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Pre-Cooked Beans for Improving Food and Nutrition Security and Income Generation in Kenya and Uganda

107842

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Executive summary

This report describes the work done under the project “Pre-Cooked Beans for Improving Food and Nutrition Security and Income Generation in Kenya and Uganda” (hereafter referred to as the precooked bean project or the project). The project was implemented for 33 months from October 2014 to June 2017. The precooked beans project aimed at increasing bean consumption, Income, improve diets, reduce time spent on cooking beans and create a sustainable lucrative market for bean farmers. The project worked in 10 districts in Uganda and 5 counties in Kenya.

During the 33 month, the project pre-screened 47 bean varieties based on cooking time, color, micro nutrient content, form retention and agronomic traits for production and selected 12 varieties for precooking. Precooking trials were conducted on pre-screened beans to produce three precooked bean products; the ready to eat bean snack, a bean flour and an easy to cook precooked bean product. The bean snack does not require additional processing and can be eaten as a snack or blended with salads. On the other hand, the easy to cook bean cooks in 15 minutes reducing cooking time from 2-3 hours to 15 minutes. By cooking fast, precooked beans save over 80% of fuel and use far less water. A factory with a processing capacity of nine tons per day was set up in Kisumu Kenya for commercial production of the three precooked beans products. The three products are already on the market. To inform market targeting and pricing, the project conducted an ex ante analysis of the potential demand and willingness to pay analysis for precooked beans. The analysis showed that the potential market share for precooked beans will be 44.4% of bean consumers who are willing to pay an average price increase of 31% and the highest limit of 41% over any prevailing market price of dry unprocessed beans. Supermarkets and retails outlets including kiosks and shops (mom and pop) were reported as the major preferred outlets for buying precooked beans. In order to ensure food safety, the project conducted a Hazard Critical Control Point Analysis (HACCP). In the HACCP, 4 critical control points were identified and mitigation measures to reduce or eliminate the hazards were recommended. The 4 CCPs were site/plot selection, drying, storage and cooking and serving. A framework for food assessment to address food safety issues at various levels of the value chain was also developed. The food assessment framework culminated into a food safety tool kit that was used by the project as a behavior change communication tool for the different value chain actors.

In an effort to support sustained production of beans for precooking, the project set up two grain production models; the Community Production and Marketing System (COPMAS) model and the Collective Marketing Model (CMM) with Seed Credit. Also, two seed production models; the Seed Credit Model (SCM), the Formal Seed Production Model (FSM) were set up to support seed production. During the project life, a total of 5,396 women and 3,210 men farmers were engaged in grain production and produced 923,781 Kg of beans. On the other hand, the project worked with 13,503 (6,445 men and 7,055 women) farmers organized in farmer groups in seed production. Farmers were supported with 79,310 Kgs of seed credit and were able to produce 982,595 kg of seed that was used for further seed and grain production. Through its operations, the project directly or indirectly created employment for 24,615 people at production, aggregation and intermediate processor levels. This increased the number of people employed by project partners by 66.3% from the time of project inception.

During the project, 22,901 farmers were trained in good agronomic practices, Collective Marketing & post-harvest handling, Records & financial management and Safe handling of agricultural chemicals to assist the farmers to sustainably increase their production and sales of beans for better incomes. In addition, 2,102 Trainers of Trainees (TOTS) were trained as Villages Enterprise Agents (VEAs) and Community Based Facilitators (CBFs). These served as an immediate contact with the farmers and also the research extension interface. Through the use of innovative communication and education

materials, the precooked bean project was able to reach 52,802 farmers with information that is critical in bean production, group management and tackling gender issues. The project collaborated with different actors through three Bean Innovation Platforms (BIP) to establish 45 result demonstrations to expose members to improved bean crop growth practices. In addition, through the BIPs, men and women farmers were able to access low interest loans (at an interest rate of 3%) from four micro finance institutions under the platform. To further boost women farmer access to credit, the project strengthened 33 Village Saving and Loaning Associations (VSLAs). A total of 1,418 women accessed credit and have opportunities for accessing credit through the VSLA system.

The precooked bean project targeted youth and women and thus supported interventions that fostered their inclusiveness in the precooked bean value chain. By promoting capacity building and supporting collective marketing, the proportion of women that participated in bean marketing increased from 50% in 2014 to 55% in 2016. Also, women's average incomes from bean sales significantly increased from US\$126 in 2014 to US\$170 in 2016. Promotion of internal saving and lending and linkages to financial institutions resulted in progressive increase in the proportions of women that accessed credit. End line studies showed that the proportion of women that accessed credit increased to 59.2% in 2016 from 35.9% in 2014.

