated component of the Kivu agricultural supply chains and the Kivu diet, the benefit to cost ratio is likely to be the highest for the target commodities. Importantly, there are no known insurmountable obstacles that would make interventions prohibitively costly. Particularly, small interventions in the seed innovation area could have positive, scaled effects. The key leverage points, however, may have to do with solving particular constraints, such as certification gaps (including corruption in the inspection system) which can lower overall seed productivity.

The table below summarizes the main constraints that could be addressed, which represent opportunities for intervention. Certain "deal-breakers"—obstacles that cannot be reasonably overcome in the scope of a project—are also marked.

Table 13. Summary Analysis of Major Constraints

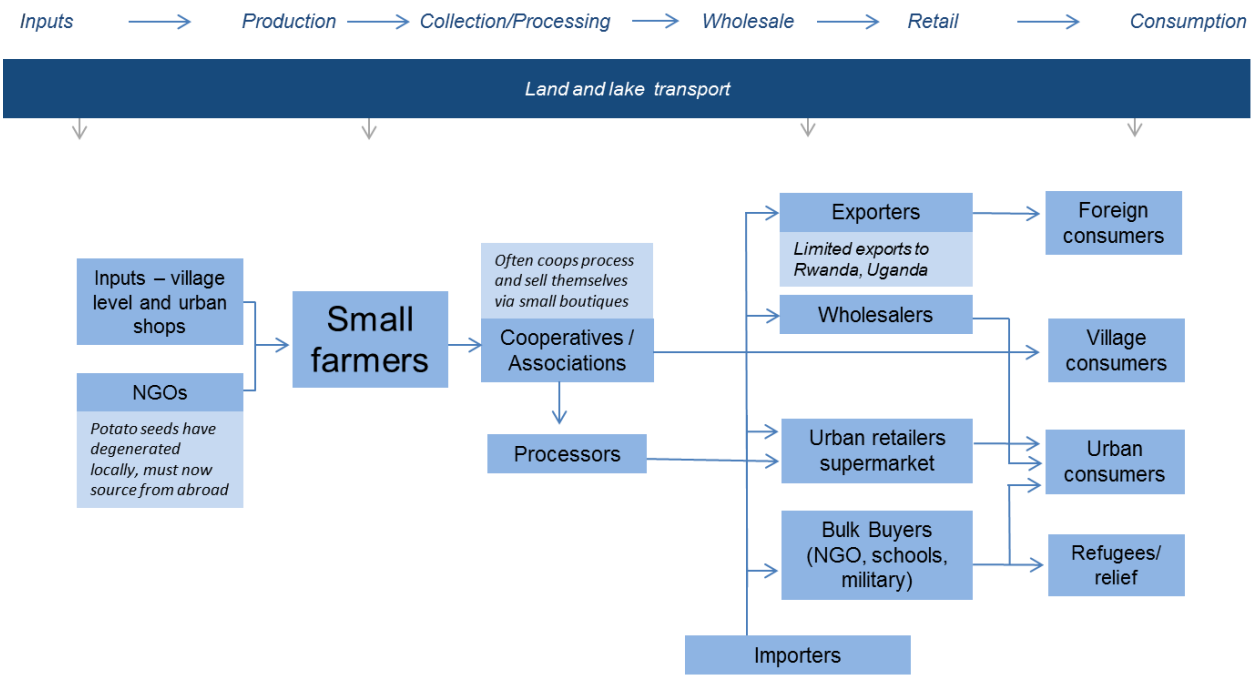
Potential for Overcoming	Description
Medium	Lack of literacy and numeracy
Medium	NGO market distortions
Medium	Price volatility
Medium	Lack of seed certification
Medium	Financial services limited/payment systems risky
Medium	Low crop yields
Medium	Lack of effective storage facilities
Medium	Lack of market information
Low	Overpopulation and land shortage
Low	Compost limited with reduced livestock
Low	High transport costs including risks from banditry and undue taxation*
Low	Lack of enforceable contracts
NA	Dependence on child labor
* Potential deal-breaker	

VI. KIVUS: POTATOES VCA

According to the International Potato Center, potatoes were introduced in the DRC in the late nineteenth century.[33] In one of the last, more reliable estimates from the 1980s, the Kivu Region accounted for 50-85 percent of the country's potato production, of which some 90 percent is concentrated in the North Kivu.[34] Potatoes are still emerging as a staple crop in the South, with considerable growth in production and consumption in the last decade, largely due to NGO intervention. In the North, while potatoes have been a staple for some time, production has declined due to the conflict and ongoing insecurity, and is still recovering to regain its former stature as a staple crop and food.

Potatoes are generally produced in the higher altitude areas in the Kivus: in Beni, Rutshurua, Nyiragongo and Masisis. The common varieties used are Cruza, Montsama, Kinigi, Nseko, Gasore, Mabondo, Gahinga, and Sangema, which tend to be resistant to notable pests and diseases suffered in the region.[35] As with other products, potatoes are produced by small-scale farmers and with a similar market structure to the bean value chain, as depicted below.

Figure 6. Potato Value Chain—North and South Kivu



[33] World Potato Atlas, International Potato Center (Centro Internacional de la Papa or CIP) , Africa - Archive Country Chapters, Congo (DRC), last edited by Hirahoka, Daniel (CIP) on Dec 03, 2008 (view change) show comment

[34] Scott, G. 1988. Potatoes in Central Africa: a Study of Burundi, Rwanda, and Zaire. International Potato Center.

[35] Bandundu, N. nd. Pomme de Terre au Zaire: Reprise de la Selection et Perspectives d'Avenir. Institut National pour l'Étude et Recherche Agronomiques (INERA)

A. COMPETITIVE POSITIONING

North and South Kivu have similar competitive profiles, though the North has an advantage in its proximity to export markets such as Rwanda. The market positioning is likely to evolve further as the potato, traditionally produced and consumed in North Kivu, makes a comeback and begins to be grown in larger quantities in South Kivu.

Table 14. Competitive Position of Potato Products of Various Origins

Origination	Advantages	Barriers to entry (disadvantages)	Markets served (within study)
North Kivu	• Fertile soil, suitable especially at high altitudes • Tradition of potatoes as food staple • "Organic" (non-chemical) production as compared to Rwanda and other competitors	• Conflict raises risk and transport prices • Transport costs high • Low relative yields	• North/South Kivu • Some to Rwanda
South Kivu	• Fertile soil • "Organic" (non-chemical) production • Emerging local taste for potatoes • Chip processing capabilities growing	• Low yields • Poor varieties produced locally which reportedly do not store effectively • Transport/storage issues	• South Kivu only
Rwanda	• Higher yield, lower cost • Varieties keep longer	• Transport necessary, thus higher cost • Use chemical inputs which affects taste	• North/South Kivu • Other regional (na)

B. INPUTS MARKET ASSESSMENT

As was the case with beans and other products, a weak supply of inputs lowers the productivity of potato producers. Several NGOs are currently working to improve the input chain.

The varieties of locally produced potatoes in South Kivu reportedly do not keep as long as the variety that comes from the North. This is a challenge as most consumers and traders do not have facilities to conserve the products. See the cross-cutting inputs market analysis in section IV for general constraints that affect the potato inputs market.

A local village 'boutique' outside Bukavu

C. PRODUCTION ASSESSMENT

Potato is also one of the main products grown in South Kivu, tho ugh considerably less is produced than the staples of beans and cassava as shown in table 15.

Table 15. South Kivu—Main Product Outputs

	Cassava	Beans	Potatoes	Bananas
Number of households	205,468	586,273	44,897	291,593
Area under production (ha)	323,478	116,011	15,790	98,979
Total production (metric tons)	4,077,270	85,585	70,962	455,360

Source: IPAPE 2009

A September 2014 survey of smallholder farmers in North Kivu performed by Texas A&M University found that potatoes were the fourth most commonly produced crop, with 44 percent of households producing potatoes. However, only 7 percent of households sold potatoes as a cash crop, putting it well behind most other crops. See Annex 5: North Kivu Crop Growth.

D. PROCESSING ASSESSMENT

Potato chips were identified as a likely opportunity for processing (during interviews in the South as well as the North). Youth especially have found new employment opportunities in chip processing. As chip processing requires less mechanization than other agro-processing activities, this is a more promising opportunity in the short term. However, chips are not a very nutritious food, and so this does not serve the food security requirements as well as other products.

E. CONSUMPTION ASSESSMENT

Consumption varies between North and South Kivu. In the North, potatoes are more of a traditionally produced and consumed product that in the South. As mentioned above, more that 90 percent of the production was concentrated in the North (according to the last statistically dependable estimate produced in the 1980s). According to a study by the University of Texas-Austin, almost 13 percent of families surveyed in Bukembo, a town in North Kivu with a population of 700,000, consumed potatoes as their primary staple food (while many others consumed as it as a secondary staple).[36]

Potatoes are not a traditional product consumed in South Kivu. In the past, they have been considered "foreigners' food," although tastes are changing somewhat. The intervention and support of NGOs such as ARC Relief in Bukavu have enabled the rapid growth of the market, and potatoes are now becoming a more common consumption item in the South.

Table 16. What Families Eat the Most in Butembo, North Kivu

Food	Percent
Cassava	74.37
Rice	2.37
Beans	6.96
Corn	0.47
Bananas	0.79
Meat	0.47
Potatoes	12.82
Other	1.74
Total	100.0

Note: Sample = 632.

Source: UT Austin, 2014

Processed potatoes in the form of chips have entered the local market. Foreign brands such as Lays imported from the Middle East (2,800 FC per packet) have become aspirational products for local consumers. This

[36] Combating Child Malnutrition in Post-Conflict Zones: Assessing an Intervention in the Democratic Republic of Congo, Kishore Gawande, McCombs School of Business, University of Texas, Austin , September 2014

trend is mostly in the urban cities of Bukavu and Goma, though chips have started to be consumed in rural areas as well.

F. TRADERS AND *GROSSISTES*

The primary current market for potatoes still lies regionally within the Kivus due to transport and conservation costs that make the products uncompetitive in other markets. Should the roads, the durability of the potatoes varieties, or storage capabilities improve, this may change, but this will not occur in the short term. Trucking companies in partnerships with small-scale wholesalers are responsible for sourcing and supplying urban markets. Constraints include the following:

Chips imported from the Dubai at La Beaute supermarket in Bukavu

- **Poor storage.** Inventory management is a challenge as potatoes are now mainly used as a cash crop and commercialization is at a higher rate than for other products. ARC Relief is one NGO that is working to improve the potato value chain. It manages a social enterprise which operates a depot in Bukavu and sources potatoes from cooperative potato farmers.
- **Lack of contracts and contract literacy**. As potatoes enjoy a higher degree of commercialization and an opportunity for households to increase incomes, the capacity to manage production becomes more important. There is little capacity at the farm or cooperative level at the moment to understand and manage contract farming.
- **High transport costs and risks make products uncompetitive in terms of price.** DFID's ELAN project recently performed a market study of potato prices and found that potatoes transported to Kinshasa from the Kivus would retail at 10-15 times the local price in North or South Kivu.[37]

G. END MARKET ANALYSIS

The analysis is broken down into various end-market segments, and competitiveness ratings for both the North and the South are shown in table 17 below. Emerging trends are identified as well.

While the North and South share the advantages of fertile soil and "organic" production methods, the markets have evolved differently and thus have different competitive profiles. Potatoes are a product that is traditionally consumed and sold commercially in the North, partly due to the advantage in its proximity to export markets such as Rwanda. In the South, potatoes are less of a historical staple, though NGOs are increasingly introducing the product over the last years and they are emerging as a staple of the South Kivu diet as well. The market positioning is likely to evolve further as the potato is a relatively newly consumed product in the Kivus, and as the potential for processing develops. Potato chips are also an emerging product area which is being demanded mostly in urban areas, with most consumption met through imports currently.

[37] Kivu Analysis & Strategic Direction Document, ELAN 2014

Table 17. End-Market Analysis for Potatoes—North and South Kivus

North Kivu					South Kivu				
Self-consumption	Local market	Urban market (Goma)	Kinshasa	Uganda Rwanda Bukavu	Self-consumption	Local market	Urban market (Bukavu)	Kinshasa	Uganda, Rwanda
Medium Making resurgence as local staple	*Strong* Transport less of an issue	*Strong* Existing & growing market	*Weak* Small, existing market despite transport costs	*Strong* Existing & growing market	*Medium* Not traditional food but emerging	*Strong* Transport less of an issue	*Medium* Competing with North/ imports	*None* Small volumes produced	*Weak* Hard to compete with imports from North Kivu and Rwanda

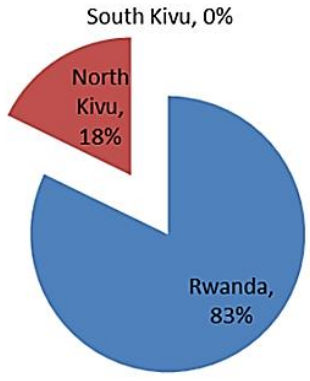
- **North/South Kivu self-consumption and local village markets**. **Ratings: North Kivu: MEDIUM, South Kivu: MEDIUM**. The potato is not a traditionally consumed product by the lower-income populations in the South. Mostly introduced by NGOs, potatoes were traditionally perceived as a food for rich people or for foreigners. However, this is said to be changing, therefore there maybe be a future growing opportunity. As mentioned above, potatoes are more often consumed in households in North Kivu.

- **National market (Kinshasa)**. **Ratings: North Kivu: WEAK, South Kivu: NONE**. Due to high transport costs, potatoes from the Kivus are not currently sold in Kinshasa. In the past, cargo planes carried potatoes from North Kivu to Kinshasa, but as these routes have become unprofitable for carriers (due to taxes and other risks), these routes are not currently available. If the air routes opened up for some reason, potatoes from the Kivus could be shipped to Kinshasa competitively. Potatoes in Kinshasa are generally sourced from abroad (South Africa) or from other parts of the DRC, which like other products are sourced in volume. Packaging challenges also hurt the Kivus as foreign competitors have scaled access to materials and packaging facilities.

- **Urban provincial markets (Bukavu)**. **Ratings: North Kivu: STRONG, South Kivu: MEDIUM.** As reflected in figure 7 based on 2010 data, there was no reported potato production in South Kivu which was consumed in Bukavu (though there was some self-consumption at the household level) as it was imported either from the North or from Rwanda. However, it should be noted that potato production has likely increased with NGO intervention since this data was collected.

- **Urban provincial markets (Goma)**. **Ratings: North Kivu: STRONG, South Kivu: NONE.** Potato consumption in the North derives from local production as well as imports from close by in Rwanda. With improved transport systems and yields, North Kivu production has the potential to grow as there is consistently increasing demand. In the meantime, imports from Rwanda fill

Figure 7. Sources of Potatoes Consumed in Bukavu



Source: Primary research collected for doctoral dissertation, Dr. Stany Vwima, 2014. Data collected in 2010.

the necessary gap to supply the market. As in the South, potato production in the North has likely increased with NGO intervention since 2010, though possibly on a larger scale, since the production base was already in place historically. From one account given by a Catholic Relief Services (CRS) representative, potatoes from North Kivu at the Goma market retail for US $500/ton, considerably higher than the US $300/ton for the Rwandan origin potatoes. Inland transport costs account for difference; in addition, traders also report that the Rwandan variety is superior.

- **Export/cross-border trade markets Ratings: North Kivu: STRONG, South Kivu: NONE**. There is an existing and growing market from North Kivu to Rwanda. (Low production, inadequate storage and high transport costs make any shipment from South Kivu uncompetitive.) With continuing peace and improved roads, this could grow even more. Despite the fact that production costs are higher for the North Kivu product, high demand means that there is still a growing market that the North Kivu potato producer can supply.

Table 18. Performance of the Potato Value Chain against USAID Objectives

Criteria	Rating	Justification
Generating inclusive growth	High	Overall, the potato offers a growing market opportunity for small farmer production and commercialization as well as increased home consumption, as tastes are changing locally and the potato is becoming more of a staple food. Recent NGO programs have succeeded in growing farmer incomes, though additional work needs to be done to overcome constraints in the supply chain.
Food security improved	Medium	The potato is increasingly a staple food, although its overall nutrient value is not as high as other products considered, such as soy or beans. Its increased capacity to be stored versus more perishable horticulture products for instance adds to its value as a secure food, particularly in light of challenges related to the conflict environment.
Conflict resilient and neutral	Medium	Potatoes present a risk in the conflict environment as they are easily taken and consumed by militia and thieves and thus a potential target. However, their storage capacity may allow them to be kept more safely than perishable items.
Pro-women	High	Women play a key role in the production, sale and trading of potatoes. Increased commercialization presents increased opportunities for women to obtain income and to feed their households.
Benefits youth	High	Youth have expressed special interest in assisting with the development of the processing of potatoes to make chips. This offers new value-added opportunities.
Climate-change robust	High	High tolerance to weather, pests and disease overall and low perishability.
Synchronization or overlap with existing programs	Medium	Several other NGO programs area already involved in supporting the potato value chain including ARC Relief.
End market competitiveness	High	With fertile soils and favorable altitude conditions, the Kivu-produced potatoes are relatively competitive, especially on the local market. If certain varieties and transit constraints are overcome, there is an increased national and export market that could be pursued.
Benefit/cost	Medium	Many potential leverage points of intervention and a widespread potential impact without any substantial deal-breaking obstacles.

H. POVERTY REDUCTION POTENTIAL

On the whole, potatoes offer a significant opportunity to raise income for farming households to help them to emerge out of poverty.

UPDI calculated a producer's profit at 120 CF per kilogram of potatoes out of a total retail price of 400 CF, which amounts to a 30 percent margin. This margin varies, however, and can be lower if sold through an intermediary, and higher if sold directly to the end market (e.g., by taking the product directly into the city market). ARC Relief is working with potato farmers to help them plan and calculate their business costs in order to maximize returns in the future.

Though hard to estimate, overall yield is said to be decreasing due to soil degradation and poor farming practices. Inter-cropping and rotating crops is one method that NGOs are undertaking to alleviate this.

Potato chips can retail for 1,200 CF for a portion made from 1 kg of potatoes. This does not include other input costs (oil, labor, etc.) but gives an estimation of the total potential value that can be created using the potato as a base.

I. BENEFIT–COST ANALYSIS OF POTENTIAL INTERVENTIONS

There are many potential leverage points of intervention and a widespread potential impact without any substantial deal-breaking obstacles. Table 19 summarizes the main constraints that could be addressed, which represent opportunities for intervention. There are some potential low-hanging fruits in terms of improving inputs and upgrading storage facilities.

In assessing potential benefit to cost for potato interventions, it will be important to consider the other NGO programs such as ARC Relief and Asili that are working with the commodity to make sure efforts are complementary. The potato in particular has been a focus of the NGO sector; in the South, this is the main reason that this commodity has even become a staple of the diet. Another consideration is that some of the successful potato interventions (such as Asili) may be good candidates for replicating and scaling to other communities.

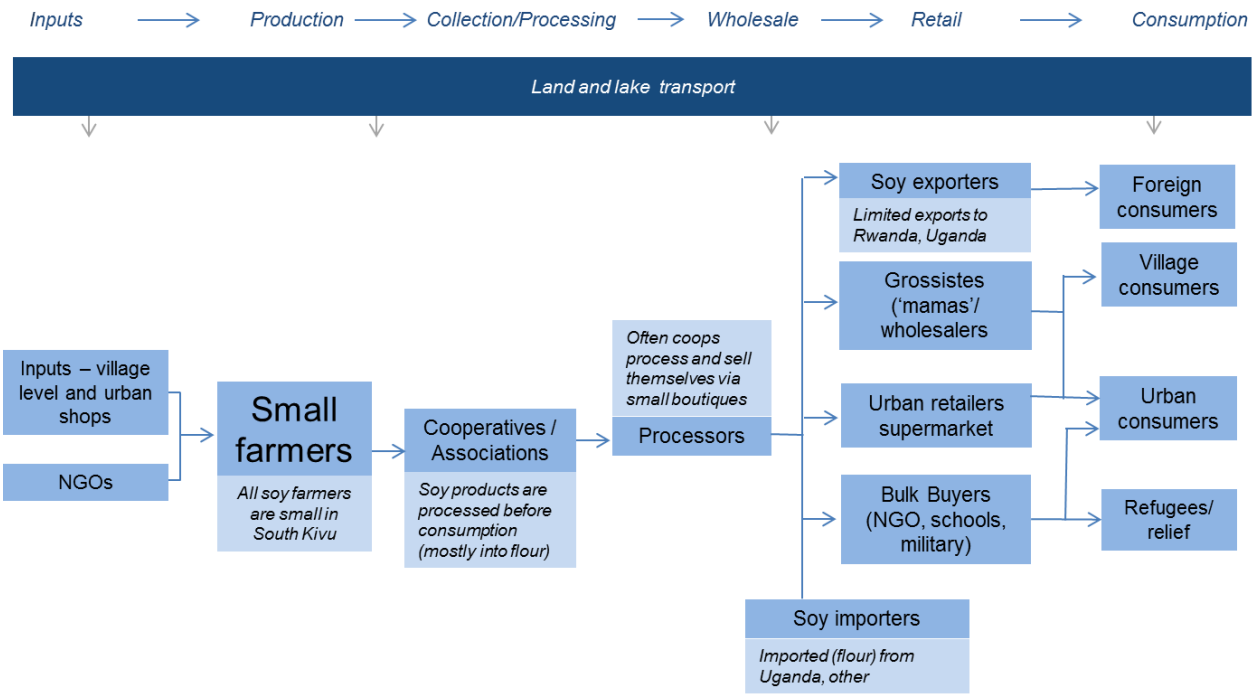
Table 19. Summary Analysis of Major Constraints

Potential for overcoming	Description
Medium	Weak potato seed varieties
Medium	Lack of inputs such as fertilizers and phyto-sanitary products
Medium/High	Poor storage
Medium	Lack of tradition as a staple food in the South
Medium	Lack of contracts and contract literacy
Low	Low relative nutritional content as compared to beans and soy
Low	High transport costs
Low	Risks due to insecurity and conflict
Low	Unpredictable taxation and road-stop payments

VII. KIVUS: SOY BEANS VCA

Soy presents a unique opportunity as an emerging, highly nutritious food and income source which is also relatively conflict-resistant. Unlike other parts of the DRC, where soy is mainly used as animal feed and is not widely produced, soy is consumed by the rural and urban consumers alike in the Kivus.

Figure 8. Soy Value Chain—South Kivu



In the DRC, soybean cultivation has expanded as a result of its nutritive and economic importance and diverse usage in the household, which includes various end products such as soy flour, oil, soymilk and even soy "meat" (such as tofu). Other products derived include infant food and spices. Soy-based protein-fortified flour has been an important raw material for many small and medium enterprises. Soy beans can also consumed roasted, or else be used for production of concentrated milk or "Masoso" products for the treatment of malnourished children.

Soy product to treat malnourishment

A. COMPETITIVE POSITIONING

Competition for soy products comes mainly in the form of other staple products such as beans or maize which may vie for planting space. Imports from Uganda and Rwanda also challenge the local products and may even be lower priced due to higher crop yields, high volumes, and wider availability of packaging.

Higher-end products such as tofu compete with imports from Europe. One frozen tofu product imported from Germany was offered at a local restaurant in Bukavu; however, the cold chain required to ship this product would make the price unattainable for the average consumer.

Table 20. Competitive Position of Soy Products of Various Origins

Origination	Advantages	Barriers to expansion (disadvantages)	Markets served (within study)
North/South Kivu	• Price and quality, fertile soil • Proximity	• Lack of processing capacity • Emerging but still small demand for soy in the DRC • New products need to be introduced	• Village and urban
Imports (Europe)	• Consistent volumes	• Frozen cargo requires cold chain • High costs for general population	• Urban (Bukavu observed)

B. END MARKET ANALYSIS

The current and possible expansion opportunities vary greatly among target markets, particularly due to soy's emerging status as a staple food, which is relatively unknown outside the Kivus.

- **Home and village consumption**. While soy provides a solid base for a household's protein consumption, home-consumption of soy is at lower levels than other staple products such as cassava or beans. Sale within the local village market was the most common end market due to proximity. Soy processing, however, depends on the capacity and functioning of flour mills which are known to be inconsistent.

- **Urban Kivu markets**. Urban markets include 1) the sale of soy flour (and to a lesser degree other products) at the local central market; 2) on the shelf at the retail supermarkets such as La Beauté in Bukavu, or 3) via bulk buyers (*"grandes maisons"*) such as schools, the military, hotels and restaurants, 4) larger-scale soy processors such as Olame in Bukavu; and lastly 5) humanitarian relief efforts undertaken by NGOs.

Soy flour at La Beaute in Bukavu

- **Kinshasa and other national markets**. There is virtually no market and little perceived opportunity for growth for Kivu's soy products outside of the region. While in Kivu soy is emerging as a core staple food, in other regions it is used as animal feed and has a much lower value. If tastes change, or additional value-added products such as tofu emerge, a national opportunity may arise.

- **Export markets.** In South Kivu, some farmers are currently exporting small amounts of soybean to neighboring countries such as Rwanda and Uganda.[38] This may be largely due to the close cross-border trade between Rwanda and Goma or from the South via the river-way. However, high transport costs and risk may render the products from Kivu uncompetitive in the short term.

[38] Bintu, 2013.

Table 21. Soy End-Market Analysis

Self-consumption	Local market/ relief NGOs	Urban markets (Goma/ Bukavu)	Kinshasa	Uganda, Rwanda, Bukavu
Medium Some consumed at home, providing good nutrition	Medium Flour form mostly now	*High* Growing current sales, more opportunity, little competition. Tastes emerging.	*Low* Not developed yet, but possibly competitive	*Medium* Emerging competitiveness though limited exports to date

C. INPUTS

Like other crops in the Kivus, soy production suffers from a lack of optimized seeds, fertilizer and phyto-sanitary products. The lack of access to chemical fertilizers has motivated farmers to develop inter-cropping methods to optimize production. One cooperative found bananas to be an effective inter-crop, but with the recent decimation of the banana product due to the wilt bacteria, farmers now have to seek out alternative production enhancement means.

Donors are active in improving soybean production in the Kivus through the introduction and trial of inputs. For instance, the N2Africa project, supported by the Bill & Melinda Gates Foundation and the Howard G. Buffett Foundation, worked in both North and South Kivu in 2013 to deploy improved soybean varieties, integrate soy into existing rotational or intercropping arrangements and introduce Rhizobium inoculants (a form of bacteria that helps nitrogen fixation to increase yields and soil benefits). In South Kivu, soybean production was enhanced by over 500 kg per hectare after application of Rhizobium.[39]

D. PRODUCTION

Soybeans are being produced by small farmers across the Kivus, for household consumption and for sale into markets. Soybean production in the DRC is affected by low soil fertility, poor agricultural practices, and lack of improved seed and extension services, which lead to yields estimated at 483 kg per hectare (FAOSTAT, 2010). This is very low when compared to other countries with the same agro-ecological conditions: Rwanda and Uganda have yields of 790kg and 1,113kg per hectare respectively.[40]

E. PROCESSING

Soy is one product that must be processed before being consumed, using mills to process the soy into flour. NGOs have assisted cooperatives in financing such mills. Further processing into more value-added products

[39] Enhancing legume productivity in Eastern DR Congo with N2Africa technologies. Research highlight 2013 - Central Africa, Research highlights 2013

[40] Bintu Nabintu Ndusha, University of Nairobi, 2013.

such as soy milk, beignets or even tofu has been introduced, and these products have the potential to grow into a wider market. There are a number of constraints in the area of soybean processing:

- **Lack of power**. Operating a mill to process soy requires electricity which is inconsistently available. Soy product can sit and accumulate waiting for the power source to re-initiate, causing inconsistent volumes and the need for prolonged interim storage.
- **High capital investment and maintenance necessary**. Soy processing at the village level generally requires an operational mill, which in the case of the Kivus has often been supplied through NGO and donor support. Larger processors such as Olame in Bukavu have depended on multiple large charitable donations to supply their processing machines as well as a generator. Still, even maintenance of these machines is a challenge with tools and technicians in limited supply.
- **Lack of access to new technology.** Soy processors and potential processors lack access to new technology as their equipment and their processes are outdated, or often non-functioning due to a lack of power or other disruption. A large fire recently put Olame, the soy processor in Bukavu, out of operation for more than a year.
- **Packaging is a challenge**. The local processor serving Bukavu (Olame) must import bags from Uganda to package soy flour for sale. This can cost upwards of 10-20 percent of the total sale cost.

Idle processing machine during a power outage

Olame operations still recovering from fire

F. CONSUMPTION ASSESSMENT

Soy products are provided to the retail consumer in several forms and through several channels. *Grossistes* in the city markets and local markets offer soy in flour form for consumption; typically the local population consumes soy as a substitute for dairy in tea, or cooks the flour with other ingredients such as maize into a mixed cake. Relief groups purchase soy in bulk in forms such as "Masoso," a soy-based product which is used to treat malnourishment. Although soy is not widely known outside the Kivus, its popularity is growing and a taste seems to be developing for soy products. NGOs, perhaps influenced by soy's reputation as a health food in the developed world, are also contributing to the emergence of soy.

G. TRADERS (*GROSSISTES*, IMPORTERS/EXPORTERS)

Soy is traded by a variety of actors depending on the end market, ranging from "mamas" who distribute to retailers in the local or urban markets, to big box urban retailers and exporters. Importers also bring products from abroad. As in other value chains, traders take the bulk of the transport risk, which can be debilitating when delivering staple items which require consistency in delivery methods. One of the greatest costs in the value chain can be the packaging. There is no local supply of professional-grade materials, so packaging has to be imported which can be prohibitively costly and at times is unavailable.

H. RETAIL

Retail urban supermarkets such as 'La Beauté' in Bukavu have a markup up of 140 percent from the street-market wholesalers for the flour product. This is partly due to the packaging of the product, which must be imported (from Uganda in this case).

Table 22. Price (Value-add) per kg

Farmers	$0.45
Proces-sors	$0.95 (+$0.50)
Traders	varies
Retailers	$2.70 ($1.85) Supermarkets $1.10 ($0.15) Mamas at city market

In addition to supplying highly subsidized or free equipment and other inputs, relief efforts are also one of the major end consumers of the processed products; however, these relief efforts are not (hopefully) intended to be long-term customers, and therefore may create a business dependence that will hurt soy product marketers in the future.

Table 23. Performance of the Soy Value Chain against USAID Objectives

Criteria	Rating	Justification
Generating inclusive growth	High	Soy is an emerging product increasingly demanded by local consumers which can bring increased incomes to small farmers. Flour processing is enabled through cooperatives, which provides increased value-added.
Food security improved	High	Soy has the highest protein and protein quality scores of any non-meat product available, with a high protein content of 40 percent and high output of vegetable oil. Its relative low cost makes it a promising opportunity to increase food security and is used as a low-cost alternative to dairy products in the Kivus (as the conflict has reduced dairy production drastically).
Conflict-resilient and neutral	High	Because soy has to be processed, it is relatively conflict resistant as the militias prefer to take immediately consumable items. Soy may also be stored safely.
Pro-women	High	Women play a core role in the production, sale and processing of soy. One entrepreneur in Bukavu is successfully producing and marketing processed soy milk and training other women to process soy as well. Other potential soy products include tofu and soy beignets.
Benefits youth	Medium	Although no notable advantages from other products, soy as an emerging base for new products offers increased commercialization and marketing opportunities for new entrepreneurs.
Climate-change robust	High	Soybean can improve soil fertility by capturing nitrogen from the atmosphere, which is a major benefit in South Kivu, where soils have become exhausted by the needs of the increasing population.[41] In addition, this soil renourishment is important as fertilizers are seldom available and too expensive for farmers (IITA, 2009).
Synchronization or overlap with existing programs	Medium	NGOs are active in the soy sector, notably in the support of several processing facilities, as well as in the consumption of soy – Masoso, which contains soy flour as a main ingredient, is a product largely purchased for relief efforts targeting malnourished children.

[41] Effectiveness of Rhizobia Strains Isolated From South Kivu Soils on Growth of Soybeans., Bintu Nabintu Ndusha, Department of Land Resource Management and Agricultural Technology (Larmat), Faculty of Agriculture, University of Nairobi, 2013.

End market competitiveness	High	The local market in the Kivus is growing and is a significant opportunity for local farmers. As an emerging product, soy from the Kivus is yet unproven in regional or export markets. Notably, in other parts of the DRC, soy is not a typical product for human consumption; in Katanga for instance, soy is used mainly for animal feed.
Benefit/cost	Medium	The high potential for nutrition benefits and financially feasible interventions possible for processing operations make soy a viable product to consider.

I. POVERTY REDUCTION POTENTIAL

Soy beans are an emerging staple in North and South Kivu. Though largely introduced by NGOs to treat malnutrition, soy products have become a local favorite for daily consumption, whether as a substitute for dairy in tea or as a protein bases in "la bouie," which is a roasted porridge-type foods made from corn meal, wheat meal, and soybean meal that had been roasted.

Several factors contribute to profitability, which can vary greatly in the context of both North and South Kivu including availability, cost and quality of inputs, and access to power. Since soy must be processed, it requires this extra level of cost which may be prohibitive in some cases. However, this can also be a positive as soy in flour form is easier to keep hidden safely and easier to store than more perishable items such as horticultural products.

According to Texas A&M's recent ConDev study, revenue from soy for an average farm in North Kivu was about twice as high or more than that of beans or potatoes: for households whose primary product was soybean, total season income averaged at US $125 in the high season and US $91 in the low season, whereas beans reaped US $65 and US $46; and potatoes, US $45 and US $34. Note that this does not account for size of property but does indicate a higher tendency to scale at the commercial level. See Annex 5: North Kivu Crop Growth for more details.

J. BENEFIT–COST ANALYSIS OF POTENTIAL INTERVENTIONS

Table 24 summarizes the main constraints, which represent opportunities for intervention.

Table 24. Summary Analysis of Major Constraints

Potential for overcoming	Description
High	Still an emerging product in the local diet and as a commercial commodity; many further applications to explore
Medium	Pests (and lack of access to solutions such as bananas for inter-cropping)
Medium	Low reported yields due to poor agricultural practices
Medium	Lack of access to new technology
Medium	Packaging unavailable and/or costly
Medium	Lack of marketing capacity and understanding
Low	Transport risk
Low	Lack of power needed for processing
Low	Lack of access to capital for equipment and maintenance
Medium	NGO market distortion; particularly an issue as soy originated as a relief item to treat malnutrition

VIII. KIVUS: HORTICULTURE VCA

Horticulture is an important part of the production from the Kivus, both for subsistence and commercialization. This category is defined as the more perishable and delicate agricultural products mainly including tomatoes, cabbage or carrots and the somewhat less perishable onion. (Though some definitions of horticulture include the potato and the bean, such as in the Adam Smith International 2014 assessment, these less perishable items are treated separately in this assessment).

Horticulture products are traded by specialized traders or brought to the city market by farmers themselves.

A. END MARKET ANALYSIS

In addition to the ever-present local markets and the nutritious benefits to the household diet via home-consumption, there is a growing wider demand for horticulture products both in urban areas (which are expanding) and from commercial mining enterprises in certain areas. However, in general the Kivu region's competitiveness in terms of both quality and price is challenged by the poor quality of seeds, lack of inputs which limits yields, and limited transport and conservation infrastructure.

Table 25. Competitive Position of Horticulture Products of Various Origins

Origination	Advantages	Barriers to growth (disadvantages)	Markets served (within study)
North/South Kivu	• Fertile soil	• Transport, cold chain • Low yields due to poor inputs	• Village and urban
Imports (Rwanda, Uganda, Europe)	• Consistent volumes • Consistent quality and packaging • Varieties keep better	• Limited urban, high end (hotels) market • Too high costs for general population • Cargo requires cold chain	• Urban (Bukavu/Goma) • National (Kinshasa)

While the Kivus used to be a major provider of horticulture products to urban and regional markets alike, the conflicts and declined roads and other transport infrastructure have limited production and delivery. Self-consumption and village-level sales remain the highest end markets, with local urban markets being a supporting, though difficult market for Kivu farmers to serve.

Table 26. Horticulture End-Market Analysis

Self-consumption	Local market	Urban market (Goma/ Bukavu)	Kinshasa	Uganda, Rwanda, Bukavu
Strong Core nutritious food, no competition (due to conservation)	*Strong* *Core* nutritious *food*, no competition (due conservation)	*Medium* High demand, conservation/transport challenge, competition from Rwanda	*None* Not competitive with imports and closer markets	*Weak* Not competitive price or quality-wise (small market to Rwanda via Goma)

- **Home consumption and local markets. Ratings: North Kivu: STRONG, South Kivu: STRONG.** Horticulture products are consumed in quantity within the household and sold on the local markets. This is the most competitive market due to the high cost and risk of transporting and/or conserving these perishable products. They are also a strong form of nutrition and diversification of diet.

A grossiste waiting to distribute her tomatoes in a rented depot near the Bukavu market

- **Urban markets (Bukavu/Goma**). **Ratings: North Kivu: MEDIUM, South Kivu: MEDIUM**. Also a strong market, the relative proximity of provincial urban markets is the driving factor for local horticultural products' competitiveness. However, farmers who are cut off, for instance because a road is washed away, can become suddenly cut off from their market. Many farmers carry their horticulture products on foot to the nearest urban areas, walking hours in each direction, to sell their products. These individuals are at a disadvantage as most buyers know that they must sell their products by the end of the day. However, strong demand and the preference for local products keeps this a competitive opportunity; consumers often favor the local varieties out of both tradition and also because they are produced organically, versus Rwandan products which are made with pesticides.

- **National markets (e.g., Kinshasa). Ratings: North Kivu: NONE, South Kivu: NONE**. In the past, the Kivus provided horticultural products to Kinshasa with centers of production in the North (in Beni and Lubero). However since the conflicts of the last decades, the market route virtually no longer exists aside from some specialty items.[42] Other parts of the DRC now supply the national markets—for instance, tomatoes and onions from Bas-Congo and other nearby regions now supply the Kinshasa market. Even these can barely compete with imports, which are brought in from markets as far away as Holland, Belgium and even China; these foreign competitors produce at scale and at such a higher rate of efficiency that they supply most of the produce both to the urban street markets and to the higher-end retail supermarkets.

Onions in the Kinshasa market: loose local product and imported from Holland

- **Export markets**. **Ratings: North Kivu: WEAK, South Kivu: NONE**. In the future, there could be opportunities to export to Rwanda and Uganda which would need to be assessed. Trade currently operates at a small scale across the border with the close-by Rwanda provinces.

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[42] PNSAR, 1998a: Monographie de la province du Nord-Kivu. PNUD/UNOPS Programme national de relance du secteur agricole et rural (PNSAR) 1997-2001.

B. PRODUCTION ASSESSMENT

Tomatoes, onions, cabbage and carrots are among the primary horticultural products planted. Many farmers' also inter-crop these items with other staples to obtain a diversified diet and also to generate a higher income level. Challenges faced include:

- **Poor seeds**. The varieties produced are often not the strongest, or those most demanded by consumers.
- **Lack of fertilizers**. Particularly with delicate farming commodities, support of growth would help to control the maturing and harvesting of the crops.
- **No electricity for conservation**. Conservation is a challenge for perishables as there is no electricity; this forces farmers to either consume the products within a short timeframe or to sell them right away.
- **Vulnerable to damaging weather**. Heavy rains which often occur in the Kivus particularly harm more delicate crops.
- **At risk of theft.** Horticultural items are the most at risk to theft from militia and others as they are typically ready to consume. One farmer reported that pillagers had marked on his field "do not harvest, or you will die," and then the intruders proceeded to harvest their crops to consume for themselves.

C. PROCESSING ASSESSMENT

No processing enterprises were observed to operate due to lack of capital for equipment, a lack of power and a general lack of economic incentives to invest, start up and maintain these activities.

D. TRANSPORT AND HANDLING

Horticulture is marketed by traders, often women, who may specialize in certain products. Many farmers hand-carry products to the urban markets themselves to sell for the day, often walking hours each way.

The deterioration of transport infrastructure makes market access difficult, particularly for perishable items. In a study from January 2015 of various Kinshasa markets, tomato vendors were found to lose 11 percent of their purchases, ranging from 1 percent to 67 percent. In terms of monetary value, these losses represent an average of about US $5, ranging from US $0.30 to US $25. According to the vendors, poor preservation and handling during transport are the main reasons for the losses incurred.[43]

Because of the perishable nature of horticulture products, traders must sell the products very quickly. If a trader (or the farmer themselves) carries the product into the city for the day, they expect to sell all they bring by the end of the day or suffer losses. Unfortunately, this leads them to sell at very low prices to avoid carrying the products back. Buyers who know this often wait until the end of the day to make purchases when they know the sellers must sell or lose earnings altogether.

[43] Adam Smith International, 8 January, 2015.

Table 27. Performance of the Horticulture Value Chain against USAID Objectives

Criteria	Rating	Justification
Generating inclusive growth	High	Horticulture products are widely and successfully grown at a small-scale level due to the fertile soil and appropriate climate. Improving this sector present great opportunity to improve incomes of the poorest of farmers.
Food security improved	High	High in nutritive factors and widely available, these products score high in food security.
Conflict-resilient and neutral	Medium	Horticulture products are generally easy to spot and consumable on the spot, which makes them exposed to threats from militia and thieves.
Pro-women	High	Women are core actors in the production and trading of these products. Their high value-added offers opportunities for increasing women's incomes.
Benefits youth	High	Higher value-added processing opportunities could benefit youth with new job opportunities.
Climate-change robust	Medium	High perishability and low tolerance to climate stress, but medium degree of adaptability observed.
Synchronization or overlap with existing programs	Medium	NGOs are currently active including FAO, IFDC on seeds, etc. Coordination is essential.
End market competitiveness	Medium	The quality of the Kivu products and their organic nature present a competitive opportunity to substitute for imported products. Consistency and transport issues, however, must be addressed.
Benefit/cost	Medium	Though a greater risk profile than other commodity groups, horticulture products have widespread impact potential for income growth and diversification and nutritional balance.

E. POVERTY REDUCTION POTENTIAL

Like other products, horticultural commodities can vary greatly in terms of profitability if factors change, such as greater insecurity, weather abnormalities, or demand shifts. However, because of their perishable nature, horticultural products present an even greater income risk. The higher potential revenue from these products (for instance, tomatoes in a small harvest in North Kivu reaped $104 on average versus $34 for potato and $46 for beans) can sometimes make up for the risk, but this is still largely unpredictable.

Planting horticultural products along with less perishable and easier to transport products such as bean is one way to diversify and maximize long-term revenue and profitability. In the longer term, there is the potential to explore processing or other value-added opportunities, though none were observed at present. Efforts to can for instance could also have positive effects on the length and quality of storage capabilities.

Also of prime importance is horticultural products' contribution to a balanced diet. Paired with staples such as beans, tomatoes, onions and carrots for instance provide essential nutrients. And a healthy consumption pattern is a core benefit and indicator of a reduction in poverty and the general progress of human development in the region.

Interventions focused on horticulture stand to reduce poverty considerably, though potentially "deal-breaking" obstacles may exist.

F. BENEFIT–COST ANALYSIS OF POTENTIAL INTERVENTIONS

Although having a greater risk profile than other commodity groups, horticulture products have widespread impact potential for income growth and diversification and nutritional balance. Most farming households that plant beans, soy or maize as their core product will also produce a variety of horticulture items. There is also opportunity for seed upgrading and the introduction of improved varieties, as well as an improvement in agricultural practices that would require a feasible amount of investment.

Modest adjustments to business planning could also reduce the higher risk associated with transport and handling for perishables as compared to other commodities. Relatedly, there are some potential demand opportunities (such as the UN Monusco supermarket) that could be explored and facilitated, as a lack of client services and experience with marketing is hindering local producers and associations in establishing such potentially lucrative sales relationships.

Table 28 summarizes the main constraints to horticultural development in the Kivus.

Table 28. Summary Analysis of Major Constraints

Potential for overcoming	Bottleneck description
Medium	Vulnerable to damaging weather
Medium	Lack of storage
Medium	Weak pricing power for small retailers
Medium	Poor seeds
Medium	Lack of fertilizers
Medium	No electricity for conservation
Medium	Lack of marketing capacity/client service (non-dependable supply as well)
Low	Perilous transport and handling
Low	Risk of theft

IX. KIVUS: SMALL LIVESTOCK VCA

The livestock population in the Kivus has suffered gravely from the insecurities and wars that have prevailed since 1993. During the period of the war in South Kivu, a large part of the large and small livestock population disappeared. As shown in table 29, except for cattle, the livestock industry has only recently returned to the level before the wars; and considering the growth in population (of over 200 percent, by some estimates), this amounts to a considerably smaller number of livestock per person.

Table 29. Number of Livestock—South Kivu (in thousands)

	2002*	2008**	2010**
Cows	170	120	236
Pigs	10	20	35
Rabbits	38	38	42
Poultry	247	233	254

Source: *RDC Ministry of Planning: Sud-Kivu, ** RDC Quinquennal Plan for Growth and Employment

NGOS and international relief organizations have contributed to the regeneration of small livestock populations. The breeding of sheep and goats is the most widespread intervention. Pigs are also kept, although they are considered the dirtiest animal by local tradition, and therefore pork is less expensive compared to beef and goat meat.[44] Birds are kept for both meat and eggs.

The larger livestock population is limited. The territories of Kabare, Walungu and Idjwi have only very small numbers of cattle because of the demographic pressure that consumes the entire space. The cattle population is largest in South Kivu in the high plains of Uvira and in the territories of Mwenga and Fizi, where there remains sufficient space for grazing.

A. PRODUCTION AND INPUT CONSTRAINTS

Despite the historical tradition of keeping livestock, the current conditions present several constraints to small livestock providing sustainable incomes or a nutrition source:

- **Land competition with cultivators**. Because of the increase in population in both North and South (but especially South) Kivu, there is increasingly less land available for livestock to graze. Often animals wander into neighbors' land and eat crops, leading to bitter disputes between land-owners.
- **Lack of quality breeding**. There is practically no breeding of small (or large) livestock; thus, the animals that are produced are of degenerated species, which are susceptible to disease or are not an optimized source of food in terms of meat or egg production.

[44] PNSAR, 1998

- **Antiquated livestock feeding methods**. In the Kivus, there is very little knowledge or practice of "modern" breeding or raising methods. While there is a strong cultural tradition of "*elevage*," the methods are not up to date. For instance, livestock are often left to roam freely to search for food in the wild, rather than providing specific feed and stocking inputs for livestock. Because of this lack of planning, livestock for instance, often go for days without food during the dry periods, while food is in abundance in the rainy season.

- **Poor rabbit housing worsens spread of illness.** According to UPDI, there is an epidemic that has been killing rabbits in the past two years. They believe that this is due to a lack of investment in housing for the animals (cages or "*clapiers*"). Because rabbits have a tendency to procreate rapidly, any illness spreads quickly when they are confined, or not contained properly.

Goats kept near the family home

- **Large livestock targets for theft.** Cattle theft reached its highest level during the period of wars and insecurity in all territories in the province from 2004-2008. Cattle were targeted more than other animals, as they are larger and harder to hide from thieves and pillagers. This has discouraged many farmers from even starting to breed more than a small number of cattle. For this reason, it is preferable in the short term to focus on small livestock.

B. END MARKET ANALYSIS

For all of the reasons described above, livestock-raising as a source of income and poverty reduction in the Kivus is largely uncompetitive beyond self-consumption and local village markets.

Of important note is that livestock, both large and small, are not primarily kept for consumption. The slaughtering of livestock for eating is a rare occurrence for special occasions (rabbits being the exception). In general, they are rather a form of savings and of household pride. Animal products contribute only a small portion of caloric intake due to both a lack of access and high prices.

Meat on the urban market (Goma/Bukavu) is largely imported from neighboring countries or brought in from Europe. Consumers in these urban markets are generally hotels, schools or retail supermarkets serving higher-income customers.

Meats for sale in Kinshasa are from Bas-Congo or else imported. In higher-end retail supermarkets, all meat products are imported from either South Africa or Europe. Even at very high prices of US $10-15 per package, local meat cannot compete on price or quality. Meat from the Kivus is far below quality and has a higher cost. One exception is for specialty meats such sausages and beef

Imported meats in Shoprite Kinshasa

which are sold in small quantities at stores such as the "Grocery of Kivu Products" in Kinshasa, which features specialty products of all sorts from the Kivus. Kivu livestock are not competitive as exports to neighboring or other countries.

Table 30. Small Livestock End-Market Analysis—North and South Kivu

Self -consumption	Local market	Urban market (Goma/ Bukavu)	Kinshasa	Uganda, Rwanda, Bukavu
Low Mostly for savings, only rabbits consumed	*Low* Weak consumption	*Low* Most consumption from Rwanda	*Low* Small, specialty shipments	*Low* Most consumption from Rwanda

C. THE DAIRY SECTOR

Before independence there was a strong dairy sector in the Kivus and it is a historical tradition. There are currently just limited production facilities in the South as well as in the North. While these still operate, they are reportedly at much lower volumes of production than in the past.

The fabled *"Laiterie de Bouchie"* assembled milk and exported even to Rwanda. The King of Kabare attempted to re-launch this and even submitted a proposal to the African Development Bank; but although it was accepted, it was turned into a re-integration of soldiers project instead of a dairy development project.

Yogurt produced by convent of nuns outside Bukavu

The King of Kabare's proposal to revive the Laiterie involves:

- Rehabilitating the central milk facility
- Rehabilitating the space for livestock
- Upgrading breeding of livestock
- Building a milk collection system

Because of the historical tradition of dairy production, as well as the existence of some remaining facilities, there may be the possibility to revive the industry. However, this is a high-risk option due to the prevalence of competitive imports, as well as the security risks of investing capital equipment into such as operation.

Table 31. Performance of the Small Livestock Value Chain against USAID Objectives

Criteria	Rating	Justification
Generating inclusive growth	Medium	Small livestock are a source of savings and some income and (to a lesser degree) food for small farmers across the Kivus, and are tended for along with other agricultural production. Their ability to be marketed and commercialized is limited, however, especially in the current conflict circumstance.
Food security improved	Low	In the poor populations of the Kivus, livestock are not generally consumed as meat very often. To some degree, chickens are used for egg production, which is consumed. Livestock are kept primarily as a form of savings (and pride) and eaten on special occasions.

Conflict-resilient and neutral	Obstacle	The cow population was ravaged during the insecurities from 2002-2008, as they were often the first target of thieves and militia. As such, they are not conflict-resistant. Pigs, rabbits and other animals that are kept closer to the home suffer less loss.
Pro-women	High	Tending to small livestock has traditionally been a women's role versus men who cared for cows. Replenishing this industry could provide women additional sources of income and nourishment for the family.
Benefits youth	Medium	To a certain extent, livestock herding and shepherding present employment opportunities for youth. However, additional value-add is hard to develop competitively.
Climate-change robust	Medium	When dealing with weather challenges, pests and diseases, rating varies from high resilience and adaptability for goats, to a medium rating for sheep and low for pigs.
Synchronization or overlap with existing programs	Medium	NGOs have been active in promoting small livestock care and supporting services such as vaccinations, though many efforts have been undermined by the conflict.
End market competitiveness	Low	Small livestock for meat consumption is only significantly competitive for the local market and self-consumption, although this consumption is infrequent. Urban and higher-priced markets generally import meat, and the local stock cannot compete on consistent volume supply, quality or price.
Benefit/cost	Low	The security situation makes intervention in this area highly risky, as potential gains may be decimated overnight by a raid.

D. POVERTY REDUCTION POTENTIAL

Keeping small livestock is an essential element of the management of household income (and savings) and diet. Animals are kept as a form of savings and their products and meat are sold when the household needs additional income. Milk and eggs are produced, with the actual meat only being consumed on special occasions. Large livestock are also held, but are at greater risk of theft. While profitability is difficult to measure, small livestock do provide an important tool for financial diversification and planning.

However, it should be noted that providing assistance in the livestock area for small-scale farmers may not be a good method to achieve poverty reduction as operations are not generally built in such a way that can be scaled and commercialized, and livestock raising typically remains at a small, subsistence level. There are, in fact, several medium-scale commercial operations (such as those that supply to the charcuteries in Goma), but these are few, face their own operational challenges, and would be difficult to replicate.

A consortium formed by the African Union, FAO, the Red Cross and others has created a potentially useful Handbook called the *Livestock Emergency Guidelines and Standards (LEGS)* which recommends ways to design, implement and evaluate livestock interventions to help people affected by humanitarian crises. It is based on the three principles of livelihood objectives: providing rapid assistance, protecting livestock assets, and rebuilding assets in crisis-affected communities. The Handbook recommends interventions and also provides standards, key actions and guidance notes based on good practice. Technical interventions cover the following areas: destocking, veterinary support, feed supplied, water, shelter and settlement and provision of livestock.[45]

[45] Livestock Emergency Guidelines and Standards (LEGS), 2nd edition LEGS Handbook, 2009, www.livestock-emergency.net.

E. BENEFIT–COST ANALYSIS OF POTENTIAL INTERVENTIONS

The security situation makes intervention in this area highly risky. Furthermore, support may not be welcome as households prefer to maintain a low profile and not bolster their livestock holdings. The prevalence of competitively priced and relatively high-quality imports of dairy and other livestock products may make interventions economically unfeasible, as local production may not be able to compete. These factors are potential deal-breakers in deciding to intervene in the livestock sector.

Table 32. Summary Analysis of Major Constraints

Potential for overcoming	Description
Medium	Lack of quality breeding
Medium	Antiquated livestock feeding methods
Medium	Poor rabbit housing worsens spread of illness
Low	Limited land for grazing and competition for space with cultivators
Very low	Large livestock targets for theft*
Very low	Competitive imports*
* Potential deal-breaker	

X. KIVUS: BANANAS VCA

Bananas are one of the traditional staple foods of the Kivus region. However, a recent disease called the wilt bacterial has ravaged the plantations in almost all of North and South Kivu territories, causing significant yield reductions. There are four varieties of banana that are traditionally produced in the Kivus, with some variation between North and South:

- **Sweet bananas** (*banane douce* or *banane à cuire*). These are produced more in the South, but are found in both provinces.
- **Plantains**. Produced more in the North, but also in South, these are a staple food for cooking and eating with beans and rice.
- ***"Banane à bière".*** This variety of banana is used to make an alcoholic beverage, which is produced in both the North and South provinces.
- ***Banane dessert.*** These are the variety most often consumed at breakfast, produced in both the North and South.

While some of these crops are still produced and consumed within the Kivus, the volumes are largely ravaged and many of the products consumed are imported by nearby regional producers.

Table 33. Bananas End-Market Analysis—North and South Kivus

Self-consumption	Local market	Urban market (Goma/ Bukavu)	Kinshasa	Uganda, Rwanda, Bukavu
Medium High demand but wilt bacteria has ravaged	*Medium* High demand but wilt bacteria has ravaged	*Medium* High demand but wilt bacteria has ravaged	*None* Not competitive with imports and closer markets	*None* Not competitive, bacteria eliminates

A. END MARKET ANALYSIS

Reviving the banana industry will require long-term measures to restore production. In addition, global markets are dominated by large-scale banana producers such as Costa Rica or Brazil. Therefore it is not a possibility that the DRC or the Kivus will attain any level of competitiveness beyond possibly small niche markets.

In areas where the banana remains unaffected by the wilt bacteria, it remains a key contributor to nutrition and local trade. However, many areas of the Kivus no longer have this production. NGOs such as CRS and FAO are working to solve this challenge; but until the bacteria issue is overcome, the banana is not a dependable product with which to intervene.

There is still high demand for all four types of bananas in urban markets. However, in the short term, the local product remains uncompetitive with foreign imports from Rwanda. The banana from the Kivus is not competitive in Kinshasa or to export to any regional locations. On top of the transport and general cost challenges, the wilt bacteria has further deteriorated its competitiveness.

Bananas have a complex reproductive process, and it is said that the methods used by farmers in the DRC to breed production results in low multiplication rates, and the vegetative propagation classically practiced by farmers is also more conducive to spreading viral diseases.[46] For this reason, it was highly susceptible to the wilt bacteria which has decimated the sector in the Kivus.

Table 34. Performance of the Banana Value Chain against USAID Objectives

Criteria	Rating	Justification
Generating inclusive growth	High	Widely grown in the past, bananas are a traditional food in the Kivus that grew in abundance and provided additional food and income to poor populations. They were a source of income because they were consistently and widely available, and poor families would sell bunches as needed to replenish household income.
Food security improved	High	The banana's abundance in the Kivus and its wide use in traditional cuisine contributed to food security; however, its susceptibility to disease renders it no longer a strong contributor in this area.
Conflict-resilient and neutral	Low	Unfortunately, bananas are highly visible and immediately consumable and therefore not hidden and safe from pillagers.
Pro-women	Medium	Bananas do not have any particular benefit to women over other products other than to provide an overall source of income and employment.
Benefits youth	Medium	Bananas do not have any particular benefit to youth over other products other than to provide an overall source of income and employment.
Climate-change robust	Low	Low tolerance and high perishability as evidenced by the effects of the wilt bacteria.
Synchronization or overlap with existing programs	Medium	Different NGOs including FAO work in the sector. CRS for one is working on a solution to combat the wilt bacteria.
End market competitiveness	Low	All types heavily affected by bacterial wilt. Dramatic decrease of production.
Benefit/cost	Low	The wilt bacteria would stand in the way of any short-term intervention to work with the banana sector.

B. POVERTY REDUCTION POTENTIAL

Bananas are historically a staple food and income-raising product across the Kivus, being a key ingredient in various forms. In the past, they grew abundantly in the region and could be accessed quite easily. If the wilt bacteria were overcome, then bananas would be a viable candidate for intervention.

C. BENEFIT–COST ANALYSIS OF POTENTIAL INTERVENTIONS

Because the wilt bacteria have decimated the crops and there appears to be no known solution, the cost seems to heavily outweigh any potential benefit of intervention. While there is some talk of measures to overcome the bacteria, such as CRS' proposed solution, most practitioners as well as farmers in the field express

[46] Les Biotechnologies chez le bananier (Musa sp) Editions universitaires europeennes (2015-02-16), r), Kwey Michel Mazinga, Louis Baboy Longanza, Michel Van Koninckxloo.

little hope that this will be effective. (One interviewee explained that the CRS solution involves destroying all the existing crops and re-building, which the interviewee calculated to be economically unviable.)

Table 35. Summary Analysis of Major Constraints

Potential for overcoming	Description
Very low*	Wilt bacteria has decimated the banana sector
Very low	Visible and open to theft /pillage
Medium	Kivu region's banana reproduction practices are weak, leaving it susceptible to diseases such as the wilt bacteria
* Potential deal-breaker	

XI. KIVUS: RECOMMENDATIONS

Interventions in any of the focus value chains in the Kivus will face significant challenges due to the volatile nature of life in the regions. However, there are some areas which could be explored further. Also, there are certain strategies which should be considered when designing a targeted value chain-driven program.

A. INPUTS

There are some potential leverage points that could bring quick wins, as poor inputs or a lack of inputs is a major problem:

- **Work with other partners**. There are many ongoing programs including those undertaken by IFDC, INERA, ARC Relief and others. It is important to integrate learnings and build upon the work they have done.
- **Improve certification**. Improving the certification standards and compliance via improved traceability and accountability at SENASEM could improve bean yields and prevent crises when bean crops fail due to degenerated varieties.
- **Provide training on fertilizers**. Misusing chemical can cause great disruption to harvesting and harm; this could potentially be avoided with simple training.
- **Build market capacity**. There are several existing small distributors of inputs who are currently challenged with being able to source and transport inputs at a competitive price. Any intervention should not crowd out these existing players.

B. SELECTING PRODUCT VALUE CHAINS

The sections above analyzed each product using a set of eight criteria. USAID will decide how much weight must be given to each category in driving a decision. The study identifies several opportunity leverage points as well as obstacles, and deal-breakers which may make or break success in this area. These factors may in fact trump scores along all other lines.

- **Beans as staple and highly competitive foods**. The bean is solidly accepted as a staple and nutritious food in the DRC and is one of the very few products that is internationally (regionally) competitive. As such, this offers many leverage points for intervention.
- **Potato production competitive and conserves well**. The cost competitiveness as well as the growing local taste for potatoes makes this a good choice.
- **Soy an emerging staple.** Soy beans are an emerging staple food with high nutritive value. Unlike other regions (such as Katanga), soy is a core part of the people's diet, serving for instance as substitute for dairy in the daily tea.
- **Bananas decimated**. The wilt bacteria has decimated the banana crops in the DRC and it was widely advised that this presented an obstacle to any intervention in this area. However, since bananas were a core staple food in the past, if any opportunity comes to revive the sector, this should be explored.

C. FINANCE

Farmers, as well as other members of the value chain, lack access to credit, savings, as well as other financial services such as money transfer. Some leverage points for intervention include:

- **Educate in numeracy.** Many farmers lack the basic numeracy skills needed to be able to calculate and plan for their finances. The simple concept of savings can help farmers plan for buying inputs and planting before they can reap revenues from products sales.
- **Mobile services and rural infrastructure.** The fastest growing sector of enhanced financial services for the poor is being delivered via mobile technology. A lack of connectivity in rural areas is one of the major barriers to farmers in the Kivus accessing these services. Working with mobile operators (and the telecommunications regulator) to build out rural infrastructure could address this problem.
- **Build existing savings group capacity**. Work with existing rotating savings groups to build capacity and provide access to savings and credit at the village level.
- **Negotiate gender roles**. Currently, men are charged with the decision-making in most households in the Kivus, despite the fact that women often collect the money and perform many of the household cash-making roles. This can lead to miscommunication and mismanagement of finances. Improving a household's financial capacity will require balancing gender dynamics and perhaps providing inclusive training for both genders in the household.

D. SPECIAL FACTORS AFFECTING POTENTIAL VALUE CHAIN STRATEGIES

Working in the Kivus requires a specially-focused approach, considering the unique set of challenges:

- **Conflict-adaptive.** The security situation in the Kivus is already challenging, but is always shifting and changing. Project plans must be adaptive to changing elements. For instance, the project could evolve in several spokes with the expectation that not all regions will continue to participate.
- **NGO-heavy environment**. The well-intentioned NGO presence often disrupts a functioning market. This must be taken into account as NGO interventions are generally unsustainable.
- **Gender roles.** In the Kivus, the gender roles are entrenched in the fabric of the agricultural system, with women performing much of the planting, harvesting and trading, and men managing the finance. There is resistance to change from both genders. This factor will affect participation in programs and the continued success of any interventions.
- **Transport challenges**. It seems the greatest constraint to overcome in many value chains is transport. This may be an insurmountable challenge within any project budget, but the implications must be taken into account. One solution to consider is new technologies such as mobile or satellite communications to reduce the need for travel and the consequent loss of goods in transit.

Figure 9. Opportunity Matrix for North and South Kivu

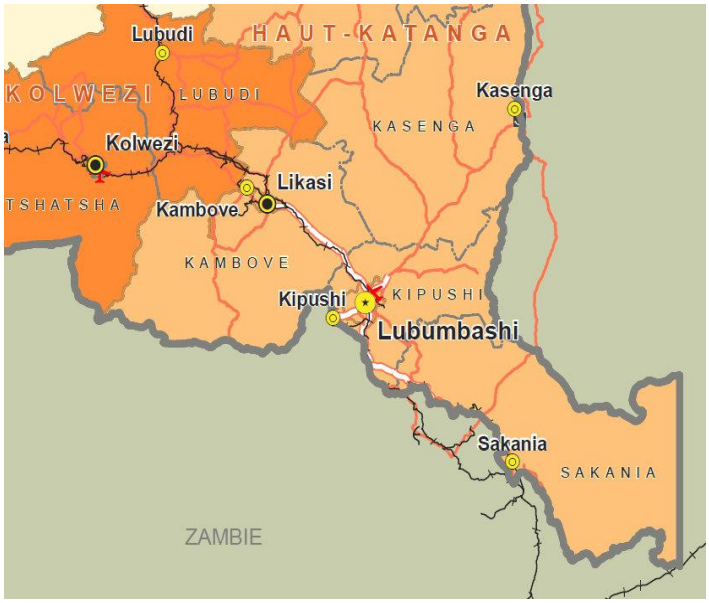
Factor/ Product	Soy	Beans	Potato	Horticulture	Small livestock	Bananas
End market competitiveness	High	High	High	Medium	Low	Obstacle
Inclusive growth	High	High	High	High	Medium	High
Food security/ nutrition	High	High	Medium	High	Low	High
Conflict-neutral and resilient	High	Medium	High	Medium	Obstacle	Low
Pro-women	High	High	High	High	High	Medium
Pro-youth	Medium	Medium	High	High	Medium	Medium
Climate change robust	High	Medium	High	Medium	Medium	Low
Benefit cost analysis	High	Medium	Medium	Medium	Low	Obstacle

Major opportunity Major obstacle

XII. KATANGA: CROSS-CUTTING ANALYSIS

Katanga Province spans 497,000 km² (16 times the size of Belgium), with an estimated population in 2010 of over 5,600,000 inhabitants, and a relatively sparse population density of 11 inhabitants/km², roughly eight times less than that of the Kivus.[47] Known previously as Shaba Province under the regime of Mobutu Sese Seko until 1997, Katanga comprises five districts of which two, Kolwezi and Upper Katanga, are partly in the study zone. The study area stretches from the urban center of Kolwezi in the north, southward along the main highway corridor running through Likasi down to the provincial capital of Lubumbashi, and ending in Kasumbalesa at the southern border with Zambia. The province is known for its rich mining reserves of copper and cobalt, with Lubumbashi, the second largest city in the Congo, serving as the hub. The population of Lubumbashi was estimated at nearly 1,800,000 inhabitants in 2012, and it has a relatively mild climate at 1,200 m, in an otherwise hot humid zone.

Figure 10. Map of Katanga Province



The study zone is located in the southern portion of the province. It encompasses a plateau that ranges from 600 meters to just under 2,000 meters. The district contrasts significantly from the agro-ecological landscape of the Kivu provinces. The southern corridor is predominantly agricultural land, interspersed with central Zambezian *miombo* woodlands, one of the prominent ecological zones of the south-central African region. The regional tropical climate is warm, punctuated by a primary rainy season of roughly five to six months (November to March), followed by a long dry period of six to seven months (April to October). The *miombo* woodlands are interspersed with riverside *dambos* or grassy wetlands, which are more abundant as one moves south into Zambia.

Climate of the Upper Katanga District is classified as "humid subtropical" according to the Köppen climate classification, with temperatures rising during the rainy months and cooling in the dry season. Average annual rainfall is just over 1,100 mm, and ranges from slightly below 800 mm to over 1,300 mm. Temperatures are fairly constant throughout the year (17 C – 25 C) and average 21 C. At Lubumbashi, rainfall is above the district average, at 1,240 mm, with temperatures rising to an average of 23.6 C in October and dropping to 16.2 C in July. Rains are abundant from December through February, reaching 240-270 mm per month on average, while becoming negligible during the dry season.[48]

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[47] http://en.wikipedia.org/wiki/Katanga_Province

[48] http://en.climate-data.org/location/503/

A. AGRICULTURE AND NUTRITION

Northern Katanga possesses excellent agricultural land but is currently poorly connected to the rest of the world. In contrast, the copper-belt is better connected. It has good soils around Likasi (Lufira Valley) but, in general lacks the soil quality of the north of the province.

The study zone receives 1,000-1,500 mm of rainfall annually with relatively low variability (15-25 percent).[49] In contrast, parts of eastern and southern Zambia experience variability of 25-35 percent. This means that, although climate change may make copper-belt agricultural production more risky, it is inherently less risky than Zambian production of the same crop. On the other hand, Zambian investment in irrigation has already done much to reduce the risk of climate change, counteracting this differential.

Large farms and ranches exist and more are being set up in Katanga. Ranches are being re-established after a decade of decline from 1995-2005. Thousands of hectares of maize are being commercially produced and more are planned. Commercial poultry farms also exist. One recent proposal is for a large sugarcane development.

In 2011, DRC had an intermediate ranking for the number of full-time-equivalent agriculture researchers but a low ranking for the percentage of researchers with postgraduate degrees (less than half) and also for the number of agriculture researchers per 100,000 farmers: between 2 and 10.[50]

Katanga produces many different crops of which the three most important as food staples are cassava, maize and beans. Traditionally, cassava was the major staple, and it remains so in much of the province. Cassava is not very nutritional but provides food resilience because it can be stored in the ground during periods of flooding and drought for later consumption. It keeps well and can be served in the form of chips or fresh. Cassava represents an estimated 60 percent of the carbohydrates consumed in Katanga.[51]

In urban areas and in the copper belt, maize has largely replaced cassava as the major staple. However, maize production in Katanga does not cover the province's consumption needs, and the province imports from neighboring countries.

Studies by Carlo Azzarri at the International Food Policy Research Institute (IFPRI) show that:

- With 40-50 percent of the population living at less than $1.25/day (extremely poor), the project zone (and the rest of Katanga and the Zambian copper belt) is better off than the rest of the Zambian population to the south (60-90 percent).
- With 0-5 percent living at extremely poor levels, Katanga (including the study zone), it is better off than surrounding areas with rates between 6–25 percent.
- With 70-80 percent of the population living at less than $2.00day (including the moderately and extremely poor), Katanga (including the study zone) is better off than adjacent Zambia (80-100 percent), except the Zambian copper belt (60-70 percent).
- With a poverty density of 5-10 percent, Katanga is better off than the immediately adjacent parts of Zambia, including its copper belt (10-50 percent).[52]

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[49] K. Sebastian 2014. Atlas of African agriculture research & development, International Food Policy Research Institute, Washington, 39

[50] K. Sebastian 2014. Atlas of African agriculture research & development, International Food Policy Research Institute, Washington, 9

[51] Republique Democratique du Congo, Province de Katanga, 'Situation dans les secteurs économiques', *Document des strategies de reduction de la pauvrete 2006*

[52] K. Sebastian (2014: 76-77)

Furthermore, IFPRI shows that:

- Katanga's stunting (lower than average height in children younger than five) is "very high," i.e., greater than 40 percent, and that this is similar to the rest of DRC and most of Zambia, including parts adjacent to Katanga.
- Katanga's wasting (lower-than-average weight for height in children under age five) is "high" at 10-44 percent, compared to "medium" (5-9 percent) or "low" (less than five percent) in adjacent Zambia.
- Katanga's underweight (low weight for age) in children under age five is "high" (20-29 percent), as in much of the rest of DRC, while it is rated as medium (10-19 percent) in adjacent Zambia.
- High rates of diarrhea contribute to under-nutrition by interfering with the absorption of food consumed. Katanga's "high" prevalence (15-20 percent) is comparable to that in surrounding Zambia and adjacent DRC provinces.[53]

B. ENABLING ENVIRONMENT & KEY STAKEHOLDERS

This section describes the set of factors driving the enabling environment in which the focus value chains operate, including a description of the key stakeholders and their roles.

1. CORE VALUE-CHAIN LIVELIHOODS

Rural livelihoods in the study zone consist primarily of smallholder agriculture, with some limited livestock production of beef and dairy cattle. Smallholders generally practice shifting cultivation on small farm plots. The distribution of farm sizes is severely skewed, with a median estimated at one hectare but a mean of perhaps five hectares. Food crops include cassava, plantains, bananas, maize, soya beans, dry beans (*phaseolus vulgaris*), sweet potatoes, and garden vegetables. The three most important food staples are cassava, maize and beans, of which cassava is the primary staple grown. While it provides low nutritional content, it is resilient in terms of addressing food security due to superior storage capacity (in the ground) during periods of severe climate stress such as flooding and drought. In urban areas of the copper belt such as Lubumbashi and Kolwezi and their associated peri-urban areas, maize has largely replaced cassava as the major staple. Nonetheless, maize production in Katanga does not cover the province's consumption needs, and additional stocks are imported from neighboring countries.

Rains are sufficient to allow for two agricultural seasons of short-cycle crops, from October through January and February through May. Most smallholder farmers devote these seasons primarily to subsistence rather than cash crops. In addition to the primary staple crops, some limited dry-season gardening can be found, particularly in peri-urban areas. Little irrigation is practiced in the study area. Soils are relatively poor, although more productive soils are found in the Lufira Valley near Likasi.

Both production and marketing of horticultural crops are carried out primarily by women. The most important market vegetables include cabbage, tomato, onion, eggplant, and leafy greens. In peri-urban areas where market demand is strong, horticultural production has become a year-round activity for women. They also manage the wholesale and retail marketing of maize, dry beans, and soya beans, along with vegetables.

[53] K. Sebastian (2014: 78-79)

Beef cattle raising has always been limited in the copper-belt, largely due to the prevalence of the tsetse fly. Production mostly involves traditional small-scale grazing of cattle, along with sheep and goats. Thus the copper-belt contrasts with northern Katanga, which has large-scale ranches.

Fish farming in ponds, or aquaculture, is practiced on a very limited scale in the study area. Introduced early on in Katanga Province as one of the first pilot areas for aquaculture in the DRC, fish farms have been abandoned or fallen into disrepair with the protracted conflict in eastern and southern parts of the country. Tilapia (mainly *Tilapia rendalli* and *Oreochromis macrochir*) are raised by farmers in earthen ponds located near perennial river valleys and streams, and in wetland areas. FAO estimated production in 1999 for the entire province at 163 tons, involving 1,147 ponds on 65 ha of land.[54]

Finally, Katanga includes part of the copper-belt that extends into Zambia. Mining is a significant driver of the regional and national economy. Copper and cobalt mines include both formal-sector, industrial-scale mining and informal-sector, artisanal mining—which provides important alternative employment opportunities to family farming in the region.

2. GOVERNMENT POLICY

The national parliament has adopted an Agricultural Code that is only partly applied. In particular, importers of agricultural inputs do not automatically benefit from a tax exemption granted by the code.

The Code also specifies that non-Congolese cannot own more than 49 percent of agricultural land. In principle, this matters because more productive management cannot be applied to Katangan farms. In practice, there are ways around this regulation because the Forest Code and the Mining Code provide loopholes that the determined foreign investor can exploit.

The Katangan provincial government requires each mine to grow 500 ha of maize and cassava.[55]

3. IMPORTS

The copper belt imports most of each of the seven commodities studied that are consumed in the region. This is partly because DRC is a rentier state suffering from the Dutch disease—an "overvalued" exchange rate that makes non-mineral exports uncompetitive and renders import substitution weak. This affects all non-mining tradable commodities, i.e., all the inputs and products studied. For those imported from Zambia, there is a further factor: Zambia's kwatcha has fallen in value by approximately 25 percent against the dollar over the last year, while the FC has remained fairly constant against the dollar, favoring exports from Zambia to DRC. Zambia has more than 300,000 ha of irrigated farmland for year-round production, about thirty times more than DRC (though this is partly offset by the higher inherent variability in Zambia's rainfall, when compared to Katanga's rainfall).

A fund proposed to promote agriculture, to be financed from taxes on imports, remains another unimplemented part of the Agricultural Code. Agricultural inputs—expensive because of a long supply line—are even more so because of bribery and delay at the border. Oligopolies exist in the markets for inputs and outputs.

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54 http://www.fao.org/fishery/countrysector/naso_congo/en

55 www.forbescustom.com/EmergingMarketsPgs/CongoInterviewsP1.html

4. GOVERNMENT INTERESTS

The president, the governor and others have made major investments in agriculture and trucking, so agribusiness is very political. DRC politicians at the national and provincial levels stand accused of importing food and effectively dumping it on the Congolese market. Katanga's governor has "substantial interests in the trucking sector" in Zambia,[56] as well as a history of both maize trading and fish farming in Zambia.[57]

5. TRANSPORT & PACKAGING

The SNCC railway has historically connected Katanga to the rest of DRC, to Zambia and Southern Africa, and to Angola. Its current non-operational state means that the copper-belt is less economically connected than it has been in the past. However, repairs underway should open the copper-belt line and link it to Angola within two years. In the meantime, the copper-belt is lucky to have a serviceable tarred road linking Kolwezi to Lubumbashi, the border at Kasumbalesa, and thus to East and Southern Africa.

The trucking fleet along the tarred corridor to the Indian Ocean ports is international and consists of large trucks, sometimes with trailers. Not enough time has elapsed since the demise of SNCC for DRC truckers to build large fleets. The fleet's international composition and the economies of scale from large trucks mean that it is technically efficient and economically competitive. However, its efficiency is compromised by bribery and delays at Kasumbalesa. There is a rough equality between north-south and south-north freight along this corridor, so that freight in one direction is not subsidizing freight in the other direction.

In contrast, domestic trucking in Katanga is inefficient due to its small-sized, completely amortized fleet that spends 90 percent of its time waiting in line for business. The provincial government has banned the use of mini-buses for passenger transport between towns with the result that they now provide additional transport for agricultural commodities.

From the farm to the first market, most produce travels by bicycle (pushed, rather than ridden) or is carried by head. This is true even within 5 km of the main road if rural roads are poor and vehicles few. Sacks are the main means of packaging the produce, particularly maize, beans and soy beans. Sacks also serve for some relatively robust vegetables, e.g., onion, cabbage and eggplant. However, the need to protect delicate vegetables, such as tomatoes, requires boxes that may not be available, limiting production for market. Tomatoes from Zambia arrive in re-usable wooden crates that are not collapsible and, though they partially stack within each other, occupy a significant portion of the carrying capacity of vehicles returning to Zambia. The saving grace for this return leg is that there is not much competition for space in small trucks from DRC to Zambia. Supermarkets with their own farms use plastic crates to protect their supplies of vegetables. There appears to be no Katangan manufacturer of cardboard (or other) packaging.

6. SUPERMARKETS

Supermarkets account for a small but increasing share of retail outlets in the study area, particularly as it contains the province's three largest cities (Lubumbashi, Kolwezi and Likasi). Lubumbashi has at least three modestly sized supermarkets. The South African chain Shoprite, Africa's largest supermarket operator, intends to

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[56] African business 2013. *Katumbi: the Moses of Katanga*, 4th April, http://africanbusinessmagazine.com/profiles-and-interviews/profile/katumbi-the-moses-of-katanga/

[57] Governor Moïse Katumbi Chapwe owns (or has owned) Chani Fisheries in Zambia. "Katumbi has in the past run a chain of businesses in Zambia including maize trading." Source: news24archives 2007. DRC asked to extradite governor, 8th March, http://www.news24.com/Africa/News/DRC-asked-to-extradite-governor-20070308

open a Lubumbashi branch in 2016. The supermarkets serve a middle-class clientele that wants convenience and quality. Customers can choose between imported and Congolese meats (beef, pork, mutton and chicken) and meat products. Congolese meats may come via the abattoir from the supermarket's own farm. Some imported meat is chilled but most is frozen, as is all imported fish. Customers are unlikely to be able to buy maize or, in some cases, even maize meal. Loose beans and soy beans are also rare in supermarkets. In contrast, large numbers of retailers in the cities' markets retail maize, maize meal, beans and soy beans. Some supermarkets offer vegetables mostly from their own farms; others contract them in from a combination of domestic or Zambian sources. On average, both the quality and range of a supermarket's vegetables exceeds those available in the market. Eggs are available everywhere, sold in imported cardboard trays of 30. Supermarkets have cold-store capacity that allows them to preserve their stock of perishable products better than their competition in the market. They may sell maize meal in own-branded sacks but no other product that concerns this study is branded.

7. MAIZE'S IMPORTANCE AND ITS LINKS TO OTHER VALUE CHAINS

Although Katangans' calories come principally from cassava, maize is the second source. From a marginal foodstuff at independence, maize has grown in importance, first as an urban food more convenient to prepare than cassava, then as a food for miners, and then to smaller settlements along the length of the copperbelt, where it has become the most important staple.

Maize has links to beans and soy beans in agricultural production. Both types of bean are leguminous, putting nitrogen into the soil. Thus, small farmers have traditionally intercropped beans with maize to limit the fertilizer they have to add to the field. Soy beans, introduced several decades ago, can replace beans in this function. Mechanized farmers also seek the nitrogen-fixing benefits of beans and soy beans. However they find intercropping difficult so they instead follow a rotation of beans and/or soy beans every 3-4 years with maize.

Maize and soy beans provide the major constituents of feed for poultry and farmed fish: maize meal and bran and soya meal.

In consumption, maize and beans provide balanced nutrition in the human diet. Maize lacks two amino acids that the human body needs to synthesize proteins (lysine and tryptophan). Beans also lack two amino acids, but different ones (methionine and cysteine). Eaten together, maize and beans mutually compensate for the amino-acid deficit of the other.

Thus five of seven of the Katanga value-chains examined are linked. Beef and horticultural production are largely separate.

8. MINES & AGRICULTURE

Mining for copper and cobalt in Katanga's copper belt takes two forms: formal-sector, industrial mining and informal-sector, artisanal mining. International companies in joint ventures with the Congolese state operate the formal-sector mining operations, which take place on large concessions, little of which may be exploited at any point in time. Some of these international companies are part of conglomerates that may include agribusinesses and farms, in which case they supply much of the food for the meals served to the related mines. The most prominent example is the Indian Soumika conglomerate that includes the African Milling Company (Congo) with an annual milling capacity of 150,000 tons per year and a farm with an area of 10,000 ha on which it has started mechanized maize cultivation to meet the new mill's capacity. Chinese operations appear to be structured more loosely but Chinese mines apparently buy much of their food from Chinese-run farms.

In contrast, artisanal miners work on a smaller scale, with fewer occupational-safety constraints or environmental considerations, generally within the concessions that the state has formally given to formal-sector operations because that is where the minerals are thought to be. Some of the informal operators may have worked the deposits before the granting of a concession to the company and feel that they therefore have a right to do so, but many workers are opportunists without a social tie to the local area or a historical tie to a particular artisanal mining site. Relations between the industrial and artisanal sectors are often delicate. To limit artisanal-sector activity, the companies may partially fence the concession, conduct surveillance of informal mining, and deploy deterrence using government and private security forces.

Lax environmental controls have caused water pollution, which renders unsafe the production from farms and fisheries affected. Formal-sector companies may have better safeguards but, when pollution occurs, it tends to be on a large scale, such as the pollution of tens of square kilometers of Lake Tshangalele, east of Likasi. In contrast, the many informal-sector operations use inherently more polluting technologies, though individually they operate on a much smaller scale.

According to the World Bank, "In Katanga, mining is taking place (and has taken place over many years) without regard to effective environmental protection. Mine tailings and waste dumps are decaying and may suffer catastrophic failure, posing significant pollution dangers to water courses and agricultural soils. Acid mine drainage in many areas is polluting water supplies. Improper closure of pits and mines poses a danger to humans and animals. Heavy trucks, hauling equipment, supplies, and mineral product frequently pass through villages at speeds that put inhabitants at risk. The many small-scale furnaces and processing plants that have been established in Katanga over the past several years to process the ores sold to them by artisans operate with few or no environmental protection measures."[58]

A tension exists between the formal-sector mining operations and the inextricably linked combination of the informal-sector mining operations and the local population. Earlier incarnations of mining companies, principally Gécamines, generated expectations among local populations that the mines would provide "all sorts of material benefits." In managing these expectations, some contemporary companies have changed their security operations from "a main guarding function, iron gates, secur[ing] an office complex or mine complex against theft or wrongdoing" to "more of a risk management role." One Kolwezi company created "a joint unit, combining security, social development, and public relations departments" using "soft modes of managing potential threats and grievances by engaging with communities" and "avoid[ing] confrontation with communities over critical issues at low cost.

"[S]ecurity strategists see security risks to mining companies increasingly emanating from the communities next to the mines. No public actor can be easily made responsible for taking care of the grievances of artisanal miners and communities living adjacent to the mines. Also, reputational risks have grown over recent years and have become an important factor in the local risk calculations of firms. Companies in Katanga thus refer to these communities ambiguously as both most immediate threat and potential belt of protection for operational security. Companies have begun encouraging workers and adjacent communities to behave in favor of the company and to help secure its premises, while at the same time keeping tight physical controls and fences in place keeping people out."[59]

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[58] World Bank 2008. Democratic Republic of Congo: growth with governance in the mining sector, report no. 43402-ZR, May, 66-67 http://siteresources.worldbank.org/INTOGMC/Resources/336099-1156955107170/drcgrowthgovernanceenglish.pdf

[59] J Hönke c.2010, Companies, communities and local security governance: disciplinary paternalism, participatory community engagement and indirect rule, draft, 6 http://www.open.ac.uk/socialsciences/bisa-africa/files/building-states-j-honke.pdf

This approach includes "strategically placed development projects," some of which aim to enhance agricultural productivity of communities affected by the mine.[60] More sophisticated companies' strategic thinking has evolved so that they seek to engage the local populations' support in maintaining an environment that supports their operations, including with respect to informal-sector operations. This approach provides a framework within which mines can help their local communities to increase agricultural yields and thus generate agricultural surpluses and, at the same time, secure reasonably priced supplies of local foodstuffs, such as maize and beans.

Historically, well-paid jobs in the formal mining sector were the principal way that mines had to inject wealth into the local community. As mining becomes increasingly capital-intensive, the mines provide fewer, better-paid jobs. It is strategically important, where practical, to allocate these jobs to local workers. However, their small number limits the widespread economic benefits, making development projects a more important way of spreading the wealth and influencing local opinion in a more broad-based way. As most folk outside the mines are involved in agriculture, the success of agricultural development projects for the mines' immediate communities becomes important.

Within this framework, mining companies had to decide how to implement the provincial government's legal requirement that each mine should farm 500 ha of maize.[61] One way to do so, apparently so far adopted by most mines, is to grow the maize themselves. A few meet this requirement more innovatively by helping local small-scale farmers to produce more productively, e.g., MMG (near Lubumbashi) and TFM (based in Fungurume).

MMG is an Australian company operating a mine about 25 km north of Lubumbashi. Since 2008, the company has run a three-pronged approach to fostering local agricultural development. It works with individual farmers to grow maize, beans and groundnuts. MMG supplies technical advice and agricultural inputs so that yields have grown significantly. The farmers keep much of their larger production of these crops but can also sell the surplus to MMG. Similarly, the company works with associations to promote horticultural production. The associations also have an option to sell to MMG, and do so, but they also sell to the nearby Lubumbashi market when it is more remunerative. MMG has a longer-term plan to not only meet its obligation to grow 500 ha of maize, but also promote a development pole within which farmers can make phased progress from intensification to mechanization as they evolve into small and medium-sized enterprises (SMEs). MMG has done a feasibility study, acquired land with an area greater than 500 ha, and should start this project in April 2015.

TFM is a US company operating in a concession between Fungurume and Tenke. Like MMG, the company also started supporting farmers within its concession in 2008. TFM chose 600 farming families to support to produce maize, beans and groundnuts, providing agronomic advice. The company also provided inputs on

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[60] Hönke c.2010: 7-8

[61] At least when it started in 2010, this provincial decree concerned 16 mining companies: la Compagnie minière du Sud-Katanga, Congo Loyal Will Mining, Cota Mining, Feza Mining, Golden African, JMT/MJM, Katanga Copper Co., Katanga Metals, Magma Minerals, Mehul Mining, MIEL International, Mining Yue, New Dathu Minerals, Rubamin SPRL, SARDC, and Volcano Mining. Source: AFRIK*ARABIA*.com 2010. *RDC: le Katanga sanctionne 16 sociétés minières*, 3rd February, http://afrikarabia.blogspirit.com/archive/2010/02/03/rdc-le-katanga-sanctionne-16-societes-minieres.html This blog notes that the companies could farm a combination of maize and cassava. Comments made in the blog suggest that several of the companies listed were Chinese. A separate source notes that the gubernatorial decree also required each brewery to grow 500 ha of maize, a request that has become more relevant with the very recent start of operations by the African Milling Company. Source: F.M. 2015. 'Maïs: le sac de 50 kg passe 50 à 11 dollars US au Katanga', *Le Phare* 27th February, http://www.lephareonline.net/mais-le-sac-de-50-kgs-passe-50-a-11-dollars-us-au-katanga/

credit, with post-harvest reimbursement in kind. Yields grew from 0.8 to 5.3 t/ha over six years. Thus even a half-hectare plot provides a surplus beyond household consumption needs for sale. However, the farmers were not ready to manage the large surpluses: they had neither easy access to banks to obtain receipts from sales, nor access to good storage facilities to hold unsold maize. This led to large post-harvest losses. As the terms of its business license dictate that TFM may not market agricultural commodities, it has been unable to play a role to reduce these losses. However, it mills the maize it receives as repayment from the farmers and uses it to prepare meals for its workers. TFM wants to set up a microfinance scheme that would take over the granting and management of the credit that the company currently undertakes. It is difficult to find a microfinance organization that wants to get involved in agriculture but, without one, farmers have nowhere to save the revenue they derive from such an operation. To mainstream this operation, TFM thus needs to find private-sector operators to play key roles in a system that it has shown to be technically successful: it needs an input supplier, a trader of agricultural commodities, and a financial institution.

9. RECOMMENDATIONS REGARDING MINING AND AGRICULTURE

Three conclusions stem from these experiences. Firstly, there is a need for a forum for mining and other companies to exchange information and learn about best practices. Secondly, a better market information system would allow private-sector solutions to the problems that the success of TFM's initiative has created. This system might be based on radio programs that not only broadcast commodity prices but also share information about availability of stocks of commodity for sale. Thirdly, it is not clear that a microfinance institution would work on a large-enough scale to accommodate the savings that selling surplus maize would generate. Innovative financial-market solutions may have a role to play here. In particular, mobile banking extended to accommodate savings, as ELAN proposes to test, could solve the problems of Fungurume farmers (with good cellphone signals) who sell their excess maize and beans but need somewhere safe to store their revenues. On the other hand, if an established bank in, say, Kolwezi were to open a branch in Fungurume, even with limited but well-defined opening hours, this conventional solution would largely solve the farmers' savings problem.

C. INPUTS MARKET ANALYSIS

This section analyzes the inputs market across value chains.

1. SEEDS

The FAO states: "Appropriate seed legislation at the national and regional levels [is] essential to create an enabling environment for the development of the seed sector." The first step towards such legislation is achieving consensus on seed policy as agreed by sectoral stakeholders in the short, medium and long terms. Policy covers seed-quality assurance schemes, including seed-quality control and variety-release procedures, extension services, skills development, credit and subsidies, taxation and international cooperation. When these elements have been determined, the corresponding legislation can address seed certification, variety release, plant property rights, biosafety, seed production, seed marketing, packaging, labelling and institutional arrangements. Regional harmonization of seed laws facilitates cross-border movement of seeds to build a broader market with economies of scale for flourishing seed enterprise.[62]

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[62] FAO n.d. *Seed rules and regulatory frameworks*, http://www.fao.org/agriculture/crops/thematic-sitemap/theme/seeds-pgr/seed-sys/rules/en/

In 2014, the Common Market for East and Southern Africa (COMESA) issued and promulgated regulations of a regional Seed Coordination Unit, National Plant Protection Organizations and National Seed Authorities; a COMESA seed-certification system and variety release system; along with quarantine and phyto-sanitary measures for seed.[63] Although DRC has a draft seed law, it is not complete and has not been integrated into this regional framework. In the meantime, government flexibly allows foreign seed to enter DRC and, as the next two paragraphs explain, has acted pragmatically to boost the availability of improved seeds developed nationally.

The classic seed-production system starts with plant breeders producing new strains of improved disease-free seed at the "pre-basic" level and multiplying them to greater quantities of basic seed. This can be done using traditional crossing of open-pollinated varieties or, increasingly, using plant tissue culture techniques. "Improved" may mean higher-yielding, drought-tolerant or disease-resistant. Until recently in Katanga, breeders at INERA and the University of Lubumbashi (UNILU) had worked together to create open-pollinated maize varieties, and produce pre-basic and basic seed. The researchers had then made this seed available to specialized farmers who multiplied it to produce enough "foundation seed" for sale to farmers who wanted to grow better crops commercially.