To effectively disseminate project results to multiple stakeholders, the project recruited and supported 12 Masters Students. The students completed their first year of study and undertook thesis research on different topics covering aspects such, gender research, markets and value chains analysis, production and farm institutional analysis, communication and Nutrition studies. In addition, seven oral and seven poster presentations with different project outcomes were made at scientific conferences. The project published 2 scientific papers in peer reviewed journals and submitted 4 manuscripts to journals for publication.

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ACRONYMNS

List of Acronyms

BoP - Base of Pyramid
BIP – Bean Innovation Platform
CEDO – Community Enterprises Development Organisation
CIAT – International Center for Tropical Agriculture
COPMAS -Community Production and Marketing System Model
EAC – East African Community
EAGC - East African Grain Council
GAPs - Good Agronomic Practices
HACCP- Hazard Critical Control Point Analysis
IDF- Independent Development Fund
IDRC – International Development Research Center.
KALRO – Kenya Agricultural and Livestock Research Organisation
KAT B – Katumani Bean
KEBS - Kenya Bureau of standards
MAMEDICOT – Masaka Microfinance Development Cooperative Trust
NABE – Namulonge Bean
NARO – National Agricultural Research Organisation
NGO – Non Governmental Organisation
NTV – Nation Television
OWC - Operation Wealth Creation
RSM - Revolving Seed Model
SCM - Seed Credit Model
UGAFOD – Uganda Finance Development Trust
UNBS - Uganda Bureau of Standards
VEAs - Village Enterprise Agents

1.0. The research problem

Common beans (*Phaseous Vulgaris* L) form a substantial part of household diets in East and Central Africa and are consumed by a majority of households. They are an important food crop contributing to nutrition and food security, income and employment. They are applauded as a strategic remedy for hidden hunger and healthy eating and are mostly important for children and women of reproductive age (Larochelle et al., 2015). Bean is an excellent source of cholesterol-free dietary proteins, energy, folic acid, fibre and micronutrients (iron and zinc). When compared with meat, bean is a low cost protein alternative to lowly endowed segments of the community. No wonder, they are considered a poor man's meat (Larochelle et al., 2015). Generally, beans are bought without processing and are prepared using wood fuel and wood fuel products like Charcoal. This typically takes 2 to 3 hours in cooking time (Castellanos et al. 1995 and Kahenya, 2014), which, if valued is a significant cost in terms of fuel cost and cooking time. This constrains the consumption demand for beans, as it is neither convenient nor affordable to prepare beans frequently.

Processing to reduce cooking time for beans offers great potential for improved consumption, nutrition, food security, reduced energy use and conservation of the environment. It can spur common bean production, trade and economic growth of millions of smallholder farmers and consumers. While processed bean products with short cooking time already exist on Ugandan and Kenyan food market, their current market share remains small for several reasons. First, most of the traditional processed beans on the market are imported and less affordable by most consumers. For example, canned beans on the Ugandan market are mostly imported from Egypt and U.A.E (Kilimo trust, 2012) and cost about US \$ 2.49 -2.84 per kilogram which is more than 3 times higher than the cost (\$0.62 – 0.84 per kilogram) of unprocessed bean dry grain (UBOS, 2016). Other processed bean products like chilled beans require preservation, for example through refrigeration, which is another constraint to a number of consumers who lack such technologies in their homes. Inadequate demand for processed bean products has been a disincentive for private sector investment into bean processing (Kilimo trust, 2012).

In recent years, the rapid expansion of urban populations, rising incomes, and high costs of energy have fueled the demand for fast-cooking processed foods. Developing affordable, convenient, on-the-shelf bean products that require less time, fuel and water to cook, will greatly enhance bean consumption, improve incomes for producers and conserve the environment. Using the Public Private Partnership Approach, this project introduced an easy to cook bean (Precooked bean) product to the market to help ameliorate constraints to be consumption and meet demand of changing trends.

1.2. Progress towards milestones

This section gives a synthesis towards the achievement of project milestones (as specified in the grant agreement). Evidence that milestones are being achieved is also provided and referred to in attached annexes where applicable. The milestones are reported sequentially based on the period in which they were expected to be delivered.