It became clear that the resources available to researchers were insufficient for this pathway for genetic improvement to reach commercial farmers on a large scale, and that this was significantly limiting increases in Katanga's agricultural productivity. Therefore ELAN and others brokered a deal whereby specialized professional farmers took over the production of basic seed, with professional feedback from the plant breeders who had more time and resources to focus on their work at the pre-basic level. Reciprocally, the professional farmers provide feedback to the researchers on the quality of their basic seed. The private-sector producers invested more in basic-seed production than INERA and INILU had been able to do, producing more inputs to the production of foundation seed and, ultimately, a larger supply of improved seed for farmers.

Among issues that remain to be resolved are compensation for the breeders' intellectual property rights and marketing of the greater quantities of commercial seed that is now coming onto the market.

Other improved seed, including all very-high-yield hybrid seed, is imported, mostly from South Africa and Zambia. Lubumbashi has three big importers/wholesalers: SeedCo and ZamSeed (subsidiaries of Zambian companies) and Katanga Mboleo (a subsidiary of Pannar in South Africa). Each also sells fertilizer, crop chemicals and other agricultural inputs, and each has a network of retail outlets throughout the towns along the main road through the copper belt. In its warehouse, dominated by fertilizer, Katanga Mboleo had seed for three varieties of medium-maturity maize (<120 days) that yield 5-8t/ha and one variety of long-cycle maize (six months) yielding 10-15t/ha. During the 2014-15 season, the company lacks seed for beans and soya beans, though in previous years it has stocked these. A diverse range of vegetable seeds completed the product range. Of these, okra, cabbage, bok choi, carrots and onions sold best. Customers come from throughout the copper belt to buy seed there. The importers have agronomists on staff who make farm visits with a company car to provide free advice to those who have bought inputs from them.

Independent traders bypass the importers' offerings and travel to Kasumbalesa where they buy cheaper seed to sell in their own shops. They compete with other retailers that the importers supply. In Likasi, *Le bon cultivateur* shop, stocking a full range of agricultural inputs, bought seeds from SeedCo and other sources. The

[63] COMESA 2014. COMESA seed trade harmonization regulations, 27th–28th February, http://foodtradeesa.com/wp-content/uploads/2013/06/COMESA-Seed-Harmonisation-Regulations.pdf

branch visited was one of ten *Le bon cultivateur* retail outlets, with another ten planned for 2015-16. The manager explained that 30 percent of the seed sold was maize and 70 percent was for horticultural and other crops (including beans, soy beans and vegetables). The shop ran maize demonstration plots with yields of 5t/ha. In Kolwesi, the owner of another agricultural input shop also supplied by SeedCo, noted that he mostly sold maize seed, rather than seed for beans and soybeans, plus vegetable seed (largely in the dry season). In both cities, these shops faced competition from several other retailers.

Katanga Mboleo ag. input supplier, Lubumbashi

At the wholesale and retail levels, seed sales have been growing briskly year-on-year. None of those interviewed mentioned supplies derived from INERA/UNILU seed, which must reach farmers through different channels.

2. FERTILIZER

Cropping intensity in most of Katanga in 2010, including the study zone, was low (0.2–0.4 harvests per year) due to shifting cultivation and the absence of irrigated agriculture.[64] This suggests that intensification of agriculture is possible by reducing fallow periods and increasing fertilizer use.

Katanga produces none of the constituents of chemical fertilizer that meet plants nutrient needs. The only prospects of such production lie in Bas-Congo Province. DRC has signed a joint-venture agreement with South Africa to produce phosphate fertilizer from shallow deposits near Boma at the mouth of the River Congo.[65] Further upstream, in 2009, the African Development Bank proposed a plant for the energy-intensive production of nitrogenous fertilizer as part of the revived Inga Free Trade Zone (ZOFIA) project. A massive dam on the River Congo 140 km southwest of Kinshasa would provide the source of the large quantities of energy needed.[66] Nor does Katanga produce any of the secondary nutrients or micronutrients necessary in smaller amounts for plant growth. The cost of transporting fertilizer from other DRC provinces to the Katanga is so high that, in the near future, the copper-belt will not benefit from the country's moves towards domestic production of fertilizer. Therefore Katangan farmers using chemical fertilizers buy imports. However, a site near Likasi provides limestone, which may be used to increase the pH of acid soils.[67]

Big importers of fertilizer in African countries buy by the shipload of 20,000–50,000 tons in order to benefit from significant economies of scale. Informants made no reference to Katangan imports on this scale. Pro-

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[64] K Sebastian (2014: 29)

[65] M. Kabamba 2014. Bas-Congo: bientôt une usine de production d'engrais à Boma. https://www.youtube.com/watch?v=JDhXXREW6gM 6th February

[66] African Development Bank 2009. Democratic Republic of Congo: economic and sector work, regional development in Bas-Congo in the context of decentralization in the Democratic Republic of Congo (DRC), October, 17 http://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/DRC_Etude%20decentralisation_english__01.pdf

[67] P van Straaten 2002. Part 2: 'Congo (Democratic Republic of Congo)', *Rocks for crops: agrominerals of sub-Saharan Africa*, University of Guelph, http://www.uoguelph.ca/~geology/rocks_for_crops/19congo_drc.PDF, last updated 2009

vincial importers buy on a much smaller scale at higher unit prices via East and Southern Africa. Their supplies come from the world market through ports such as Dar es Salaam (Tanzania) and Durban (South Africa).

Most of the fertilizers that Katangan importers buy from Zambia in fact come from South Africa or from the world market through South African ports, particularly Durban. Durban is the largest port in Southern Africa and relatively efficient.[68] In contrast, imports of fertilizer via Tanzania are expensive, more than $200/t above FOB prices on the world market, due to high-cost deliveries in small vessels (15,000 t) and to port inefficiencies. Operators of the Mozambican port of Beira are constructing an 8,000 t/day dedicated fertilizer terminal, handling 30,000 ton vessels, designed to serve the Zimbabwean and Zambian markets, in direct competition to Durban.[69] It should also serve Katanga, directly or indirectly. Competition with Durban should contribute to price moderation.

South Africa also produces some fertilizer (35 percent of its needs in 2011[70]). Four companies controlling 94 percent of the South African market provides the opportunity for oligopoly rents and, in 2008, the Grain SA fertilizer report noted several contraventions of South Africa's Competition Act. Zambia produces a "very limited" amount of fertilizer[71] and Tanzania produces only phosphates.[72]

Katanga is at the end of supply chains from ports, so costs of supplying fertilizer to farmers are higher than elsewhere. Distances to Kasumbalesa from major Indian Ocean ports are: Durban 2,600 km, Dar es Salaam 2,280 km and Beira 1,850 km. Despite the long distances, there are positive aspects to this supply from the world market: these routes are tarred so trucks can run quickly along them, and the diversity of sources engenders competition not only between ports but between trucking fleets. Trucks typically carry loads of 40 t, more if they tow a trailer, thus bestowing economies of scale on this supply route.

Other supply chains connect indirectly through suppliers in Zambia, Tanzania and South Africa that receive much of their supplies through these ports but may also use limited inputs from domestic production. One large Katangan farmer purchases in Johannesburg, presumably from South African importers who buy from the world market by the shipload.[73] In 2014, he paid $350/t for the fertilizer and $390/t for road transport on top of which he paid $330/t in administrative fees and bribes at the Kasumbalesa, the major crossing point

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[68] B Mncube, 2013. *Major boost for Durban port efficiency*, South African Government News Agency, 13th May, http://www.sanews.gov.za/south-africa/major-boost-durban-port-efficiency

[69] FTWOnline 2014. *Beira to compete with Durban over fertilizer shipments*, 22nd January, *http://www.ftwonline.co.za/WebsectionNews.aspx?Command=&websectionno=2&currentpage=94&pagesize=10&ccurrentpage=1&cpagesize=10&tabContentNo=&CAKeyDataNo=0&NewsNo=22292* and Port Consultants Rotterdam 2014. *Beira Masterplan*, 22nd October, 5, http://www.partnersvoorwater.nl/wp-content/uploads/2015/01/Economische-analyse-final-version.pdf

[70] Grain SA 2011. *Fertiliser report 2011*, iv http://www.namc.co.za/upload/input_cost_monitoring/Value%20Chain%20Study%20of%20the%20South%20African%20Fertiliser%20Industry.pdf

[71] '[L]ocal production is very limited and dependent on a state-run plant (Nitrogen Chemicals of Zambia [NCZ]) that is in need of major repairs/upgrades.' IFDC 2013. *Zambia fertilizer assessment*, July, 16 http://www.ifdc.org/r-d/research/zambia-fertilizer-assessment

[72] IFDC 2012. Tanzania fertilizer assessment, June, 39 http://www.ifdc.org/r-d/research/tanzania-fertilizer-assessment

[73] Durban's bulk terminal mostly receives cargoes in 'Handysize' vessels carrying 35,000- 50,000 deadweight tons (dwt) and 'Panamax' vessels carrying 60,000-80,000 dwt. Source: UE & University of Kwazulu-Natal c.2006. *Durban economic development: port summary*, 3 and Transnet c.2014. *Port development plan*, http://www.transnet.net/BusinessWithUs/LTPF%202012/1.LTPF%202014_Chapter%2004__Ports_Final%20Proof_Sept%202014.pdf

along Katanga's border with Zambia.[74] As with other imports, the process is costly and fraught with delays due to corruption by government agents, particularly customs agents. Government agents use errors and omissions in paperwork to extract bribes and, where none exists, may, for instance, reallocate cargo from one import-tax category to another to create a false tax liability, the receipts from which disappear from official revenue. Only those with good accounting and willing to pay a lawyer to resolve such issues can hope to escape them.

One importer noted that the *Office Congolais de Contrôle* (OCC) checks fertilizer quality at Kasumbalesa, taking a sack per truck to test, providing the results a month or so later. In the meantime, customs releases the truck long before the test results are available and the importer is immediately free to sell, which it does. On the one hand, it is difficult to reject the hypothesis that OCC agents principally want free sacks of fertilizer; on the other, over time, the importer has found no evidence from OCC or any other source that there are problems of fertilizer quality.

The less visible costs due to delays at Kasumbalesa exceed explicit costs due to corruption. Delay-related costs assume several forms. Firstly, the importer's capital is locked up for days, sometimes weeks, when it could otherwise be making a profit. Likewise, secondly, the trucker's vehicle is stationary, rather than making money by hauling freight. A well-maintained tractor-trailer, worth about US $100,000, can typically make four round trips per month between Johannesburg and Lubumbashi but delays at the border may reduce this to 1.0-1.5 trips monthly. Normally a more minor consideration is the driver's salary and costs while he is not driving the truck. However, thirdly, South African trucking companies have a legal obligation to fly home any driver who has been working continuously for more than 12 days, a situation to which delays at Kasumbalesa can contribute quite often. The one-way cost of US $500 is doubled because of the need to fly in a replacement driver. Fourthly, distinct from the delay itself, the uncertainty of the arrival date of the fertilizer in Lubumbashi can play havoc with the importer's stock management. Likewise, fifthly, the uncertainty of the arrival time of the truck back in Johannesburg, and thus its availability to haul new cargo, disrupts the trucking company's logistics. Analysis of border delays at Beitbridge between South Africa and Zimbabwe estimate the corresponding daily costs at about 1.0 percent of the value of the goods.[75] A truckload of 40 t of fertilizer worth $25,000 when loaded in South Africa would thus incur costs of $250 daily. Evaluated at the value of the load when unloaded in Lubumbashi (US $42,500) the daily costs rise to US $425. The trucking company passes on the additional costs to the importer who may have every incentive to have the fertilizer delivered to Kasumbalesa and then take advantage of personal border-agency contacts to smooth the border crossing and accept using smaller, less technically efficient local trucks for the final 90 km.

The same informant noted that the flows of long-distance trucked trade along the copper-belt corridor were approximately even in each direction. This equality means that the truck owner will tend to charge the same for trucking in each direction which, for instance, is not the case on the Kinshasa-Matadi corridor, where imports trucked to Kinshasa cover the cost of mostly empty loads in the other direction.

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[74] Some of this cost may also be payable at Beitbridge and Chirundu, the border crossing points between South Africa and Zimbabwe and between Zimbabwe and Zambia, respectively. The informant did not make this clear. The Chirundu crossing is relatively efficient but Beitbridge is more difficult. Sources: M. Tran 2012. 'Zambia and Zimbabwe's single-stop solution to boosting intra-African trade', *The guardian*, 29th May and T. Muleya 2014. 'Truckers chaos at Beitbridge border post persists', *Chronicle*, 8th July, http://www.chronicle.co.zw/truckers-chaos-at-beitbridge-border-post-persists/

[75] ZimSitRep_W 2015. 'Beitbridge delays hugely costly', Zimbabwe situation, 27th January, http://www.zimbabwesituation.com/news/zimsit_w_bulawayo24-news-beitbridge-delays-hugely-costly/ It is not clear if this estimate includes all the costs listed in the text.

The recently enacted Agricultural Code allows importers to claim exemption on imports of agricultural inputs, including fertilizer. However, the exemption is not automatic: importers only receive it if they formally request it. Nonetheless, this contribution to the reduction in input costs is welcome.

Efficient and uncorrupt cross-border crossings would thus save the importer large sums and contribute significantly to lowering the cost of Katangan agricultural production and thus the price of Katangan agricultural commodities.

The economic effect of the border regime is to generate rents for the agents involved in the rackets and to increase the cost of fertilizer to Katanga farmers. Unlike similar costs imposed on imports from Zambia or Tanzania of agricultural commodities also produced in DRC, the costs associated with importing fertilizer unambiguously penalize, rather than protect, domestic agricultural production.

Informants suggest that, superimposed on top of these inefficiencies, a cartel exists among importers based in Lubumbashi, artificially raising fertilizer prices for all other than those who can afford to spend the time and money importing directly from Zambia. In addition, they said that public procurement through these sources often resulted in less fertilizer going to the stated beneficiaries and corresponding levels of funds going astray.

Southern African countries have access to granulated compound fertilizers suitable for blending according to crop needs in different soils without supplying additional nutrients that the crop does not require.[76] South Africa, in particular, has many such plants. Access to blending plans continues to grow: a plant in Beira port in Mozambique to supply blended fertilizer for Mozambique and Malawi is under construction. Figure 11 shows a crude version of the soils map that exists for Katanga, providing a spatial guide to soil types.[77] Combining knowledge of the nutrients available in the soil and the nutrient needs of a given crop allows the calculation of the fertilizer formulation that will complement soil nutrients to meet the crop's needs, and no more. Despite this, Katanga has no blending plant that can combine existing fertilizers to synthesize such a mix. So farmers buy commercially available N:P:K mixes that generally poorly match their crops' needs. Katangan fertilizer suppliers usually stock urea (46 percent) and various N:P:K mixes, plus some with formulations including secondary nutrients and micronutrients.

The *Société Coopérative pour l'Agriculture au Katanga* (SCAK), an association of large farmers and agribusinesses, proposes a blending plant to optimize fertilizer, principally for its members' benefit, and seeks donor funding or cheap credit to enable its construction.

Inert filler generally constitutes half or more of the weight of fertilizer. Fillers dilute the concentration of the active ingredients, which can burn the fertilized crop. However, given the high cost of transport to Katanga from distant sources of fertilizer, it would be appropriate to concentrate to the maximum the nutrients in fertilizer transported. This is already so for nitrogen (urea) for which 46 percent is the maximum permissible before it becomes a plausible input to explosives. However, for example, diammonium phosphate (DAP, 18:46:0) contains 64 percent of active ingredients, monammonium phosphate (MAP, 13:52:0) contains 65 percent, and potash (KCl, 0:0:60) contains 60 percent. These appear not to reach Katanga and could be imported. After transport, a blending plant could add local fillers, such as sand, granular limestone, ground maize cobs, etc., as necessary.

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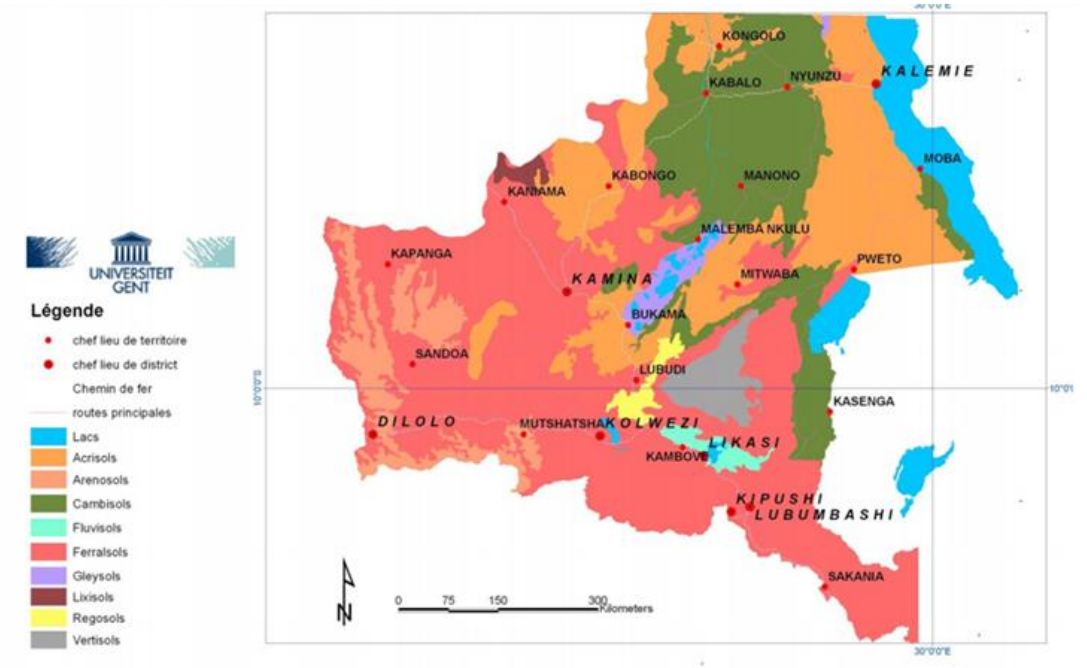
[76] Rijksdienst voor Ondernemend Nederland c2009. *Manufacturing of granulated compound fertilizers for the Southern African markets*, http://www.rvo.nl/subsidies-regelingen/projecten/manufacturing-granulated-compound-fertilisers-southern-african-markets

[77] See also: G Baert et al. 2012. *Soil survey in DR Congo – from 1935 to today*, paper presented at the meeting of the Selection of Natural and Medical Sciences, 27th March, http://www.kaowarsom.be/documents/B_59_2013/BAERT.pdf

Figure 11. Simple Soils Map of Katanga Province



Source: WRB: FAO, IUSS, ISRIC, 2006. (Van Engelen *et al*., 2006)

One informant reported that South African engineers are currently repairing the copper-belt rail line that connects Lubumbashi to the Benguela railway at Luao in northeast Angola (just across the border from Dilolo in southwest Katanga). He thought the line would be operational by 2017. This would then open up a rail connection Angola's Lobito port on the Atlantic Ocean that would compete with Durban, Dar es Salaam and Beira and could therefore potentially allow cheaper imports of fertilizer to Katanga. The distance from Lubumbashi to Lobito is 2,020km.

Wholesalers have imported fertilizer delivered to their Lubumbashi warehouses whence buyers from the public and private sectors buy it and, in the absence of a functional railway, convey it by road to its point of use. The most common means of road transport within Katanga is the small truck carrying 4-10t. Most such trucks are completely amortized, poorly maintained and susceptible to accidents. Their use adds per t-km costs significantly greater than those from the port to the Lubumbashi warehouse, particularly so once the delivery truck leaves the main tarred N1-N39 copper-belt corridor. The Mobutu regime cleared much of Katanga's rural population into roadside settlements. Farmers lucky enough to live near the main road receive fertilizer fairly easily; once off the main road, availability drops markedly.

Nonetheless, net inter-annual fertilizer sales in the copper belt have grown continuously over the last few years, according to a wholesaler and two retailers interviewed. Elimination of many of the existing constraints to fertilizer imports would have led to significantly greater growth in fertilizer use and much larger harvests in southern Katanga.

Interviews took place with one Lubumbashi fertilizer wholesaler (Katanga Mboleo) and retailers in Likasi and Kolwesi. At its Lubumbashi warehouse, Katanga Mboleo sells various NPK formulations: 17:17:17 (US $56 per 50 kg sack), 10:20:10 & 6S (US $48), 17:17:14 (US $54) and 18:18:9 (US $57) plus two formulations of

urea 46:0:0 and 35:0:0, both selling for US $46. It appears that the 10:20:10 & 6S had been specifically formulated for maize in the copper-belt but the Katanga Mboleo employee did not know the crops for which the others were best suited. She did explain that the rationale for buying the weaker of the two urea formulations was to avoid disorderly evaporation. There were, she explained, also formulations for beans and soy beans but, since Katanga Mboleo was then stocking seed for neither, the company stocked neither formulation. In general, her clients were not very discriminating, taking whatever formulation is available (within reason).

A Likasi retailer of agricultural inputs principally sold sacks of 18:18:14 & 5S (with traces of boron and zinc) and urea, competitively priced (US $55 per sack) with respect to Lubumbashi. (US $53 per sack). He was importing 1,800 sacks of fertilizer from Zambia weekly.

The Kolwesi shop stocked two formulations of NPK, which the manager contrasted. He believed that 17:17:14 with sulphur was best for maize but, he said, only a small informed clientele (10 percent) sought this formulation. Most bought the other option 10:10:10 because it was cheaper per sack but not per kg of nutrient. Though the manager, a veterinarian, provided after-sales service for livestock inputs, he did not do so for inputs to agriculture—and this would seem to be a case in point.

Boosting private-sector investment in fertilizer supply is one of the priorities of COMESA, of which DRC is a member. A partnership between COMESA and the South Africa-based African Fertilizer and Agribusiness Partnership (AFAP) aims to develop regional trade in fertilizer by strengthening agribusiness SMEs and integrating farmers into markets, thus increasing competitiveness. To promote growth in the trade of fertilizer between member states, COMESA and AFAP aim to:

- Establish a fertilizer trade facility that will invest in medium-scale enterprises trading fertilizer in member states; and
- Work with member states on the harmonization of national policies, laws and regulations to enhance the flow of fertilizer trade in the region.[78]

DRC's representatives at COMESA, headquartered in Lusaka, should promote Katangan interests in negotiations to meet these goals.

As a poor, primarily landlocked (DRC has a small strip of Atlantic Coast and one port as well as several river ports) Central African country, DRC's low fertilizer use is perhaps predictable: on average in 2010, landlocked African countries use 0.6 kg/ha, while coastal countries use 1.2 kg/ha; low-income African countries use 1.0 kg/ha, compared to 2.5 kg/ha for countries with upper-middle incomes; Central Africa uses about 0.2 kg/ha, but Southern Africa uses 5.4 kg/ha.[79]

3. CROP CHEMICALS

Large-scale farmers use herbicides in place of weeding as part of their capital-intensive approach. They use pesticides and fungicides where they prove cost-effective. Poor rural dwellers with small farms use a labor-intensive approach and shun herbicides. Those growing high-cost horticultural crops may use pesticides or

[78] D Nawa 2014. 'COMESA, AFAP partner over fertilizer', *Zambia daily mail*, 20th November, https://www.daily-mail.co.zm/?p=11664; AFAP 2014. *COMESA and AFAP launch Joint Fertilizer Programme*, 13th November, http://www.afap-partnership.org/what-we-do/press-releases/comesa-and-afap-launch-joint-fertilizer-programme.aspx ; and AFAP 2014. *COMESA and AFAP discuss modalities on a joint fertilizer policy and regulatory harmonization in the region. 24th November,http://www.afap-partnership.org/what-we-do/press-releases/validation-workshop-commences.aspx*

[79] K. Sebastian 2014. *Atlas of African agriculture research & development*, International Food Policy Research Institute, Washington, 4

fungicides but other small-scale farmers do not. Small-scale farmers need instruction about the safe use of these chemicals.

4. MECHANIZATION

Large farmers have their own tractors and other mechanized equipment, as necessary. The farm sizes of very small farmers do not justify the use of tractors. In between these extremes, farmers with medium-sized farms, e.g., 10–50 ha, already using improved seeds and fertilizer, could benefit from mechanization but are far from being able to afford to buy a tractor. For these intermediate cases, tractor-leasing could solve the problem. Either on a daily fee or charged by the hectare, a tractor could plough or harrow the land. Limited tractor-leasing is already available but, with agricultural growth, there are opportunities to expand the market. For many entrepreneurs who may consider this option, the main problem is credit to buy the tractor, but there are two other considerations: starting such a business where there is a strong concentration of medium-sized farms will make it more profitable, avoiding high transport costs and long down-times between successive fields to be prepared is important; and finding work for the tractor outside the main periods of agricultural activity is important in order to keep it working.

5. AGRIBUSINESS INFORMATION

To share technical information about production and commercial information that will allow farmers, traders and processors to take advantage of business opportunities otherwise unknown, a market-information service would integrate the agricultural economy. Most agribusiness operators know the value of good market information and can take steps to ensure that they have what they need to buy and sell at profitable prices. Many copper-belt farmers on poor feeder roads off the main Kolwezi-Lubumbashi road do not have the same advantage, though they understand the potential of such information.

Two sources of information could radically alter the unfair playing field that results. Firstly, an agricultural price information system would provide basic data on prices of inputs and agricultural products in reference markets, perhaps initially only for Kolwezi, Likasi, Lubumbashi and Kasumbalesa. If the main target audience for this information is small-scale farmers, the best way to make it available would be through FM radio broadcasts several times a week at times, perhaps in the early evening, when most people are at home. Secondly, more general information beyond prices would include details of who has what to sell: a new input supplier wants farmers to know about his promotional prices for fertilizer; the caterer for a mine wants to buy 20 t of maize for delivery in three weeks; Minagri wants to air information about the dangers of counterfeit veterinary drugs on the market, etc. Advertising revenue could enable such an intervention to break even, if not make a profit. The goal would be a vibrant, sustainable exchange of information that makes agriculture more productive and agribusinesses more competitive and efficient. The only part of this that currently exists is a price information system for horticultural produce in Lubumbashi markets, providing prices in markets and supermarkets in printed bulletins for women producing vegetables in the Lubumbashi suburbs, supported by the APEFE project. The project is interested in sharing its information by radio.

Separately, cellphone-based market information systems exist in many emerging economies. For a small fee deducted from their cellphones, farmers and traders can get specific price information that is of importance to them, e.g., today's price of urea in Kasumbalesa. Conversely, if they contribute information, e.g., today's price of maize in Kolwezi, they receive a cellphone credit. Systems have to be put in place to avoid false information; reputations have to be built for honesty. Like the FM radio program proposed above, it should be possible to structure the cellphone information system first as a project, then as a viable business—or as a startup with project support.

D. FINANCE

Most Katangan farmers have difficulties obtaining finance and financial services for agriculture. The same is true for those in agribusiness further down the value chain.

1. CREDIT TO AGRICULTURAL VALUE CHAINS

Large, non-DRC farmers can often access credit abroad for multi-year projects at rates of, say, 5–10 percent per annum, but local farmers have greater difficulty. Large Congolese farmers and agribusiness operators may be able to obtain credit from DRC banks for activities with relatively short payback times, perhaps up to two years, at rates of up to 2.5 percent per month. Small Congolese operators in the agribusiness sector obtain almost no bank finance. They may have access to micro-finance but the scale of many of the plausibly profitable projects they wish to undertake would be better financed by banks. On the other hand, some small borrowers, often women focused on ensuring their children can attend school, use microfinance quite successfully.

Three banks lend for agriculture: Pro Credit Bank (a subsidiary of the Frankfurt-based KFW bank), Ecobank (based in West Africa) and TMB (Trust Merchant Bank, based in Lubumbashi). Together they represent the start that the Congolese financial sector has made to mainstreaming agricultural credit, but it is still timid. KFW has required Pro Credit Bank to diversify its portfolio, at least partly by making loans to economic operators in agricultural value chains. Examples have been the creation of a small dairy plant to make yoghurt, broiler production, and a building related to fish-farming. Pro Credit Bank's interest rates range from 1.6 to 2.5 percent monthly. The rate falls with the principal borrowed and with shorter terms (but terms beyond two years seemed fairly unlikely). Loan officers have some discretion to reduce rates. In addition, borrowers have to pay additional fees.[80] Pro Credit's Lubumbashi branch has not managed to make more than ten agricultural loans. Its agricultural loans department notes difficulties in finding clients who meet their requirements for accounting documentation and clean title to properties that would serve as loan guarantees. Staff include no agronomists. In an ambivalent approach, the bank advertises on TV that it makes agricultural-sector loans but does not make efforts in other ways to increase the size of its agricultural portfolio.

The description above is not unfamiliar in other African countries. Potential borrowers with energy and an otherwise bankable proposal lack some combination of a clear business plan, formal accounts and a suitable loan guarantee. Perhaps as importantly, they do not understand banking principles and how bankers approach lending. Conversely, bankers do not have a good understanding of agricultural value chains and may have a social distance from their potential clients. There is an intellectual and cultural divide that itself requires investment to bridge. A partial loan guarantee for a portfolio of agricultural loans would increase the likelihood of a higher disbursement rate but would not necessarily mainstream agricultural loans. This requires frequent contact between dedicated loan officers and potential clients in an institutional forum that both respect, so that the loan officers imbibe the range of options, the problems and incentives of the enabling environment, and the culture of the agribusiness sector. Ideally, those with banking experience would mentor and coach the loan applicants to help them jump through the hoops that banks present, not only to obtain credit but to manage the project to meet the applicant's goals and those of the bank. It would take commitment at a high level within a bank to develop such a constructive agribusiness-friendly environment. But it would greatly increase the chances of success of a credit-guarantee scheme.

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[80] Borrowers pay a commission of 2 percent on the initial principal and a fee of 0.5 percent of the initial principal plus US $775 to the land registration office for the certificate that confirms property as a guarantee.

2. MOBILE BANKING

Mobile banking allows transfers of funds from one cellphone to another, with the recipient able to travel a short distance to a cellphone company bureau where she can convert the credit she has received into cash. This is a fast, cheap and safe way of transferring money. Vodacom DRC operates MPesa mobile banking, with a maximum daily transfer limit of 3.0 million FC (US $3,000). This would allow payment for 120 sacks of maize or 55 sacks of fertilizer. In contrast, most mobile-money users currently send only US $20-30 at a time. Operators in the value chains studied do not currently make use of mobile banking despite good cellphone coverage on and near the main road through the copper-belt because mobile banking is a recent phenomenon that they do not yet know (and trust), and because the cellphone companies lack a network of agents in rural areas who can convert mobile credit into cash.

ELAN intends to promote mobile banking, not just to transfer funds but also to provide a virtual savings bank for clients. The project had considered integrating credit into the mix but decided that this would likely generate too many problems. To the extent that ELAN implements this initiative in Katanga and includes agribusiness operators, this would be a useful service to reduce costs of doing business and speed up commercial transactions. For instance, it would partially meet the deficit of financial savings options that TFM has encountered in trying to shift the surplus of maize that its successful promotion of more intensive agriculture produced.

E. GENDER

Women dominate horticultural production, as well as retail marketing of maize, beans, soya beans and vegetables. They participate equally with men in the wholesale marketing of maize, beans, soya beans and vegetables. Though microfinance institutions consistently note that they manage credit better than men, women rarely seem to graduate to bank credit for companies they own and manage. This appears to be largely because they are socialized to limit their expectations to taking care of their children, particularly ensuring that available funds can cover their school and health-care fees.

A younger generation of women, who are better educated and with wider horizons, should be encouraged to expand their agribusinesses and to formalize them, particularly if bank credit would play an important role in expansion.

F. YOUTH

Unemployment and underemployment are wastes of resources in an economy. They also have a lamentable social impact and may be politically dangerous. Youth unemployment is a particular problem because it constitutes a potential source of instability: unemployed young men can channel their energies into rebellion of various sorts. At present, many young men and women in rural areas in Katanga work hard on unprofitable family farms. For parts of the year at least, they are not underemployed. Indeed, they may be overworked at key points in the agricultural calendar. However, their problem is that they work on small labor-intensive farms without improved seed and, at current exchange rates, the crops they produce are not competitive with imported equivalents. Their families sell the crops at a loss, particularly if they include the cost of their own labor: they can consume these crops themselves so they generally have a granary that gives them the reassurance that they will not starve. They can eat and they can sow again next year. But merely averting food insecurity is not an optimal solution. Considering alternatives, many youth realize that it would be better to find another way to earn a living and then buy food in the market to meet their needs. Anyone working on a small family farm in Katanga confronts this issue. However, whereas older folk may be willing to accept the status

quo and are wed to the system they have inherited, young people are more prepared to get up and go elsewhere to find something better. Young men have the mines as an alternative and many take that option. Young women may be equally willing to leave the farm but relatively few of them find jobs in the mines. Particularly around Kolwezi, the second-largest city in Katanga, with soils that are not as rich as those in the Lufira Valley around Likasi, an aging farming population bears witness to the flight of youth from agriculture.

Pro-youth development essentially means providing jobs for young people, however defined. There are two routes to providing employment for youth, indeed for the entire population. The first is to aim for large amounts of labor-intensive jobs. This approach increases employment in the short run but, in the long run, it is a dead-end solution because it does not improve productivity and thus raise incomes. The second route is to incorporate labor into new production systems with more capital and better technology. To the extent that the wages and profits from this approach are spent locally, the resulting multiplier effects will generate more agricultural and non-agricultural jobs. More jobs reduce unemployment; jobs in a diversity of sectors provide greater economic stability.

Making agriculture more profitable requires greater productivity. The ways to achieve this are through the knowledgeable use of high-yielding seeds and chemical fertilizer (in combination with organic fertilizer). The yields that this combination can generate will allow the family to feed itself and produce a surplus for sale. The local spending of the revenue from sales generates the multiplier effects, spreading the wealth within the community and supporting a range of other professions. Young men and women can then leave the farm, if they choose, for local work the salaries for which will have to compete with the returns from profitable agriculture. Larger farm sizes will reap additional benefits from economies of scale, increasing the profitability of family farms and thus the multiplier effects. In this way, agriculture can provide a plausible alternative to mining jobs.

One large farmer near Fungurume has started a scheme to work with local farmers who want to increase their productivity. In a joint venture, the large farmer clears the land with a tractor and supplies fertilizer and high-yielding seed. With the formerly arduous work now done, the local farmer then takes over, completing the rest of the agricultural tasks by hand. At the harvest, they split the harvest of 6t/ha, with the large farmer taking 2t/ha and the small farmer taking the rest: 4t/ha. The large farmer used his resources to spread his risk and makes a modest profit; the poor farmer's part of the harvest is four times as great per hectare as he would otherwise have had. ELAN is working with the large farmer to extend this scheme. Katanga has enough available land to reproduce this system many times over and make a sizeable impact on rural poverty. It would also allow Katanga as a whole to compete with different but similarly efficient production systems in Zambia and successfully substitute for imports.

XIII. KATANGA: MAIZE VCA

A. PRODUCTION

Within 200 km of the copper-belt in every direction, whether in DRC or Zambia, the dominant farming system is "maize mixed".[81] However, Katanga's land productivity for staple food crops in 2000 was below the African average, lying between US $250 and US $500 per hectare, whereas, for instance, production of staple crops in large parts of northern Kasaï Oriental generated over US $1,000/ha.[82] This reflects little use of improved seed and fertilizer, as well as a low level of improved techniques and mechanized technology, combined with limited economies of scale.[83] Across Africa as a whole, maize yields and the area of maize cultivated have each doubled since 1960,[84] generating a fourfold increase in maize production over this roughly 50-year period, but not in Katanga. The low profitability does not reflect the absence of effective demand for maize (or other crops): in addition to the three large cities of the Katangan copper belt, a good road connects it to its nearby Zambian counterpart and to Lusaka, each with a population of over two million. Now ranked as a "lower middle income" country,[85] Zambia had a GDP/capita of US $1,700 in 2012, so it has the income to buy Katangan maize if it were to be competitive.

Maize has become the urban staple in southern Katanga and it continues to replace cassava in rural areas. However, local production has not kept pace with this growth in consumption. Katanga as a whole imports about 70 percent of its maize, principally from neighboring Zambia. Zambia has a distinctly different enabling environment for farmers than does DRC. Its farmers receive subsidized fertilizer, agricultural mechanization is much more widespread than in DRC, and Zambia has over 300,000 ha of irrigated land, a large part of which serves for maize cultivation.[86] The result is high year-round yields of maize at a low cost.

High yields are demonstrably possible in Katanga too. Although small farmers there obtain yields of about 1.0 tons per hectare, large-scale farmers may get greater than 10 tons per hectare. While small-scale farmers are so

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[81] C Auricht et al. in K. Sebastian 2014. *Atlas of African agriculture research & development*, International Food Policy Research Institute, Washington, 14-15

[82] U Wood-Sichra and S Wood in Sebastian (2014: 30-31)

[83] As a poor, landlocked Central African country, DRC's low cereal yields are perhaps predictable: in 2010 on average, landlocked African countries produced 1.2 t/ha, while coastal countries managed 1.7 t/ha; low-income African countries produced 1.2 t/ha, compared to 2.2 t/ha for countries with upper-middle incomes; yields in Central Africa averaged 1.0 t/ha, but Southern Africa achieved 3.6 t/ha. Source: S Wood and K Sebastian in Sebastian (2014:4)

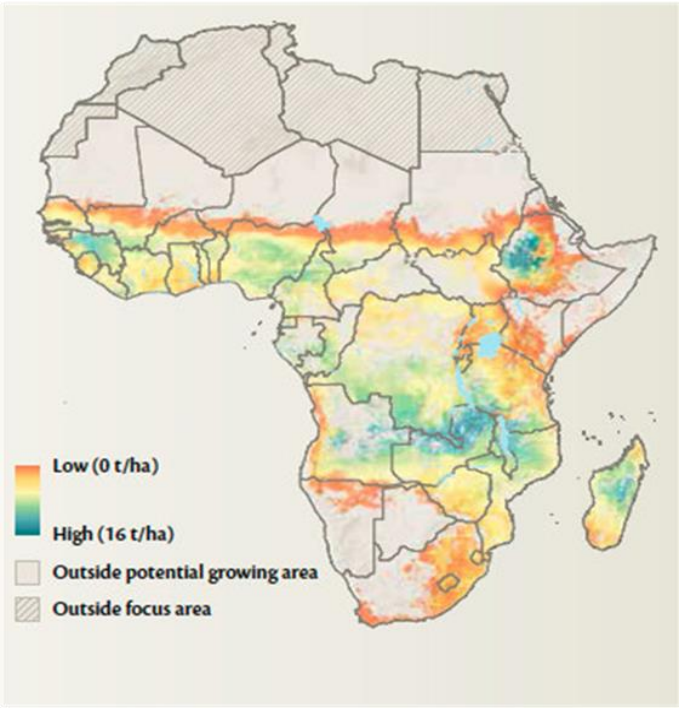
[84] U Wood-Sichra in Sebastian (2014, 20)

[85] Wikipedia, *Economy of Zambia*, http://en.wikipedia.org/wiki/Economy_of_Zambia and The World Bank, *Data: Zambia*, http://data.worldbank.org/country/zambia

[86] In contrast with Zambia's 300,000+ ha of irrigated farmland, DRC has about 10,000 ha. However, it is probably erroneous to suggest that irrigation might be an important part of the solution to Katanga's poor maize productivity. Zambia has lower rainfall, a shorter rainy season and greater rainfall variability than Katanga and so benefits more from irrigation more than Katanga would. Katanga's inter-annual rainfall variability of 15-25 percent is lower than Zambia's. (Source J Koo and C Cox in Sebastian (2014: 44-45). However, it still presents risks of inter-annual variability of maize production, but this must be compared to the high cost of irrigation infrastructure. Technically efficient inter-annual maize storage is probably a better investment to buffer this variability than irrigation schemes.

unproductive that they are actually losing money if they sell their maize, particularly if their time is taken into account, large-scale farmers produce so efficiently that they could profitably win market share in Zambia (if it were not more profitable to substitute for imports).[87] Figure 12 shows that this makes sense: both northern Zambia and the Katangan copper-belt, shaded green and blue, are among the privileged parts of sub-Saharan Africa where maize yields of up to 16 t/ha are possible. Compared with Zimbabwe and South Africa, which have historically been viewed as Southern Africa's breadbasket, Katanga and northern Zambia are the maize-production zones of the future.[88]

Figure 12. Map of Potential Rain-Fed Maize Yield



Source: J Koo in Sebastian (2014: 58-59)

How can Katanga achieve its high-yield potential for maize? There are two steps. Firstly, farmers should use improved seeds and appropriate quantities of fertilizer tailored to their mix of soil and crops. In this way, over six years, the TFM mining company has helped local small farmers to increase their maize yields from 0.8 t/ha to 5.3 t/ha. Achieving this increase requires a cost-effective means to ship fertilizer to the farm. At the moment, only a few locations off the main road are easily served by trucks. Accessibility creates a second constraint. Once farmers produce far more than their households can consume, they need to be able to ship the surplus to market. The roads will limit the extent to which farmers can benefit from increased yields. Agricultural land near roads will become much more valuable and pressure to build and/or maintain roads will grow. As production increases, investments in improved storage technology will become more profitable. Even if renting a truck is very expensive, when many farmers want to truck their increased production to market in the immediate post-harvest period, with storage that limits losses, the farmer can wait until later in the year when trucking becomes cheaper. Secondly, mechanization can increase the cultivable areas of their farms, multiplying the yields accordingly, but creating

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[87] An average-sized farm of 1.0 ha uses almost no marketed inputs and produces about 1.0 t/ha, for which the market price is about US $300, though the small farmer's household may consume most of it. Although farming a hectare of maize is not a full-time job over the five-month growing season, it absorbs maybe half his time, it is arduous work, and there is the risk of drought or other factors that may reduce the yield. If he were to do a menial job in a mine, he would earn more than this sum in a month. In contrast, a commercial farmer invests about US $1,300/ha to produce 6.0–10.0 t/ha. At 6t/ha, his revenue is US $1,800/ha and his profit is US $500/ha; at 10t/ha, revenue is US $3,000/ha and profit is US $1,700/ha.

[88] To a lesser extent, the 500 km x 300 km western part of Katanga, shaded green on figure 12, is also a potential breadbasket. Now relatively inaccessible, it is best served by the refurbished Benguela railway to Lobito port. However, roads to the railhead are not good. Once the rehabilitation of the extension of this line to Lubumbashi has happened, producers in the southern portion of this zone will have relatively easy access to rail transport and exports of maize through Lobito seem a plausible prospect. Alternatively, they may ship their maize east to contribute to import substitution for Katanga and, ultimately, ship it further down the railway for sale to Zimbabwe and South Africa. New roads through this zone linking to the railway would open up large parts of this area. The important question will be where to stop so that tree cover, an important determinant of rainfall patterns, is not excessively disrupted.

even greater bottlenecks in road transport and storage. As producers farm much of Katanga in a shifting-cultivation (or long fallow-period) production system, a lot of additional potential farmland is available.[89]

Implementing the first stage (increasing agricultural productivity) requires technology transfer in the form of demonstration plots, public and/or private extension systems, access in person or by radio to agronomic advice, as well as extended seasonal credit and, to ship the greatly increased quantities of fertilizer needed, development of road-transport infrastructure, and a larger fleet of more efficient trucks. Allowing farmers to fully profit from marketing their surpluses generated due to intensification also requires more trucks on better roads, but also more and better storage capacity, and easy access to accurate market information. TFM and MMG mining companies have good experience in parts of these processes.

Microfinance would be stretched to fund a package of inputs for small farmers to implement first-phase high-yield cultivation. To farm 1.0 ha optimally, a farmer requires 25 kg of hybrid-maize seed (US $125), 300 kg of urea (US $300) and 300 kg of NPK (US $300), totaling US $725. (The rest of the inputs consist mostly of family labor.) Summary statistics for microfinance institutions (MFIs) in DRC for 2003-2014 show a total of 203,665 borrowers receiving US $180.2 million in loans, yielding a mean loan size of US $885.[90] Thus the magnitude of the loan per farmer would fall within MFI norms, but any MFI would want to limit its exposure to this type of loan in a given province because the risk of crop failure would be highly correlated among farmers, creating an imbalanced loan portfolio. The provincial Ministry of Agriculture uses the figure of 3.0 million small-scale farmers in Katanga. Finding finance for each of them in the short run would seem to be out of the question. However, there is no practical way to transport 600 kg of fertilizer to most Katangan farms, severely limiting the number to include in the first phase. Secondly, compromises in the level of fertilizer application would reduce the loan per farmer. Thirdly, it should be possible to make a systematic start to making credit available across MFIs, spreading the risk.

Implementing the second stage is largely an exercise in making more credit available for leasing of tractors and other mechanized equipment. Another consideration at this stage is replacing trees removed as agriculture expands. Planting eucalyptus as raw material for charcoal production would be an important part of any agricultural program to increase agricultural production. This would limit deforestation and thus global warming, mitigating changes in weather patterns and retaining biodiversity.

Twice in recent history, in 2007 and again in 2011, government tried to set up a tractor-leasing sector. In both cases, the tractors did not find their way to entrepreneurial private-sector operators. If another attempt is to be made, it is essential that the equipment be channeled to private-sector operators with an incentive to make them productive.

The Youth section below features an example of a joint-venture between large and small farmers, whereby the large farmer provides land, tilling services and credit for inputs and the small-scale farmer provides the labor for the rest of the cultivation, with a division of the harvest.

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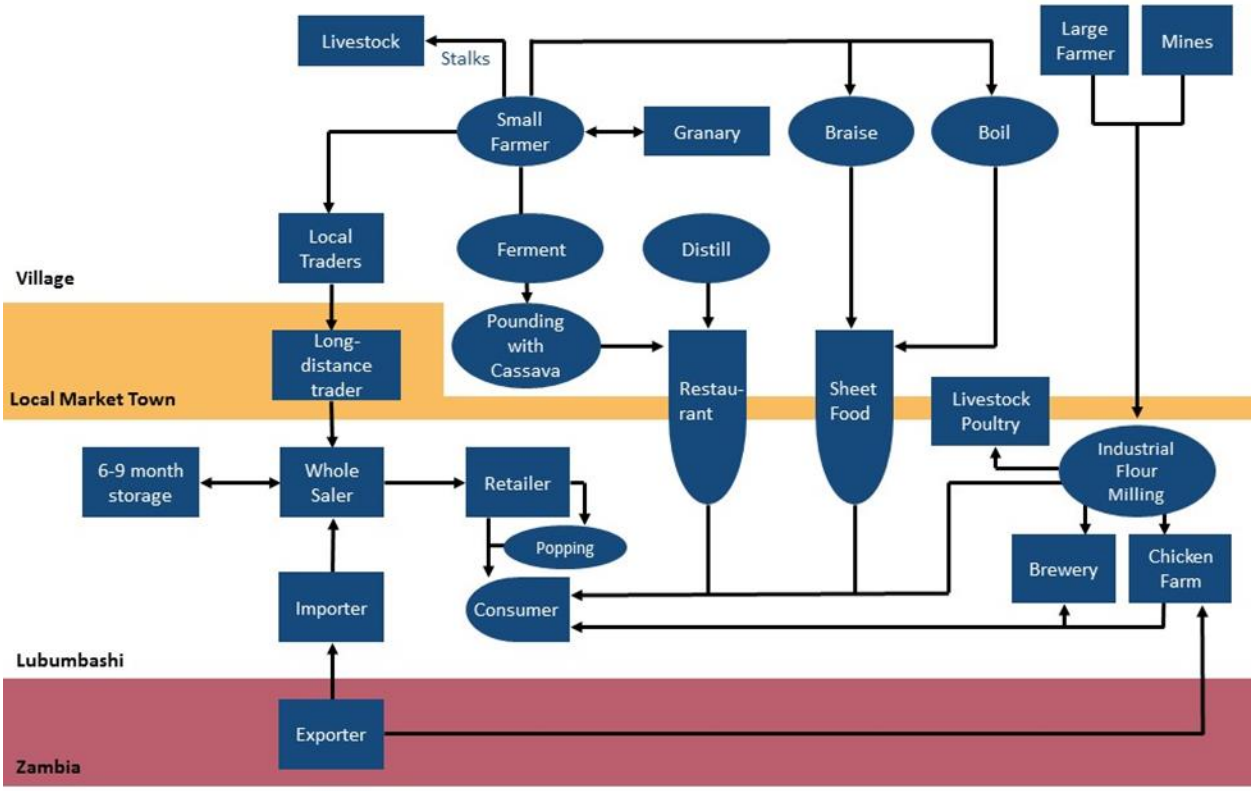
[89] S Siebert et al. in Sebastian (2014: 28-29) show that the study zone has between 0.2 and 0.4 harvests per year. The explanation for this low number is doubtless shifting cultivation.

[90] MixMarket, *Congo, Democratic Republic of The Market Profile*, http://www.mixmarket.org/mfi/country/Congo,%20Democratic%20Republic%20of%20the

Figure 13. Maize Value Chain Map—Katanga Copper-Belt



B. MARKETING AND PROCESSING

Katangans consume about three million tons of maize, of which about 70 percent is imported, mostly from Zambia. It reaches consumers in a variety of forms and by a variety of routes.

After harvest, the farmer removes the ears from the stalks, which go to animal feed. On average, he retains 20-25 percent of the harvest for his household consumption. Between a quarter and a fifth of the maize is eaten on the cob, either braised or boiled. Through a chain of traders and cooks, the cobs reach consumers as street food. Specific varieties are grown for the purpose, but little of this form of maize is sweetcorn. For all other uses, the maize is in the form of grain. An estimated 20 percent of this is fermented, for two purposes. One part is lightly fermented and pounded with cassava to make a dish often found in restaurants. The larger part, accounting for 20–30 percent of rural maize consumption, is more fully fermented and then brewed and distilled to produce a strong liquor, most widely consumed in rural areas but also available in towns and cities.[91] Bralima, Brasimba and Bracongo all brew maize-based beer in Lubumbashi; Bracongo also brews in Kolwezi. The breweries use large quantities of yellow maize.

[91] Consumption of the distilled liquor has deleterious effects on health, family economics and crime. Relative to rural inhabitants, urban dwellers consume a higher proportion of beer than spirits because the industrial breweries are located in towns and because the cost of transporting glass bottles to rural locations is high.

The largest part of the marketed maize grain goes into a trading chain that takes it to wholesalers in towns and cities. Two types of small trader buy maize grain from smallholder farmers after the harvest. Before the farmer sows his seed, the first type of trader advances in-kind credit to the farmer, which takes the form of seed and fertilizer, along with clothes for members of his household. At this point, they agree on the volume and price of the maize that the farmer will sell to the trader after the harvest. The second type of trader does not grant credit to the farmer but attends the small markets near his farm and buys maize in the immediate post-harvest period when the price is low. Both types of trader rent trucks to transport the sacks of maize bought to a Lubumbashi warehouse, typically with a total capacity of less than 100 tons. They stuff the sacks into the warehouse, without leaving space for air to circulate through pallets beneath the sacks or without constructing stacks of sacks around which air would circulate. They thus maximize the storage volume without optimizing the storage conditions. Their management is deficient in other dimensions: they use little chemical pesticide to limit weevils and other pests and their stock rotation is rudimentary. Either type of trader may turn over his stock quickly and buy more, making small margins on a large turnover or may instead speculate on seasonal maize prices, only selling six or more months after buying to make a considerable profit on the contents of his warehouse. Together, small traders using these strategies account for an estimated 20 percent of the supply not met by own-consumption.

Inventory discussion in a Katangan storage facility

Zambian traders supply maize to the Katangan market; Tanzanian traders supply maize and maize flour. Together they account for about a further 30 percent of the market. Governor Moïse Katumbi Chapwe's company, Établissement Katumbi, provides the remaining portion of the province's marketed maize supply, mostly in the form of flour (see table 37).

MAIZE WHOLESALING

A female maize wholesaler interviewed in the Lubumbashi's *marché de Zambia* had started business in 1991, renting her premises. Reinvesting her earnings, she had then bought a plot of land and built her current depot, consisting of storage for four thousand 100 kg sacks of maize, an office and a covered work area. Four men work for her full-time. She also deals in beans, soy and other dry agricultural goods. Mostly she buys from Congolese wholesalers who bulk up volumes of commodities at rural markets and then come to her depot, but sometimes she travels to upstream rural markets within DRC to buy more cheaply. She is aware that she has little formal technical knowledge of storage techniques but, as she sells the maize as soon as she can after buying it, she does not have big problems with weevils consuming her stock. Her oldest stock was about five months old. Her ambitions would be (1) to have a vehicle so that she could capture the profit of that upstream portion of the market chain, (2) to buy a maize mill, and (3) to double her depot's storage capacity. 200 meters from the wholesaler's depot, where she actively oversees buying, cleaning, re-measuring and reselling maize, another depot was full of maize and closed, suggesting an alternative strategy: seasonal arbitrage. The competitor buys in the post-harvest period and then locks the door for at least six months, counting on prices rising over the seasons until the hungry season, at which point he liquidates his stock.

Maize storage encounters the threat of insect infestations, particularly from weevils. The keys to controlling these post-harvest losses are thoroughly cleaning equipment coming into contact with the grain, avoiding mixing old and new grain, avoiding moisture, monitoring for insects, prudent use of insecticide and ultimately fumigation.[92] These steps apply equally to storage of beans and soy beans.

In Lubumbashi, the domestic and imported channels of maize supply converge. Imported maize arrives mostly at the *marché de Kenya*, rather than at the *marché de Zambia*.

Table 36 shows the prices and gross margins at various points along the domestic maize marketing chain supplying Lubumbashi, as related by the female wholesaler in the *marché de Zambia*.[93] Four sales take place along the chain, with the farmer receiving two-thirds of the retail price. The rural wholesaler takes the highest gross margin, which includes the cost of transport to bring the maize to Lubumbashi. Road transport for a 50 kg sack of maize costs 3,000 FC, i.e., 60 FC/kg. The retail volume measure equates approximately to one kilogram (quantification of maize for all wholesale and retail transactions takes place by volume, using a standardized plastic pail). So trucking accounts for about 40 percent of the rural wholesaler's gross margin, to which may be added handling, including loading and unloading. His net profit is thus less than the urban wholesaler, whose function is to clean, measure, store and sell.

Table 36. Prices and Gross Margins for Maize (FC per retail measure)

Location on the value chain	Price	Margin
Producer	600	
Rural wholesaler	750	150
Urban wholesaler	850	100
Urban retailer	900	50

An independent observer claims that oligopolies exist in the marketing chains for most agricultural commodities in Katanga. When a farmer or small trader arrives in a marketplace he must sell to a member of a cartel, which sets an artificially low price. To test this assertion would require more information about the different stages of the marketing chain and their cost basis than this study gathered.

Other than distinguishing between white and yellow maize, no grading exists for maize. Consumers prefer white maize for food, the yellow (richer in carotene) for brewing and feed. However, yellow is used for corn-on-the-cob. Some peri-urban maize producers grow sweetcorn for the urban market and some specialize in production of maize for popcorn. These are seasonal niche producers, each with a short, dedicated market chain. The sweetcorn chain is particularly short because of its perishability.

Consumers of maize as food in Katanga buy about 70 percent of it in the form of meal, which takes two forms: whole-maize and refined "breakfast" (with the bran removed), which urban dwellers prefer, though it is less nutritious. Both industrial and artisanal mills produce these products in Katanga. The main industrial maize mills are African Milling Company near Lubumbashi and Gécamines in Lubumbashi, Likasi and Kolwezi. African Milling Company (Congo), starting production in early 2015, and has a production capacity of 150,000 t/year. There are also medium-sized mills selling the same products at the same price—and many

[92] See, for example: D. Johnson and L. Townsend n.d. *Controlling insects in stored grain*, University of Kentucky College of Agriculture, ENTFACT-145, http://www2.ca.uky.edu/entomology/entfacts/ef145.asp

[93] In table 36, the price given is the price at which the named seller sells. The producer sells at the farm gate or her local market; the rural wholesaler sells in Lubumbashi to the urban wholesaler; the urban wholesaler sells to the retailer; the retailer sells to the consumer.

small mills, particularly in rural areas. Imports provide much of the maize meal: all imported maize is breakfast.

SCAK wants to take over three non-functioning maize mills formerly operated by Gécamines, one each in Lubumbashi, Likasi and Kolwezi. SCAK officials relate that the mills are fundamentally sound but need some work to restore them to full functionality. Their total milling capacity is 300,000 tons per year. They calculate that SCAK members producing 8 t/ha of maize brings the export parity price of maize flour down to US $328/t at Kasumbalesa, which is competitive with Zambian imports. The mills can also produce animal feed and crush oilseeds to produce cooking oil.

Katangans consume roughly 1,500,000 t of maize flour directly, independent of animal-feed requirements. From this figure should be subtracted an unknown part that is inefficiently milled locally from locally produced maize, which industrial mills cannot outcompete because of transport costs. The combined African Milling Company and ex- Gécamines mills would create a total industrial milling capacity of 450,000 tons per year, almost a third of total current consumption. Government policy is to increase Katangan industrial milling capacity, as well as commercial farmers who grow enough maize to satisfy that capacity.

Table 37. Competitive Position of Maize Products of Various Origins

Origination	Advantages	Major barriers to entry (disadvantages)	Markets served (within study)
Northern Katanga	• Organically grown	• High transport costs	• northern Katanga • Kasaïs
Katangan copper-belt	• Low-price production (large producers) • Organically grown (many small producers) • Good transport (near the main road)	• Poor transport (away from the main road) • Low productivity (small producers)	• Katangan copper-belt
Zambia	• Large irrigated area (> 300,000 ha) • Large fertilizer subsidies • Low-price production • Katangan governor is a major importer	• na	• Zambia • Katangan copper-belt

C. END-MARKET COMPETITIVENESS

Existing market demand for maize is high at all value chain levels: rural and urban consumers, rich and poor, are increasingly consuming maize, rather than cassava, as their staple. Maize is currently uncompetitive with respect to imports from Zambia. Its quality does not differ from that from Zambia. Market access for maize is, on average, medium, i.e., there are no particular difficulties or advantages in marketing maize from copper-belt farms, relative to other crops.

Buyers can choose between Katangan and imported maize. They have little access to market information but there is some question about how they might benefit from such information, given the constraints on where and when they buy. In practice, buyers cannot go round the cartels to which sellers must sell in markets, and of the existence of which they may be unaware.

Table 38. End Market Analysis for Maize

	Katanga copper-belt		
Supply to:	Own consumption	Local market	National DRC and export markets
Rating	*Strong* Staple foodstuff	*Medium* Staple foodstuff	*Very Low* Better to focus on import substitution

Input markets may suffer from oligopoly in importing but, once the inputs have reached Katanga, markets seem competitive.

D. BENEFIT–COST ANALYSIS OF POTENTIAL INTERVENTIONS

A productive USAID-financed investment in maize production at the smallholder level requires a dedicated extension system (monitoring and support to the individual farmer, in combination with demonstration plots and local meetings to discuss progress), timely delivery of inputs, and credit. It should target motivated farmers not already using improved production methods located within easy reach of the main road, so that they can easily market their increased production and avoid contributing to local gluts.

Private-sector extension companies should compete with each other for contracts to coordinate and advise on this initiative, in collaboration with the provincial Ministry of Agriculture, ASARECA's Eastern and Central Africa Maize and Wheat Research Network, INERA, UNILU and SENASEM. It is suggested that the Ministry of Agriculture give members of its extension division the opportunity to participate full-time in private-sector agricultural-extension companies, with the guarantee of their jobs back for up to two years.

A reasonable assumption is that small farmers can increase their productivity from about 1.0 t/ha to about 3.0 t/ha as they learn to manage the new system; once fine-tuned, they should be able to attain 5.0 t/ha. At a farm-gate price of 340 FC/kg, this would represent an initial annual gross increase in revenue of 680,000 FC for a farmer using this improved farming system or US $1.98/day. Allowing for repayment of credit for inputs but the use of family labor, the net revenue increase would probably be of the order of US $1.50/day, rising to US $3.00/day as productivity rises to 5.0 t/ha. The extra benefits per person would vary according to household size.

Motivated medium-sized farmers could receive the same package of assistance as small-scale farmers, but with the addition of mechanized soil preparation. In both cases, a credit package will be necessary, probably via MFIs for small farmers and via banks for medium-sized farmers. A problem of cumulatively massive credit for very closely correlated risks could make the financing system unworkable, particularly if climate change were to make crop failure more frequent, but if multi-year credit and savings schemes with high interest rates were available (perhaps via mobile banking) this would allow farmers time to recover from one or

two bad years. Particularly in this context, breeding more drought tolerant maize (and soy and beans) becomes imperative.

Table 39. Performance of the Maize Value Chain against USAID Objectives

Criteria	Rating	Justification
End market competitiveness	Low/High	Zambian imports compete year-round in urban markets. Small traditional Katangan copper-belt producers are uncompetitive; large commercial Katangan copper-belt producers are competitive.
Generating inclusive growth	High	As the second staple (after cassava), maize provides subsistence and basic employment to millions of households. In addition, there are thousands of poor maize retailers and hundreds of laborers employed in the supply chain (though about half of those jobs are based on Zambian maize). Preparation of food and drinks derived from maize creates many other jobs (but, again, partially based on adding value to Zambian maize).
Food security improved	High	Maize is the major source of calories and protein in the copper belt, particularly in urban areas. When consumed with beans or soy, it provides balanced protein. Maize stores well enough to last 12 months till next harvest.
Conflict-resilient and neutral	High	Maize may be stolen but this is not a big risk in the Katangan copper-belt.
Pro-women	High	Women are involved in up to 80 percent of small-scale production and retailing of maize, though less at the wholesale level, and derive income from these functions.
Benefits youth	Medium	Maize provides millions of household livelihoods, but the largely low-skilled nature of jobs is not ideal.
Climate-change robust	Medium	Production is more sensitive than storage, which is relatively resistant.
Synchronization or overlap with existing programs	Medium	ELAN is facilitating (1) a more efficient multiplication of maize seed by INSER and UNILU and (2) expansion of a joint venture between a large farmer (land, inputs, tilling) and small farmers (labor).

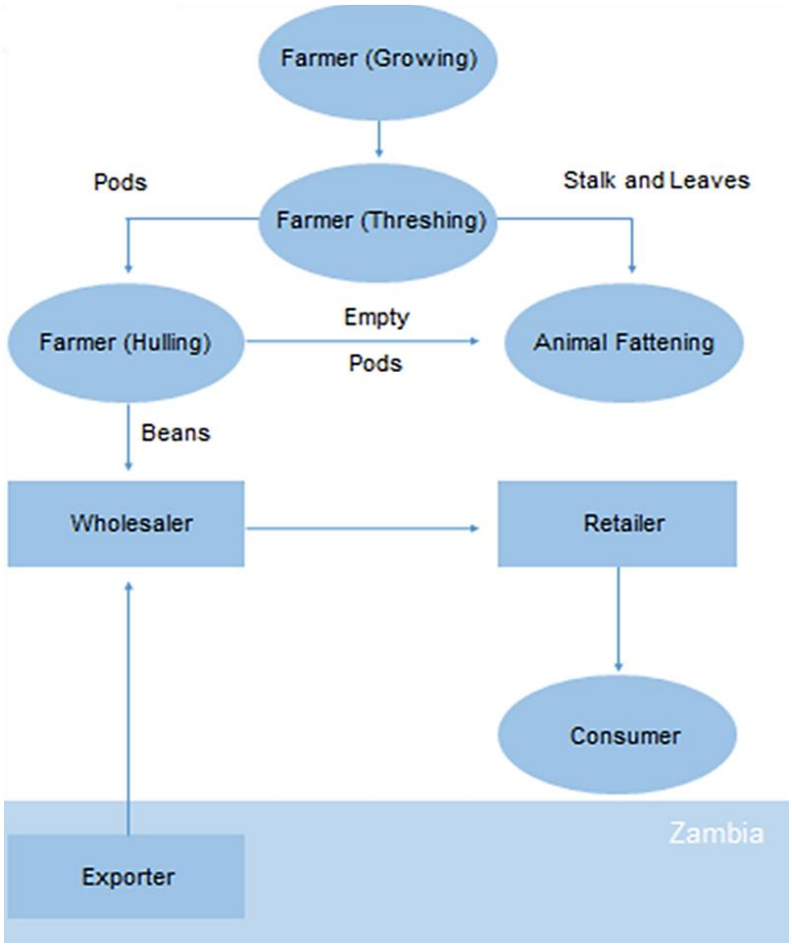
XIV. KATANGA: BEANS VCA

A. PRODUCTION

Beans are the third most important crop in Katanga, after cassava and maize, but they do not have as important a place in agricultural production as they do in the Kivus. Within the copper-belt, Fungurume area's soils and climate are particularly suited to bean production.

Farmers tend to sow their own retained bean seed, although improved seed is available from input suppliers.[94] They grow beans in combination with maize. Small farmers intercrop them so that the nitrogen-fixing beans fertilize the soil for the benefit of the maize. Intercropping 2–3 maize plants with 6 bean plants per m^2 can result in a 100 percent yield for both crops. Intercropping does not lend itself to large, mechanized farms where, instead, the farmer integrates one or two crops of beans after every two or three years of maize. The choice of one or two crops comes about because the bean production cycle is generally short enough to allow two seasons within the span of the rainy season. The first season lasts from October to January; the second season lasts from February to May.

Figure 14. Bean Value Chain Map—Katanga Copper-Belt



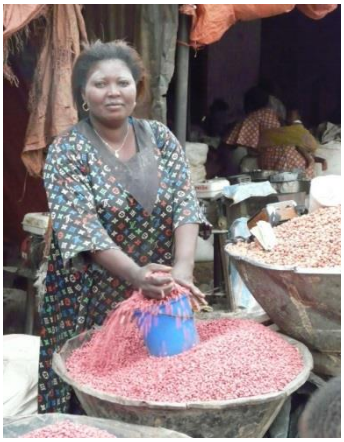
Whitefly is the biggest pest for the growing plant and may compromise production. Neonicotinoid insecticides can be ineffective—or counterproductive if they disrupt populations of whiteflies' natural predators. The neonicotinoids can be harmful if ingested and toxic to bee populations, thus compromising pollination and honey production.

B. MARKETING AND PROCESSING

After harvest, farmers thresh the bean plant to remove the pods and then hull the pods to obtain the beans. Animals benefit from all non-bean parts of plant as feed, with one exception: Lubumbashi households consume bean leaves as a vegetable. Farmers store much of the bean crop for their own household consumption.

[94] A Lubumbashi input wholesaler visited was not stocking improved bean (or soy) seed for 2014-15.

Unless they make use of pesticides, weevils and other insects begin to make serious inroads into their stocks, particularly noticeable from about two months after harvest. Farmers also sell some of their crop to wholesalers who confront the same problem for beans in storage but are more likely to use pesticides. The remarks about precautions to limit losses in maize storage in section XIII apply equally to beans.



The beans then enter wholesale and retail markets, often alongside imported equivalents. Beans are a traditional crop that sells well, certainly compared with soya beans. Its human nutritional importance lies in its amino-acid composition which complements that of maize for more efficient production of protein in the human body (see table 40).

Table 40. Competitive Position of Beans of Various Origins

Origination	Advantages	Major barriers to entry (disadvantages)	Markets served (within study)
Northern Katanga	• Organically grown	• High transport costs	• northern Katanga
Katangan copper-belt	• Low-price production (large producers) • Organically grown (many small producers) • Good transport (near the main road)	• High transport costs (away from the main road) • Low productivity (small producers) • Large producers' output grown every 3-4 years as part of a rotation based on maize	• Katangan copper-belt
Zambia	• Large irrigated area (> 300,000 ha) • Large fertilizer subsidies • Low-price production • Good transport	• NA	• Zambia • Katangan copper-belt
Tanzania	• Low-price production	• NA	• Tanzania • Katangan copper-belt

A bean wholesaler interviewed in Lubumbashi's *marché de Zambia* explained that she bought mostly local beans after the February and May harvests. Retailers interviewed at the *marché de Kenya* said that the Congolese second season harvest was four times larger than its first season harvest. Bean retailers in the city's *marché de Kenya* (where the majority of imported agricultural commodities arrive) said they bought and sold beans from the area around the city and from Zambia and Tanzania. Imported beans are the majority, and arrive in fairly steady quantities over the seasons, over which is laid the more modest local seasonal contribution. Much of these imports come from large-scale, irrigated production systems using improved seed, significant quantities of fertilizer, and mechanized production with subsidized fuel. Zambian and Tanzanian farmers growing them therefore have low production costs and, even after long-distance transport, their beans are competitive in Katanga. However, the retailers maintained that consumers have taste preferences and would pay slightly

more for local beans, *ceteris paribus*, with local beans selling for 3,700 FC against imported beans' price of 3,500 FC, a premium of 6 percent. They also stressed a marked preference for organic beans, which sell at a premium of 40 percent over the same beans grown non-organically. However, it seems unlikely that the volume of organic beans is significant or that organic bean production without fertilizer is more profitable for the farmer. The retailers explained that Tanzanian beans spoiled more quickly than Congolese beans (possibly because they have been selected from older stocks in Tanzania) and that the new, shiny beans from the February 2015 Katangan harvest sold better than Katangan beans from the previous season (which were dull and deformed).

Sales take place using small plastic buckets, which is the unit of measure at wholesale and retail level. At each level in the market chain, sacks are emptied for verification of quantity (using traditional measures of volume) and quality. At no point are the beans weighed. All transactions take place in cash.

Table 41 provides the prices and gross margins for beans and soy beans sold in Lubumbashi's *marché de Zambia*, according to a wholesaler based nearby.[95] The farmer receives 2,000 FC for her beans. By the time the beans reach the rural wholesaler, who can be male or female, the price has risen to 2,350, leaving 350 FC to cover assembly and transport costs, as well as traders' profits. Several individuals may be involved. This is the price at which the informant buys at her depot near the *marché de Zambia*. She sells to market retailers at 2,500 FC and believed that the retailers sold to consumers at 3,000 FC. Retailers are mostly women. The retail margin is proportionally higher than the wholesalers' margins but the volumes the retailer sells are significantly smaller and total profit will therefore be smaller. The farmer receives two-thirds of the retail price.

Table 41. Sales Prices and Gross Margins for Beans and Soy Beans—*Marché de Zambia* (FC per retail measure of volume)

Seller in the value chain	Beans		Soy beans	
	Price	Margin	Price	Margin
Producer	2000		800	
Rural wholesaler	2350	350	1750	950
Urban wholesaler	2500	150	2000	250
Urban retailer	3000	500	2500	500

Table 41 also shows comparable statistics for soy. To a farm-gate price of 800 FC that is much lower than for beans, the rural marketing process and transport to the *marché de Zambia* adds an additional 950 FC, which is much more than for beans. This is the price at which the informant buys. She sells at 2,000 FC to retailers who, in turn, sell at 2,500 FC to consumers. The farmer receives only one-third of the retail price. This seems unrealistically low. However, various observers remarked independently that the soy value chain was poorly integrated and this may be evidence of that disconnectedness.

[95] In tables 41 and 42, the price given is the price at which the named seller sells. The producer sells at the farm gate or her local market; the rural wholesaler sells in Lubumbashi to the urban wholesaler; the urban wholesaler sells to the retailer; the retailer sells to the consumer.

Table 42 provides the prices and gross margins for beans and soy beans sold in Lubumbashi's *marché de Kenya*, according to retailers trading there. The retailers were five widows, who worked to support their children and pay school fees. They explained that the cost of rural marketing and transport to Lubumbashi adds 500 FC to a farm-gate price of 2,800 FC. The *marché de Kenya* wholesaler adds another 200 FC. The retailers add another 500 FC. The farmer, located nearby, receives 70 percent of the retail price.

Table 42. Sales Prices and Gross Margins for Beans and Soy Beans—*Marché de Kenya* (FC per retail measure of volume)

Seller in the value chain	Beans		Soy beans	
	Price	Margin	Price	Margin
Producer	2800		1500	
Rural wholesaler	3300	500	1800	300
Urban wholesaler	3500	200	2000	200
Urban retailer	4000	500	2300	300

Table 42 also provides details of the prices along the supply chain for soy. In this case, the farmer sells at 1,500 FC and the marketing system adds only another 300 FC to bring the soy to the urban wholesaler. At this point, the price is almost the same as at the corresponding point in the market chain through the *marché de Zambia*. The market has homogenized the commodity price. Thereafter, the 200 FC wholesale margin applied in the *marché de Kenya* to beans also applies to soy. However, the retailers apply a lower margin to soy, which is consistent with their statement that it was more difficult to sell: they had one bowl of soy in contrast to perhaps ten bowls of different types of beans. The farmer receives 65 percent of the retail price of the soy beans. If a customer wants soy flour, a nearby maize mill will grind it for an additional 700 FC.

The *marché de Zambia* wholesaler tries to get out to the rural markets that supply her to integrate upstream along the value chain and increase her profit but is constrained by the need to manage storage and marketing at her warehouse, and by family obligations. However, this is the most likely way to shorten the value chain, squeeze out additional transaction costs, and reduce marketing redundancy.

C. END-MARKET COMPETITIVENESS

Existing market demand for beans is high at all value chain levels: rural and urban consumers, rich and poor, all consume beans as standard fare with their carbohydrate staples. Beans are currently uncompetitive with respect to imports from Zambia and Tanzania. Their quality is higher than imported alternatives because they are generally fresher, particularly than beans from Tanzania. Consumers also prefer them because they know the local varieties grown in the copper-belt. Market access for beans is, on average, medium, i.e., there are no particular difficulties or advantages in marketing beans from copper-belt farms, relative to other crops.

Buyers can choose between Katangan and imported beans. They have little access to market information but there is some question about how they might benefit from such information, given the constraints on where and when they buy. In practice, buyers cannot go round the cartels to which sellers must sell in markets, and of the existence of which they may be unaware.

Table 43. End Market Analysis for Beans—Katanga Copper-Belt

Supply to:	Own consumption	Local market	Kinshasa/export markets
Rating	*Strong* Staple food	*Medium* Staple food	*Low* Much competition

Input markets may suffer from oligopoly in importing but, once the inputs have reached Katanga, markets seem competitive.

D. BENEFIT–COST ANALYSIS OF POTENTIAL INTERVENTIONS

A productive USAID-financed investment in bean production at the smallholder level would require a dedicated extension system, timely delivery of inputs, and credit. It should target motivated farmers not already using improved production methods located within easy reach of the main road, so that they can easily market their increased production. If such a system is put in place for maize, the costs of extending it to include beans would be modest. Small-scale copper-belt farmers already usually intercrop these two crops. Advantages of this combination are: free chemical fertiliser from nitrogenous beans, resulting in a higher production per land unit; natural pest regulation through crop biodiversity; and higher yield security (with the chance of one crop if the other does not develop well).

Private-sector extension companies could compete with each other for contracts to coordinate and advise on this initiative, in collaboration with the provincial Ministry of Agriculture, UNILU and ASARECA's Eastern and Central Africa Bean Research Network (ECABREN). Provincial Minagri could potentially give members of its extension division the opportunity to participate full-time in private-sector agricultural-extension companies, with the guarantee of their jobs back for up to two years. Extension services should be able not only to give agronomic advice but also recommendations on negotiation with input providers, potentially for lower-cost bulk purchases, and on post-harvest storage techniques and marketing strategies. Input providers themselves may want to participate in consortia that bid for extension contracts.

A reasonable assumption is that small-scale farmers can increase their current productivity of about 0.50 t/ha to about 0.8 t/ha as they learn to manage the new system; once fine-tuned, they should be able to attain 1.0 t/ha. At a farm-gate price of 2,000FC/kg, this would represent an initial annual gross increase in revenue of 600,000 FC for a farmer using this improved farming system or US $1.75/day. Allowing for repayment of credit for inputs but the use of family labor, the net revenue increase would probably be of the order of US $1.25/day, rising to US $2.90/day as productivity rises to 1.0 t/ha. Two crops of beans are possible annually in the copper-belt, providing the opportunity for a revenue increase of up to US $5.80/day for each hectare cultivated. These benefits would accrue to those from maize (estimated at US $3.00 daily). The extra benefits per person would vary according to household size.

Beans are not as a big crop in the copper belt as they are elsewhere in Katanga. However, they play a useful nitrogen-fixing role in combination with maize. Higher-yielding varieties are available and should be promoted as part of more productive maize production.

Table 44. Performance of the Beans Value Chain against USAID Objectives

Criteria	Rating	Justification
End market competitiveness	High	Small Katangan copper-belt producers are uncompetitive. Zambian and Tanzanian imports compete year-round in urban markets, though urban consumers pay a modest premium for copper-belt beans, partly because of freshness. Hassan supermarket in Kinshasa sells 'Katangan' beans but this constitutes a very small proportion of copper-belt production.
Generating inclusive growth	High	As the third staple, beans provide subsistence and basic employment to millions of copper-belt households. In addition, there are thousands of poor bean wholesalers and retailers (though about half of those jobs are based on Zambian beans), and hundreds of laborers employed in the supply chain. Fattening animals with bean by-products creates a few more jobs.
Food security improved	High	Beans provide amino acids that complement those in maize, providing balanced protein. Beans have a short-enough growth cycle that farmers can produce two crops a year, so they only have to store for 9 months from May (second season) or 3 months from February (first season).
Conflict-resilient and neutral	High	Beans may be stolen but this is not a big risk in the Katangan copper-belt.
Pro-women	High	Women are involved in up to 80 percent of small-scale production and retailing of beans, though less at the wholesale level, and derive income from these functions.
Benefits youth	Medium	Beans provide millions of household livelihoods; however, the largely low-skilled nature of jobs is not ideal. Because there is no processing function either, there is little opportunity for future, significant value-add.
Climate-change robust	Medium	Production is more sensitive than storage which is relatively resistant.

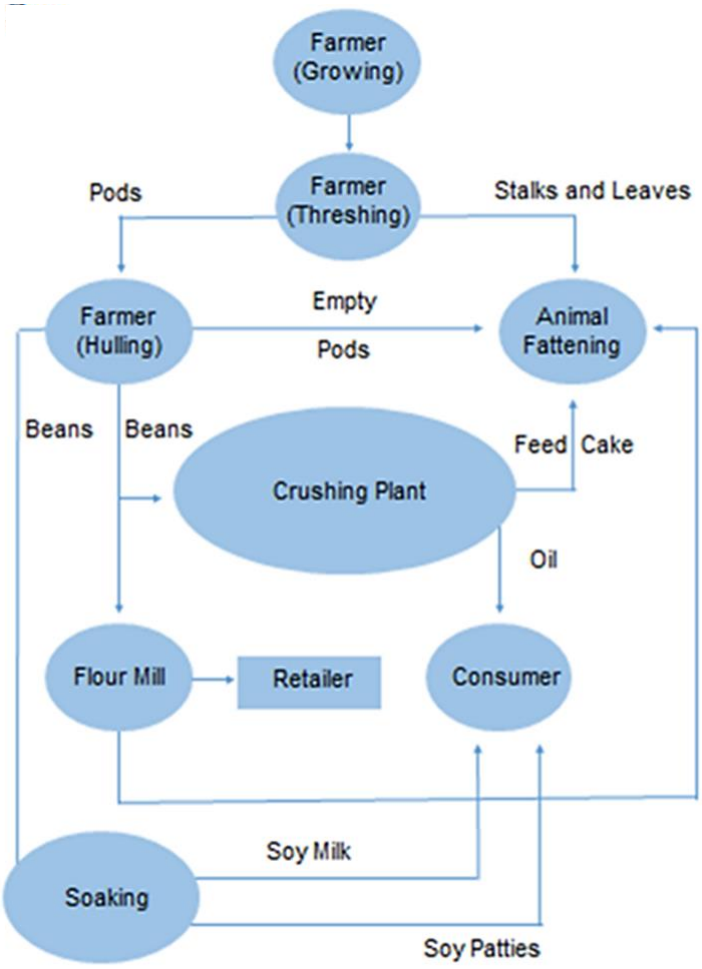
XV. KATANGA: SOY BEANS VCA

A. PRODUCTION

Aid agencies introduced soy to DRC in the 1970s for child nutrition. Soy still features as part of the humanitarian-aid diet. However it is not a common crop and the value chain is poorly integrated.

Farmers use soy in the same way that they use beans, to complement their maize crops because of the nitrogen-fixing bacteria on its roots. It is technically superior to beans in this respect, particularly if the beans are dipped in inoculum before planting and if a field has not been planted to soy before. Inoculum is a leguminous catalyst. Well inoculated, soy can obtain 50–75 percent of its nitrogen from the air. So farmers rarely apply nitrogen fertilizer to soy crops. Phosphorous in acidic soils, such as those in the copper-belt, increases soy productivity. Zheng concludes that "development of P-efficient soybean varieties that can efficiently utilize both native and added P in acid soils would be a sustainable and economical approach to increasing production".[96] Soy has a short cycle: farmers can grow it in the first or second season, or both. Improved seed is available.

Figure 15. Soy Bean Value Chain Map—Katanga Copper-Belt



B. MARKETING AND PROCESSING

After harvest, the farmer threshes the plant to separate the pods from the stalks and leaves. He then hulls the pods, separating the beans from the empty pods. The stalks, leaves and pods are valuable stover.

Women play an important part in marketing soy, which follows the same farm-to-market value chain as for beans, including imports from Zambia. Section XIV describes the cost build-up along the domestic soy value chain. Marketed volumes are not great: in Lubumbashi's *marché de Zambia*, the proportion of soy to beans did not exceed one-tenth. Retailers noted three sources of demand: (1) humanitarian organizations that want

[96] S Zheng 2010. 'Crop production on acidic soils: overcoming aluminum toxity and phosphorous deficiency', *Annals of botany*, 106 (1): 183-184, http://aob.oxfordjournals.org/content/106/1/183.full

beans to soak to make soy milk and soy patties, (2) local folk who have the beans ground in maize mills to make soy flour and (3) livestock rearers who want to crush them to make soy cake. Soy stores significantly better than beans: the retailers asserted that it resists weevils for up to two years.

Table 45. Competitive Position of Soy Products of Various Origins

Origination	Advantages	Major barriers to entry (disadvantages)	Markets served (within study)
Katangan copper-belt	• Low-price production (large producers) • Good transport (near the main road)	• Poor transport (away from the main road) • Low productivity (small producers) •	• Katangan copper-belt
Zambia	• Year-round production from large irrigated area (> 300,000 ha) • Low-price production due to large fertilizer subsidies and mechanization on large farms	• N/A	• Zambia • Katangan copper-belt

The beans form the basis of various products for human consumption: flour, oil, soy milk, soy patties. Katangans do not consume much of these, mostly because they are not familiar with them, but perhaps also because they take a long time to cook. Despite the nutritional strengths discussed earlier in this report, soy appears to have a set of negative aspects, including anti-nutrients and anti-thyroid properties,[97] analysis of which goes beyond the scope of the current study. The beans are more used as a feed ingredient for non-ruminant animals (fish, pigs and poultry). When crushed, they yield a cooking oil and a cake valued for animal fattening. Soy oil is a substitute for other cooking oils, such as sunflower or canola.

Table 41 showed that soy prices are lower than bean prices. Technoserve finds that when total costs are considered for Zambian smallholders, soy is an attractive crop only because its inclusion in annual rotation increases maize yields. However, when considering only cash costs, soy seems attractive to the farmer, though it pays him less than the opportunity cost of his labor.[98] Smallholders can increase the profitability of soy by adopting more intensive—and expensive—husbandry, but this requires access to credit to pre-finance the inputs.

The Chief of Staff of the provincial Ministry of Agriculture asserted that the market for soy is poorly integrated. A *marché de Zambia* wholesaler in Lubumbashi said that, compared to beans, soy was "easy to buy, difficult to sell." A commercial farmer complained that in 2014 his farm had produced 400 t of soy cake which

[97] B Hunter c2000. *The downside of soybean consumption*, http://superiorsites3.com/NNF01SoyBeatrice.htm

[98] TechnoServe 2011. *Southern Africa soy roadmap – Zambia value chain analysis: November 2010 – February 2011*, http://www.technoserve.org/files/downloads/technoserve-bmgf-zambia.pdf

he had found difficult to sell, while Levy (2014) notes that the soy used for local poultry production is imported. The commercial farmer attributed his inability to sell to potential clients' limited purchasing power, but it seems more likely that potential buyers were not aware of the cake's availability.

A constraint to a blossoming soy sector in the Katangan copper-belt is the absence of dynamic animal-feed and cooking-oil sectors, generating a well-developed market for soy beans. Development of soy mills with crushing facilities to produce cooking oil and feed cake as joint products is big business in Zambia. In Zambia, the feed industry and the soy processors are often one and the same, vertically integrated (Technoserve 2011).

These joint products of soy generate two markets that are unlikely to grow in synch: feed cake for animal nutrition and cooking oil for human consumption. Although soy cake has no direct substitutes, palm oil and sunflower oil from the world market compete with soy oil and can reduce the profitability of a soy pressing plant and thus the demand for soy. Technoserve (2011) found that low-cost imports of palm oil from East Africa in 2009-10 had reduced the competitiveness of Zambia's domestic soy oil and thus of the soy sector. Further, without a cooking-oil refinery, soy oil may not be competitive with imported refined oils. Finally, Katanga's current small scale of soy production presents problems of market integration due to limited information on a thin market, but this should improve as production increases. Overall, the need to coordinate significantly increased soy cultivation with large-scale investment for processing in the context of the uncertainty of cooking-oil markets mean that soy will be volatile and risky, probably placing investments in the sector outside USAID's manageable interest. On the other hand, without development of the soy sector, Katanga's animal production will be disadvantaged and imported cooking oils will dominate its market.

C. END-MARKET COMPETITIVENESS

Existing market demand for soy is low locally, medium at national urban level (mostly for fattening), and high at the international level (where factories can process soy industrially into cake and cooking oil). Soy is currently uncompetitive with respect to imports from Zambia. Its quality does not differ from that from Zambia. Market access for soy is low: the market is thin and segmented.

Buyers can choose between Katangan and imported soy. They have little access to market information but there is some question about how they might benefit from such information, given the constraints on where and when they buy. In practice, buyers cannot go round the cartels to which sellers must sell in markets, and of the existence of which they may be unaware.

Table 46. End Market Analysis for Soy Beans—Katanga Copper-Belt

Supply to:	Own consumption	Local market	Other national/export markets
Rating	*Low*	*Low*	*Low*

Input markets may suffer from oligopoly in importing but, once the inputs have reached Katanga, markets seem competitive.

D. BENEFIT–COST ANALYSIS OF POTENTIAL INTERVENTIONS

Investments in soy production at the smallholder level would require a dedicated extension system, timely delivery of inputs, and credit. The system should target motivated farmers not already using improved production methods located within easy reach of the main road, so that they can easily market their increased production. If such a system is put in place for maize, the costs of extending it to include soy would be modest. Small-scale copper-belt farmers already intercrop maize and beans; replacing beans with soy would be an easy step but would produce a soy crop for which there is little tradition of rural domestic consumption. Advantages of this combination are: free chemical fertilizer from nitrogenous beans, resulting in a higher production per land unit; natural pest regulation through crop biodiversity; and higher yield security (with the chance of one crop if the other does not develop well). Intercropping need not result in any reduction in yield for either maize or soy. The provision of extension services should follow that suggested for maize and beans.

A reasonable assumption is that small farmers can increase their current productivity of about 0.80 t/ha to about 1.0 t/ha as they learn to manage the new system; once fine-tuned, they should be able to attain 1.3 t/ha. However, inter-annual variation in rain-fed yields can be considerable. At a farm-gate price of 2,500FC/kg, this would represent an initial annual gross increase in revenue of 500,000 FC for a farmer using this improved farming system or U S$1.45/day. Allowing for repayment of credit for inputs but the use of family labor, the net revenue increase would probably be of the order of US $1.00/day, rising to US $2.50/day as productivity rises to 1.3 t/ha. Two crops of soy are possible annually in the copper-belt, providing the opportunity for a revenue increase of up to US $5.00/day for each hectare cultivated. These benefits would accrue to those from maize (estimated at US $3.00 daily). The extra benefits per person would vary according to household size.

Soy plays a more efficient nitrogen-fixing role than beans in combination with maize. Downstream opportunities are principally in substitution of imports for animal feed. Exploiting these would require:

- Development of crushing plants to produce (1) soy oil and promotion of a branded soy-oil product and (2) feed cake.
- Better research and extension to promote higher yields of soy.
- Extension to promote and optimize farmers' cultivation of soy.

Table 47. Performance of the Soy Value Chain against USAID Objectives

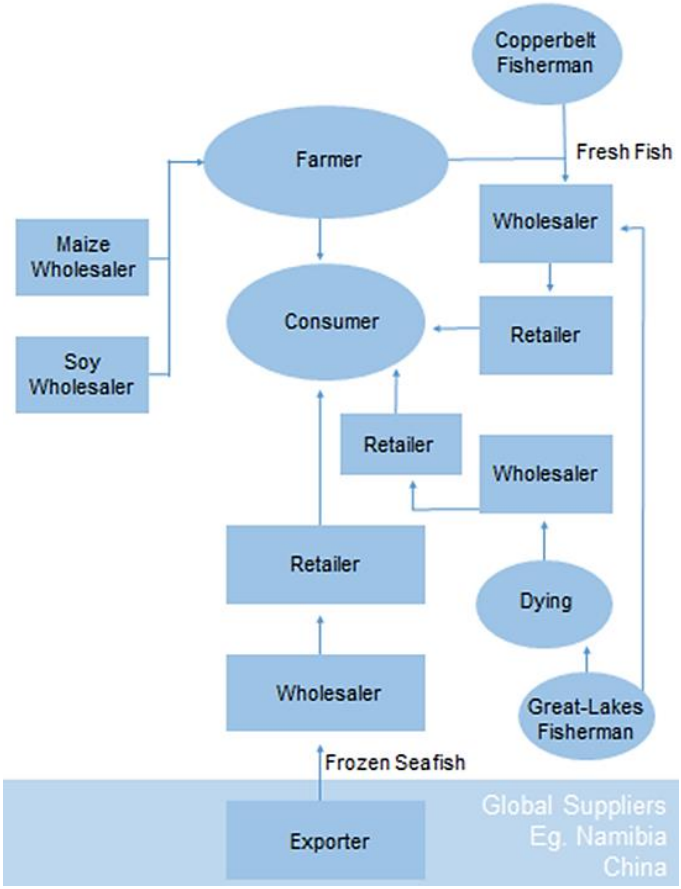
Criteria	Rating	Justification
End market competitiveness	High	In the Katangan copper-belt, small producers are uncompetitive and large producers produce only every 3-4 years, as part of a maize-based crop rotation. Both are poorly connected to markets for beans and animal cake, partly because total quantities on the market are small.
Generating inclusive growth	Medium	Soy provides subsistence and basic employment to tens of thousands of households. In addition, there are hundreds of poor soy retailers, and hundreds of laborers employed in the supply chain. Processing possibilities exist for human consumption and animal production but the scale is low and jobs for the poor are relatively few.
Food security improved	Medium	Soy is a high-calorie, almost perfect-protein food. It stores very well. However production is not high and most of it goes to animal feed so relatively few folk benefit from its high nutritional content.
Conflict-resilient and neutral	High	Soy may be stolen but this is not a big risk in the Katangan copper-belt.
Pro-women	High	Women are involved in up to 80 percent of small-scale production and retailing of soy, though less at the wholesale level, and derive income from these functions. Women dominate domestic-scale production of soy milk and soy patties.
Benefits youth	Low	Soy does not create many jobs for youth. Processing for human consumption and animal production create a small number of semi-skilled jobs.
Climate-change robust	Medium	Production is more sensitive than storage which is very resistant.