1. Six months after starting date

In the first six months after the inception of the project, the project set out to achieve three major milestones; (1) **Project research activities fully underway with research work plans and schedules**, (2) **Research and coordination team has defined roles and responsibilities** and (3) **All administrative procedures for the project set up**. These were targeted towards laying the ground work for the implementation of the project. To set up project research activities with research work plans and schedule of activities to ensure delivery on all objectives, the project held inception and planning meetings that facilitated the development of research plans and schedule of project activities. Also, a gender strategy for mainstreaming gender (Annex 107842-002), a communication strategy (Annex 107842-003), a Project Implementation Plan (Annex-107842-004a) and performance monitoring framework (Annex-107842-004) were developed. For the other milestone, the project set up project implementation teams based on project objectives and recruited support staff. To further support research activities, the project recruited 12 students through a competitive process that involved recruiting and interviewing of candidates from different universities in Kenya and Uganda. All project and administrative procedures were fully set up.

2. Twelve Months after starting date

During the second half of the first year, the project had seven milestones namely; screening of available bean varieties completed; alternative processing methods based on the cooking time, cooking pressure and drying time developed; as well as models for bean seed and grain production set up. The other milestones included; Current market demand, supply and economics of pre-cooked beans assessed and documented, key gender issues are identified and key interventions implemented and documented, entrepreneurs trained in precooked bean production and business skills and environmental impact assessment completed.

A total of 47 bean varieties were screened by Lasting Solutions Limited based on cooking time, appearance before and after cooking. Following the prescreening exercise, 12 varieties were selected as suitable for precooking. The selected varieties include; NABE 4, NABE 19, NABE 17, NABE 6, NABE 14, NABE 21, NABE 23, NAROBAN 1, KAT B1, KAT B9, ROSCOCO and WAIRIMU (see a catalogue of prescreened varieties attached as Annex 107842-005). Four alternative processing methods including; pressure-cooking, extrusion, hydrolysis and malting were tested. Pressure-cooking was selected for processing precooked beans given its simplicity, ability to keep the processed bean intact and cost effectiveness. The project set up and tested two grain production and three seed production models with a total of 23,875 smallholder men and women farmers. Specifically, 13,650 farmers (6,442 men and 7,208 women) were involved in seed production while 10,225 (5,005 men and 5,220 women) were involved in grain production. Market demand and supply analysis were conducted for different value added bean products. In the market demand and supply analysis, other products were used as a proxy for precooked bean product because the product was not yet on the market. The activity was not fully

implemented because the precooked bean product was introduced late on the market. Since the product is now on the market additional analysis is being undertaken by the processor to assess the performance of the product. The entry point for the products in Kenya was middle level supermarkets including Tumaini supermarkets.

A baseline study was conducted to assess to men, women and youth participation in bean production and decision making and to document barriers to their participation (See attached the gender baseline report as Annex 107842 – 007). Through the baseline, key gender issues that formed intervention areas were identified, documented and interventions for tackling them designed. The interventions implemented included; Capacity building and support on collective marketing, supply of seed to men and women farmers on credit, targeted training highlighting the importance of gender in bean production and trade, promotion of internal saving and lending and attitudinal change campaigns to reduce stereotyping in allocation of bean production roles (Annex 107842 – 008 for details).

Farmers supplying seed and grain have received training in farming as a business and in collective production and marketing techniques. Moreover, supermarket product handlers particularly in Tumaini supermarkets have been trained on marketing and promotion of the precooked bean product and can comfortably explain what the product is all about. The milestone on training of entrepreneurs was partly completed because the development of precooked bean product was completed towards the end of the project. Training of product handlers and dealers will be continuously undertaken by the product supplier as the precooked bean product becomes fully established on the market.

An environmental impact assessment for the precooked bean factory in Mukono was conducted by a private firm – environmental Planning and Management Consult. From the assessment the factory was approved as suitable by the National Environment Management Authority (NEMA). See attached the environmental impact assessment report and certificate (Annex 107842-042 and Annex 107842-042b).

3. Eighteen month after starting date

Eighteen months after project inception, the project expected to achieve the following additional milestones; Market and consumer studies completed; Different packaging materials developed and tested; Precooked bean value chains developed and profitability analysis completed; Studies on evaluation of models for seed and grain supply completed and Gender advocacy activities and activities targeting women and youth implemented.