XVI. KATANGA: FARMED FISH VCA

A. PRODUCTION

Aquaculture has several parallels with egg production, discussed in section XVII. It requires high initial investment in pond creation (or rehabilitation), including channels to lead water into the ponds (and to lead water away from ponds when flooding threatens), as well as drainage systems. Depending on topography, pumps may be needed. Once established, productive farming requires a source of good fry and has high variable costs in the form of feed. Some fish-farmers breed their own fry and mix their own feed. As with egg production, maize and soy are major constituents, which some integrated farmers grow themselves. Farmers also use brewing residues. Ponds must have "trays" situated a few centimeters below the surface of the water so that feed scattered on the surface for top-feeding tilapia, the most widespread farmed species, does not fall to the bottom of the pond without being eaten. Production of catfish, a second farmed species, may be more efficient.

Figure 15. Farmed Fish Value Chain Map—Katanga Copper-Belt



B. MARKETING

Katangans get most of their fish in frozen form from China and Namibia, in dried form from Lake Tanganyika, and fresh from Katangan rivers and lakes. Perhaps only one percent derives from farmed fish (see table 48). Farmed fish competes directly in the market with fresh fish from lakes and rivers, indirectly with frozen fish. Mining pollution has reduced the number of lakes and rivers from which fish are safe to eat, as in the well-known example of Lake Tshangalele, next to the main road to the east of Likasi. Some lakes and rivers have been overfished. So the trend is towards a reduction in the offtake from these natural sources.

Farmed fish are harvested after about six months by draining the pond. In peri-urban areas, the market chain for small quantities of fresh fish is short, sometimes with a list of buyers ready to receive it. In Kolwezi, fresh fish sells at prices from 5,000-9,000 FC/kg while imported frozen fish sells for

3,000-4000 FC/kg; in Lubumbashi the corresponding prices are 4,500 FC/kg and 2,500 FC/kg (which suggests that there is some opportunity for arbitrage between the two cities). Restoration of the rail connection to Lobito port in Angola could allow cheaper imports of Namibian fish. A fish farmer near Kipushi sometimes distributes his fish in Lubumbashi himself but he prefers selling to a trader with transport who wants to collect the fish from his farm. Fresh fish from lakes and rivers will sell for the same price but small-time fishermen (or their wives) may only sell on the side of the road at a lower price, not having a fast, direct connection to urban markets. Transporting fresh fish does not need a cold chain, other than the addition of some ice, where available; storing the fish not immediately eaten requires a refrigerator.

Table 48. Competitive Position of Fish Products of Various Origins

Origination	Advantages	Major barriers to entry (disadvantages)	Markets served (within study)
Northeast Katanga (Lake Tanganyika)	• Large-scale commercial fisheries	• High transport costs to copper-belt • Dried • Reduced harvest due to overfishing	• northern Katanga • copper-belt • (Tanzania?)
Katangan copper-belt (river & lake)	• Fresh	• Some bodies of water polluted • Reduced harvest due to overfishing	• Katangan copper-belt
Katangan copper-belt (fish farm)	• Fresh • Many valley-bottom sites still exist to be used for fish farming • Two seasonal harvest periods when fish from Lake Tanganyika and local rivers and lakes less available	• Poor transport (away from the main road) • Two harvests annually provide a discontinuous supply. • Capital-intensive site preparation Some available fish-farm sites require pumps.	• Katangan copper-belt
World market (Namibia & China)	• Much lower cost	• Frozen	• Zambia • Katangan copper-belt

Technically, expansion of fish farming is possible because there is no lack of unoccupied stream-side sites in Katanga. However, obtaining title to land may be difficult and many of the sites are in steep-sided valleys that require pumps to raise water to maintain pond levels.

Two seasonal constraints on the availability of non-farmed fish create the possibility of profit for fish-farmers raising tilapia. Firstly, there is a ban on fishing covering the three months from December to February, during which fish farmers largely have the market for fresh fish to themselves. Secondly, during the cold-season months of July and August, fish metabolisms slow down and they are difficult to catch in streams and lakes, leaving more of the market to fish-farmers. The combination of these two time slots, roughly six months apart in the calendar, taken with the 5-6 month growing period for tilapia, suggests an annual cycle of production timed to capture higher prices at each of these two periods.

C. END-MARKET COMPETITIVENESS

Effective market demand for fresh fish is low at the household and village urban levels because of poverty. Higher incomes at the regional urban level result in medium demand and, at the national urban and international levels, in high demand. Katangan fresh fish is currently uncompetitive with respect to imports from the world market. However it is fresher grade than imported fish, which is frozen. Market access is high for producers near urban centers (but lower elsewhere).

Buyers can choose between Katangan and imported fish (and dried Katangan fish). They have little access to market information but there is some question about how they might benefit from such information, given the constraints on where and when they buy.

Table 49. End Market Analysis for Farmed Fish—Katanga Copper-Belt

Supply to:	Own consumption	Local market	Other national/export markets
Rating	*Low* Expensive calories	*Low*	*Very low*

Markets for feed inputs (maize and soy) are open and transparent (though there may be some upstream oligopoly); veterinary products may suffer from oligopoly in importing.

D. BENEFIT–COST ANALYSIS OF POTENTIAL INTERVENTIONS

A well-financed, technically savvy entrepreneur would be the ideal candidate for fish-farming. Katanga has a stronger tradition of businesses run individually than collectively. Donors could help fill in gaps in finance and technical expertise to enable the private sector to succeed in aquaculture. Examples of private-sector successes are Ferme Mwena and Ferme Le Créatif. However, for more equitable development, USAID may prefer to support a cooperative smallholder approach.

Fish-farming for smallholder farmers is a collaborative venture because the creation of the necessary ponds, spillways and sluices requires labor and machinery that a smallholder farmer cannot individually afford. USAID could consider investing in the creation and/or rehabilitation of fish farms in two phases. The first phase would be a pilot involving, say, ten smallholder cooperatives, each creating pond systems on the scale of 0.25–1.00 ha, preferably clustered within a 25 km radius for economies of scale in mechanized pond construction, ease of management and mutual advice; and, for risk diversity, using water from at least two separate water courses. Competitive grants could finance each phase of the initiative.

Selection criteria might include the following:

- The general location would be within easy, perhaps a one-hour walk, of a point of loading of fish into a truck for shipment to urban markets. (In the short- to-medium run, there is little need for a cold chain or for drying/smoking the fish if the production site is well chosen. The targeted market would be the urban middle class and mining caterers, which together provide an unsated market for fresh fish.)
- The cooperative would have a good record of working together over at least five years, preferably with trouble-free micro-credit reimbursements, as well as literate and numerate office bearers.
- The cooperative would have unfettered control (clear title or a long lease) to a site next to a water course that needs limited excavation.

- The monetary and in-kind contributions that cooperative contribute would play a role in selection.
- Women's participation would be included as a criterion.

Each cooperative competing for a grant would draw up a fully-costed business plan that would include details of the initial construction investment, hydraulic management systems (to allow controlled filling and emptying of the pond, as well as protect it from flooding), ongoing maintenance and fish-farming inputs, sales arrangements, banking details, and loan repayments. The business plan would justify the scale and design of the earthworks proposed, explain the operation of the system, once constructed, demonstrate that the cooperative would avoid seasonal labor crunches, and specify monetary and in-kind contributions.

USAID's responsibilities might include:

- Facilitating a preliminary meeting between loan officers from participating banks and representatives of cooperatives to explain banks' operating principles and loan-application criteria to the cooperatives and to introduce the cooperatives to bank staff.
- Facilitating a partially guaranteed line of credit with one or more banks to which pre-approved cooperatives could submit their proposals to be assessed by banks according to their normal criteria.
- Hiring through a competitive process a private-sector extension company, paid partly on the basis of agreed criteria of fish-farming success, to advise the cooperatives and participating banks on site preparation and maintenance and on fish-farming operations (stocking rates, feed-ration optimization, hydraulic control, water quality, harvesting details, market prices of fry, feed and fish, etc.), as well as providing an initial appraisal of proposals, supporting documentation and the proposed site before a cooperative submits a loan application to a bank.
- Facilitating collaboration between the extension company, on the one hand, and the provincial Ministry of Agriculture, UNILU and INERA, on the other.
- Exploring possibilities of contracts for fish delivered to mining-company caterers.
- Organizing site visits by cooperatives selected for the second phase.

Ministry of Agriculture might consider giving members of its extension division the opportunity to participate full-time in private-sector agricultural-extension companies, with the guarantee of their jobs back for up to two years. INERA's fish-farming research station at Kipopo, near Lubumbashi, should participate. Collaboration with the Belgian-funded PRODEPAAK project would allow project participants access to this fishing and aquaculture project's experience in Katanga since 2007. Examples of successful fish-farming cooperatives with which USAID might collaborate are Kabongo, supported by Peace Corps and, near Lubumbashi, OPSAR and Mukuma.

Each cooperative could become a member of an association serving as a clearing house for information and through which extension services and market information would be coordinated and in which context systematic monitoring, evaluation and planning would take place. In collaboration with the extension company, the association could also serve as a forum for scheduling from each cooperative's sales, to avoid multiple simultaneous sales that might depress prices, as well as any joint services, such as feed purchases.

Estimated initial costs for the construction by bulldozer and manual labor of a 0.25 ha earth pond, with an average depth of 70 cm are US $3,000, including standard water-management canals, slipways and gates. USAID might want to choose a project zone that included fish farms previously constructed with USG funds but no longer operating in order to save funds through rehabilitation of an existing basin and capitalize on previously trained local manpower.

Fresh fish in Kolwezi sells at between 5,000 and 9,000 FC/kg, approximately twice the price of imported frozen fish. Low-intensity rearing in earthen ponds, such as tilapia production in Katanga, involves growing fish at low to medium densities (5-15 t/ha). Assuming conservatively a fish density of 5 t/ha and a price of 5,000 FC/kg, the 0.25 ha pond described above would thus yield 1.25 t of tilapia worth US $6,650. Therefore two annual production cycles of 5-6 months would allow a gross annual margin of around US $13,000, from which expenses for feed, aeration, labor, maintenance and marketing might subtract US $3,000, leaving a potential profit of US $10,000 per year. Each cooperative might have a membership of 20 households. Each would benefit from an additional annual income of US $500 or US $1.37 daily, in addition to which several local workers would receive incomes. The extra benefits per person would vary according to household size. These estimates are minima as fish densities in semi-intensive pond production can attain 5-15 kg/m^3, in which case the pond's 1,750 m^3 would yield 8.75 t or seven times the production assumed in these calculations.

As an alternative (or additional) approach, USAID could support partly guaranteed bank loans for individuals with approved business plans for fish farms, for a fish-farm support service (e.g., production of quality fry or of balanced, low-cost, pelleted fish feed), or an innovative integration of aquaculture with other agriculture. Profit would be less diffusely spread but new productive ideas could be developed and made available for extension.

In its basic form, fish production does not require access to much electricity. However, given the location of fish farms beside streams, hydro-electric production of electricity would be possible in many cases. This would represent an additional investment but opens up possibilities of pumping water to ponds further uphill from the valley bottom than would otherwise have been practical.

A second phase would only start if the first phase showed promise in terms of profitability, the spread of benefits and food security. The opportunities for fish-farming in the study zone are bright but suffer several constraints that would need to be addressed:

- An absence of coordinated support for technical development, perhaps through INSER and UNILU, and extension services.
- Resurrection of the fish-farm school in Kolwezi that is now closed
- A lack of a professional association with lobbying capacity.
- A need for lower-cost maize and soy, which depends on greater efficiency in these sectors.
- Need for a quality fry-production farm.
- Need for bank credit for initial investment (or MFI credit for small produces) but it is possible that investors would come forward if feed costs dropped.

Fish-farming is robust in the face of drought because it is irrigated but not as women-friendly as the egg value chain. Fish-farming is the most promising of the Katangan animal-protein value chains considered for this study for the following reasons:

- Many copper-belt sites lend themselves to pond creation.
- USAID could reduce part of the budget for supporting fish farming by starting with existing ponds that need rehabilitation.
- In the short run, fish-farming is profitable for producers who have good access to the copper-belt's urban centers, i.e., without need of a cold chain.
- It would be most profitable for individual entrepreneurs but the commercial prospects for cooperatives are also bright.

- Disciplined production to produce harvests twice annually during periods when fishing is less competitive would maximize profits.

Table 50. Performance of the Farmed Fish Value Chain against USAID Objectives

Criteria	Rating	Justification
End market competitiveness	High	On a small scale, farmed fish easily finds a premium market. If a Katangan feed mill and more efficient production of maize and soy can reduce the cost of fish feed, a sizable middle-class demand for fresh fish exists.
Generating inclusive growth	Low	Buying land and constructing fish farms are capital-intensive and, whereas poor fishermen can afford to fish, construction of a fish farm is only for the well-off. There is a possibility to jointly invest in infrastructure, however, or for USAID to rehabilitate poorly or non-functioning ponds.
Food security improved	Low	High-cost protein/calories for middle-class consumption
Conflict-resilient and neutral	High	Fish may be stolen but this is not a big risk in the Katangan copper-belt. Once title is obtained to land, there is no uncertainty about its ownership.
Pro-women	Low	Women are involved in retailing fresh and (imported) frozen fish but quantities are not great.
Benefits youth	Low	Fish farming does not create many jobs.
Climate-change robust	Medium	As long as flows of water to fill and top-up ponds are sufficient, fish production is not compromised, but feed of maize and soy are dependent on the rains.

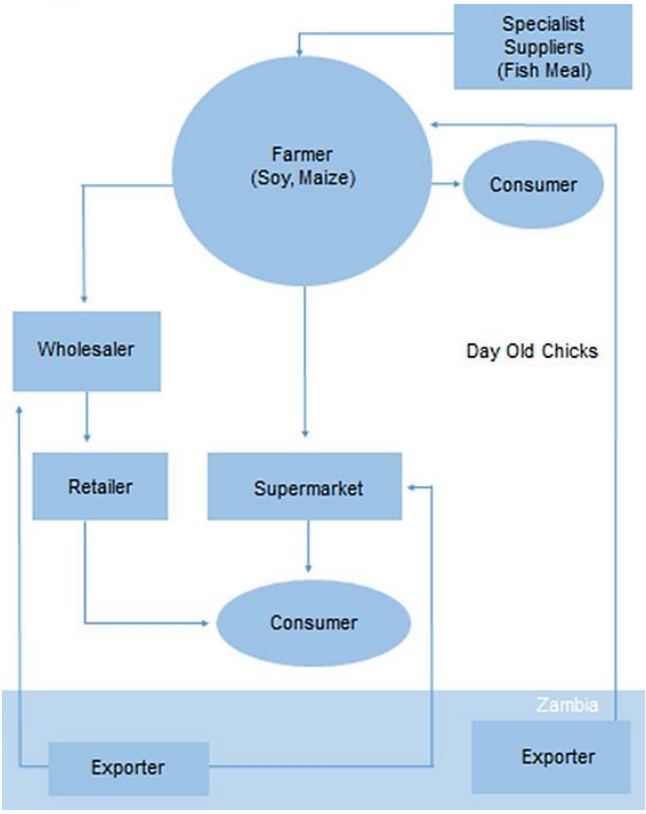
XVII. KATANGA: EGGS VCA

A. PRODUCTION

Katangan egg production takes two forms. Throughout the province, small producers informally keep poultry that supplies the household with eggs. More purposively, egg production takes place on a commercial scale, concentrated in peri-urban areas. Levy estimates that Lubumbashi produces 150 million eggs annually with a value of US $20 million.[99]

Commercial operation requires mesh-sided buildings to shelter the birds from rain and predators but to allow good air circulation. A chicken farm visited in an otherwise residential district of Lubumbashi had a three brick sheds with corrugated-iron roofing. Each shed had about 300 birds, at a stocking rate of 3 birds/m². Each hen laid approximately 300 eggs in its 12-16 month lifetime and was then fattened for a week, after which it was sold at 6,000 FC for its residual meat value. The owner is aware that, from a wider perspective, his farm is small and that even producing on a scale ten times as great he would only be a medium-size producer. He wants to expand.

Figure 16. Eggs Value Chain Map—Katanga Copper-Belt



The initial investment in a site and sheds is considerable, constituting a barrier to entry to large-scale operations. However, a roof moderates the ambient temperature in the shed, which is important for egg-laying productivity. Katanga does not incubate day-old chicks so those that the farm buys come from Zambia.[100]

Feed accounts for about 80 percent of variable costs (other than labor).[101] The farm initially tried using an imported commercial feed mix for layers that gave an 80-85 percent daily egg-laying rate but, given the price of eggs (determined by the sales price of Zambian eggs), allowed almost no profit. So management started making its own blend based on locally available ingredients: maize dross (30 percent), maize bran (30 percent), soy cake (20 percent),[102] fish meal (6 percent) and small amounts of salt, calcium and vitamins. The owner's farm supplies the maize and soy. The local mix gives a sharply reduced laying rate (about 50 percent), but it costs

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[99] U Levey 2014. *Animal feed market analysis – compte rendu de mission*, April

[100] One larger farm owned by a politician apparently imports its day-old chicks from Europe via Kinshasa. Logistical care at Ndjili airport ensures that the transfer to a flight to Lubumbashi is short. In Likasi, an agricultural-input shop included a few "day-old" chicks in its stock but, awaiting a buyer, they had matured into "21-day-old chicks."

[101] Levy puts this figure at 70 percent. Source: U. Levy 2014. *Animal feed mission analysis – compte rendu de mission*, April

[102] A small commercial egg farmer stated that varieties of soy grown locally do not make good ingredients for chicken feed because they contain antitrypsin, a toxin. Roasting can reduce the toxicity.

much less and allows a profit of around 15 percent.[103] Levy (2014) estimates that, for its broiler and egg production, Lubumbashi has 400 small producers, 10 medium-sized producers and five large farms that annually consume 25,000 t of feed, worth US $20 million. Yet the city lacks an animal feed plant. SCAK is seeking finance to construct and operate one.

Farm workers vaccinate the birds but disease, particularly Newcastle's disease, has broken out, in which cases losses exceeded 20 birds/day until it was brought under control with outside veterinary assistance. Otherwise losses are low. Egg-laying productivity drops during the hot season, particularly as temperatures rise above 26C; high humidity also lowers production. Staff had attached makeshift sheeting to the chicken-wire sides to the sheds to prevent the birds getting wet. Four full-time staff provide 24/7 coverage, mostly for security, rather than to provide technical inputs. A car suffices to transport inputs to the farm and of eggs and old hens to the sales point, and chicken feces to the owner's farm (for use as fertilizer). The farm sells the chicken litter to women who use it as fertilizer for vegetable production.

B. MARKETING

Egg sales take place in imported cardboard trays holding 30 eggs from the farm's well-known store in central Lubumbashi, from which it also sells the old hens. They also deliver to restaurants. Sales mostly take place with cash. The owner may extend credit of one week to a hotel that is a regular client. Egg retailers and street-food omelet venders are often women. Women play a large role in traditional, small-scale poultry production that the farming described above is replacing. At the other end of the scale, Levy (2014) notes that opportunities to supply large quantities of eggs to catering companies supplying mines remain untapped.

Around 2008, competition was not great and the price of a tray of eggs was twice its current price. A tray of eggs then sold for around 7,000 FC, compared to today's 3,500 FC, a price at which it seems to have stabilized over the last two years, with the price of Zambian imports providing the price floor and the price of Zambian feed playing a role in determining profitability.

Most of Katanga's eggs are imported from Zambia with minimal quality control. To keep costs down and make logistics easier, the supply chain from Zambia does not involve a cold chain. This may generate quality problems, as Levy (2014) suggests, but Katangan producers did emphasize these. On the time scale of a few days needed to reach the Katangan consumer, the eggs do not spoil, though DRC eggs are noticeably fresher and sell at a 10 percent premium. It is not clear how much of this premium is for freshness and how much for being brown, which Katangans prefer. Traditionally familiar with brown eggs, Katangans have only recently met white eggs imported from Zambia. As they associate white eggs with reptiles, they were reluctant to eat them, at least initially. Separately, a taboo had existed that pregnant women should not eat eggs but this prohibition has apparently fallen by the wayside.

[103] The owner, who imports and resells the commercial poultry feed from Zambia, believes that any farm that is using it cannot be making much of a profit. This would apparently include the president's large farm.

Table 51. Competitive Position of Eggs of Various Origins

Origination	Advantages	Major barriers to entry (disadvantages)	Markets served (within study)
Northern Katanga	• Organically produced	• High transport costs	• Northern Katanga
Katangan copper-belt	• Moderately cost of production (if using locally made feed) • Good transport (near the main road)	• Poor transport (away from the main road) • High-cost production (if using imported feed) – no local animal-feed producer • No production of day-old chicks • Capital-intensive production • Packaging imported	• Katangan copper-belt
Zambia	• Low-cost industrially blended feed • Large producers • Low-cost transport • Own production of day-old chicks • No cold chain needed to access Katangan copper-belt market • Cardboard packaging industry exists	• Eggs arrive on the copper-belt market less fresh than local production	• Zambia • Katangan copper-belt

C. END-MARKET COMPETITIVENESS

Effective market demand for eggs is low at the household and village urban levels because of poverty. Higher incomes at the regional urban level result in medium demand and, at the national urban and international levels, in high demand. Katangan eggs are produced competitive enough to hold their own in Lubumbashi. They are fresher than imported eggs. Market access is easy for urban and per-urban producers.

Buyers can choose between Katangan and imported eggs. They have little access to market information but there is some question about how they might benefit from such information, given the constraints on where and when they buy.

Table 52. End Market Analysis for Eggs—Katanga Copper-Belt

Supply to:	Own consumption	Local market	To urban (Lubumbashi) and export (Zambia)
Rating	Medium	Medium	Very low

Markets for feed inputs (maize and soy) are open and transparent (though there may be some upstream oligopoly); veterinary products may suffer from oligopoly in importing.

D. BENEFIT–COST ANALYSIS OF POTENTIAL INTERVENTIONS

As with fish production, egg production may be best left to the private sector, such as successful private farms Kaobondo at Likasi, and Derk and KIM at Lubumbashi. However, USAID may want to promote more equitable development through an approach targeting smallholders. Whereas fish-farming requires significant capital investment that excludes most rural and peri-urban households, such households can keep poultry and produce eggs. On the other hand, they do so on a small, low-yield basis, mostly for domestic consumption. More productive egg production that contributes meaningfully to import substitution requires construction of sheds and the purchase of day-old chicks and feed, as well as veterinary care and marketing. Two Likasi-based cooperatives that have succeeded in this domain are Ndakata and Kapulwa.

Cooperative commercial egg production can be structured in much the same way as described for cooperative fish farming, with an initial large investment in constructing the hen-house, rather than a fish pond. On a scale of 1,000 laying hens it is possible to build with local bricks, wooden beams supporting zinc roofing, and mesh-covered open side-walls to allow air circulation. This improvised low-cost building may not cost more than US $2,000. However, the upfront cost may require a loan, with day-old chicks costing about US $0.70 each, and commercial feed US $33/sack (accounting for 70 percent of variable costs, with most of the rest labor). Thus for a thousand-bird, low-tech system, the upfront cost would be about US $2,700 plus variable costs for feed, etc., of around US $2,500/month. When operating at a scale an order of magnitude greater, concrete walls and steel rafters allow the roof to span greater building widths. This is the construction mode for Katanga's industrial-scale Espoir and Beijin poultry farms for which the costs per bird may about the same.

Analysis of egg-production and marketing data for Lubumbashi shows that it is unprofitable using imported commercial feed. Feed constitutes about 70 percent of variable costs (with the remaining 30 percent covering labor, transport, veterinary care, taxes, etc.). Although commercial feed enables the birds to attain a laying rate (eggs/bird-day) of 80 percent, the feed is so expensive that egg sales do not cover costs, even setting aside the initial capital costs (which should be spread across multiple egg-production cycles). In contrast, mixing feed from locally available ingredients results in a drop in the laying rate to about 50 percent but at a significantly lower cost of US $20/sack. Amortizing the initial capital costs over four 1.5-year cycles, egg production can break even at US $18/sack and a laying rate of 0.57. One interviewee asserted confidently that the large poultry farms designed for tens of thousands of birds that use commercial feed were losing money, which this analysis would support. Therefore any USAID-funded egg-production project should use home-made feed or, preferably, industrialize Katangan feed production to further reduce feed prices, preferably to a level below US $350/t (as well as increasing feed quality). In most circumstances, this would allow Katangan egg production to outcompete Zambian imports, probably on both the small-to-medium and larger industrial scales. That the market prices should have stabilized at this level suggests that the egg market is very competitive.

A cooperative venture with, say, 20 members running an egg-production business on this scale and benefiting from feed at US $350/t, with a laying rate of 0.60, would need a credit line of US $6,500 to finance the initial construction and get through the first four months before egg-laying starts. At the end of the first 18-month cycle, they could expect to have a gross margin of around US $3,000, before interest payment at 20 percent p.a. of US $1,500, leaving them US $1,500, i.e., US $75 each or US $0.30/day each. With the initial capital costs then covered, during subsequent cycles, they could expect a gross margin of US $5,250 per cycle and bank interest charges of US $900, leaving them US $4,350, i.e., US $215 each or US $0.89/day each over this period, plus a share in the hen house. In addition, they would have created 3-4 full-time-equivalent jobs.

A long-term contract with a mining caterer would provide an assured core market but also require the cooperative to schedule its production to be able to deliver eggs year-round at the required level. Otherwise, without a well-known urban outlet, such as KIM has in central Lubumbashi, the producer is more exposed to fluctuations in demand.

The egg sector has potential for large-scale import substitution but requires:

- Coordinated support for technical excellence and lobbying, perhaps from SCAK for commercial producers, to promote a stronger enabling environment, but including representatives of small-scale producers, as well as INSER and UNILU, and extension services.
- Lower-cost maize and soy, which depends on greater efficiency in these sectors.
- A day-old chick incubating and sexing plant.
- Bank credit for initial private investment (or for a cooperative of small-scale produces) but, as Levy (2014) suggests, this may not be critical: investors would come forward if feed costs dropped.
- (Of secondary importance) a plant manufacturing cardboard egg trays and cardboard boxes.

Table 53. Performance of the Eggs Value Chain against USAID Objectives

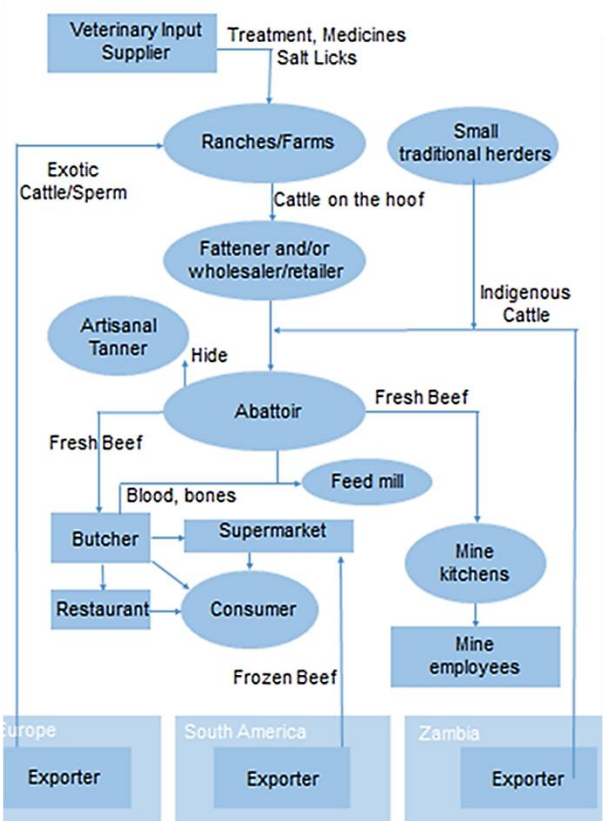
Criteria	Rating	Justification
End market competitiveness	Medium	Small Katangan copper-belt producers are uncompetitive; small egg farms are competitive with home-mixed feed. Zambian imports compete year-round in urban markets, though urban consumers pay a modest premium for fresh copper-belt eggs. With lower-cost maize and soy (currently largely imported), an animal-feed plant, and day-old-chick production, competitiveness would increase for large-scale producers.
Generating inclusive growth	Medium	Local production of eggs takes place on a small scale throughout the copper-belt (but there is little potential for profitable growth of production at this level).
Food security improved	Medium	Eggs are a form of high-quality protein sold in small units that many can afford. However, they still represent an expensive form of calories and protein. Newcastle's disease can quickly kill off an entire flock.
Conflict-resilient and neutral	High	Eggs may be stolen but this is not a big risk in the Katangan copper-belt.
Pro-women	Medium	Women are involved in small-scale poultry operations that cumulatively produce few eggs and in retailing.
Benefits youth	Low	Eggs generate few jobs for youth.
Climate-change robust	Medium	80 percent of inputs are maize and soy, which are susceptible to drought. Poultry mortality increases at high temperatures.

XVIII. KATANGA: BEEF CATTLE VCA

A. PRODUCTION

In contrast to the Kivus, Katanga does not have a long-standing tradition of cattle rearing, in the East African sense of unfenced pastoral herds following rainfall patterns in search of seasonal pasture. This is largely because tick-borne diseases—particularly trypanosomiasis—limit their productivity. Instead, ranching has been the main production system. Ranching produces beef cattle, not, as in the Kivus, dairy cattle. Moreover, it mostly takes place on a more arid plateau in the north of the province, where upland pasture is more propitious and tsetse-harboring trees are fewer. There are two big ranches in the drier, low-trypanosomias zones north of the copper-belt that favor cattle rearing.[104] Along with several smaller ones the total herd now numbers about 60,000 head of cattle.[105]

Figure 17. Beef-Cattle Value Chain Map—Katanga Copper-Belt



In addition, there are some small-scale traditional herders with 20-100 head each, kept unfenced, like goats. Some small herds of this sort doubtless also exist in the copper-belt but they do not play a very important role in the commercial beef supply, particularly in comparison to the many small herds of goats that small copper-belt farmers keep. MINAGRI staff in Likasi listed five farms in the district that have had cattle, one of which no longer does so; the other four had a total of about 500 head. Overall, the Katangan copper-belt is a minor producer of ruminant livestock.[106] Katangan beef meets only about 30 percent of regional demand, so cattle and beef are imported into the copper-belt.[107]

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[104] Source: A Trabucco & R Zomer in Sebastian (2014:54-55)

[105] The *Grands Elevages de Katongola* (Grelka) ranch has 33,000 head of cattle on 300,000 ha. M. Devey 2012. 'Katanga: dans les ranchs des hautes plaines', *Jeune Afrique*, 9th June, http://economie.jeuneafrique.com/dossiers-2/458-le-katanga-grandeur-nature/10632-katanga-dans-les-ranchs-des-hautes-plaines.html

[106] Mapping by P. Thornton in Sebastian (2014:24-25) indicates that the study zone is largely a 'non-livestock vegetated area'.

[107] In Sebastian (2014: 25-28), Thornton characterises most of the study zone as a 'non-livestock vegetated area' whereas, further north and west in Katanga province, several areas are identified as livestock-grazing areas ('rain-fed-humid-sub-humid' and 'rain-fed-temperate/tropical highlands'). Thornton also shows the study zone and the rest of Katanga in the lowest category of ruminant density (0 – 1 animal per km^2) for cattle, sheep and goats.

The closing down of SNCC, Gécamines and the *Société minière de Bakwanga* in the mid-1990s resulted in a much lower demand for red meat. In addition, violent disruption in the late 1990s extended into northern Katanga and resulted in the rustling of a large part of the provincial herd. In 2012, the herd size was only 20 percent of its earlier size. Three ranches closed down completely.[108] It is only recently that ranch-owners have had the confidence to rebuild their stocks. Finding finance for restocking the herds is difficult for most. Cattle on ranches receive veterinary care, inoculations against infectious diseases that threaten herd health and treatment for a range of animal-specific maladies. Though natural pasture gives them the majority of their feed, they may receive salt licks to ensure mineral nutrition. Ranches started with African zebu cows, animals with some resistance to African bovine disease and able to withstand the climate. They have bred these cows with more productive exotic species to reach an equilibrium genotype that balances performance against resilience.

B. MARKETING & PROCESSING

A typical ranch has a commercial offtake of 25 percent annually. Few clients travel to the ranches to buy. Instead, drovers lead herds for sale south on the hoof towards the copper-belt, for sale in markets (such as those at Kolwezi, Likasi and Lubumbashi). Before the events of the 1990s, there had also been some demand from the Kasaïs but this is currently weak. Driving cattle is not affected by the poor state of the roads linking northern and southern Katanga. It takes about 20 days to reach Likasi. Another strand of the market chain brings cattle imported from Zambia to these markets, also on the hoof. Likasi holds a three-day monthly livestock market on 18th–20th of the month. Buyers include local butchers and buyers from Lubumbashi. Likasi butchers slaughter 40-60 cattle monthly, with beef selling at a premium over goat meat. Trade cattle continuing to Lubumbashi mostly do so on the hoof: little trucking of cattle takes place along the value chain. The photo on the right shows a herd being fattened before going to the abattoir.

Uniquely in the southwest of the province (outside the copper-belt), a commercial flow of cattle crosses the border on the hoof into Angola to meet local demand and for loading onto the train to Benguela on the Atlantic coast. Volumes involved are unclear. Informants speculated that, on completion of the rehabilitation of the railway, there will be an increased demand for Katangan cattle for the Angolan market and that beef prices will rise, making cattle rearing more profitable.

The abattoirs in Kolwezi, Likasi and Lubumbashi operate but are in a poor state of repair. MINAGRI performs sanitary checks but no cold chain exists. In Lubumbashi, carcasses may go to a butcher to produce retail cuts or to the butcher's departments of either restaurants or supermarkets (Hyper Psaro, Jambo Mart and Megastore) or to a mine-caterer's kitchen. Megamart raises its own cattle nearby. One butcher, Number One, has its own abattoir under MINAGRI sanitary controls. In supermarkets, fresh local beef competes against frozen imported beef (and other meats), typically from South America. The fresh local product sells at 3-4 times the price of the frozen imported despite being of a lower grade and thus occupies a niche market, with sales falling short of those of imports. (This is also true in Likasi and Kolwezi.) Since an industrial tannery,

[108] M. Devey 2012. 'Katanga: dans les ranchs des hautes plaines', *Jeune Afrique*, 9th June, http://economie.jeuneafrique.com/dossiers-2/458-le-katanga-grandeur-nature/10632-katanga-dans-les-ranchs-des-hautes-plaines.html

Bata, went out of business, artisanal tanners buy the hides and tan them for locally sold manufactures. However, most are now sold for human consumption. Small feed mills process blood and bones to produce inputs for animal feed.

Table 54. Competitive Position of Beef Products of Various Origins

Origination	Advantages	Major barriers to entry (disadvantages)	Markets served (within study)
Northern Katanga	• Large-scale ranching with veterinary care, medicines and salt licks • Low tsetse-fly threat • Fresh meat	• Limited production (still re-stocking) • Capital-intensive protein production	• Northern Katanga • Kasaïs • Katangan copper belt • Angola (from western side)
Katangan copper-belt	• Organic • Fresh meat	• Very limited small-scale, informal-sector production • Higher tsetse threat	• Katangan copper-belt
World market (South America)	• Low-cost production • Efficient transport	• Frozen meat	• Rest of the world • Katangan copper-belt

Table 55 provides prices along the value chain from the ranch gate in northern Katanga to the consumer in Lubumbashi. The live-weight price for cattle as they leave the ranch is US $1.25/kg, increasing to US $2.40/kg by the time they reach Lubumbashi. After slaughter, the wholesale beef price is US $6.00, assuming a killing weight of 45 percent, i.e., a 45 percent yield of bone-in beef carcass from the animal. The retail price depends on where and in what form the consumer buys her beef. If she buys it a non-supermarket retailer, the price will be US $7.50/kg. For the convenience and assurance of quality that a supermarket can provide, the price will be US $10.00/kg. If she buys from a vendor of a much-liked dish, the price may rise to US $20.00/kg. The rancher's price is 46 percent of the minimum retail price but as the retail price includes 25 days of trekking, possibly intermediate market fees, and the cost of slaughter, this does not seem unreasonable. With competing imported frozen cuts selling at least three times cheaper than this domestic beef, it seems unlikely that there is any incentive for the market to inflate prices.

Table 55. Prices and Margins for Cattle/Beef (US $)

Stage in the market chain	Liveweight price/kg	Price/kg (meat)	Price/kg (meat-equivalent)	Gross margin/ kg
Ranch gate (northern Katanga)	1.25		2.78	
Trader (Lubumbashi)	2.40		5.33	2.55
Wholesale ex abattoir		6.00	6.00	0.67
Consumer (at retailer)		7.50	7.50	1.50
Consumer (at supermarket)		10.00	10.00	4.00
Consumer (dish: *cabri*)		20.00	20.00	14.00

A South African investor in Kolwezi told a different story. He explained that fresh Katangan beef fillet steak cost 15,000 FC/kg and fresh Katangan topside cost 12,000 FC/kg, but both were objectively C-grade meat.

In contrast, frozen imported equivalents from South America cost 18,000–22,000 FC/kg but would be A-grade meat. It seems that the price ratio for local and imported beef of 3-4 cited above takes into account the quality difference.

About 10 percent of the province is suitable for livestock rearing and the current herd falls far below the carrying capacity of the land. Government is promoting further investment in both ranching and village-scale livestock rearing, proposing artificial insemination but only of 1,000-2,000 cows over five years. It also intends to reinforce sanitary inspections at abattoirs, improve the supply of vaccines and give relatively small direct support to livestock rearers (US $5,000- 15,000). It is not clear to what extent it is likely that government will achieve these goals. More importantly, it is looking for private investors, particularly from South Africa and Zimbabwe.[109]

C. END-MARKET COMPETITIVENESS

Effective market demand for fresh beef is low at the household and village urban levels because of poverty. Higher incomes at the regional urban level result in medium demand and, at the national urban and international levels, in high demand. Katangan beef is currently uncompetitive with respect to imports from the world market. It is fresher but of lower grade than imported beef. Market access is slowed down by the need to trek animals to market, but otherwise acceptable.

Buyers can choose between Katangan and imported beef. They have little access to market information but there is some question about how they might benefit from such information, given the constraints on where and when they buy.

Table 56. End Market Analysis for Beef Cattle—Katanga Copper-Belt

Supply to:	Own consumption	Local markets (e.g., growing middle class mining communities)	National markets	To regional markets
Rating	Low Expensive calories	Medium	Low	Low

Input markets for veterinary products may suffer from oligopoly in importing

D. BENEFIT–COST ANALYSIS OF POTENTIAL INTERVENTIONS

Traditional cattle rearers in Katanga are few, informal and dispersed. The cattle-beef value chain does not offer much employment to poor populations and the wages paid to ranch employees, drovers, butchers or supermarket employees do not compete with wages paid by mines. Few women are involved. The value chain's principal product, beef, plays but a minor part in the nutrition of ordinary Katangans. The cattle themselves are vulnerable to rustling, as the events of the late 1990s have shown. Once herds are restricted to ranches, even large ones, the lack of mobility leaves them susceptible to seriously increased mortality if drought strikes: variability of annual rainfall in northern Katanga falls into the 25-35 percent range, though in the copper-belt

[109] M. Devey 2012. 'Katanga: dans les ranchs des hautes plaines', *Jeune Afrique*, 9th June, http://economie.jeuneafrique.com/dossiers-2/458-le-katanga-grandeur-nature/10632-katanga-dans-les-ranchs-des-hautes-plaines.html

it is not so great: 15-25 percent.[110] Although the restored rail connection to the Angolan coast, continued mining growth and population growth all point to potential for economic development of the livestock sector in northern Katanga, possibly justifying trypanosomiasis control in some areas,[111] in the study area, livestock development cannot be considered a priority.

Therefore increased beef production lies mostly in the hands of commercial ranchers. After a period of decapitalisation during the 1990s and 2000s, ranchers are now expanding their operations, particularly in northern Katanga where large tracts of land are available, rather than in the copper-belt. Despite poor road connections over the large distances separating ranches from large cities, connecting to markets is not a constraint because drovers can trek cattle to copperbelt markets at low cost, stopping to fatten animals en route, if appropriate. However, good roads would promote a lower-cost switch to trucking.

Significant expansion of the beef-cattle sector thus depends on the preferences of big investors, for whom ranching may be just one portfolio element. Through either retained earnings or bank loans, these investors can expand cattle numbers if desired, subject to finding enough suitable breeding stock. Small-scale farmers have a limited role to play in the efficient expansion of this sector.

Table 57. Performance of the Beef-Cattle Value Chain against USAID Objectives

Criteria	Rating	Justification
End market competitiveness	High	Middle-class buyers will pay a premium for fresh beef.
Generating inclusive growth	Low	Capital-intensive production is limited to big investors or very small traditional informal-sector producers.
Food security improved	Low	Beef is a high-quality, but expensive, form of calories and protein.
Conflict resilient and neutral	Medium	Cattle may be stolen but this is not a big risk in the Katangan copper-belt.
Pro-women	Low	Women have almost no role in this value chain.
Benefits youth	Low	Youth have a few jobs in herding, droving, slaughter and retail.
Climate-change robust	Medium	Cattle can move if pasture dries up due to severe drought conditions; however, this could provoke more conflict with farmers in accessing new pastureland further south and constrain movement of animals through cattle corridors. Accelerated slaughter due to drought would depress prices and is inefficient because of the time taken to rebuild a herd afterwards. In contrast, the Katangan copper-belt cattle have greater flexibility given their small numbers. Access to water points for animals could also become a source of conflict as ephemeral water sources dry up during severe drought periods. Also, extreme flooding and inundation severely constrains movement of cattle to access pasture.

[110] P Thornton in Sebastian (2014: 38-39)

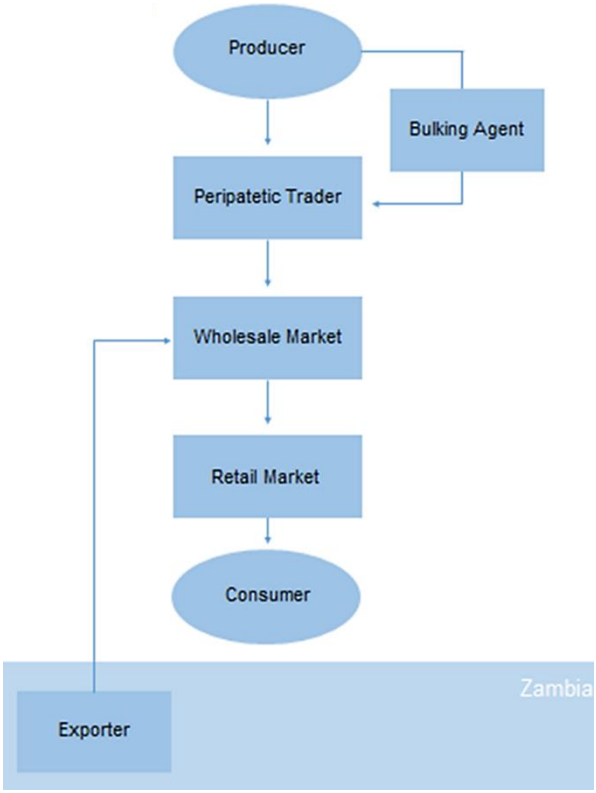
[111] See details of the profitability of trypanosomiasis elimination in the Horn of Africa: Robinson et al. in Sebastian (2014: 62-63).

XIX. KATANGA: HORTICULTURE VCA

A. PRODUCTION

Horticultural crops include onion, cabbage, bok choi (Chinese cabbage), tomato, purple/garden eggplant, okra, leafy green vegetables, such as amaranth (all of which Nkulu identifies as the biggest sellers[112]) in addition to leek, hot pepper, sweet pepper, cucumber; green bean, carrot, squash/pumpkin, lettuce, cassava leaves, sweet-potato leaves, spinach, hibiscus and strawberry.

Figure 18. Horticulture Value Chain Map—Katanga Copper-Belt



Women typically grow these crops during the dry season only, organized into cooperatives or associations that may employ men. Around Lubumbashi, Nkulu & Tshomba (2014) noted 40 active horticultural associations farming areas ranging from 3 to 70 ha, each producing 130–15,000 t annually.[113] Traditionally women reserved the rainy season for the cultivation of staples.[114] However, year-round irrigated horticultural zones have blossomed around the valley bottoms around the copper-belt cities[115] and, in some cases, in rain-fed areas for rainy-season production. Year-round production does not translate into year-round harvest of a given crop, though Nkulu & Tshomba's agricultural calendar for the peri-urban horticultural production indicates harvests of some crop in each month, with the bulk of the crop harvests between March and July.

A male-dominated association on the outskirts of Likasi has diversified into cabbage production during the rainy season in response to their disappointment at low prices when dry-season producers try to sell their crops simultaneously. In the dry season, availability of water may limit production, depending on the depth of

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[112] J Nkulu & J Tshomba 2014. *Etude de marché des produits maraîchers à Lubumbashi*. draft

[113] The value density of horticultural crops varies greatly and this range of weight of production may not give a good indication of the range of market value.

[114] This blossoming may be at least partly attributable to an FAO project, Growing greener cities in the Democratic Republic of Congo. Source: FAO 2010. *Growing greener cities in the Democratic Republic of Congo*, http://www.fao.org/docrep/013/i1901e/i1901e00.pdf

[115] Nkulu & Tshomba (2014:12) estimate that just over 4,000 women work in this sector at the 40 sites around Lubumbashi, of which about 1,300 work at six big sites.

the water table and the availability of pumps. Partial formalization of peri-urban horticulture can form the basis of greater productivity: forming associations through which to organize and lobby, obtaining title to the land (usually a valley bottom) on which production takes place, coordinated management of water resources, and horticultural extension (pest control, seed selection, fertilizer use, etc.).

B. MARKETING

Short distances link peri-urban production sites with urban markets. However, not all producers market their produce. In Lubumbashi, wholesalers buy up produce in the fields daily and take it to the early morning sales at the *marché de Zambia* where female retailers buy for sale at various markets in the city.[116] Lubumbashi traders transport about half their produce by vehicle, with the remainder carried by motorbike, bicycle or porter. This system seems to apply to all crops listed above. In Lubumbashi, nine markets serve as retail outlets for horticultural crops.[117] Similarly, the Likasi association tended not to market its cabbages but to wait for wholesalers and retailers to come to buy from them in the field. In contrast, villagers from Kitumba, located 7 km from Luambo market on the main copper-belt road, farm individually and carry their horticultural produce to market or wheel it on bicycles. They mostly do so on Mondays and Thursdays, the days before Luambo's two weekly markets, which start by torchlight at 03:00. By 08:00 all produce is sold and female traders have secured transport to take their purchases of no more than 100 kg to Kolwezi and Lubumbashi markets. On non-market days, the Kitumba producers may sell to Luambo wholesalers who come to their village to buy. The study team found no evidence of processing of horticultural products, with the exception of the artisanal manufacture of hot-pepper powder.

In Lubumbashi, the market for horticultural crops is less seasonal than the production, due to imports from Zambia where irrigation allows more even production throughout the year, though there are still some seasonal fluctuations in volumes and prices. Observation in the *marché de Kenya* in March 2015 suggested that importers bring large amounts of tomato, eggplant, cabbage and onion, less of other crops, and little of the leafy greens, which have a short shelf life in a supply that lacks a cold chain. Wooden crates manufactured in Zambia make it practical to truck tomato to Katanga at ambient temperatures. Other horticultural produce comes in sacks. Imports take place on a range of scales, from 20 tons of tomatoes from a Zambian production zone arriving on three 10 t trucks, to 200 kg of South African onions as part of a multi-trader shipment in a 6 t truck. Importers buy much of their produce on the Zambian side of the border at Kasumbalesa, which has a range of specialist wholesalers, transporters and brokers to deal with illicit fees. Trucks arrive from Kasumbalesa each morning and unloading takes place at a depot where each small trader rents space to sell and store his or her imported produce until it is all sold. These small importers have every incentive to sell within a day or two in order to fit in several cycles per week. One depot owner said he would like to have a chiller for overnight storage but it was clearly not a priority.

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[116] Amaranth is the most profitable crop in Lubumbashi, at least partly because its short cycle allows multiple seasons.(Nkulu & Tshomba 2014: 23)

[117] Nkulu & Tshomba (2014).

Table 58. Competitive Position of Horticulture of Various Origins

Origination	Advantages	Major barriers to entry (disadvantages)	Markets served (within study)
Katangan copper-belt	• Low-price production (large numbers of organized small producers with high water tables) • Low-cost transport (peri-urban sites and those near the main road) • Many valley-bottom sites still exist to be used for horticulture. • No competition from Zambian producers for some vegetables	• High-cost transport (away from the main road) • Some available horticultural sites require pumps • Limited rainy-season production	• Katangan copper-belt
Zambia	• Large irrigated area (> 300,000 ha) for year-round production • Large fertilizer subsidies • Low-cost production • Suppliers have a system of reusable tomato crates	• Greater delivery times (for perishable produce) and distances (cost) to Katangan copper-belt markets than for Katangan copper-belt producers	• Zambia • Katangan copper-belt

Supermarkets source some of their vegetables locally and import others as a function of the seasonal availability of different vegetables and the quality and reliability of different supply chains. They have refrigerators for display and chillers for overnight storage, extending the shelf life of their produce, in contrast to the market depots. At least one Lubumbashi supermarket has its own horticultural farm to supply its needs. Shoprite, which intends to open a Lubumbashi store in 2016, seeks reliable suppliers who can supply local produce that meet its customers' tastes.

Nkulu and Tshomba (2014) show that prices for a given horticultural product may vary considerably between markets. Separately, prices are higher in supermarkets. Differences of quality may explain some of this price diversity (a) between markets and (b) between markets as a whole and supermarkets. The APEFE project has set up a horticultural price-information system for Lubumbashi, designed to inform the mostly female producers of the range of price options around town. APEFE is open to making the data available to others. The system might usefully be extended to other agricultural commodities, perhaps taking account of quality.

C. END-MARKET COMPETITIVENESS

Effective market demand for vegetables is medium at household and village levels, and high elsewhere. Some vegetables hold their own in competition with imports from Zambia but others are less competitive. Competitiveness varies seasonally. Quality is as good as, or better, than imports from Zambia. Market access is high because of the proximity of production areas to urban markets. In many cases, buyers can choose between Katangan and imported vegetables, though this varies seasonally. They have little access to market information and the variation in prices between Lubumbashi market suggests that availability of price information might allow consumer arbitrage to close these apparently unjustifiable price differences.

Table 59. End Market Analysis for Horticulture—Katanga Copper-Belt

Supply to:	Own consumption	Local market
Rating	Low	High

Fertilizer markets may suffer from oligopoly in importing but, once the inputs have reached Katanga, markets seem competitive.

D. BENEFIT–COST ANALYSIS OF POTENTIAL INTERVENTIONS

Horticultural production may aim to meet urban demand for non-staple vegetables year-round. To do this efficiently requires irrigable land located conveniently for shipping outputs to urban markets. It also requires technical facility and access to inputs, particularly fertilizer. Once having set up such a production system, maximization of benefits entails using it year-round, squeezing in as many production cycles as possible over the seasons.

Traditionally, women have pursued horticulture over the dry season in low-lying fertile land near rivers or streams for easy irrigation at a time when rain-fed agriculture is not possible. However, many abandon it when the rains come in order to join the household efforts to produce rain-fed staples. It takes a leap of faith to de-emphasize staples and embrace 12-month horticultural production: the producer is then hostage to market caprices and loses control of basic nutritional needs. Nonetheless, this should be considered as a pre-condition to any participation in a USAID-funded horticultural project.

Unsurprisingly, the best horticultural land around Lubumbashi has already been taken, largely due to projects promoting this form of production. Any new horticulture takes place at the extensive margin, further from urban markets and from roads leading to them, with correspondingly higher transport costs. However, the landform has many small rivers that run almost, if not completely, year-round and, if not, water is often available via shallow wells. In Lubumbashi, peri-urban production competes with imports from Zambia. This is true too in Likasi, Kolwezi and other towns in the copper-belt, but Lubumbashi is a larger market nearer the major Kasumbalesa border-crossing point, so the potential there is greater.

Forty cooperative units remain active around Lubumbashi out of an estimated 250 set up by donor-funded projects. Membership totals around 4,000, mostly women. Horticultural work takes place in all months, with harvesting mostly from March to August. Nkulu & Tshomba (2014) record that harvesting of bok choi, cabbage and tomato continues (relatively unprofitably) from August to October, followed by very limited production from November to February, with the exception of December, when sales evidently increase as a function of holiday demand. Within agronomic limits, there appears to be scope to even out the seasonal supply and thus capture market share from Zambian imports, which arrive in all seasons.

Recent horticultural projects have benefited many women directly, undoubtedly with micro-credit to boost capitalization of their efforts, and others indirectly through their demonstration effects. Mines and NGOs are funding similar efforts in Kolwezi (and probably in Likasi). A USAID horticultural project could aim to optimize fertilizer applications and seasonal timing of sales. It could also work with a Belgian project that has started disseminating weekly horticultural price information to increase market transparency and potentially allow producers to get better prices for their produce. However, it seems that this sector has already received significant attention and it might be better to ensure that women benefit from participation in productive projects in other sectors.

Horticultural production already has momentum, with potential to go further. There is more import substitution to undertake, seasonality to manage, productivity to increase and transformation to start. Consumption of horticultural products increases the minerals and vitamins in the diet. Women are at the center of this value chain, which is irrigated and thus largely immune to the effects of climate change. However, a wave of projects has already done a lot of work in the easiest production locations. A new project would have to bring a new twist in some combination of scaling up production, enhancing productivity, developing production in seasonal niches, setting up a market-information system, or transforming some of these perishable products to extend their shelf lives, e.g., canning/bottling.

Table 60. Performance of the Horticulture Value Chain against USAID Objectives

Criteria	Rating	Justification
End market competitiveness	Medium	Small Katangan copper-belt producers are competitive during the dry season, winning a significant share of the market in competition with Zambian producer, but few produce during the rainy season (rather than farm traditional rain-fed crops) when Zambian produce dominates. At this time, there is great potential for profitable Katangan copper-belt producers.
Generating inclusive growth	High	Labor-intensive, small-scale production at multiple sites, particularly in peri-urban but also in other locations that can access transport to urban markets.
Food security improved	High	Horticultural crops are a good source of vitamins and minerals.
Conflict-resilient and neutral	Low	Vegetables may be stolen but this is not a big risk in the Katangan copper-belt. Once title is obtained to land, there is no uncertainty about its ownership.
Pro-women	High	Women are involved in up to 95 percent of production and retailing, though less at the wholesale level, and derive income from these functions.
Benefits youth	Low	A few men find work in production, some of them young. Some younger women are involved in production, but more so in retail.
Climate-change robust	Medium	Irrigation, input-intensive production moderately adaptive to climate change, but many horticulture crops highly sensitive to extreme hot and cold temperatures, vulnerable to new pests and diseases, and highly perishable after harvest and during transport.

XX. KATANGA: RECOMMENDATIONS

A. EXISTING MARKET DEMAND AT DIFFERENT MARKET LEVELS

The high cost per calorie limits household and village demand for fresh beef, fresh farmed fish and eggs because most village-level consumers are poor: optimal rations do not include large amounts of these high-protein foods. In contrast, regional urban demand and, particularly, national urban and international demand are higher for animal protein because of the higher proportions of richer consumers in these populations (see table 61).

Table 61. Existing Market Demand by Market Level

Commodity	Market level				
	household	village	regional urban	national urban	international
soy	low	low	low	medium	high
fresh beef	low	low	medium	high	high
fresh farmed fish	low	low	medium	high	high
eggs	low	low	medium	high	high
horticultural produce	medium	medium	high	high	high
beans	high	high	high	high	high
maize	high	high	High	high	high

Soy demand is also low at the village level—and at regional urban level—but for different reasons: soy has not yet become a staple food in Katanga despite its high and balanced protein content, relatively little animal fattening using concentrated inputs takes place, and no industries exist to process soy into its several end-products. This finding holds only slightly less true at the national urban level, with part of the national urban demand stemming from humanitarian agencies that recognize this commodity's high nutritional value. Only at the international level is demand for soy high.

Demand for horticultural produce is medium at the household and village level. For many such households, the selection is limited because they do not know introduced "European" vegetables. Where these households have become familiar with a wider diversity of horticultural produce, they embrace them fully. At all other levels, demand is high for horticultural products.

Demand for maize and beans is high at all levels. For all consumers in the copper-belt they are staple foods, mutually complementary in protein composition. Demand for maize as a major component in animal feed reinforces this strong demand among those at higher levels who fatten livestock and poultry. However, in rural areas much of the demand is met from own production, rather than through the market.

B. COMPETITIVE POSITIONING OF DRC PRODUCTS

The cost of production and marketing of most Katangan agricultural commodities considered exceeds that of comparable imports. This justifies a "low" for price competitiveness in table 62. Egg-production costs approximately equal those of Zambian imports and the same is true of some horticultural production. The quality of commodities produced in the copper-belt from the point of view of the copper-belt consumer is "medium" to "high." Some of the perceived quality of these provincial foodstuffs derives from freshness (beef, fish, and eggs) and some from taste preferences (beans).

Market access relates to how easily foodstuffs produced in the copper-belt find their way into copper-belt markets: high transport and logistics costs en route to major markets lead to low competitiveness in this sense. The Katangan copper-belt market for soy is particularly disjointed and thus its market access is "low." Marketing of most other commodities is more efficient but they compete directly with ready imports: the market access of maize, beans and beef is thus "medium." The "high" market access for horticultural produce, eggs and fresh farmed fish produced in the Katangan copper-belt derives from peri-urban supply for an urban market: a preponderance of short marketing chains mean easy outlets for limited volumes of production.

Table 62. Three Dimensions of Competitiveness

Commodity	Dimension of competitiveness			Comments
	price	*quality*	*market access*	
soy	low	medium	low	in the form of beans, rather than flour
maize	low	medium	medium	
beef	low	medium	medium	local fresh vs imported frozen
beans	low	medium/high	medium	fresh local seasonal production preferred to year-round imports
fresh farmed fish	low	high	high	farmed fresh vs imported frozen & national/regional dried
horticultural produce	medium	medium/high	high	local production more seasonal than Zambian imports
eggs	medium	high	high	local fresh vs imported less fresh

Note: In the "price" column, "low" means a low level of price competitiveness, not "low-priced."

C. BARGAINING POWER OF BUYERS

Buyers of the commodities from Katangan agricultural value chains considered here have bargaining power based on the availability of supplies from various parts of Katanga and from imports. The market is therefore competitive as seen from the buyer's side: the slow border crossing at Kasumbalesa, though rightly decried, provides little effective economic protection for Katangan producers. This is true of all seven value chains considered. For most of the value chains, the external competition comes from Zambia, with its subsidized fertilizer and year-round, irrigated production of maize, beans, soy and horticultural products. For beef, the competition comes frozen from South America; for fish, dry from the Great Lakes and frozen from China and Namibia. The availability of these imported products places an upper limit on the prices that Katangan consumers pay at any point in time.

Most consumers are poor, spending the majority of their food budget on staples. For these commodities they have low price elasticities of demand (with expenditure dropping by only 0.3–0.5 percent when prices rise by 1.0 percent) and high income elasticities of demand (with expenditure increasing by as much as 0.78 percent for each percentage increase in income).[118] These buyers are sensitive to changes in food prices but have significant choice between individual foods from different sources and between individual foods and fairly close dietary substitutes. Exercising this latter choice closely links the price trends of substitutes. Superimposed on this price-driven substitution, richer consumers with preferences for foods that they know and for fresher foods, both of which are likely to be of local origin, may choose to pay more to exercise these preferences.

Informants assert that suppliers of food commodities to most markets find themselves constrained to sell to cartels, raising prices systematically at each level thereafter downstream; the study team's rapid appraisal did not have the resources to find corroborating evidence. To the extent that such cartels exist, they increase prices paid by buyers of food, as well as decreasing the prices paid to sellers of food. Neither did the team find evidence of vertical integration that would tend to suppress competition: market chains tended to comprise sequences of distinct collectors, long-distance traders, wholesalers and retailers.

Market information systems take the form of collegial exchanges of price data between multiple networks of traders, overlapping but mutually competing, suggesting competitive markets. Consumers have limited access to such information. However, in most cases, consumers would not be able to alter their behavior to take advantage of spatial price patterns or temporal price trends revealed by analysis of these data and so, in practice, lose little from this lack of access.

D. BARGAINING POWER OF SUPPLIERS OF AGRICULTURAL INPUTS

Inputs to agriculture are labor, fertilizer and seed. Markets for labor and non-improved seed are locally open and competitive. A limited number of seed multipliers sell improved seed for staple crops but government oversees this sub-sector, which lacks allegations of cartel activity. For animal nutrition, maize markets are accessible and transparent though soy markets are disconnected. Cattle, fish and chicken rearers must buy imported veterinary products.

DRC does not produce chemical fertilizer. Importers/wholesalers of chemical fertilizer, numbering around a dozen, dominate provincial markets but the team's rapid appraisal found no evidence of oligopoly rents.

Within Katanga, input retailers buy from Lubumbashi-based wholesalers or from sources in Zambia, suggesting multiple conduits for inputs, limited vertical integration, and thus a competitive market. In towns and cities, rivalry among retailers of agricultural inputs seems to ensure competitive markets; in more rural settings, geographic monopolies exist more easily.

E. MARKET TRENDS

With the emergence of a copper-belt middle class, the transition from markets to supermarkets is underway, particularly in Lubumbashi where multiple supermarkets compete to provide quality produce and convenient

[118] A Muhammad & B Meade 2011. Low-income countries are most responsive to income and food-price changes, USDA, Economic Research Service, 1st September http://www.ers.usda.gov/amber-waves/2011-september/low-income-countries.aspx#.VS1UEfnF-rg These statistics are generic for low-income countries.

shopping. The supermarkets' product ranges vary and they do not offer all the commodities offered in the market but they offer most of them. They can sell processed products based on the commodities studied and brand these to build consumer confidence in quality merchandise for which secure and dependable supplies, some of which they produce themselves, are important.

Within Katanga, there are opportunities to tailor supplies of agricultural surpluses to the multiple copper-belt mines that currently source much of the food for their workers from outside DRC. This would be a profitable market but requires a systematic approach with good management that can provide dependable sources of high-quality foodstuffs.

Supermarkets and butcher shops manage slaughter nearby in order to have a stock fresh local meat for their consumers. However, this meat is available in small quantities and is much more expensive than frozen extra-African meat. It will take great strides to increase the scale of production and change the animal nutrition to include low-priced local fattening feeds in order to make local meat competitive for a significantly greater share of copper-belt consumers. Fresh farmed fish faces a similar challenge.

F. HIGH-POTENTIAL MARKET SEGMENTS

Increasing the productivity of maize and beans to win back the market share lost to Zambia and Tanzania is a simple but important opportunity. It is fortunate that maize and beans are complementary in production (largely through beans' nitrogen fixing) so it is possible to increase the supply of both simultaneously with less fertilizer than would otherwise be the case. This provides the opportunity to satisfy basic food-security needs because maize and beans are also complementary in consumption (together meeting human needs for animo acids).

The same complementarity is true of maize and soy but the market for soy is thinner and less integrated. Expanding a market for soy requires large investments in pressing plants to produce soy cake that is an important for animal production, as well as soy cooking oil. The demand for one of the two joint products may fall, affecting the profitability of the plant and thus the demand for the raw material, even though the demand for the other may remain vibrant. However, to complement maize in feed, soy is important. Without a dynamic soy sector, the Katangan copper-belt's production of eggs and farmed fish will remain dependent on imports; and its beef production will continue to be finished for market on pasture, a formula that it can sustain in the short- to-medium term because of the small size of the provincial herd and the large areas of grazing currently available but an inefficient mode of production.

Separately, development of horticultural production to meet increasing demand can hope to win market share from Zambia but only with the addition of greater quantities of fertilizer, which maize, beans and soy also require. The general goal of agricultural development is to make farming less labor-intensive and avoid expanding the area under crops, which requires more roads to take inputs in and crops out, reduces biodiversity and destroys trees (thus contributing to global warming). All crops should receive more, more carefully chosen, and more carefully applied agricultural inputs, particularly chemical fertilizer applied with organic fertilizer. Katangan fertilizer companies should import by the boatload, through a diversity of ports to spread the additional potentially port-blocking load, including Beira, which is much closer than the traditionally used ports of Durban and Dar es Salaam. Fertilizer users should receive training so that they are more discerning consumers, buying what they need and not wasting money.

A study should examine whether the rumored oligopolies in various agricultural input and output markets exist and, to the extent they do, propose solutions to counter them.

Banks should compete to participate in a partial loan guarantee scheme for loans to farmers and agribusinesses, accompanied by systematic support to banks and credit applicants so that banks better understand the agricultural sector and that educated, aspiring farmers and agribusiness operators appreciate bank procedures. Provide help to applicants who meet the basic bank conditions to produce a business plan that will serve not only to facilitate credit but as a reference document during the life of the loan and beyond. Examples of approved activities: tractor leasing, fish-farming, fertilizer imports, seed multiplication.

Katanga should have its own animal-feed factory, capable of manufacturing a variety of feeds, principally for the fish and poultry/egg sectors, subject to a detailed financial and economic benefit-cost evaluation.

Efforts should be made to promote caterers with contracts to supply meals to mines to make local purchases of products in all of the sectors considered in the current study.

Another area of potential intervention would be to develop a basic packaging industry that can produce sacks, wooden crates and cardboard boxes/trays.

1. MAIZE (AND BEANS AND SOY): INTENSIFICATION THROUGH A SMALL-BUSINESS APPROACH

Potential interventions include the following:

- Promote intensification of maize production by small, motivated farmers with fields near roads, without any extension of their cultivated area. Provide MFI credit to enable purchases of fertilizer and high-yielding seed through approved input suppliers. Provide training and extension to ensure that they use these expensive inputs efficiently. Include production of intercropped high-yielding beans and soy. Where possible, facilitate this project through joint-ventures with large farmers who provide land, credit for inputs and initial tilling of the land, in return for an agreed share of the harvest.
- Work with the input-importing companies and the trucking/rail sectors to supply inputs on time to small farmers participating in the project and others.
- Promote intensification of maize production by medium-scale, motivated farmers with fields near roads, without any extension of their cultivated area. Provide bank credit to enable purchases of inputs and leasing of mechanized land-tilling (tractor) services through approved suppliers. Provide training and extension to ensure that they use these expensive inputs efficiently. Every third year, switch to high-yielding soy or beans, using the same inputs. Where possible, integrate this project into mines' efforts to produce 500 ha of maize annually through contracts between mines and medium-sized farmers.
- Integrate the maize, bean and particularly soy value chains through a radio program that communicates price information for inputs and outputs, details of tractor-leasing availability, discussions of production techniques and transport availability.
- Plant trees (eucalyptus) for wood production as part of each year's maize/beans/soy intensification.
- Promote private-sector-built and operated animal-feed factory (see above).
- Maintain existing roads and gradually build more feeder roads through good agricultural land.
- Promote local purchases by mines' caterers (see above).
- Provide training in dry-goods storage techniques to farmers and wholesalers.

2. EGGS AND FISH

Potential interventions include the following:

- Put egg farms and fish farms on the list of approved activities for bank credit, subject to approval of a detailed business plan.
- Power pumps, if needed, by micro-hydro on the river/stream used for fish farming.
- Promote private-sector-built and operated animal-feed factory (see above).
- Plant trees (eucalyptus) for wood production as part of each year's fish-farm activities.

3. HORTICULTURE

Potential interventions include the following:

- Put horticultural production on the list of approved activities for MFI credit, subject to approval of a detailed business plan.
- Power pumps, if needed, by micro-hydro on the river/stream used for horticulture, if it exists.
- Promote expansion of horticultural production into non-traditional seasons, i.e., first and second seasons, offering guarantees of minimum earnings over two years to remove the risk of not producing staples during those seasons.
- Promote research into improved seed for horticultural production in Katanga.
- Plant trees (eucalyptus) for wood production as part of each year's horticultural production.

Figure 19. Katanga Opportunity Matrix

Factor/ Product	Horti-culture	Farmed fish	Maize	Beans	Eggs	Soya beans	Beef cattle
End-market competitive-ness	Medium	High	Low/High	High	Medium	High	High
Inclusive growth	High	Low	High	High	Medium	Medium	Low
Food security/ nutrition	High	Low	High	High	Medium	Medium	Low
Conflict-neutral and resilient	Low	High	High	High	High	High	Medium
Pro-women	High	Low	High	High	Medium	High	Low
Pro-youth	Low	Low	Medium	Medium	Low	Low	Low
Climate-change robust	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Benefit cost analysis	High	High	High	Medium	Medium	Medium	Medium

Major opportunity Major obstacle

XXI. CLIMATE SCREENING OF SELECTED AGRICULTURAL COMMODITIES

Agricultural commodities are sensitive to a range of climate risk factors that may have deleterious effects on production, storage, processing, and transport. This section of the report provides a cursory overview of such risk factors and scores selected commodities based on three components of climate vulnerability: 1) *exposure* of commodities to a wide range of climate shocks and stresses (droughts, floods, changes in seasonal temperature and precipitation); 2) *sensitivity* of commodities (i.e., tolerance) to such shocks and stresses, most importantly heat waves, dry spells, erratic distribution of rainfall, high winds, severe storms, etc.; and 3) *adaptive capacity* of individuals to draw upon key assets (production inputs, knowledge of improved farming methods and storage/processing technology, market transport, etc.) to adjust and recover from a myriad of climate risk factors. Scoring is inherently subjective due to a lack of site-specific data on climate variability and the absence of contextual information at the community level on adaptive response patterns and adjustments needed by smallholder producers to surmount a broad range of climate risk factors.

There is a notable paucity of observational data from weather stations in the DRC (and Central Africa region in general), posing unique challenges in the reconstruction of climate analogues and outlooks of future climate trends for the region. Thus a number of recommendations are proposed for the USAID DRC mission in terms of actionable items needed to fill gaps in data analysis and to build a stronger evidence-base of current and future climate trends in order to make informed decisions on mission programming with a more robust climate lens.

A. NATIONAL AND REGIONAL CLIMATE TRENDS

Due to the lack of reliable climate records and the fact that the DRC is located in a relatively moist, humid tropical forest region on the continent, the Central Africa region as a whole receives scant attention and low priority for climate resilience development interventions. Climate models are consistent in projecting a general warming trend for the DRC, with estimates of a 3°C rise by the end of the century. Projections on precipitation are less certain, with some estimates suggesting that rainfall may remain constant, while others suggest an increase in the Great Lakes region. There is, however, more concurrence that a drying trend will occur in the southern region of the country, such as the southeastern Katanga province, one of the target areas of this study. Despite the relative neglect of climate research in the DRC (aside from mitigation impacts on forest biodiversity in the Congo Basin and Albertine Rift), climate variability is notably increasing on shorter observed timeframes in terms of changes in intra- and inter-annual seasonal patterns, with more pronounced episodes of extreme heat waves, droughts and floods, violent rains, and prolonged dry spells.

In terms of agricultural commodity value chains, projected changes in climate are expected to have negative consequences for agricultural production across Central Africa, with losses estimated at 2 to 4 percent by the end of the century. Impacts on livestock and pasture lands could also be adverse should precipitation increase, due to changes in the distribution of disease vectors that could pose new problems for ruminants and other animals.

Regional climate trends for the study zones of North and South Kivu, and southern Katanga (Upper Katanga District) show a marked multi-decadal warming trend over the past century. Research on rainfall trends for the Great Lakes region are inconsistent, but general consensus is that annual precipitation could rise significantly, by as much as 15-20 percent by the end of the century. Increases in rainfall intensity and shifts in seasonal distribution of rains increasing late in the year are anticipated. A drying trend is projected for the southern Katanga region with the dry period expected to increase from four to five or six months by the end of the century.

B. CLIMATE SCREENING OF SELECTED AGRICULTURAL COMMODITIES

Using criteria of climate exposure, sensitivity, and adaptive capacity, selected agricultural commodities for this study were scored for their overall resilience as high, medium, or low. Potatoes and goats rank high for the Kivu provinces due to their overall resilience in withstanding a range of climate stresses during production, their relative ease of storage and processing (potatoes only), and their capacity to withstand loss or spoilage during transport under extreme conditions of damage to transport systems, particularly roads and bridges, due to extreme flooding, storms, and landslides. Commodities that score low in the Kivu provinces due to high sensitivity to changes in rainfall and temperature and extreme events (drought, flooding, intense rainfall) are bananas, horticultural vegetables, and pigs. These commodities are also highly perishable with low storage capacity unless processed, and have a greater risk of loss during episodes of destruction or disruption of main transport supply routes.

In Katanga, only soy beans score high in terms of their resilience to withstand a range of climate stresses, as well as their general ease of storage and transport. Eggs, beef and dairy cattle, farmed fish, and horticultural vegetables all received low scores due to their relative sensitivity to changes in temperature and precipitation and their high perishability when unable to reach market via transport routes washed out by intense flash flooding and storms.

Table 63. Climate Score Summary Table for Selected Agricultural Commodities—North and South Kivu

Commodity	Climate Exposure, Sensitivity of Commodity Value Chains			Adaptive Capacity	Resilience Score
	Production Capacity	Storage/Processing Capacity	Transport Capacity		
Potatoes	HIGH-MEDIUM	HIGH	HIGH	LOW	HIGH
Dry Beans	LOW	HIGH	HIGH	MEDIUM-LOW	MEDIUM
Soy Beans	HIGH	MEDIUM-HIGH	HIGH	MEDIUM-LOW	HIGH
Bananas	LOW	LOW	LOW	LOW	LOW
Small Animals					
Goats Sheep Pigs	HIGH MEDIUM-LOW LOW	N/A N/A N/A	HIGH HIGH MEDIUM-LOW	MEDIUM MEDIUM MEDIUM	HIGH MEDIUM LOW
Horticulture Vegetables	LOW	LOW	LOW	MEDIUM-LOW	LOW

Table 64. Climate Score Summary Table for Selected Agricultural Commodities—Katanga

Commodity	Climate Exposure, Sensitivity of Commodity Value Chains			Adaptive Capacity	Resilience Score
	Production Capacity	Storage/Processing Capacity	Transport Capacity		
Maize	MEDIUM-LOW	MEDIUM	LOW	MEDIUM-LOW	MEDIUM
Dry Beans	LOW	HIGH	HIGH	MEDIUM-LOW	MEDIUM
Soy Beans	HIGH	MEDIUM-HIGH	HIGH	MEDIUM-LOW	HIGH
Poultry Eggs	LOW	MEDIUM	LOW	MEDIUM-LOW	LOW
Cattle					
Beef Dairy	LOW LOW	N/A N/A	MEDIUM LOW	MEDIUM-LOW MEDIUM-LOW	LOW LOW
Farmed Fish	LOW	LOW	LOW	MEDIUM-LOW	LOW
Horticulture Vegetables	LOW	LOW	LOW	MEDIUM-LOW	LOW

C. RECOMMENDATIONS: CLIMATE-RESILIENT AGRICULTURAL VALUE CHAINS

Agricultural commodities selected for this study will require "climate smart" approaches to production, storage, processing, and transport to assure that economic gains accrue to targeted farming communities in the study zones. Such practices will need to intensify crop production by increasing efficiencies in soil and water management, enhancing the storage capacity of carbon in soils, trees, and vegetation, and maximizing productivity on less land, thereby reducing pressure and encroachment onto new forest lands and biomes rich in biodiversity.

Two agricultural practices in particular should be actively supported and integrated within a new regional program strategy by the mission to promote agricultural value chains: intercropping, and agroforestry. Both practices are essential to attenuate rates of deforestation and to reduce extensive farming practices that continue to encroach onto new lands and fragile areas of high biodiversity and forest cover. While no tree crops have been identified on the list of agricultural commodities under consideration, the intercropping of trees with cereals, legumes, and other crops is urgently needed to reduce deforestation, slow down agricultural expansion into ecologically sensitive landscapes, and mitigate carbon and forest cover loss and the attendant rise of GHG emissions in the Congo Basin region.

Agroforestry practices that mix tree crops with cereals and legumes can boost crop productivity by providing shading and lower soil temperatures while simultaneously increasing soil moisture and nutrients in the form leaf litter and detritus as natural mulching on soils.

Cropping in mountain areas should adopt contour planting with crop rotations of peanuts, potatoes, soy, beans, sweet potatoes, cassava, and maize. Bananas, which are highly susceptible to damage when exposed to high winds and hail at high altitudes in the Kivu provinces, are more productive when mixed with coffee.

Other CSA practices to consider include:

- **Conservation agriculture**—promote sound NRM practices such as minimum tillage, continuous ground cover, mulching, crop rotation, and contour terracing will help to retain soil moisture, slow erosion, and reduce periodic stress to drought-sensitive crops such as maize.
- **Agroforestry**—introduce tree planting and nurseries, tree crops for shading (grevilla, pterocarpus, acacia, cedrilla, moringa) to lower soil temperatures and increase soil moisture.
- **Intercropping**—introduce mixed cropping, such as banana, cereals and legumes, particularly on denuded landscapes, to help increase carbon storage in soils.
- **Crop diversification**—diversify food and cash crops (coffee, cocoa) in order to buffer against losses resulting from increasing climate variability and unpredictability of growing seasons.
- **Improved seed varieties**—promote use of short-cycle varieties adapted to heat and water stress, particularly maize, beans and horticultural garden crops.
- **Agricultural water management**—promote improved water management methods and technologies such as rainwater catchment (reservoirs, water retention ponds) and low-cost, scalable drip irrigation systems to extend water resources for off-season crops during the dry season or periods of drought.
- **Intensive animal fattening**—develop intensive livestock and small animal breeding and fattening, coupled with community-based micro-credit savings and loans programs.
- **IPM**—supported integrated pest management and monitoring systems to control against new, emerging pest and plant diseases under changing climate conditions (i.e., "new normal").

D. PROPOSED FUTURE MISSION ACTIVITIES ON CLIMATE CHANGE

Few authoritative studies on climate change trends are available for the DRC, particularly at sub-national, provincial scales. One such study, funded by the MacArthur Foundation under the WCS Albertine Rift Program, acknowledges the dearth of observational baseline data that is needed to reconstruct historical climate trends and generate reliable projections of climate change scenarios (Birdlife 2013; Seimon and Phillipps 2012). Climate models, using interpolated data, have improved significantly in recent years in projecting future climate trends. There are caveats, however, as considerable uncertainty remains in predicting climatological changes across time and space at high resolution landscape levels, particularly given the geo-morphological complexity and heterogeneity of land surface and water body features in montane areas such as the Kivus. Climate scientists from the Albertine Rift Program underscore such limitations:

> A common problem encountered when working with climate model output for many regions of Africa is the lack of baseline data needed to ensure that models are launched with proper representation of actual conditions as a starting point. Instead, interpolation techniques must be applied between widely separated data points, greatly smoothing out local climatic detail – the detail that determines many characteristics and particularities of local ecology. This insufficient representation is especially problematic in mountains, around large water bodies and other regions of complex togography, where both climatic and related ecological gradients are especially large. This is largely the case for much of the Great Lakes Region where complex landscape configurations and widespread absence of verifiable point data resulting from sparse and poorly sustained climatological observations stand as obstacles to efforts to apply models for predicting climatic and ecological futures."
>
> (Birdlife 2013, p. 21)

The authors go on to call for more observational field studies such as vulnerability assessments, rather than a sole reliance on climate models, to fill gaps in observational data that are needed:

> "We need to move away from climate models that exclusively focus on exposure to climate change without incorporating other aspects of vulnerability, as acclimation, interspecific interactions, dispersal limitations and adaptive capacity …. A process of assessing vulnerability by integrating mechanistic, empirical and observation methodologies is needed to provide more accurate adaptation options …."
>
> (Ibid, p. 39)

The USAID DRC mission could contribute significantly in reducing this information gap by carrying out a series of climate research and assessment activities. Potential next steps might include:

- **Archive Retrieval and Analysis of Climate Records**
  INERA has archived records of weather station data from their regional network of research centers, housed at their central field station in Yangambi (Orientale Province) and in the library headquarters in Kinshasa[119]. There is a wealth of historical data dating back to the colonial era on rainfall, temperature, etc., that remains in hard copy only. These records should be digitized and fully exploited to help reconstruct climate records from the past 50+ years. The mission should consider providing assistance to INERA and any other meteorological research applications centers (METTELSAT, University of Kinshasa, other) in retrieval and analysis of these records to better document decadal trends in climate variability dating back to the early 20th century. Individuals interviewed for this study also indicate that private sector industrial firms in mining, agriculture, etc., have kept detailed climate records for their own production interests dating back well into the colonial era. These, along with INERA and other possible records should be inventoried and accessed if possible for full climatological study.[120]

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[119] Located 90 km west of Kisangani, both INERA and IFA University in Yangambi have surprisingly remained intact from pillaging during the two Congo Wars. From one blog site, local folk lore suggests that "….. it has to do with a large tree growing several kilometers into the jungle outside of Yangambi proper. This "Tree of Authenticity" is supposed to posses[s] special powers that grant a long life to anyone who eats its bark. However, the tree is also thought to host evil spirits – as it was once visited by Mobutu and is the throne for the Yangambi witchdoctor(s). Perhaps this fear of bad spirits is what kept civilians and military alike from pillaging Yangambi's research facilities." The blogger goes on to conclude: "Yangambi represents both D.R. Congo's glorious past and its potential future. The research trials and preservation that INERA is currently conducting are both impressive and important for the progress of agriculture R&D in the D.R.C. IFA University possesses a wealth of knowledge about agriculture in central Africa and the potential for renovation is still alive. However, without outside funding and resources, neither of these institutes will make it far – as is indicated by the general state of conditions there today." (http://acrowinghen.com/2011/09/06/yangambi-%E2%80%93-a-symbol-of-congo%E2%80%99s-past-potential-future/)

[120] INERA currently has a full-time statistician who receives frequent requests from private sector interests, as well as small-scale farmers, to provide seasonal and short-term forecasts for the upcoming agricultural season. This is carried out on a per request basis. The statistician indicated that he wishes to exploit INERA's archived climate records, but that this is not his primary responsibility, and that he could greatly benefit from funding to recruit two highly qualified students at the University of Kinshasa to assist him in analyzing INERA's climate records. INERA recently lost the only two field staff at Yangambi who were assigned to work with the climate records. The two individuals are not being replaced due to budget shortages.

- **Climate Change Vulnerability Assessment at Provincial Levels**
  Reconstruction and analysis of historical climate records should be complemented by a more detailed contextual understanding of local, site-specific understandings of climate risks and the nature of climate variability over several decades at provincial and district levels (such as the zones for this study). This would increase understanding of local vulnerabilities of people, places, livelihoods, commodities, and institutions to climate threats. Such research should replicate and build upon the experience of ARCC, such as studies in Uganda, Senegal, Malawi, and elsewhere in Africa that examine not only the nature of climate exposure and sensitivity, but more importantly, the adaptive capacity of communities to respond and recover from a range of climate shocks and stresses.

- **Crop Phenology and Crop Suitability Studies**
  The vulnerability assessments should also ideally include crop phenology studies that identify changing climate conditions that may affect critical stages of crop growth in the near and long-term future. This would include emerging threats of pests and plant disease given anticipated changes in temperature and precipitation. Crop phenology analysis should be supplemented by crop suitability mapping which models areas of suitability for specific crops under various time frames, given future climate change scenarios. This analysis, while of lower priority or value in addressing current and near-term preoccupations of smallholder producers, could nonetheless signal important policy considerations and actions to be undertaken by the Congolese government in preparing for possible scenarios of crops that may not be viable in certain regions under future climate conditions. The example of robusta coffee (from the ARCC study) that will not be a viable crop at high elevations in Uganda, is an instructive case study that merits replication of crop suitability mapping in other areas of Africa.

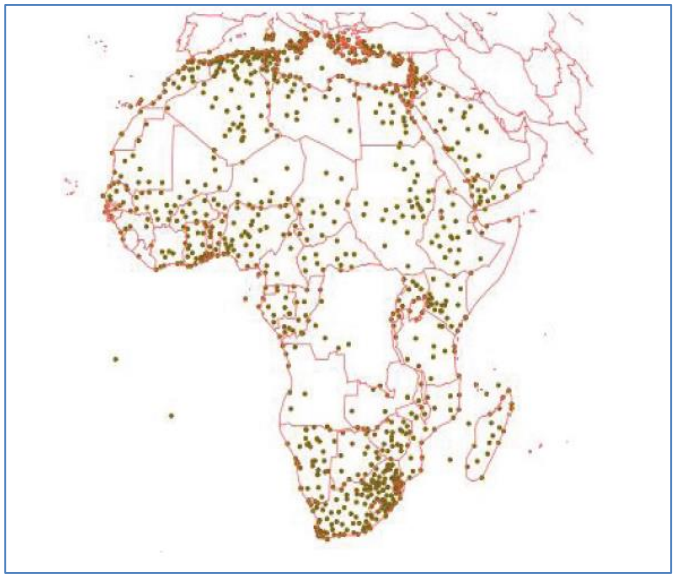
- **Climate Proofing of Mission Program Activities**
  This study represents a positive first step toward screening new mission program activities with a climate lens. As noted, DRC and the Central Africa region are expected to experience less severe climate stress and fewer climate-related risks relative to other regions of the continent. Nonetheless, individuals interviewed and a desk review of the literature confirm that inter-annual and seasonal variability of local climate conditions is changing and becoming more unpredictable. Therefore, adopting a proactive, precautionary optic which screens program activities for potential climate risks will minimize unforeseen costs and consequences of poorly planned activities, consistent with a "no regrets" approach to climate resilience programming that takes sustainable environmental stewardship into account.

E. OVERVIEW OF CLIMATE CHANGE IN THE DEMOCRATIC REPUBLIC OF CONGO

This section of the report presents an analysis of current and future climate trends and a cursory screening for climate risk factors that should be taken into account when identifying and prioritizing commodity value chains. The notable absence of a reliable climate record in the form of an extensive network of data points generated from observational weather stations in the DRC poses unique challenges for this study. Figure 20 below illustrates this quandary, in which the DRC along with a few other neighboring countries (Angola, Zambia), and Somalia have a marked absence of observational data points in relation to other countries on the continent. In general, the tropical moist forest region of Central Africa has received far less attention and robust analysis of climate change trends than other parts of Africa due to the general paucity of reliable climate data for the region (Christensen et al., 2007; IISD 2011). In the DRC, this is due in large part to years of protracted conflict (First Congo War 1996-1997; Second Congo War 1998-2003) which destroyed or left

much of the observational infrastructure in disrepair. Fortunately, recent advances in the use of new satellite-based rainfall monitoring technology are improving the science of downscaling of general circulation models (GCM), enabling the scientific community to make more reliable projections of general trends in key parameters such as changes in rainfall and temperature (Seimon and Phillipps, 2012). While the range of uncertainty in climate projections for rainfall is greater than for temperature in the DRC, there is nonetheless a concurrence of general trends for most modeled scenarios.

Figure 20. Climatological Observation Network in Africa, based on Global Summary of Day Observation (GSOD) Listing, 2008-2009



Source: http://moyhu.blogspot.com/2010/07/spatial-coverage-of-ghcn-and-gsod.html, in Seimon et al., 2011

The degree of uncertainty of projections is known to increase as the scale of resolution (or downsizing) moves from global to regional and local levels. Thus predicting temperature and rainfall at a community level, particularly when looking at seasonal and inter-annual patterns (termed climate variability) becomes less precise (Baethgen 2013; Trzaska, personal communication). Analysis in this report section draws observations on national and regional climate trends, recognizing limitations of the climate record for the DRC and the fact that granularity in analysis becomes obscured as one moves from the national to sub-national and provincial level. Field observations of recent historical trends in seasonal, inter-annual and decadal climate variability, generated from focus group discussions and structured interviews, was not possible given the scope of this study. Therefore, some subjectivity is inherent in making observations on how climate variability is currently impacting crop production and associated commodity value chains. Nonetheless, consensus among scientists in terms of overall climate trends on temperature and precipitation enable one to arrive at relatively well informed observations in an initial phase of climate screening for agricultural commodities.

1. NATIONAL CLIMATE TRENDS

Climate change trends in the DRC and for the Central Africa region are expected to be modest in relation to other areas of the continent (Boko et al., 2007). Thus, the region in general is considered to be of relatively low climate risk, which may play some role in the lack of scientific research and attention that it has received. Nonetheless, a general review of the literature and some anecdotal information gathered, suggests that climate variability is increasing on a shorter time scale in terms of changes in intra- and inter-seasonality.

The climate of the DRC is primarily equatorial, with regional variations due to the vast size of the country. The tropical rainforests of the Congo River basin in the north and west are hot and humid, while the southern, central and eastern regions are cooler and drier. Climate trends in recent years have seen an increase in seasonal and inter-annual variability and more pronounced episodes of extreme heat waves, droughts and floods, violent rains, and prolonged dry spells (MENCT, 2009).

A number of studies, based on different climate models and varying scenarios for carbon emissions based on a range of development pathways and other key variables, agree on a warming trend for the country. Estimates project a moderate increase in mean annual temperature of 1˚C to 2.5˚C by 2050, and a rise of 3˚C by the end of this century (World Bank, n.d.; Christensen et al., 2007; MENCT 2009; Nsombo et al. 2012). Projections on precipitation are less certain, with some estimates suggesting that rainfall may remain constant, while others suggest an increase from 0.3 to 7.5 percent by 2050 (MENCT 2009). Projections are also not consistent in terms of an increase in the number of dry days or the intensity of high rainfall events that may occur (World Bank, n.d; Christensen et al., 2007). There is, however, more concurrence that a drying trend will occur in the southern region of the country, such as in the southeastern Katanga province, one of the target areas of this study. The dry season is expected to increase five to seven months by mid-century (MENCT 2009).[121]

Projected changes in climate are expected to have negative consequences for agricultural production across Central Africa, with losses estimated at 2 to 4 per cent by the end of the century. Impacts on livestock and pasture lands could also be adverse should precipitation increase, due to changes in the distribution of disease vectors that could pose new problems for ruminants and other animals (Boko et al., 2007; IISD 2011).

Analysis of historical trends on temperature and precipitation for four neighboring countries of DRC illustrate a consistent trend in warming for the Central Africa region dating back at least several decades (table 65). Trends in rainfall, however, show a largely downward trend (with the exception of Burundi), contrary to some analyses that project increased rainfall for the Great Lakes region. This comparative overview is illustrative in showing congruence of most historical trends on temperature and rainfall for the region.[122]

Using comparative decadal time frames (of thirty-years) from 1900 to 2009, a trend analysis showing changes in mean monthly rainfall and temperature for the DRC are illustrated in figure 21.[123] Changes are subtle and not easily discernable, however, a slight rise in monthly temperatures of about 1˚C is apparent over the 109-year time period. The seasonality of temperature and rainfall shows the abundance of rainfall from September through May, and a truncated dry season from June through August. Temperatures have risen from just under 25˚C to about 26˚C during the peak of the wet season (March-May), and again from under 24˚C to about 25˚C during the second wet season (October-November). Average temperature for the coldest month of July has also increased approximately one degree from about 22.5˚C to 23.5˚C over the same time period. Changes in rainfall are less perceptible, but appear to have risen slightly to just over 200 mm during the peak wet months of October and November, while remaining fairly constant during the dry months of June through August.

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[121] This is consistent with the opinion of one of the leading climate change experts in the DRC interviewed for this study, who indicated that the dry season has already from four to six months over the past few decades.