The project was able to undertake market and consumer studies ex ante. From consumer analysis, consumers are willing to pay an average price increase of 31 percent (an additional USD 0.24) for a kilogram of precooked beans and this can go to as high as 41 percent (an additional USD 0.3) per kilogram. Willingness to pay was influenced by household perceived self-sufficiency in bean supply, the quantity of beans consumed in a household, perceived benefits from precooked beans and education level of the consumer (see Annex 107842-009 and Annex 107842-010 for details). Different packaging methods were tested and a polymer type packing material selected for use. The polymer materials (PET and PE) selected for use are classified as a food grade material and was therefore deemed safe for packaging precooked beans. Using this packaging a shelf life of 12 months has so far been attained for precooked beans.

Profitability analysis and margins accruable to different stakeholders in the bean value chain was conducted in Kenya as a student thesis (see Annex 107842-011 and Annex 107842-012 for details). Also,

studies on the evaluation of different production and supply arrangements for grained were conducted in Uganda. A full report from the analysis of production arrangements/models is attached as Annex 107842-013

The project developed a gender strategy (Annex 107842-002) that guided implementation of gender interventions in bean research, dissemination, marketing and utilization to better integrate gender in the project. The strategy guided gender analysis, mainstreaming and capacity building across all project objectives. The strategy was based on the theory of change where increasing equitable distribution of benefits from production, marketing and consumption of precooked beans among women, men and youth is expected to lead to gender empowerment. Awareness raising on various gender aspects was conducted through radio programmes, meetings, and feedback from gender studies, group discussions and interactive capacity building sessions among farmers. During radio talk shows, women as key stakeholders in bean farming were given a dedicated phone call in and discussion line to allow them share their views.

4. Twenty-four months after starting date

For the period twenty-four month after project start, the project set out to achieve the following milestones; Selected models for production and supply promoted among producer groups, promotional materials on precooked beans developed and disseminated and models for both formal and informal uptake of precooked beans tested (Entrepreneurs trained in precooked bean production and business skills). Other milestones included; studies on impacts of gender interventions in the precooked bean value chain completed, consumers including organizations reached with information on precooked beans and scientific community is made aware of the project results.

Two models for grain production (collective marketing with seed credit support and Community production and marketing system Model) and 2 models for seed production (Seed credit model and formal seed assess and production model) were fully developed and adopted by the project for grain and seed production respectively. Details of the grain production models and seed production models (Annex 107842-006). Promotional materials including leaflets, brochures, product panel/shelf, Branding materials and fliers where produced. The milestone was however not fully achieved because it was tied towards availability of the precooked bean product and was thus not undertaken since the product was introduced in the market at the end of the product. The activity to train entrepreneurs on formal and informal uptake of precooked bean production and business skills was initiated when the precooked bean product was introduced on the market. Initial product off takers included supermarkets as part of the formal uptake of the products. The supermarkets have since been sensitized on product attributes and trade by the processor.

To access impacts of gender interventions in the precooked bean value chain, documentation of gender outcome stories was undertaken in project areas. Also, an end line study for the project was conducted. (See Annex 107842-014 for details). To reach consumers including organizations with information on precooked beans. Information and education communication messages were developed and are being utilized. The implementation of this activity started in June 2017 when the precooked bean product was launched on the market. Information has been provided to the formal off takers of the product; supermarkets and specialty stores.

In this period, project information was disseminated to the scientific community through journal paper, conference presentations, technical reports and thesis. Two papers were published (annex 107842-015 and annex 107842-022) and 4 manuscripts were submitted to journals for publication (Annex 107842-023, 024, 025, 026). Seven papers were presented in conferences (See attached oral presentations (Annex 107842-016, 017, 018, 019, 020) and 1 key note presentation was made (Annex 107842 -021). A total of 7 poster presentations were made at different fora (see annex 107842-047 to annex 107842-53). Also, the project in its publication road map ear marked the development of 24 additional papers. These will mostly come from student research work. Students sponsored by the project are finalizing writing their thesis reports and will be disseminating them through Universities and conferences. See annexes 107842-011, 107842-009, 107842-013 and annex 107842-55, 56, 57, 58, 59, 60 and 41 for drafts of student progress towards publication of thesis. In this period, the second technical interim report and financial reports were written.

5. Thirty months after start of the project.

This period covered the last six month of the project. In this period, the main milestones to be achieved included; Changes in production, incomes, consumption, gender norms and relations documented, policy makers and other stakeholders access information and are aware of the results of the project, scientific publications developed and submitted to peer review journals nationally, regionally and internationally, project external evaluation completed and technical and financial reports finalized.