[122] Trends are generated from historical monthly temperature and rainfall data found on the World Bank Climate Change Knowledge Portal for specific climate adaptation country profiles. No profile exists for the DRC. The data were produced by the Climatic Research Unit (CRU) of University of East Anglia (UEA). (http://sdwebx.worldbank.org/climateportalb/home.cfm?page=country_profile)

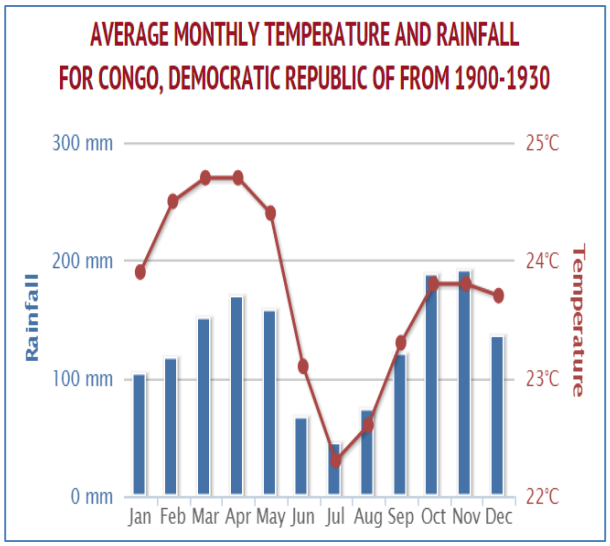
[123] The charts shows mean historical monthly temperature and rainfall for the DRC during the time period 1900-2009, generated through the World Bank Climate Change Knowledge Portal (http://sdwebx.worldbank.org/climateportal). The dataset was produced by the Climatic Research Unit (CRU) of University of East Anglia (UEA).

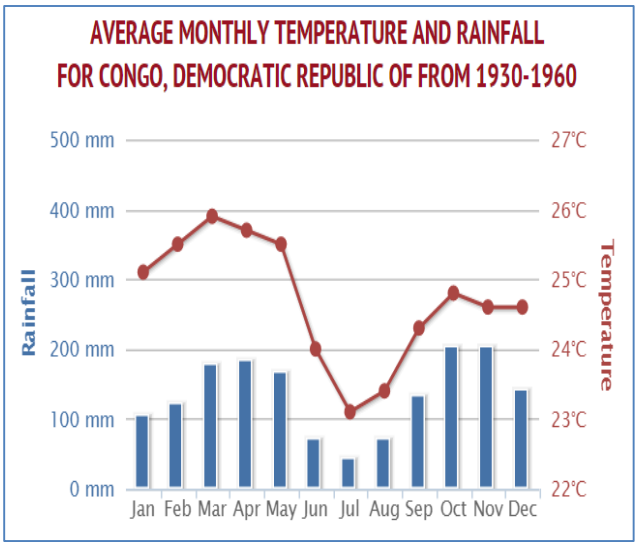
Table 65. Comparison of Recent Decadal Climate Trends in Neighboring Countries of the Democratic Republic of Congo.

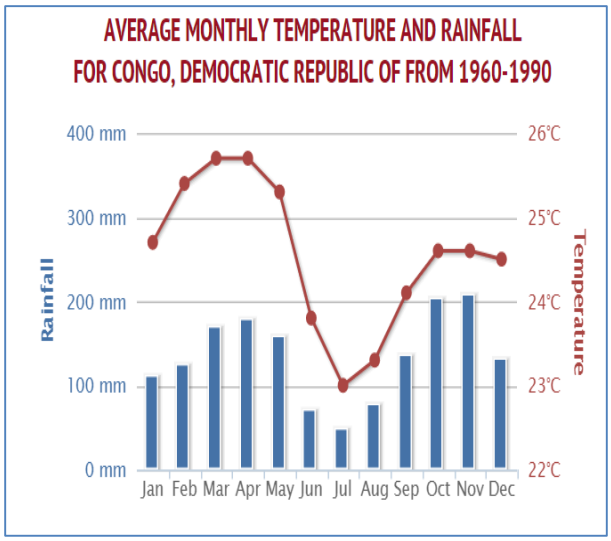
Country	Temperature	Rainfall	Seasonality	Extreme Events
Burundi	▲ mean annual temperature by 0.7-0.9°C since 1930s	▲ in precipitation during the rainy season (October-May) since 1951	▲▼ shortened rainy season coupled with an extension of the dry season in the northeastern regions of Burundi from 1999-2006. The rainy season experiences heavy rains, thunder, and lightening.	
DRC	▲ average maximum temperatures by 0.76°C (1951-1999) ▲ average minimum temperatures by 0.69°C (1951-1999) ▲ mean annual temperature by 0.6°C	▼ mean annual precipitation (1950s-1980s)	▲▼ the intra-seasonal precipitation pattern during the September-November and March-May rainy seasons have fluctuated in recent years, either shortening and/or lengthening seasons	
Rwanda	▲ mean annual temperature by 1.2°C (1971-2009)	▼ mean annual rainfall by 80 mm (1961-2006)	▼ shortening trend in rainy seasons (March-May and September-November)	▲ droughts and heavy rainfall events
Zambia	▲ mean annual temperature by 1.3 °C since 1960 ▲ number of hot days - 43 per year since 1960 ▲ number of hot nights - 43 per year since 1960	▼ mean annual rainfall by 1.9 mm/month since 1960		

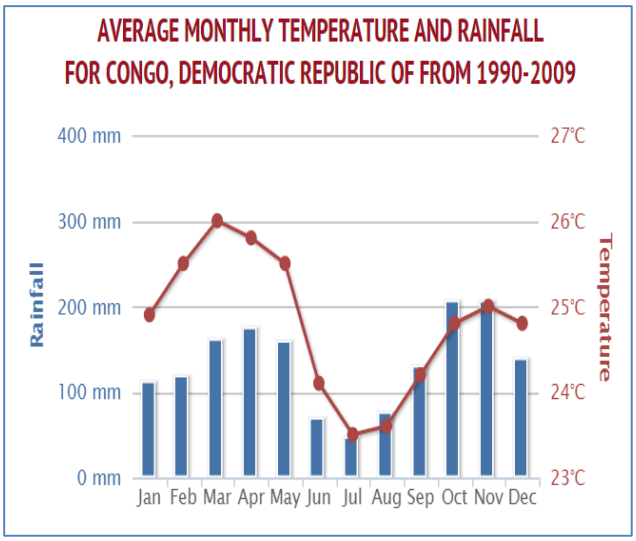
Source: adapted from http://sdwebx.worldbank.org/climateportalb/home.cfm?page=country_profile&CCode=TCD&ThisTab=ClimateBaseline

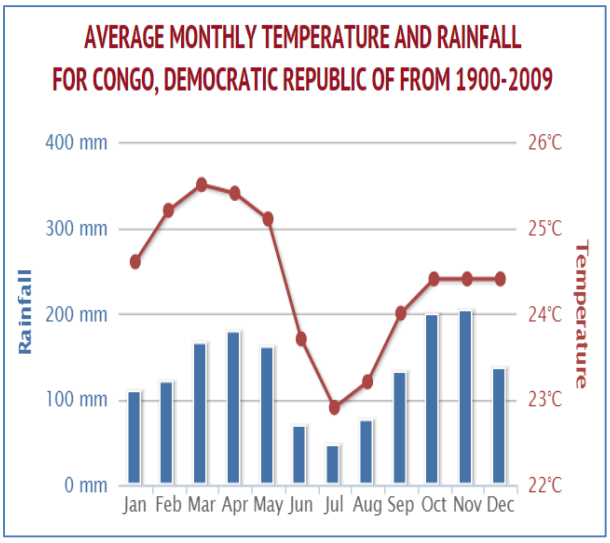
Figure 21. Average Monthly Temperature and Rainfall, DRC. 1900-2009.











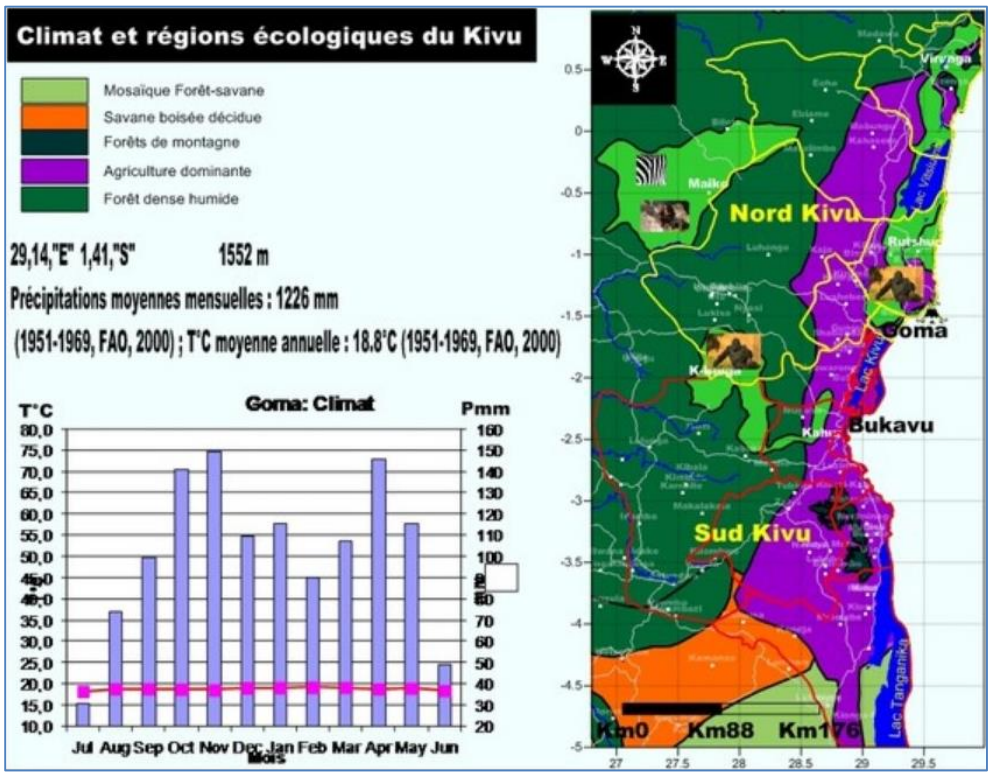
2. REGIONAL CLIMATE TRENDS

NORTH AND SOUTH KIVU

Observations on climate trends for North and South Kivu are based upon climate change research carried out under the Wildlife Conservation Society (WCS) Albertine Rift Programme.[124] and historical trends on changes in temperature and precipitation generated through the World Bank Climate Change Knowledge Portal.[125]

Climate in the Kivu provinces is influenced significantly by wide variations in local topography with a pronounced range in elevation from just above 500 m to over 5,000 m at the Nyiragongo crater. Most of the area of study in North Kivu (Rutshuru, Masisi, Walikali districts) and South Kivu (Kabare, Kalehe, Walungu districts) is comprised largely of agricultural land interspersed with a forest-savanna mosaic, montane forests in protected areas, and more dense humid forests stretching toward the western interior (figure 22).

Figure 22. Climate and Ecological Regions of Kivu



Source: http://rdcmaps.centerblog.net/

[124] The Albertine Rift Programme is funded by the MacArthur Foundation, whose overall goal is to "develop a baseline set of information so that conservation practitioners can make informed decisions about the severity and geographic variation of climate change effects, and the likely impacts of these changes on biodiversity, ecosystem services and human population distribution in the Albertine Rift." http://programs.wcs.org/albertineclimate/Home.aspx; http://programs.wcs.org/albertineclimate/ClimateChange.aspx

[125] http://sdwebx.worldbank.org/climateportal/index.cfm

Seasonality is the direct result of the movement of the ITCZ as it moves above and below the Equator, forming two rainy seasons from March-May and September-December. Research studies on recent climate trends on temperature and rainfall at the provincial level are unavailable. Thus, observations at a larger regional scale for East Africa are used here as a proxy for the eastern Kivu provinces. A marked multi-decadal warming trend has occurred over the past century and has been accelerating over recent decades. Temperatures in the region have risen by 0.7˚C from 1880-2000, and have been accelerating by 0.15 ˚C to 0.20˚C per decade since the 1970s (Hansen et al., 2010).

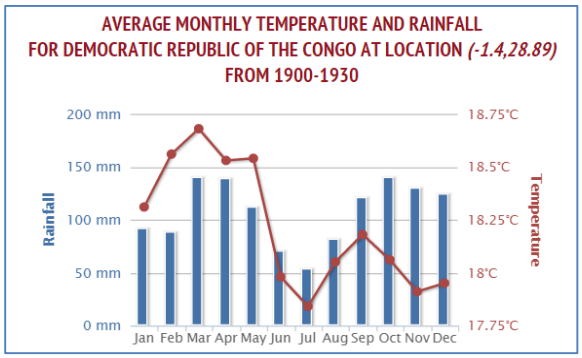
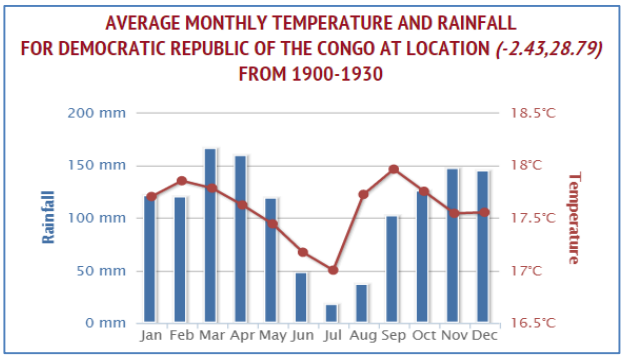
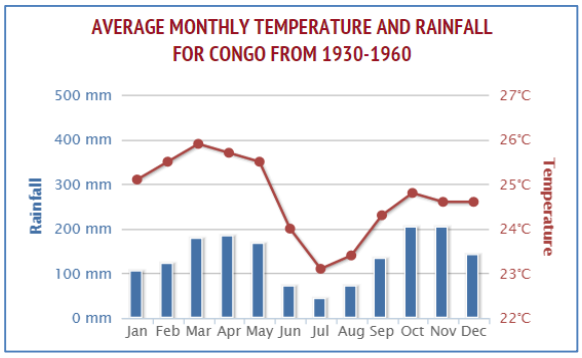
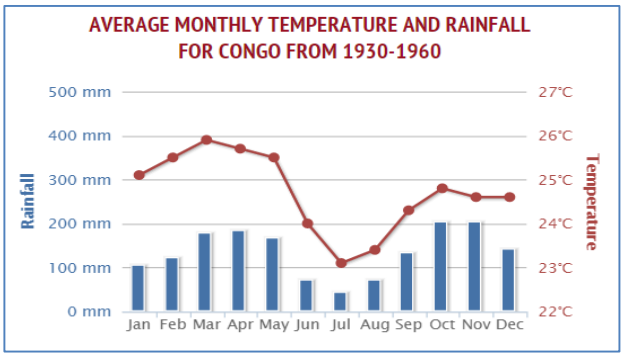
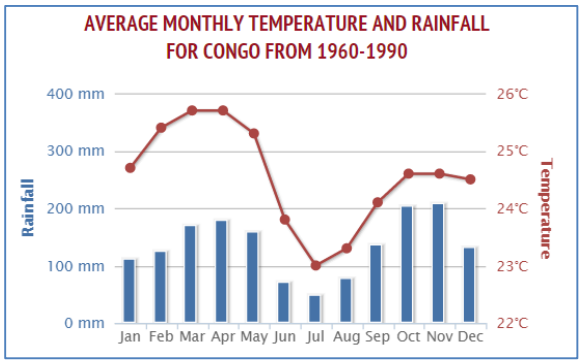
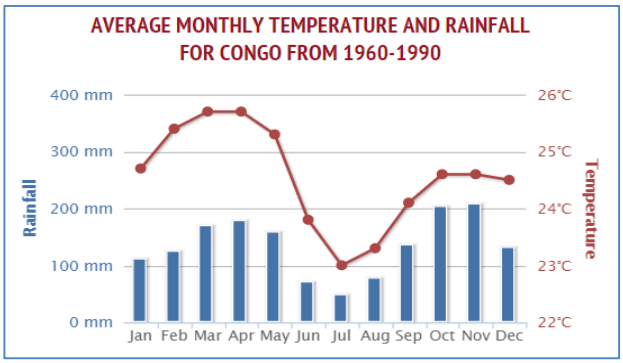
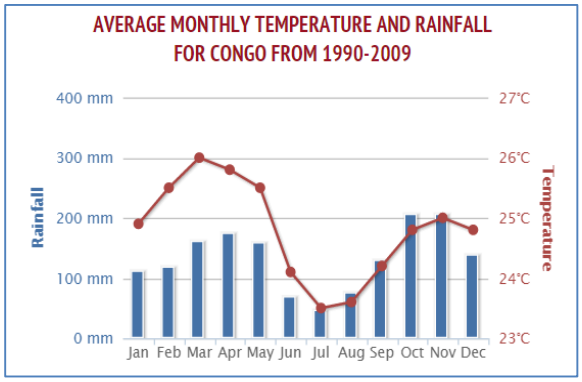
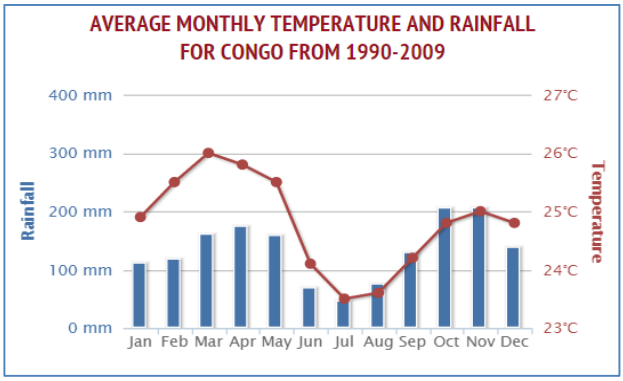
Research on rainfall trends for the Great Lakes region are inconsistent, making a general observation on a trend for the region inconclusive (Stampone et al., 2011; Seimon and Phillipps, 2012). Despite disparities in modeled projections, particularly for rainfall, the authors nonetheless arrive at the following conclusions for overall climate trends that are projected through the end of this century:

- The secular trend of rising temperatures will continue at a rate of approximately one-third of a degree C per decade.
- Total annual precipitation will rise significantly (15-20 percent) across much or all of the Great Lakes region, although the trend may not become established for several more decades.
- Hydrological stress will initially intensify under the warmer and more variable climate before alleviation from large precipitation increases after several decades.
- Precipitation will intensify as temperatures increase.
- Seasonality of precipitation will shift, especially in the southern basins, with pronounced increases in late-year rainfall.

Some climate models project increases in rainfall late in the year that could carry over into the short dry season months of January and February (USAID 2013). Farmers and foraging communities such as Ituri pygmies carry out slash-and-burn bush clearing during this relatively short dry period to improve foraging and to prepare for the next cropping season in March. Extended rains during this period could retard bush clearing and potentially have adverse effects on the food security status of some farming and foraging groups during this period (Wilkie et al, 1999; Magistro 2009).

Trends in decadal variability in temperature and rainfall from 1900-2009 for the study areas are illustrated in figure 23 for the Kivu provinces. Using downscaled models from the World Bank portal, the trends for thirty-year decadal time frames are nearly the same in both Kivu provinces. There is a significant warming on average of almost 7˚C over the 109 year time frame. Average monthly temperatures for 1900-1930 are significantly below those of the remaining decadal time series and thus call into question the validity of the data for the early historical time period. South Kivu exhibits slightly cooler temperatures than North Kivu during that time frame. The figures reveal the bimodal seasonality and two wet periods when both rainfall and temperature reach their peak from March-May and October-November. With the exception of the 1900-1930 time frame, rains reach their highest monthly average of about 200 mm during the second rainy season of October-November while temperatures are slightly warmer, peaking at roughly 25˚C - 26˚C, during the first rainy season from March-May. Rainfall drops below 100 mm per month from June-August and temperatures reach their coolest, around 23˚C in July.

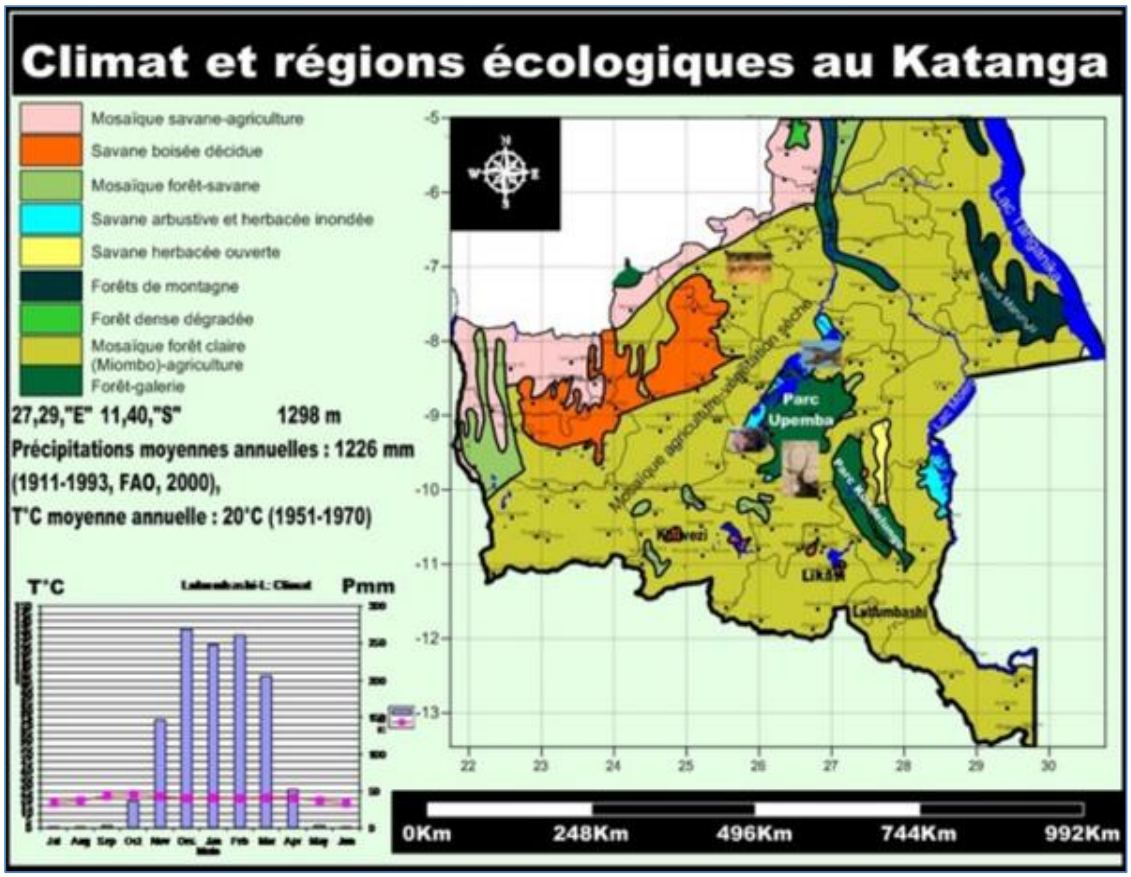
Figure 23. Average Monthly Temperature and Rainfall, 1900-2009

North Kivu	South Kivu
	
	
	
	

UPPER KATANGA DISTRICT

Analysis of climate trends for southern Katanga (Upper Katanga District) are generated from two sources: the World Bank portal and climate data from the PANA-ASA project, funded by UNDP.[126] The climate of Katanga has a noticeably more punctuated wet and dry season than the Kivu provinces and the study zone of Upper Katanga District is almost entirely farm land located in a miombo woodland plateau area (figure 24). Mean annual temperature for the entire province from 1951-1970 was 20˚C, slightly warmer than the average of 18.8˚C at Goma in North Kivu for roughly the same time period (figure 22).

Figure 24. Climate and Ecological Regions of Katanga Province



Source: http://rdcmaps.centerblog.net/

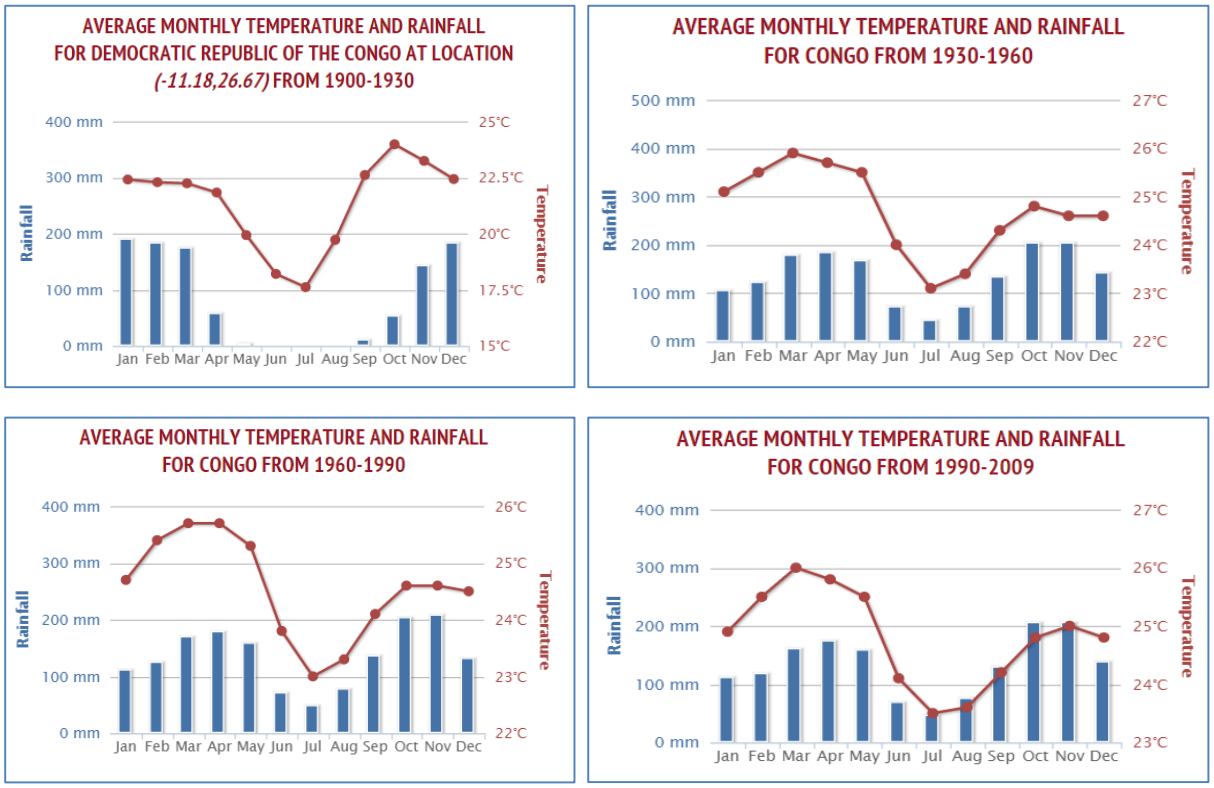
A time series analysis of trends in decadal variability in temperature and rainfall using the same time frame (1900-2009) from the World Bank portal for Upper Katanga District is illustrated in figure 25. Data illustrate a more pronounced seasonality between wet and dry season than in the Kivu provinces. While two growing seasons are possible for short-cycle crops such as beans, there is a prolonged dry season of approximately four months from May-August. Monthly rainfall peaks in March-April and October-November and temperatures, comparable to those in the Kivus, reach 25˚C - 26˚C during the first wet season (March-May) and dip slightly during the second wet season (October-November). Data for the 1900-1930 time period reveal a severe drying trend in the summer months of May-August with no perceptible rainfall, as well as temperatures

[126] PANA-ASA refers to the Programme of Action for Adaptation and Food Security, funded by the UNDP.

significantly below those of latter time frames. Again, this calls into question the reliability of the model and historical reconstruction of the first thirty years of the 20th century using the World Bank portal.

Figure 25. Average Monthly Temperature and Rainfall, 1900-2009

Upper Katanga District



3. CLIMATE RISK SCORING OF COMMODITY VALUE CHAINS

This section examines the climate resilience of each agricultural commodity by assigning a score based on three criteria that determine the relative vulnerability, and thus resilience, of selected commodities to climate stress factors, and the capacity of the general population to adapt their farm assets, in this case crops and animals, to various climate phenomena. These criteria include:

- The degree of ***climate risk exposure*** – this includes the nature of climate stress factors such as variability in rainfall and temperature, and extreme events such as drought or flooding as they affect key segments in the value chain, including production, storage and processing, and transport.
- The degree of ***climate sensitivity*** of the selected commodities – this includes a threshold of sensitivity (or relative degree of tolerance) of a commodity to withstand various climate stress factors and extreme events.
- The degree of ***adaptive capacity*** of individuals – this includes one's ability to manage or adjust their farming strategy for each commodity to a range of climate stress factors, by drawing upon knowledge, skills, or other key assets (e.g., production inputs such as seed, fertilizer, capital) to overcome a given climate stress or extreme event.

A caveat is in order, as scoring is inherently subjective at this preliminary phase of screening. This is due to the lack of localized information at the area of the study zones which is needed to make more informed judgements on the relative resilience of each commodity being evaluated. Information is unavailable on recent climate trends at a sub-provincial level that would help determine how well various commodities have managed to withstand various climate stresses (exposure) under variable weather conditions. This would include information such as the number of dry or extreme wet days in a growing season, date of onset and end of the growing season, maximum and minimum daily temperatures, and the frequency of extreme climate events (droughts, floods) in the recent past. Also, it is helpful to have a thorough understanding of crop phenology, such as was undertaken in the ARCC vulnerability assessment in Uganda in 2012, in order to understand how various stages of the growth cycle of a plant, such as foliation and flowering, are affected by changes in temperature, precipitation, altitude and other biophysical factors[127]. Often, changes in humidity, temperature, and rates of transpiration can trigger an increase in the incidence of pest and plant diseases, including new ones that may have not existed previously. This is useful to understand by looking at climate analogues of recent historical trends that may have prompted outbreaks of pests and disease, as well as future climate projections that may affect both the timing of critical stages of plant growth, as well as the emergence of new pests and plant diseases, particularly viral and bacterial infestations.

Information for scoring in this section is drawn from three sources:

- ARCC Uganda vulnerability assessment – information on plant phenology studies on potatoes, bananas, and beans overlap with these crops for this study; some limited information and observations from the study are used here as a proxy to help inform criteria on exposure, sensitivity and adaptive capacity involving these crops[128];

- Key informant interviews with representatives from DRC government ministries on agriculture, the environment, and rural development; plant and animal scientists at INERA; and program and project administrators from a broad range of bi/multi-lateral donor organizations and civil society institutions (NGOs).

- Memento de l'Agronome – a thorough reference document on the agronomy of crops and animals produced by the French Ministry of Foreign Affairs and two French international development research groups, CIRAD and GRET. While some information is available on most crops on the selection list for this study, there are gaps in climatic information for the growing and reproduction conditions of animals and fish which are lacking in scoring analysis.

Each commodity is given an overall score of high, medium, or low, based on very limited information for each criterion in the matrices below (tables 66-80). Scoring from the matrices is also informed by more detailed information (when available) on general growing conditions for each commodity, prevalence of the most common pests and diseases, and specific information on climate exposure and sensitivity (tables 81 and 82).

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[127] Phenology is defined as "the study of periodic plant and animal life cycle events and how these are influenced by seasonal and interannual variations in climate, as well as habitat factors (such as elevation)." http://en.wikipedia.org/wiki/Phenology

[128] Limitations in extrapolating from this study in Uganda to the DRC are taken into account given differences in climate, geography, and topography between the two countries. Nonetheless, in very relative terms, findings from the ARCC assessment are relevant in helping guide general parameters on the vulnerability and resilience of these crops under local climate conditions in Uganda.

Table 66. Climate Score Summary Table for Selected Agricultural Commodities—North and South Kivu

Commodity	Climate Exposure, Sensitivity of Commodity Value Chains			Adaptive Capacity	Resilience Score
	Production Capacity	Storage/Processing Capacity	Transport Capacity		
Potatoes	HIGH-MEDIUM	HIGH	HIGH	LOW	HIGH
Dry Beans	LOW	HIGH	HIGH	MEDIUM-LOW	MEDIUM
Soy Beans	HIGH	MEDIUM-HIGH	HIGH	MEDIUM-LOW	HIGH
Bananas	LOW	LOW	LOW	LOW	LOW
Small Animals					
Goats Sheep Pigs	HIGH MEDIUM-LOW LOW	N/A N/A N/A	HIGH HIGH MEDIUM-LOW	MEDIUM MEDIUM MEDIUM	HIGH MEDIUM LOW
Horticulture Vegetables	MEDIUM	LOW	LOW	MEDIUM	MEDIUM

Table 67. Climate Score Summary Table for Selected Agricultural Commodities—Katanga

Commodity	Climate Exposure, Sensitivity of Commodity Value Chains			Adaptive Capacity	Resilience Score
	Production Capacity	Storage/Processing Capacity	Transport Capacity		
Maize	MEDIUM-LOW	MEDIUM	LOW	MEDIUM-LOW	MEDIUM
Dry Beans	LOW	HIGH	HIGH	MEDIUM	MEDIUM
Soy Beans	HIGH	MEDIUM-HIGH	HIGH	MEDIUM	HIGH
Poultry Eggs	LOW	MEDIUM	LOW	MEDIUM	MEDIUM
Cattle					
Beef Dairy	LOW LOW	N/A N/A	MEDIUM LOW	MEDIUM-LOW MEDIUM-LOW	LOW LOW
Farmed Fish	MEDIUM	LOW	LOW	MEDIUM-LOW	MEDIUM
Horticulture Vegetables	MEDIUM	LOW	LOW	MEDIUM	MEDIUM

Table 68. Climate Risk Scoring for Potatoes—North and South Kivu

Climate Exposure, Sensitivity of Commodity Value Chains			Adaptive Capacity	Resilience Score
Production	**Storage/Processing**	**Transport**		
▪ **HIGH** tolerance (low sensitivity) to variable weather conditions, withstands a broad range of temperatures[i] ▪ Grows well in marginal soils ▪ **MEDIUM** tolerance (sensitivity) to disease and pests (potato wart) under variable weather conditions	▪ **LOW** perishability (high storage capacity)	▪ **LOW** perishability in transit due to extreme flooding, landslides	▪ Local knowledge of bean cultivation ▪ **LOW** access to improved seed varieties ▪ **LOW** access to microcredit, loans ▪ **LOW-MEDIUM** knowledge/adoption of climate smart practices such as intercropping with beans, peas, sweet potatoes, contour planting, conservation agricultural practices	**HIGH**

[i] Findings from ARCC study in Uganda

Table 69. Climate Risk Scoring for Banana—North and South Kivu

Climate Exposure, Sensitivity of Commodity Value Chains			Adaptive Capacity	Resilience Score
Production	**Storage/Processing**	**Transport**		
▪ **LOW – MEDIUM** tolerance (high sensitivity) under future variable precipitation and temperature scenarios ▪ **LOW** tolerance (high sensitivity) to wind damage, intense storms, heavy flooding ▪ **LOW** tolerance (high sensitivity) to disease and pests (e.g., bacteria wilt), potential to increase with rising temperature, spread to unaffected plants[i]	▪ **HIGH** perishability (low storage capacity), unless processed, access to cold chains	▪ **HIGH** perishability in transit due to extreme flooding, landslides [i]	▪ **LOW** access to disease-resistant varieties ▪ **LOW** access to cold chains ▪ **LOW** access to microcredit, loans ▪ **MEDIUM** access to technology for processing (drying) ▪ **LOW-MEDIUM** knowledge/adoption of climate smart practices such as intercropping with shade grown coffee, contour planting, conservation agricultural practices	**LOW**

[i] Findings from ARCC study in Uganda

Table 70. Climate Risk Scoring for Dry Beans—North and South Kivu

Climate Exposure, Sensitivity of Commodity Value Chains			Adaptive Capacity	Resilience Score
Production	Storage/Processing	Transport		
▪ **LOW** tolerance (high sensitivity) to heat stress, drought or flooding [i] ▪ **LOW** tolerance (high sensitivity) under future variable precipitation and temperature scenarios [i] ▪ **LOW** tolerance (high sensitivity) to pests and disease (fungal, root rots) [i]	▪ **LOW** perishability (high storage capacity)	▪ **LOW** perishability in transit due to extreme flooding, landslides	▪ **LOW** access to disease-resistant varieties ▪ **LOW** access to micro-credit, loans ▪ **MEDIUM** access to technology for processing (drying) ▪ **MEDIUM** knowledge/adoption of climate smart practices such as intercropping with cassava, maize, sweet potatoes, contour planting, conservation agricultural practices	**MEDIUM**

[i] Findings from ARCC study in Uganda

Table 71. Climate Risk Scoring for Soy Beans—North and South Kivu

Climate Exposure, Sensitivity of Commodity Value Chains			Adaptive Capacity	Resilience Score
Production	Storage/Processing	Transport		
▪ **HIGH** tolerance (low sensitivity) to heat stress, drought or flooding ▪ **HIGH** tolerance (low sensitivity) to pests and disease	▪ **LOW-MEDIUM** perishability (high storage capacity)	▪ **LOW** perishability in transit due to extreme flooding, landslides	▪ **LOW** access to improved seed varieties ▪ **LOW** access to micro-credit, loans ▪ **MEDIUM** access to technology for processing (drying, milling) ▪ **MEDIUM** knowledge/adoption of climate smart practices such as intercropping with cassava, maize, sweet potatoes, contour planting, conservation agriculture, etc.	**HIGH**

Table 72. Climate Risk Scoring for Small Livestock—North and South Kivu

Climate Exposure, Sensitivity of Commodity Value Chains			Adaptive Capacity	Resilience Score
Production	Storage/Processing	Transport		
Goats				
▪ **HIGH** tolerance (low sensitivity) to extreme weather conditions (heat, water stress) ▪ **HIGH** tolerance (low sensitivity) to pests and disease	▪ **HIGH** risk of (butchered) meat spoilage in heat	▪ **LOW** risk for loss of animals during transport to market under conditions of severe flooding ▪ **HIGH** risk of loss of (butchered) meat under conditions of extreme heat	▪ **LOW** access to improved breeds ▪ **LOW-MEDIUM** access to veterinary services, feed supplements ▪ **LOW** access to micro-credit, loans ▪ **MEDIUM-HIGH** knowledge/ adoption of improved livestock management practices (zero/low grazing, intensive fattening)	**HIGH**
Sheep				
▪ **LOW-MEDIUM** tolerance (high sensitivity) to extreme weather conditions (heat, water stress) ▪ **MEDIUM** tolerance (medium sensitivity) to pests and disease	▪ **HIGH** risk of (butchered) meat spoilage in heat	▪ **LOW** risk for loss during transport to market under conditions of severe flooding ▪ **HIGH** risk of loss of (butchered) meat under conditions of extreme heat	▪ **LOW** access to heat-tolerant, improved breeds ▪ **LOW-MEDIUM** access to veterinary services, feed supplements ▪ **LOW** access to micro-credit, loans ▪ **MEDIUM-HIGH** knowledge/ adoption of improved livestock management practices (zero/low grazing, intensive fattening)	**MEDIUM**
Pigs				
▪ **LOW** tolerance (high sensitivity) to extreme weather conditions (heat, water stress) ▪ **LOW** tolerance (high sensitivity) to pests and disease	▪ **HIGH** risk of (butchered) meat spoilage in heat	▪ **LOW-MEDIUM** risk for loss during transport to market under conditions of severe flooding ▪ **HIGH** risk of loss of (butchered) meat under conditions of extreme heat	▪ **LOW** access to heat-tolerant, improved breeds ▪ **LOW-MEDIUM** access to veterinary services, feed supplements ▪ **LOW** access to micro-credit, loans ▪ **MEDIUM-HIGH** knowledge/ adoption of improved livestock management practices (zero/low grazing, intensive fattening)	**LOW**

Table 73. Climate Risk Scoring for Horticulture—North and South Kivu

Climate Exposure, Sensitivity of Commodity Value Chains			Adaptive Capacity	Resilience Score
Production	Storage/Processing	Transport		
▪ **LOW** tolerance (high sensitivity) to heat stress, drought or flooding ▪ **LOW** tolerance (high sensitivity) sensitivity to pests and disease	▪ **HIGH** perishability (low storage capacity), unless processed, access to cold chains	▪ **HIGH** perishability in transit due to extreme flooding, landslides	▪ **LOW** access to disease-resistant, improved seed varieties ▪ **LOW** access to cold chains ▪ **LOW** access to micro-credit, loans ▪ **MEDIUM** access to technology for processing (drying) ▪ **MEDIUM** knowledge/adoption of climate smart practices such as permaculture, IPM, etc.	**MEDIUM**

Table 74. Climate Risk Scoring for Maize—Katanga

Climate Exposure, Sensitivity of Commodity Value Chains			Adaptive Capacity	Resilience Score
Production	Storage/Processing	Transport		
▪ **LOW** tolerance (high sensitivity) to drought and short-term water stress, unreliable rainfall conditions [i] ▪ **LOW** tolerance (high sensitivity) to hail [i] ▪ **LOW-MEDIUM** tolerance (sensitivity) to major outbreaks of pests and disease [i]	▪ **LOW** perishability, (high storage capacity) ▪ **MEDIUM-HIGH** risk of Aflatoxin with high humidity, rainfall [i]	▪ **LOW** perishability in transit due to extreme flooding, landslides	▪ **LOW** access to improved seed varieties ▪ **LOW** access to micro-credit, loans ▪ **MEDIUM** access to technology for processing (drying, milling)) ▪ **MEDIUM** knowledge/adoption of climate smart practices such as intercropping with cassava, peanuts, beans, etc., contour farming, conservation agriculture, etc.	**MEDIUM**

[i] Findings from ARCC study in Uganda

Table 75. Climate Risk Scoring for Dry Beans—Katanga

Climate Exposure, Sensitivity of Commodity Value Chains			Adaptive Capacity	Resilience Score
Production	Storage/Processing	Transport		
▪ **LOW** tolerance (high sensitivity) to heat stress, drought or flooding [i] ▪ **LOW** tolerance (high sensitivity) under future variable precipitation and temperature scenarios [i] ▪ **LOW** tolerance (high sensitivity) to pests and disease (fungal, root rots) [i]	▪ **LOW** perishability (high storage capacity)	▪ **LOW** perishability in transit due to extreme flooding, landslides	▪ **LOW** access to disease-resistant varieties ▪ **LOW** access to micro-credit, loans ▪ **MEDIUM** access to technology for processing (drying) ▪ **MEDIUM** knowledge/adoption of climate smart practices such as intercropping with cassava, maize, sweet potatoes, contour planting, conservation agriculture, etc.	**MEDIUM**

[i] Findings from ARCC study in Uganda

Table 76. Climate Risk Scoring for Soy Beans—Katanga

Climate Exposure, Sensitivity of Commodity Value Chains			Adaptive Capacity	Resilience Score
Production	Storage/Processing	Transport		
▪ **HIGH** tolerance (low sensitivity) to heat stress, drought or flooding ▪ **HIGH** tolerance (low sensitivity) to pests and disease	▪ **LOW-MEDIUM** perishability (high storage capacity)	▪ **LOW** perishability in transit due to extreme flooding, landslides	▪ **LOW** access to improved seed varieties ▪ **LOW** access to micro-credit, loans ▪ **MEDIUM** access to technology for processing (drying, milling) ▪ **MEDIUM** knowledge/adoption of climate smart practices such as intercropping with cassava, maize, sweet potatoes, contour planting, conservation agriculture, etc.	**HIGH**

Table 77. Climate Risk Scoring for Eggs—Katanga

Climate Exposure, Sensitivity of Commodity Value Chains			Adaptive Capacity	Resilience Score
Production	Storage/Processing	Transport		
▪ **LOW** tolerance (high sensitivity) to temperature extremes, heat stress and cold ▪ **LOW** tolerance (high sensitivity) to disease ▪ Chickens require good air ventilation and stable temperature in their coops	▪ **MEDIUM** perishability of eggs, must be consumed or sold unless kept in cold storage	▪ **HIGH** perishability in transit due to fragile nature	▪ **LOW** access to improved chicken breeds ▪ **LOW-MEDIUM** access to veterinary services, feed supplements ▪ **LOW** access to micro-credit, loans ▪ **LOW-MEDIUM** knowledge/ adoption of improved poultry management practices	**MEDIUM**

Table 78. Climate Risk Scoring for Beef, Dairy Cattle—Katanga

Climate Exposure, Sensitivity of Commodity Value Chains			Adaptive Capacity	Resilience Score
Production	Storage/Processing	Transport		
Beef				
▪ **LOW** tolerance (low sensitivity) to extreme weather conditions (heat, water stress) ▪ **LOW** tolerance (low sensitivity) to pests and disease	▪ **HIGH** risk of (butchered) meat spoilage in heat	▪ **LOW** risk for loss during transport to market under conditions of severe flooding ▪ **HIGH** risk of loss of (butchered) meat under conditions of extreme heat	▪ **LOW** access to improved breeds ▪ **LOW-MEDIUM** access to veterinary services, feed supplements ▪ **LOW** access to micro-credit, loans ▪ **MEDIUM-HIGH** knowledge/ adoption of improved livestock management practices (zero/low grazing, intensive fattening)	**MEDIUM**
Dairy				
▪ **LOW** tolerance (high sensitivity) to extreme weather conditions (heat, water stress) ▪ **LOW** tolerance (medium sensitivity) to pests and disease	▪ **HIGH** risk of dairy in heat	▪ **LOW** risk for loss during transport to market under conditions of severe flooding ▪ **HIGH** risk of loss of milk/dairy under conditions of extreme heat	▪ **LOW** access to heat-tolerant, improved breeds ▪ **LOW-MEDIUM** access to veterinary services, feed supplements ▪ **LOW** access to micro-credit, loans ▪ **MEDIUM-HIGH** knowledge/ adoption of improved livestock management practices (zero/low grazing, intensive fattening)	**MEDIUM**

Table 79. Climate Risk Scoring for Farmed Fish—Katanga

Climate Exposure, Sensitivity of Commodity Value Chains			Adaptive Capacity	Resilience Score
Production	Storage/Processing	Transport		
▪ **LOW** tolerance (high sensitivity) to temperature extremes, heat stress and cold ▪ **LOW** tolerance (high sensitivity) to disease ▪ Tilapia require closely monitored, stable pond temperature and slightly warmer water during reproduction	▪ **HIGH** perishability, must be sold or consumed within 2-3 hours of harvest unless processed (drying, smoking), kept in cool fresh water	▪ **HIGH** perishability in transit, unless cold chain is available, require changing of water every 2 hours if not on ice	▪ **MEDIUM** access to fingerlings ▪ **MEDIUM** access to veterinary services, feed supplements ▪ **LOW** access to microcredit, loans ▪ **LOW** knowledge/ adoption of aquaculture	**MEDIUM**