To access changes in production, incomes, consumption, gender norms and relations, end line studies were conducted (see annex 107842 -14). Policy makers and other stakeholders were made aware of project results through policy discussions that were held with key organization/institution heads to discuss important issues of policy in the bean subsector while putting precooked beans in mind. This was also done during different types of meetings. A desk review of relevant policies was done to inform project focus of interventions in production, marketing and gender dimensions (Annex 107842-64).

Project external evaluation will be done by an external reviewer after the end of the project as this was not tenable within the life of the project. Technical and financial reports were completed and submitted to IDRC.

1.3. Synthesis of research results and development outcomes

This section gives an analysis of project outcomes and gives a detailed account of how the project influenced social, gender and environmental dimensions. Within the analysis, there is reference to key reports and papers that give detailed information for each outcome. The section is arranged by project objectives from Objective 1 to objective 5.

1.3.1. To develop and evaluate affordable pre-cooked bean products targeting different consumer groups

1.3.1.1. Development of precooked bean products

A prescreening exercise based on cooking was carried out to assess cooking time and grain quality of selected bean varieties. A total of 47 bean varieties were subjected to diverse cooking conditions and observed for acceptable grain (shape retention before and after cooking) and cooking qualities (cook fast) before selection. A lab analysis detailing proximate and mineral content of the 47 preselected

bean varieties was also carried out at SGS and Makerere University Food labs. Following these different analyses, 12 varieties (NABE 4, NABE 19, NABE 17, NABE 6, NABE 14, NABE 21, NABE 23, NAROBAN 1, KAT B1, KAT B9, Wairimu and Roscoco) were selected. These had the highest protein (21.94 % m/m to 24.87% m/m), total Sugar (2.99 g/100g to 4.29 g/100g), calcium (1090 mg/kg to 2790 mg/kg) and Iron (50.4 mg/kg to 231 mg/kg) levels (Table 1). The varieties had the most preferred grain and cooking attributes for precooking. The generated nutritional information on beans was also used to raise consumer awareness about the benefits of consuming beans.

Table 1: nutrient and mineral content lab analysis

Variety	Protein % (m/m)	Calcium (mg/kg)	Iron (mg/kg)	Total sugar (g/100g)
NABE 23	24.04	1920	95.8	4.29
NABE 6	23.89	1100	72.5	3.42
KAT B9	22.28	1570	82.1	3.85
NAROBAN 1	22.89	1410	50.4	3.18
KAT B1	22.60	1200	231.0	3.81
NABE 19	21.94	2790	144.0	3.73
NABE 14	23.59	2770	142.0	2.99
NABE 4	23.01	1090	72.0	4.10
NABE 21	24.84	1570	81.4	3.39
NABE 17	24.05	1920	95.80	4.20

See details in annexes 107842-039 and 107842-043.

Precooking trials were conducted on pre-screened beans to produce three precooked bean products; ***the ready to eat bean snack, a bean flour*** and ***an easy to cook precooked bean product***. The ready to eat bean snack does not require additional processing and can be eaten as a snack directly or blended with salads. The easy to cook bean on the other hand cooks in 15 minutes reducing cooking time from 2-3 hours to 15 minutes. By cooking fast, precooked beans save over 80% of fuel and uses far less water. The bean flour is easy to constitute into sauce that can be served alongside other sauces.

Two production facilities to facilitate commercial production of the developed products were established; 1 in Mukono (Uganda) and 1 in Kisumu (Kenya). The factory in Kisumu is the pilot factory and can handle a maximum capacity of 9 tons per day. However, an initial production capacity targeted at 0.5 tons per day as an entry point into the market. The second factory in Mukono will be for scaling up production to ensure mass availability of the product.

Consumer and organoleptic evaluation of the bean snack and easy to cook precooked bean using trained panel showed that the precooked bean products are acceptable with minor alterations required. Sensory attributes; color, taste, flavor, mouth feel/texture, overall acceptability, after taste and odor were scored on a 9-point hedonic scale. These showed that the easy to cook bean is generally acceptable compared to the bean snack. Also, results of food action (how often panelists would consume the precooked bean products) showed that the pre-cooked bean sauce would be consumed more frequently

compared to the pre-cooked bean snack as shown in Table 2. The information obtained was used in making improvements to the precooked bean product. This implies that the product, once on the market, would stand a high chance of being purchased and consumed.

Table 2: Average scores of the pre-cooked bean snack and easy to cook bean sensory attributes

Sample Attribute	Bean snack mean scores (standard deviation)	Easy to cook bean mean scores (standard deviation)
Color	5.86 (1.797)	6.29 (2.004)
Taste	5.24 (1.972)	5.90 (1.640)
Flavor	5.05 (2.037)	5.95 (1.627)
Mouth feel/texture	5.33 (1.880)	5.57 (1.690)
Overall acceptability	5.52 (1.778)	5.95 (1.830)
After taste	5.14 (1.931)	6.05 (1.746)
Odor	5.76 (1.700)	6.24 (1.179)
Food action		
(FACT)	1.57 (0.811)	1.95 (0.0973)

See details in annex 107842-044.

Protocols used for developing precooked bean products helped to develop standards for precooked beans. Through engaging national standards bodies (Kenya Bureau of Standards and Uganda National Bureau of Standards) reference standards were generated to inform policy and development of other precooked bean products.

1.3.1.2. Ensuring food safety using food safety tool Kit

Food safety analysis was initiated through a Hazard Critical Control Point Analysis (HACCP). This activity involved the convergence of a team of experts in diverse fields such as quality control, farmers, standards officers, toxicologists and public health experts. Thereafter the entire bean supply chain was mapped and a process flow diagram entailing all activities generated. A total of 4 critical control points were identified in the analysis and mitigation measures to reduce or eliminate the hazards were identified (See details from HACCP report Annex 107842-040). At the 4 CCPs, i.e. site/plot selection, drying, storage and cooking and serving, samples that included soil, water, cooked beans, dry beans and swabs from food handlers were collected and a laboratory analysis was conducted on the collected samples. Samples were analyzed for mycotoxins, pathogenic microbes such as E-coli, Total Plate Count and staphylococcus, heavy metals (Lead, Cadmium and Mercury) and pesticide residues.

To enable traceability of the product and to assess food safety issues, a framework for food assessment to address food safety issues at various levels of the value chain was developed. This framework is being used to assess potential hazards and critical points along the supply chain. It is also being used to assess the product along its pathway up to the final consumer. The food assessment framework culminated into a food safety tool kit that was used as a behavior change communication tool for the different value chain actors so as to ensure food is safe as it moves along the bean supply chain. (See attached the food

safety tool kit). To further educate value chain actors on what transpires in the bean value chain, video documentary showing the entire bean value chain was generated.

1.3.1.3. Consumer and nutrition analysis

A consumer nutrition survey to assess feeding habits, behavior, patterns and barriers to bean consumption in Uganda and Kenya was conducted. Information shows that bean consumption was higher in Uganda compared to Kenya. In Kenya, over 90 percent of the households indicated that they consumed beans less than three times a week. Only 1 percent of the interviewed households consume beans at least once every day (7 days a week). In Uganda however, most of the sampled households consumed beans three times a week. Overall, 14.4 percent of the sampled households consumed beans every day (7 days a week). The main factors that limited bean consumption in Kenya were; high cost of beans, long cooking time, limited cooking fuel and high water requirement. In Uganda, that main factors that limited bean consumption were; limited bean availability, limited cooking fuel and shortage supply from own production. Given that these are the major constraints that the precooked bean product seeks to solve, the product could improve bean consumption (Detail analysis in annex 107542-054).

Analysis on nutrition status was conducted using the Uganda Household demographic survey data (Findings are contained in a nutrition video that's highlights nutrition and feeding gaps and encourages good feeding) (see <https://youtu.be/CWRbewGeToo>). Information generated was used to raise awareness among stakeholders to champion the cause for improved nutrition. Also, to encourage good feeding habits for children and women of reproductive age in project sites, 52 lead mothers (49 women and 3 men) were trained. These served as champions that promoted good feeding, emphasized the importance of beans and how to maintain good hygiene in households.

1.3.2. Test models of increasing the production and supply of bean suitable for processing into precooked beans

1.3.2.1. Seed production and supply under different production models

In order to sustain supply of seed of the 12 varieties earmarked for precooked processing, 3 seed production models; the Seed Credit Model (SCM), Revolving Seed Model (RSM) and the Formal Seed Production Model (FSM) were tested. The SCM and RSM were implemented in Uganda while the FSM was implemented in Kenya. The SCM involved contracting medium and large scale farmers on seed credit to produce seed while the RSM (seed for seed model) mostly targeted smaller farmers, who produce and pay back in kind (2kg of seed for 1 kg of seed). The FSM involved contracting farmers and the integration of the agro-dealership system by seed companies. Here farmers buy seed, for cash, from agro dealers for production (See annex 107842-006). Given their commercialization abilities, can handle bulk production and have lower transaction costs, the project used the Seed Credit Model and Formal Seed Production Model in its interventions.