Table 80. Climate Risk Scoring for Horticulture—Katanga

Climate Exposure, Sensitivity of Commodity Value Chains			Adaptive Capacity	Resilience Score
Production	Storage/Processing	Transport		
▪ **LOW** tolerance (high sensitivity) to heat stress, drought or flooding ▪ **LOW** tolerance (high sensitivity) sensitivity to pests and disease	▪ **HIGH** perishability (low storage capacity), unless processed, access to cold chains	▪ **HIGH** perishability in transit due to extreme flooding, landslides	▪ **LOW** access to disease-resistant, improved seed varieties ▪ **LOW** access to cold chains ▪ **LOW** access to microcredit, loans ▪ **MEDIUM** access to technology for processing (drying) ▪ **MEDIUM** knowledge/adoption of climate smart practices such as permaculture, IPM, etc.	**MEDIUM**

Table 81. Climate Exposure, Sensitivity, and Growing Conditions for Selected Agricultural Commodities—North and South Kivu

Crop/ Commodity	Pests, Diseases	Growth Cycle	Growing Conditions		Climate Exposure, Sensitivity
		Days	Temperature	Rainfall	
Potatoes	Potato wart, potato scab, viruses, mildew (*Phytophtora infestans*), Bacteria wilt, *Rhizoctonia solani,* Blight (*Alternia solani*), Nematodes		Max day time: 24 ^{0}C Max evening: 16 ^{0}C Range: 12^0 C - 18 ^{0} C	Range: 500mm – 1500 mm	▪ Sensitive to short-term water stress, particularly during last 9 weeks ▪ Sensitive to shade ▪ Scab increases with rainfall ▪ Damages in cold storage below 4 ^{0} C ▪ Conserves well in storage at 20^0 C ▪ Harvest and storage in dry conditions
Dry Beans - *(Phaseolus vulgaris)*	Mosaic virus (BCMV), leaf rust	90-130	Range: 17.5^0 C - 25 ^{0} C Optimal range: 20^0 C - 22.5^0 C	Range: 300mm – 400 mm	▪ Rust occurs from moisture on leaves ▪ Beans develop significant fungal and viral diseases in the event of excessive rainfall during critical periods ▪ Can be produced under a wide range of climatic conditions ▪ However, prefers moderate, well distributed rainfall ▪ Sensitive to drought and excess water ▪ Dry conditions at harvest
Soy Beans	Bacterial blight (*Pseudomonas syringae*), Rust (*Phakopsosa pachyrhizi*), Sigatoka (*Cercospora, Altenaria*), Seedling rot (*Macrophomina, Rhizoctonia, Phytophtora*), Mildew		Range: 15^0 C - 37 ^{0} C Optimal range: 25^0 C - 33^0 C	Optimal: 500 mm – 800 mm	▪ Problems with high temperatures at harvest, pods burst, dispersal of beans; prefers lower temperatures, grown at altitude ▪ Sensitive to waterlogging, excessive humidity, particularly at harvest and during storage ▪ Stores best <10% humidity and at 15^{0}C - 20^{0}C
Bananas	Bacteria wilt, bunchy top viruses (BBTV, beach mosaic CMV), stripe mosaic (BSV), Fusarium, Sigatoka, funguses, root nematodes	60-90	Range: 12^0 C - 35 ^{0} C Optimal: 28^0 C	Range: 125mm-150mm/mo	▪ Wilt spreads quickly due to planting density, and high humidity (excessive rainfall) ▪ Sensitive to dry spells (1 month max) ▪ Sensitive to cool temperatures, particularly during transport (min 12^0 C) ▪ Sensitive to constant or strong winds ▪ Roots sensitive to excessive moisture
Small Ruminants					
Pigs	Worms, African swine fever, trypanosomiasis, Teschen disease, anthrax, swine erysipelas, scabies, anemia, cysticercosis	Not Available	Max: 41^0 C	Not Available	▪ Sensitive to heat
Sheep	Nematodes, trematodes, cestodes, coccidiosis, oestrose, eczema, dermatophilosis, ticks, lice	Not Available	Not Available	Humidity: 70% - 80% max	▪ Sensitive to heat
Goats	Nematodes, trematodes, cestodes, coccidiosis, oestrose, eczema, dermatophilosis, ticks, lice	Not Available	Not Available	Humidity: 70% - 80% max	▪ Low sensitivity, well adapted to a wide range of climate conditions
Horticulture	Varies per crop	Varies per crop	Varies per crop	Varies per crop	Varies per crop

Table 82. Climate Exposure, Sensitivity, and Growing Conditions for Selected Agricultural Commodities—Katanga

Crop/ Commodity	Pests, Diseases	Growth Cycle	Growing Conditions		Climate Exposure, Sensitivity
		Days	Temperature	Rainfall	
Maize	Borers (sessamia, busseola fusea), stem borers (pyrales), mildew, viruses (Maize streak virus) Fungus (*Aspergillus niger, Fusarium monoliforme*) Leaf blotch Leaf rust (*Puccinia polysora, P. sorghi*)	90-130	Range: 15^{0}C - 35^{0}C Seed germination: 18^{0}C - 21^{0}C Optimal range: 25^{0}C - 30^{0}C Average min range: 10^{0}C - 24^{0}C Average max range: 26^{0}C - 29^{0}C	Range: 500mm – 1300 mm Optimal: 800mm – 1000mm	▪ Yields negatively affected by increasing variability in precipitation ▪ Leaf blotch increases with warm temperatures ▪ Grows under widely varying climatic conditions ▪ However, sensitive to short-term water stress, dry spells/drought, intense rains, cloud cover, high winds, and heat waves ▪ Drought particularly detrimental at the time of sowing, with a stronger negative influence on the yield at the time of flowering ▪ Prone to major outbreaks of pests and disease ▪ Risk of Aflatoxin due to increased moisture, humidity in storage ▪ Requires quick drying at harvest, exposure to sunlight low humidity
Dry Beans - *(Phaseolus vulgaris)*	Mosaic virus (BCMV), leaf rust	90-130	Range: 17.5^0 C - 25 ^{0}C Optimal range: 20^0 C - 22.5^0 C	Range: 300mm – 400 mm	▪ Rust occurs from moisture on leaves ▪ Beans develop significant fungal and viral diseases in the event of excessive rainfall during critical periods ▪ Can be produced under a wide range of climatic conditions ▪ However, prefers moderate, well distributed rainfall ▪ Sensitive to drought and excess water ▪ Dry conditions at harvest
Soy Beans	Bacterial blight (*Pseudomonas syringae*), Rust (*Phakopsosa pachyrhizi*), Sigatoka (*Cercospora, Altenaria*), Seedling rot (*Macrophomina, Rhizoctonia, Phytophtora*), Mildew		Range: 15^0 C - 37 ^{0}C Optimal range: 25^0 C - 33^0 C	Optimal: 500 mm – 800 mm	▪ Problems with high temperatures at harvest, pods burst, dispersal of beans; prefers lower temperatures, grown at altitude ▪ Sensitive to waterlogging, excessive humidity, particularly at harvest and during storage ▪ Stores best <10% humidity and at 15^{0}C - 20^{0}C
Horticulture Vegetables	Varies per crop	Varies per crop	Varies per crop	Varies per crop	Varies per crop
Beef Cattle	Trypanosomiasis, theileriosis, anthrax, tuberculosis, brucellosis, pleuropneumonia, foot and mouth disease, anaplasmosis, dermatitis, dermatophilosis, scabies, worms	Not Available	Not Available	Not Available	▪ Beef cattle sensitive to extreme heat
Dairy Cattle	Trypanosomiasis, theileriosis, anthrax, tuberculosis, brucellosis, pleuropneumonia, foot and mouth disease, anaplasmosis, dermatitis, dermatophilosis, scabies, worms	Not Available	Not Available	Not Available	▪ Dairy cattle sensitive to extreme heat
Poultry eggs	Pseudo fowl plague, smallpox, colibacillosis, pasteurellosis/cholera, typhoid/ salmonella, coryza verminoses, infectious bronchitis, parasites (coccidiosis/red diarrhea), roundworms, tapeworms	Not Available	Temperature range: 10^{0}C - 30^{0}C Humidity: 40% - 80%	Not Available	▪ Chickens require stable temperatures, sensitive to extremes of cold and heat
Farmed Fish		60-250	Not Available	Not Available	▪ Sensitive to drought periods, loss of water and high evaporation ▪ Sensitive to changes in water temperature, require slight warming of water during spawning, reproduction

Due to a lack of contextual information on farming practices and access to social networks and institutions among communities in the study zones, scoring on adaptive capacity is highly subjective, and based on a general assumption that despite levels of indigenous knowledge of some farm practices, overall access to production inputs (seed, fertilizer, technology, credit) and agronomic services and training on climate smart agriculture (e.g., improved soil and water management practices) is relatively low. Thus scoring is universally low for all commodities based on the assumptions above.

Crops and animals vary in terms of their ability to withstand a range of climate stress factors, particularly the frequency, intensity, distribution, and onset/end of rains, as well as diurnal changes in temperature and protracted periods of extreme cold or heat. Much more detailed agronomic information on water and temperature requirements is needed to more adequately inform this study, particularly for ruminants, small animals, and fish.

Among them, potatoes and goats rank high for the Kivu provinces due to their overall resilience in withstanding a range of climate stresses during production, their relative ease of storage and processing (potatoes only), and their capacity to withstand loss or spoilage during transport under extreme conditions of damage to transport systems, particularly roads and bridges, due to extreme flooding, storms, and landslides. As noted, the subjective nature of scoring here is relative to the list of other commodities being considered for selection. Commodities that score low in the Kivu provinces due to high sensitivity to changes in rainfall and temperature and extreme events (drought, flooding, intense rainfall) are bananas, horticultural vegetables, and pigs. These commodities are also highly perishable with low storage capacity unless processed, and have a greater risk of loss during episodes of destruction or disruption of main transport supply routes.

In Katanga, only soy beans score high in terms of their resilience to withstand a range of climate stresses, as well as their general ease of storage and transport. Poultry eggs, beef and dairy cattle, farmed fish, and horticultural vegetables all received low scores due to their relative sensitivity to changes in temperature and precipitation and their high perishability when unable to reach market via transport routes washed out by intense flash flooding and storms.

F. CONCLUSIONS AND RECOMMENDATIONS

A number of conclusions are drawn here with recommendations on follow up activities that could be pursued by the USAID mission in Kinshasa, particularly with regard to the paucity of information on climate change in the DRC. Recommendations on climate resilient strategies to buffer against the vagaries of an increasingly unpredictable climate, focus primarily on the production node of agricultural value chains. However, some common strategies that are somewhat generic across most selected commodities in this study are also identified for the storage, processing, and transport segments of the value chains.

1. CLIMATE RESILIENT AGRICULTURAL VALUE CHAINS

Commodities to be selected for market development by USAID should be climate proofed in the sense that a policy of "do no harm" is adopted with regard to the impact of increased production of such commodities on

the environment, particularly on currently overstressed forest ecosystems in the study zones. Production systems will need to adopt well-known principles of climate-smart agriculture[129] that boost crop productivity through more efficient use of land and water resources; adopt sustainable agricultural practices that enhance the storage capacity of carbon in soils, trees, and vegetation; and promote improved farming methods that maximize productivity (intensification), thereby reducing pressure and encroachment onto new forest lands and biomes rich in biodiversity.

A succinct description of climate smart agriculture from the World Bank states:

> "Climate-smart agriculture seeks to increase sustainable productivity, strengthen farmers' resilience, reduce agriculture's greenhouse gas emissions and increase carbon sequestration ….. Climate-smart agriculture includes proven practical techniques—such as mulching, intercropping, conservation agriculture, crop rotation, integrated crop-livestock management, agroforestry, improved grazing, and improved water management—and innovative practices such as better weather forecasting, more resilient food crops and risk insurance."
>
> (http://www.worldbank.org/content/dam/Worldbank/document/CSA_Brochure_web_WB.pdf)

2. PRODUCTION

Conservation farming practices noted, such as minimum or low tillage, mulching, and perennial ground cover enhance the retention of soil moisture under warming conditions and help reduce water stress on drought-sensitive crops such as maize. Rainwater harvesting and low-cost, scalable drip irrigation technology is effective in extending crop cycles, particularly horticultural vegetables and fruits, well into the dry season when availability of such crops is low and prices are high, thus improving the market return to producers.

Short-cycle varieties of maize and beans that can withstand higher temperatures and less water are one of the most cost-effective strategies in combatting climate change and the increasing unpredictability in rainfall and irregular growing seasons. However, access to improved, heat tolerant seed varieties through viable supply chains in the study zones is not presently an option for small-hold producers. Thus, the provision of improved seed at affordable prices and in quantities that are appropriately packaged for small-scale farmers will require the systematic development of economically viable products and services at upstream, on-farm, and downstream segments of commodity value chains.

Among selected commodities identified for this study, ruminants and small animals are being considered. The potential for livestock and animal theft, a potential source of conflict in the study zones, as well as extensive, open grazing practices, places additional environmental pressure on scarce land resources, particularly in the Kivu provinces. Therefore, promotion of livestock and animal rearing practices should aim to reduce grazing pressure on fragile mountain slopes and other environmentally sensitive areas, and also minimize the potential for theft by reducing the size and distance to pastoral range lands. This could best be achieved through intensive livestock breeding and animal fattening systems that constrain the movement of animals through the use of feeding pens located within close proximity of households. This would also improve the security of women who are often at risk of gender-based violence when walking distances to fields or to collect firewood

[129] Climate Smart Agriculture is formally defined by the FAO as having three main components or pillars: 1) sustainably increasing agricultural productivity and incomes, 2) adapting and building resilience to climate change, and 3) reducing and/or removing greenhouse gases emissions, where possible. http://www.fao.org/climate-smart-agriculture/72611/en/

and water. Intensive animal fattening programs, when tied to effective, locally-based micro-credit savings and loan programs, have proven effective in some parts of Africa where livestock and small-animal husbandry is practiced (Magistro and Sanon, 2008).

Among the CSA strategies cited by the World Bank above, it is particularly important that two practices be actively supported and integrated within a new regional program strategy by the mission to promote agricultural value chains: intercropping, and agroforestry. Both practices are essential to attenuate rates of deforestation and to reduce extensive farming practices that continue to encroach onto new lands and fragile areas of high biodiversity and forest cover. While no tree crops have been identified on the list of agricultural commodities under consideration, the intercropping of trees with cereals, legumes, and other crops is urgently needed to reduce deforestation, slow down agricultural expansion into ecologically sensitive landscapes, and mitigate carbon and forest cover loss and the attendant rise of GHG emissions in the Congo Basin region.

AGROFORESTRY

Mixed tree cropping with cereals and other crops is advantageous in providing shading for crops that reduces ground surface temperatures and improves soil moisture retention capacity. Examples of promising tree varieties that have proven to boost crop productivity and restore healthy soils in the DRC include grevilla, pterocarpus, acacia, cedrilla, and moringa. While many smallholder farmers continue to prefer eucalyptus for its rapid growth and ease of regrowth after coppicing, it is well known that eucalyptus is water demanding and allelopathic, impeding the growth of other plants or crops. Revitalization of commercial tree crops such as highland coffee (robusta) and cocoa, intercropped with bananas and cassava, would help boost family income while also enhancing productivity of selected commodities promoted through mission strategy for the target regions (see intercropping discussion on shading below).

INTERCROPPING

The mountain areas of the Kivu provinces, particularly near the larger population centers such as Goma and Bukavu, are severely deforested and eroded, with landslides occurring with increasing frequency. Intercropping of heavily denuded mountain landscapes is urgently needed to restore soil fertility, increase carbon storage in soils, and combat severe erosion of mountain slopes.

Cropping in mountain areas should adopt contour planting with crop rotations of peanuts, potatoes, soy, beans, sweet potatoes, cassava, and maize. Bananas, which are highly susceptible to damage when exposed to high winds and hail at high altitudes in the Kivu provinces, are more productive when mixed with coffee. Research from the ARCC Uganda study found that introducing shade trees in a mixed coffee and banana system can reduce temperatures by 2 ^{0}C- 5 ^{0}C, thus helping to combat rising temperatures that are occurring in the higher altitude areas. These crops also provide mulch from leaf litter to help protect degraded soils and restore overall soil health.

3. STORAGE, PROCESSING, AND TRANSPORT

The selected commodities are exposed to a range of climate stresses during post-harvest storage, processing, and transport. A list of risks/vulnerabilities and recommended adaptations to minimize the impacts of climate exposure are summarized in tables 83 and 84 below. The nature of risks/vulnerabilities are similar for most commodities, and the range of adaptive interventions to reduce losses during storage, processing, and transport is somewhat narrow and homogeneous.

A synopsis of the most common risks and adaptive interventions to be considered in post-harvest management (storage, processing, and transport) include the following:

Storage

- *Cereals, legumes, oilseed*—crops like maize and soy beans are highly vulnerable to contamination by aflatoxins under conditions of high humidity and rainfall. Therefore, actions need to be taken to assure that these crops are stored in areas with minimal exposure and protection from rain and humidity.
- *Potatoes, bananas, vegetables*—these crops are perishable in extreme heat with little shelf life, and therefore require cold chain storage for marketing beyond very short time periods of several days.
- *Small animals, livestock*—most ruminants and small animals are taken on hoof to local markets, thus storage is not normally a problem. However, butchered meat and dairy products such as milk spoil quickly in high temperatures, and therefore require an efficient cold chain if being stored for any extended period of time.
- *Eggs, farmed fish*—eggs are fragile and prone to breakage during storage and transport. Both eggs and farmed fish are fresh products that require cool storage, and fish must be sold quickly if not processed. Fish must be stored in fresh, cool water that is changed every 2-3 hours, thus storage capacity and shelf life on a small, artisanal scale is very limited.

Processing

- *Cereals, legumes, oilseed*—maize and soybeans, when milled as flour, improve storage and marketing capacity by adding value, and protect against spoilage or contamination under conditions of high humidity.
- *Potatoes, bananas, vegetables*—these crops spoil quickly under high temperatures and are best preserved in the form of dried chips. However, local consumption of dried fruits, vegetables and tubers (except for cassava, yams), is very low, thus demand for such products would require significant social marketing and investment. Market demand in urban centers and internationally would also require significant investment to develop. High demand and market potential does exist locally for a variety of banana beer.
- *Small animals, livestock*—preservation of butchered meat against spoilage requires drying, smoking, salting, or cold chain storage, while dairy products (milk) require an effective cold chain on a larger industrial scale. Most milk production occurs on a small-scale for household or local consumption.
- *Eggs, farmed fish*—the sole means to process and conserve eggs against heat spoilage is by boiling; however local demand for hard boiled eggs may be limited and require extensive marketing to improve market potential. Farmed fish must be sold quickly to maintain value, ideally within hours, so they require constant cool, fresh water for conservation. Drying, smoking, and salting is widespread locally, and could benefit from improved, low-cost conservation technologies.

Transport

- All commodities are vulnerable to loss during transport to market under conditions of extreme flooding that destroys poor quality infrastructure (roads, bridges), and is often susceptible to blockage and destruction by landslides in mountainous terrain such as the Kivu provinces. Thus, improved roads and bridges that can withstand extreme stress from flooding and storms, and improved cold chain transport to market centers with storage facilities are recommended adaptive investments to be considered.

Table 83. Vulnerabilities and Adaptations of Selected Commodities during Storage, Processing, and Transport—North and South Kivu

Crop/ Commodity	Storage/Processing		Transport	
	Risks/Vulnerabilities	Adaptations	Risks/Vulnerabilities	Adaptations
Potatoes	▪ Perishable in heat, high humidity ▪ Damages in cold storage below 4 ^{0} C	▪ Cool storage, cold chain, optimum at 20^0 C ▪ Harvest, store in dry conditions ▪ Drying, processing as chips	▪ Poor quality roads, bridges – damage during flooding ▪ Perishable in heat, high humidity	▪ Improved cold chains in transport ▪ Improved roads, bridges
Bananas	▪ Perishable in heat	▪ Cool storage, cold chain, min of 12^0 C ▪ Harvest, store in dry conditions ▪ Drying, processing as chips ▪ Processing as fermented beer	▪ Poor quality roads, bridges – damage during flooding ▪ Sensitive to cool temperatures, particularly during transport (min 12^0 C)	▪ Improved cold chains in transport ▪ Improved roads, bridges
Dry Beans	▪ Perishable in high humidity	▪ Harvest, store in dry conditions	▪ Poor quality roads, bridges – damage during flooding ▪ Low perishability in transport, unless damaged by flooding, high humidity	▪ Improved roads, bridges
Soy Beans	▪ Perishable in high humidity, contamination from aflatoxins	▪ Harvest, store in dry conditions ▪ Drying, processing as flour	▪ Poor quality roads, bridges – damage during flooding ▪ Low perishability in transport, unless damaged by flooding, high humidity	▪ Improved roads, bridges
Small Animals (goats, sheep, pigs)	▪ Meat spoilage in heat	▪ Cool storage, cold chain for dairy ▪ Drying, smoking, cold chain storage for meat	▪ Poor quality roads, bridges – damage during flooding ▪ Fresh meat perishable in heat	▪ Improved roads, bridges ▪ Improved cold chains for meat in transport
Horticulture	▪ Perishable in extreme heat (varies by vegetable)	▪ Cool storage, cold chain ▪ Harvest, store in dry conditions ▪ Drying, processing as chips (varies by vegetable)	▪ Poor quality roads, bridges – damage during flooding ▪ Sensitive to extreme cold and heat during transport	▪ Improved cold chains in transport ▪ Improved roads, bridges

Table 84. Vulnerabilities and Adaptations of Selected Commodities during Storage, Processing, and Transport—Katanga

Crop/ Commodity	Storage/Processing		Transport	
	Risks/Vulnerabilities	Adaptations	Risks/Vulnerabilities	Adaptations
Maize	▪ Perishable in high humidity, contamination from aflatoxins	▪ Harvest, store in dry conditions ▪ Drying, processing as flour	▪ Poor quality roads, bridges – damage during flooding ▪ Low perishability in transport, unless damaged by flooding, high humidity	▪ Improved roads, bridges
Dry Beans	▪ Perishable in high humidity	▪ Harvest, store in dry conditions	▪ Poor quality roads, bridges – damage during flooding ▪ Low perishability in transport, unless damaged by flooding, high humidity	▪ Improved roads, bridges
Soy Beans	▪ Perishable in high humidity, contamination from aflatoxins	▪ Harvest, store in dry conditions ▪ Drying, processing as flour	▪ Poor quality roads, bridges – damage during flooding ▪ Low perishability in transport, unless damaged by flooding, high humidity	▪ Improved roads, bridges
Poultry Eggs	▪ Perishable in high heat ▪ Fragile, high breakage	▪ Cool storage, cold chain ▪ Improved packing in storage to reduce breakage ▪ Process as hard boiled eggs	▪ Poor quality roads, bridges – damage during flooding ▪ High perishability in transit due to fragile nature	▪ Improved roads, bridges ▪ Improved cold chains in transport ▪ Improved packaging for transport
Beef, Dairy Cattle	▪ Dairy – milk spoilage in heat ▪ Beef – meat spoilage in heat	▪ Cool storage, cold chain for dairy ▪ Drying, smoking, cold chain storage for beef	▪ Poor quality roads, bridges – damage during flooding ▪ Dairy, fresh beef perishable in heat	▪ Improved roads, bridges ▪ Improved cold chains in transport
Farmed Fish	▪ Perishable in heat	▪ Cool storage, cold chain for fish ▪ Drying, smoking, salting of fish	▪ Poor quality roads, bridges – damage during flooding ▪ Perishable in heat during transport	▪ Improved roads, bridges ▪ Improved cold chains, use of ice during transport
Horticulture	▪ Perishable in extreme heat (varies by vegetable)	▪ Cool storage, cold chain ▪ Harvest, store in dry conditions ▪ Drying, processing as chips (varies by vegetable)	▪ Poor quality roads, bridges – damage during flooding ▪ Sensitive to extreme cold and heat during transport	▪ Improved cold chains in transport ▪ Improved roads, bridges

ANNEX 1. DEFINITIONS OF FOOD SECURITY

For the purposes of the food security criterion, the assessment uses USAID and FAO's accepted definitions.

USAID

USAID Policy Determination: Definition of Food Security (from www.microlinks.org)

Written in 1992, this policy determination outlines USAID's definition of food security: "when all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life." Three distinct variables are recognized as important to the achievement of food security: availability, access and utilization. Contributing factors and definitions are provided for each of these variables.

Definition of food security from FAO (from www.fao.org)

"Food security is often defined in terms of food availability, food access and food utilization (USAID 1995). Food availability is achieved when sufficient quantities of food are consistently available to all individuals within a country. Such food can be supplied through household production, other domestic outputs, commercial imports or food assistance. Food access is ensured when households and all individuals within them have adequate resources to obtain appropriate food for a nutritional diet. Access depends upon income available to the household, on the distribution of income within the household and on the price of food. Food utilization is the proper biological use of food, requiring a diet providing sufficient energy and essential nutrients, potable water, and adequate sanitation. Effective food utilization depends in large measure on knowledge within the household of food storage and processing techniques, basic principles of nutrition and proper childcare."

ANNEX 2. VALUE CHAIN QUESTIONNAIRES

Questionnaire Version #1 : Agricultural Producers

Production/processing (includes inputs)

- **Product**. What products do you grow, process, or otherwise produce? Why?
- **Productivity**. What yield do you get? (area of field, 50kg sacks of commodity)
- **Packaging and storage**. How do you pack your product? Where and how do you store? How do you deal with pests and other possible threats during storage?
- **Laborers**. How many laborers do you have and what are their functions?
- **Equipment and materials**. What factors of production are necessary (such as machines, land, etc.)? Are you missing any such items that would help your production?
- **Inputs.** What inputs do you use? Do you have any problems obtaining inputs (seeds, fertilizer, etc.) What about packaging and labeling?
- **Processing** (as relevant). For processors, what processes do you undertake? What operations does this entail in terms of location/equipment? Where do you source inputs/ raw material?
- **Volumes/price**. What volumes do you produce? And how much do you sell at approximately what price? How do you decide the prices you offer buyers?
- **Inventory**. Do you have leftover products that you must store? How do you manage this?
- **Seasonality**. Is your business seasonal? In other words, do you produce in certain months?
- **Land issues**. Do you own the land used? (If the business is farming) Are there issues with land titles?
- **Future plans**. What plans do you have for your agricultural production over the next five years?

Consumption

- **Consumption**. How much of your production do you consume yourself? And how much do you sell?
- **Outside purchase**. Where do you purchase your food and what are your major foods consumed? (for smaller producers)
- **Buying factors.** How does price and quality affect your food purchases? Are you challenged to find the foods that you prefer to eat?

Buyers & market issues (forms value chain map)

- **Markets.** What is the nearest market to you?
- **Buyers**. Who are your main buyers? Who are other potential buyers you might look to sell to in the future? How did you obtain these buyers?
- **Marketing.** How do you do your marketing? In other words, how do you find and interact with new and existing buyers?
- **Contracts**. Do you have ongoing contracts with buyers? If so, oral or written?
- **Seasonality**. Are your sales seasonal? In other words, do you sell more in certain months?
- **Price**. How price sensitive are your clients? Would they buy less if you raised the prices?
- **Competition**. Do you have competitors? If so, who? Why do your buyers buy from you instead of them?

- **Finance**. How do you make financial transactions? Cash? Do you use any financial services such as loans, savings accounts or M-Pesa?
- **Transport**. How do you transport your products to where they need to be shipped? And also how to you transport inputs or raw materials that you need?

Business environment

- **Taxes**. What taxes affect your business? Are these taxes or bribes – do you get receipts?
- **NGOs**. Do you receive services from or interact with NGOs in any way?
- **Government**. Do you receive services from or interact with government (extension services, seeds, etc.)?
- **Associations**. Are you a member of a producer's association?
- **Arbitration**. If you have an issue with a buyer or supplier (such as a disagreement on contract terms), how do you go about resolving the issue?

Sources of vulnerability

- **Production risks**. Please explain the production risks you face in decreasing order of importance (e.g. pests, disease, conflict, climate-related)
- **Climate change**. If climate change features as a priority risk, refer to the *Climate-change discussion questions* form to register as many details as possible. Start with the following and obtain more detail if possible: Have climate-related factors (drought, floods, extreme heat, new pests/diseases) affected your production? Do you know or fear any future changes in climate that could affect your production?
- **Mitigation**. Which strategies do you favor to mitigate each of these risks?

Gender

- **Roles**. What roles do women and men play in your business/production?
- **Financial decision-making**. Who manages the finance for the business (and for the household/family)?

Questionnaire Version #2: Agricultural Traders

Business operations

- **Product**. What products do you buy and sell?
- **Operations**. What facilities are necessary? (such as vehicles, boats, office space.) How many employees do you have and in what functions? Do you require office space? Are you missing any such items that would help your business?
- **Employees/laborers**. How many people do you have working with you, and what are their functions?

Buyers & market issues (forms value chain map)

- **Buyers**. Who are your main buyers? Who are other potential buyers you might look to sell to in the future? How did you obtain these buyers?
- **Volumes/price**. What volumes do you buy and sell? And how much do you sell at approximately what price? How do you decide the prices you offer buyers and suppliers?
- **Marketing.** How do you do your marketing? In other words, how do you find and interact with new and existing buyers? Do you participate in public markets? How do you communicate with buyers/suppliers, e.g. by mobile or email.

- **Sourcing.** What relationships do you have with your suppliers? How long have these relationships been in place? What is the nature of contracts? Do you provide any forms of finance?
- **Seasonality**. Are your sales seasonal? In other words, do you buy or sell more in certain months?
- **Price**. How price sensitive are your clients? Would they buy less if you raised the prices? How price sensitive are you suppliers? Would they sell to others if you lowered the price you pay?
- **Competition**. Do you have competitors? Who? Why do you buyers buy from you instead of them?
- **Finance**. How do you make financial transactions? Cash? Do you use any financial services, e.g. loans/ savings? How do you manage supply-chain finance, inventory finance, etc.? Do you use mobile money?
- **Inventory**. Do you have leftover products that you must store? How do you manage this?
- **Cross-border trade**. Do you engage in cross-border trade? With whom? How did you first initiate this relationship?
- **Transport**. How do you transport your products to where they need to be shipped? And how to you receive product from your suppliers? What routes do you use for each? Has this changed recently or do you anticipate change due to the conflict, changing markets or any other factor? What bottlenecks exist?
- **Future plans**. What plans do you have for your business over the next five years?

Business environment

- **Taxes**. What taxes affect your business? Are these official or unofficial taxes, i.e. with or without government receipts?
- **NGOs**. Do you receive services from or interact with NGOs in any way?
- **Government**. What government representatives do you interact with in terms of assistance or regulation?
- **Associations**. Are you a member of a trade association?
- **Arbitration**. If you have an issue with a buyer or supplier (such as a disagreement on contract terms), how do you go about resolving the issue?

Sources of vulnerability

- **Production risks**. Please explain the trading risks you face in decreasing order of importance (e.g. changes in regulation or taxation, conflict, climate-related)
- **Climate change**. If climate change features as a priority risk, refer to the *Climate-change discussion questions* form to register as many details as possible. Or as possible, answer the following:
    - **Climate: vulnerabilities of supply**. Have any climate-related factors (drought, floods, extreme heat, new pests/diseases) affected your trade? (such as less or poorer quality product available from your suppliers)
    - **Climate: vulnerabilities of logistics**. Have climate-related factors affected your ability to process, store or get your product to market?
- **Threats**. Do you know or fear any future changes in climate that could affect your ability to trade?

- **Mitigation**. Which strategies do you favor to mitigate each of these risks?

Gender

- **Roles**. What roles do women and men play in your business?

ANNEX 3. CLIMATE SCREENING METHODOLOGY

The overall objective of the climate change assessment is to identify potential threats and opportunities that climate factors pose to the feasibility of promoting identified agricultural commodity value chains in the Katanga and Kivu provinces. As an initial phase of inquiry, the assessment involves a cursory climate screening protocol involving three phases:

1. A preliminary desk review of pertinent studies and reports on climate change in the DRC;
2. Key informant interviews (KII) in Kinshasa to obtain more localized information on the nature of adaptation and mitigation factors around climate change and agricultural commodities in the three provincial study areas; and
3. Mission debrief on preliminary findings from the study and drafting of findings and recommendations to the mission in a final report.

Desktop study

An initial phase of desk review of relevant literature on climate change in the eastern provinces included relevant project reports and studies such as the USAID/Uganda Vulnerability Assessment, and a recent environmental feasibility study in eastern DRC, completed by Mercy Corps in March, 2014. A review of key donor, government, and NGO project documents, research reports and relevant literature on climate change, environmental and natural resource management issues, and agricultural commodities was undertaken over a two week period from February 16 – 28. The literature review is intended to highlight relevant resources and identify gaps in the climate change literature for the eastern DRC. The desk review specifically focused on examining current and future projections of climate change for the eastern provinces particularly as it may impact upon the selected agricultural value chains in the study.

Field assessment data collection

A 10 day period of primary data collection was conducted in Kinshasa from March 3-13 using Key Informant Interview (KII) discussion guides with relevant government, donor, research, and civil society stakeholders working on climate change and agricultural development.

Data analysis

A feasibility matrix was designed to rank the list of agricultural commodities for each province, using categories of climate exposure, sensitivity and adaptive capacity as key criteria to provide an overall score on the vulnerability of each commodity to climate stress. The scores were integrated into the final evaluation and ranking of commodities based on multiple criteria used for the market study.

Mission debrief and final report

Scores and evaluation of the commodities, including the climate screening analysis, were then presented to USAID mission staff in the form of a PowerPoint presentation on March 12 and 13. A draft assessment report will be submitted to USAID by March 23, to be followed by a final report due on April 10.

ANNEX 4. LIST OF CONTACTS & MEETINGS

A. NORTH AND SOUTH KIVU MEETINGS

Kinshasa

Food bulk buyers

1. Shoprite – Darno Van Dyk, Buyer - (South African)- mobile +243.81.647.1924.

Inputs suppliers

2. Savannah- inputs company

Food bulk buyers/grossistes/retailers

3. Mama Bibiana (onions grossiste)
4. Mama Therese (beans retailer)
5. Mama Esperance (beans grossiste)

Government

6. SENAFIC Service National... Thu Feb 26, Richard Biemo, Chef des Divisions Laboratoires

Local / International NGOs

7. Elan RDC – Holly Krueger, Acting Team Leader, February 26, 2015 5pm – Kinshasa Elan Office

Bukavu

Local / International NGOs

1. Papy – FAO
2. ASOP- Action Sociale et d'Organisation Paysanne-.
3. Sarcaf – Rugenge Mwavita Noella (Nono) – Coordinatrice, At Sarcaf Office Contacts: Rugenge Mwavita Noella (Nono) mobile +243.994.261.101, sarcaf.bujavu@gmail.com, www. Sarcaf.com (does not work, see link here)
4. UPDI - we meet Programmation et Supervision des Activites de Terrain. Jean-Pierre Mirimba, Charge d'Analyse Recherche et Innovation
5. Abraham Leno and Tad Lunden, Bukavu ARC implements two USAID projects: Asili: health and agriculture.
6. CRONG

Cooperatives

7. Cooperatif Rugwi Sahebuvali, At Cooperatif head office in the field two hours from Bukavu center
8. Cooperatif Ludawa, At Cooperatif head office in the field one hour from Bukavu center
9. Cooperatif Agro-pastorale in Buranga At Cooperatif head office in the field one hour from Bukavu center
10. Cooperatif de Produits Agricoles de Mudaka (COPAM), At Cooperatif head office in the field

Food bulk buyers/grossistes/retailers

11. Tomato grossiste – Bukavu center market
12. Orchids Hotel – food buyer for restaurant
13. March 5 – Tofu Processor, At Sarcaf Assembly

Mining community

14. March 6 – Chef Cotumier of Luwinja – Banro (Canadian gold mining company) community At office of Chief

15. March 6 – Luhwinja community members (15+ people) including one re-settled man representing his community At Luhwinja Service Veterinary Clinic (paid for by Banro)

Government/ traditional chief

1. Ministry of Agriculture – Adophina Mul.
2. Mwami Kabare Rugemaninzi II N'Nabushi ('King of Kabare') At Orchids Hotel

Goma

Local / International NGOs

1. ADRA
2. Elan
3. MercyCorps
4. Catholic Relief Services

Association

5. ADAVEVI
6. FOPAC

Government

7. IPAPE

Food bulk buyers/grossistes/retailers

8. Chamuki (Charcuterie)

Mining company

9. Alphamin

B. NORTH AND SOUTH KIVU CONTACT INFORMATION

Type of organization	Name of organization	Name of contact/mobile
SOUTH KIVU		
Cooperative	Rugwasane (Walungu, Centre Butuza)	+243 0991618403
Cooperative	Coopabu (Walungu, Buhanga)	+243 994054894
Cooperative	Coomalu (Walungu, Ludaya)	+243 997142388
Cooperative	Coopam (Kavumu, Mudaka)	+243 994309686
Cooperative	Rugwasane (Kavumu, Birava)	+243 993470026
Cooperative	Bulende et Kabalole (Mwenga, Luwinja)	
Traditional chief	Rugemaninzi – King of Kabare	Via ARC
Government	Adolphina	Bukavu, Ministre de l'agriculture, pèche, élevage et développement
Girls school (bulk food buyer)	Sister at Lycée Wima, Responsable de l'internat	
Traditional chief	Chefferie De Luwinja	Secretary to the chief
Farmer association	UPDI (l'Union paysanne de développement intégré) - Bukavu	Jean Pierre Mirimba, Chargé d'analyse, recherche et Innovation, +243 994038592 jpmirimba@hotmail.com Updi06@yahoo.fr Peter MULAGIZI, Agronome +243 994248775 mulagizip@yahoo.fr

Local NGO	ANTI BUAKI	Saidi Chargé des coopératives et entreprenariat, +243 990347535
Agro-business (Social enterprise) NGO	ASILI/ARC :American Refugee Committee	Abraham Leno, Country Representative /RDC/Bukavu, +243 825358843, +250 787611819, Abraham@arcrelief.org Tad Lunden, Social Entreprise Project Manager, TadL@arcng.org
Local NGO	CRONG	Abias Radia (sp)
Local NGO	UHAKI Union des femmes agricoles du Kivu	ERNESTINE Coordonnatrice +243 997727708 +243 813184191
Local NGO	ASOP : Action social pour l'Organisation Paysanne	Felicien Zozo. +243 858941906, +243 997601890
Local NGO	SARCAF	Rugenge Mwavita Noella (Nono), Coordinatrice sarcaf.bukavu@gmail.com, www.sarcaf.com
Donor	FAO	Papy Pisha Busangu Chef de projet tufaidike, 1. Vodacom : +243 824158246 2. Zain : +243 998647750
Soy processor	CENTRE OLAME	Fidel BALANGANIZ A Chargé de projet, Fidele Balanagalaica 0997.760.1240 Cikuru MASHEKA, Agronome Pacome BISIMWA, Chargé de la communication
NORTH KIVU		
Mining	Alphamin	Nadine Lusi nadinelusi@gmail.com, +243 (0)994908016.
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C. KATANGA MEETINGS

Name	Position and organization	N° téléphone	e-mail
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Dr TSHIBANGU	Importateur d'intrants agropastoraux		
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ILUNGA Chantal	Importatrice et dépositaire des produits agricoles	+243 993935215	
Jean Claude MUTUNDA	Chargé des petites et moyennes entreprises et gestion des plaintes communautaires MMG		
Jean MIKOMBE	Chargé de la pêche et aquaculture		
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Jules	COORDONNATEUR APEFE (Wallonie Bruxelles Internationale		
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RUMBU Elvire	Chargé de production et santé animale ville de Likasi		
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TSHINYETA KASONGO	Inspecteur urbain ville de Likasi	+243 997030754	vktshinyeta@gmail.com
Victor MULONGO	Président (scak)	(+243)995326668	Admin.fin@scak.cd

D. CLIMATE CHANGE MEETINGS

Date	Name	Organization/Title	Telephone/Email
Tuesday 3.3.15	BILOSO, Appollinaire (Dr.)	ICRAF – World Agroforestry Centre National Coordinator	081.77.62.807 apollo_biloso@yahoo.fr
	MAYIMBA, Claude Akalakou	ICRAF – World Agroforestry Centre Junior Scientist	081.56.57.8061 a.claude@cgiar.org
	SMITH, Patrick	USAID Agricultural Officer	081.70.11.457 pasmith@usaid.gov

Wednesday 3.4.15	MANE, Landing (Dr.)	OSFAC – Observatoir Satellital des Forets d'Afrique Centrale Director	081.97.02.636 099.27.83.035 lmane@osfac.net
	KUMAKWESE, Andre Mazinga	OSFAC – Observatoir Satellital des Forets d'Afrique Centrale GIS-RS Officer	081.32.02.870 amazinga@osfac.net
	MCNEILAGE, Alastair (PhD)	WCS – Wildlife Conservation Society CARPE Chief of Party	099.65.74.558 amcneilage@wcs.org
Thursday 3.5.15	BENA, Jean-Robert	INERA Veterinarian	099.82.97.371 jeanrobertbena@yahoo.fr
	ESOMBO, Floribert Botamba	WWF – World Wildlife Fund Coordinator, Focal Point REDD	099.99.15.109 fbotamba@wwfcarpe.org
	HUART, Alain	CTB – Belgian Technical Cooperation Institutional Expert	097.00.67.051 alain.huart@btcctb.org
Friday 3.6.15	MAVUNGU, Jean-Pierre Sassa	BATIDE/Winrock International President	099.99.85.224 jpsassa@yahoo.fr
	LUBANGA, Daniel Lunze	INERA Scientific Director	081.06.05.996 llunze@yahoo.fr
	LAMPES, Desire Yalulu	Ministry of Agriculture, Fisheries, and Livestock – DPPV Director	081.63.73.243 yaluludesire@hotmail.com
Monday 3.9.15	MABELA, N'Lemba	Ministry of Agriculture, Fisheries, and Livestock Director, DPSA	081.51.26.564 dr_nlemba@yahoo.fr
	VANGU-LUTETE, Clemente	Ministry of Environment National Coordinator – Forestry Investment Program (FIP)	081.88.43.278 vangulutete@gmail.com
	MUGANGU, Trinto (Dr)	Ministry of Environment – DDD Coordinator of NAMA	099.12.79.900 Nama4drc@gmail.com
Tuesday 3.10.15	AKWALA, Francoise	Ministry of Agriculture, Fisheries, and Livestock Division Chief of Aquaculture	081.29.42.931
	LONGO, Jean Ndembo	PANA-ASA Coordinator	081.54.29.922 jndelongo@yahoo.fr
	BYAMUNGU, Willy Mulimbi	CRS National Agriculture Coordinator	099.29.03.812 willy.mulimbi@crs.org
Wednesday 3.11.15	VUNILIA, Roger Kizungu	INERA Statistician	081.500.5837 kizunguvunilia@yahoo.fr

ANNEX 5. NORTH KIVU CROP GROWTH

Source: Texas A&M University: Center on Conflict & Development, North Kivu Soil Management Project

The table below lists the percent of farmers who report growing each of the following crops at any point in the past two cropping seasons. Unless otherwise listed, percentages reflect a total of 2,207 farmers surveyed across Beni, Lubero and Rutshuru territories. The column titled 'Cash Crop' lists the percentage of farmers surveyed who report growing the given crop *primarily* as a cash crop (vs. growing the crop primarily for home consumption).

	Overall	Beni (n=661)	Lubero (n=672)	Rutshuru (n=861)	Cash Crop
Maize	80%	82%	69%	86%	29%
Cassava	79%	87%	71%	79%	41%
Beans	78%	88%	65%	82%	30%
Potato	45%	44%	48%	45%	7%
Banana	42%	56%	31%	39%	14%
Taro	39%	36%	42%	40%	5%
Peanuts	30%	34%	20%	34%	19%
Avocado	29%	17%	14%	51%	9%
Rice	26%	39%	25%	16%	18%
Amaranth	24%	18%	17%	34%	3%
Coffee	21%	35%	11%	19%	21%
Oil Palm	20%	35%	17%	11%	11%
Wood	18%	13%	10%	28%	9%
Sugarcane	18%	25%	17%	13%	6%
Mango	17%	12%	2%	32%	4%
Sorghum	14%	6%	6%	26%	9%
Yam	13%	10%	11%	17%	1%
Pineapple	11%	17%	13%	6%	3%
Cabbage	11%	7%	18%	9%	4%
Papaya	11%	7%	2%	20%	2%
Cocoa	10%	23%	7%	1%	9%
Peas	5%	4%	7%	4%	2%
Onions	5%	7%	3%	5%	3%
Soybean[1]	4%	0%	0%	10%	4%
Quinquina	4%	2%	5%	3%	3%
Millet	3%	0%	7%	1%	1%
Carrots	2%	1%	3%	3%	1%
Cowpea	2%	2%	2%	3%	1%
Wheat	1%	0%	1%	1%	0%

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C. CLIMATE CHANGE

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ANNEX 7. CLIMATE CHANGE DATA LINKS

USAID Development Experience Clearinghouse	https://dec.usaid.gov/dec/home/Default.aspx
FAOSTAT	http://faostat.fao.org/
IFPRI	http://www.ifpri.org/book-775/ourwork/researcharea/climate-change/pubs
Climate Change Congo Resources	http://www.congoresources.org/2013/02/the-persistence-of-folly.html
FAO Country Profiles	http://www.fao.org/countryprofiles/index/en/?iso3=COD
FAO	http://www.fao.org/forestry/country/61329/en/cod/
Wildlife Conservation Society Climate	http://programs.wcs.org/albertineclimate/Home.aspx
WCS Publications	http://programs.wcs.org/albertine/AboutUs/Publications.aspx
CSAG/Cape Town	http://cip.csag.uct.ac.za/webclient2/app/
NASA/TRMM	http://trmm.gsfc.nasa.gov/data_dir/data.html
WB Climate Change Knowledge Portal	http://sdwebx.worldbank.org/climateportal
Climate Data	http://en.climate-data.org/
MOABI	http://rdc.moabi.org/en/

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