The project worked with 13,503 (6,445 men and 7,055 women) farmers organized in farmer groups under the Seed Credit Model, 131 farmers (52 men and 79 women) under the Revolving Seed Model and 1635 farmers under the formal seed access and production model. Prior to selecting farmers, for the SCM and RSM, profiling of farmer groups was conducted to establish their functionality, identify existing gaps and to tailor training.

Profiling information indicated that the profiled farmer groups have been in existence for more than 3 years, comprise of men, women and youth and are engaged in multiple activities including production of bean, maize and coffee and saving and loaning. Key leadership positions in the groups are dominated by men while strength of women (in 70% of groups) lied in being group treasurers. Results also indicated that groups had an average of 5 leadership positions and women strong leadership skills lie in being treasurers (70%). The key factors that influence the proportion of women in group leadership included; number of households represented (10.7%), record keeping (27.9%), proportion of both youth (19.4%) and women (69.7%) and number of economic activities (2.9%) (Annex 107842-022). Group analysis not only helped inform the project in selecting groups to work with but also in devising interventions for increased women and youth participation and influence in farmer groups.

Farmers under the SCM and RSM were able to access 79,310 Kgs of seed. A total of 71,810 Kgs was supplied through the SCM and 7500Kgs under the RSM in the 4 seasons of project operation. Through both models, the project 982,595 Kgs of seed (880,595 Kgs under SCM and 102,000Kgs under RSM) for further seed and grain production. Figure 1 shows the volumes of seed supplied in different seasons under the SCM.

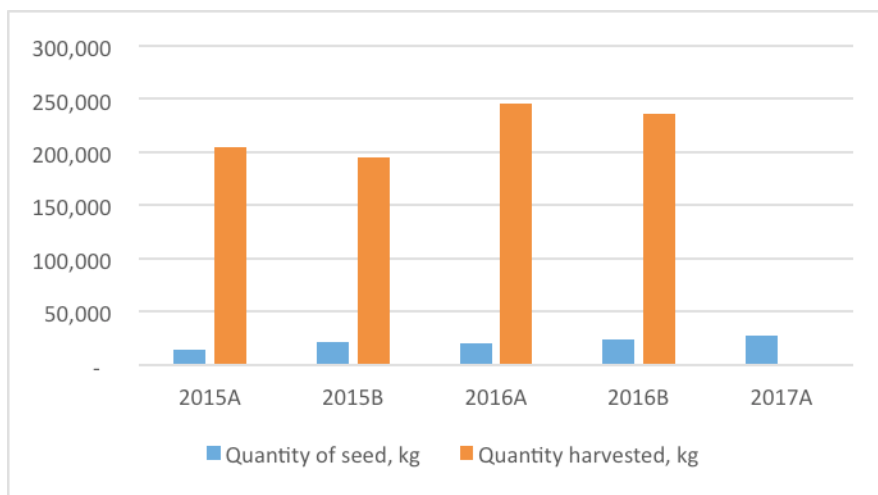


Figure 1: Volume of seed acquired by farmer and harvest during the project cycle through the SCM.

The main sources of seed for farmers that supplied seed under the bilateral market arrangement (SCM) was the seed offered on credit and then seed saved from own production. On the other hand, farmers who supplied under the spot marketing arrangement obtained seed from local grain markets and own saved seed (Figure 2). This implies that given an opportunity, farmers can ably acquire and utilize quality seed through a credit arrangement as shown under the bilateral arrangement (SCM) model. Being able to access seed on credit generally led to farmers accessing better quality seed and reduced the use of grain from the market or home saved seed as seed.

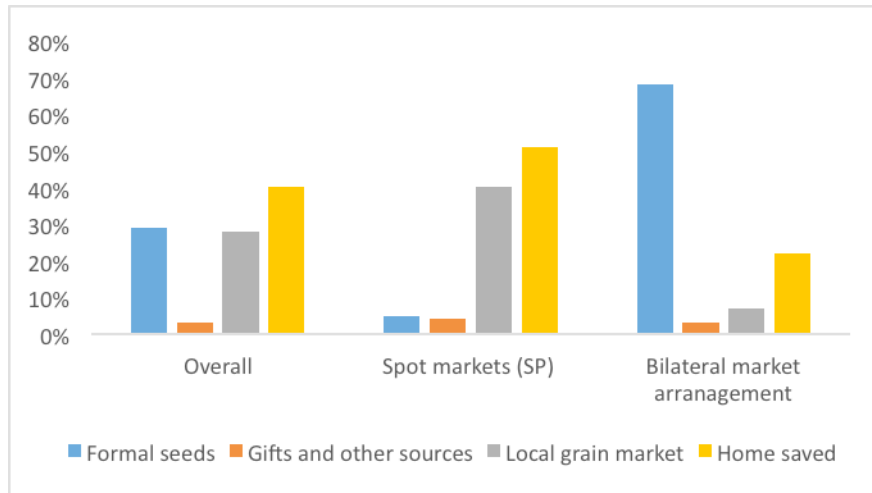


Figure 2: Sources of seed under different production arrangements

The varieties under production have good agronomic traits, a developed seed system and have been widely adopted by both men and women farmers. Generally, farmers that produced varieties targeted for precooking obtained an average of 767kg/Ha compared to 624kg/Ha obtained from other varieties grown. Six of the targeted varieties for precooking include; NABE 4, 14, 17, 19, KAT B1 and KAT B9 are on high demand [market class], highly accepted by the community due to their palatability, easy to cook and early maturity and fetch a premium price. Even though NABE 4, Wairimu and Rosecco are old varieties, they command a big market share and are highly popular in the Ugandan and Kenyan seed and grain markets respectively. In Kenya, focus was placed on KAT B1 and KAT B9 which were also more drought tolerant and less subject to impurities.

1.3.2.2. Grain production and supply under different production models

A total of 5,396 women and 3,210 men farmers were engaged in grain production, producing a total of 923,781 Kg during the project period. Farmers were organized in 2 production models; the Community Production and Marketing System (COPMAS) model and the Collective Marketing Model (CMM) with Seed Credit (**ANNEX 107842- 006**). The Collective Marketing Model with Seed Credit involved support to farmers with seed credit and some advance refinancing arrangements. The credit was then recovered from farmer as grain at the end of the production season. Comparison of the CMM and Traditional Production (TP) model indicated that while there were no significant differences in the yields or input costs, the differences in the margins received can be attributed to the better prices under the Collective Marketing Model with Seed Credit (CMM) Table 3. This highlights the importance of stable contracting for farmers.

Table 3: Profitability analysis of farmers under different production models

	TP Model	CM Model	p values
Seed rate (Kg)	88.5	72.8	0.002
Total area planted, Ha	0.6	0.6	0.216
Total crop harvest (KgHa ⁻¹)	903.6	912.9	0.896
Price for contract players	1,535	1,671	0
Gross returns (TR)	1,320,035	1,565,780	0.021
<i>Variable costs (VC in UGX)</i>			
Cost of seed	173,374	174,468	0.929
Cost of agrochemicals	19,662	40,469	0.036
Cost of labour	819,657	836,370	0.817
Cost of other variables (TCs)	41,880	93,899	0.002
Total Cost (TVC)	1,031,234	1,072,713	0.596
<i>Net returns</i>			
GM (UGX)	288,801	493,067	0.049
GM (US\$)	82.82	141.41	0.049

To further enhance the capacities of producers to supply seed and grain, farmers were linked to the innovation platform with multiple partners. The platform stakeholders include; Grain traders, Research institutions, farmer groups, financial institutions, Local government, seed companies, NGOs, Media, Insurance body, agro-dealers and a law enforcement agency. The platform is representative of all farmer groups and stakeholders involved in the precooked bean project. Through the innovation platforms, farmer groups were linked to financial service providers such as Post Bank Masaka, Masaka Microfinance Development Cooperative Trust (MAMIDCOT), Uganda Finance Development Trust (UGAFODE) and Equity bank that offered tailored loans for agriculture investment. In collaboration with UAP insurance, preparations to pilot crop insurance among bean farmers are being initiated in the Masaka platform in Uganda. However, limited number of stakeholders like Agro dealers in project sites is limiting choice and reach of platform operations.

1.3.2.3. Capacity building of farmers for increased production

In order to enhance capacity in Good Agronomic Practices (GAPs), collective bulking and marketing, quality management and post-harvest handling, trainings for different categories of stakeholders were organized through direct training and training of trainers to serve as village enterprise agents. Participation of men in trainings was only 37.2% compared to 62.8% of women participation. The great participation of women was due to the targeted training approach that emphasized strong mobilization of both men and women, training in convenient locations near farmers and awareness of the importance of training the family not one household member.

Evaluation of the trained showed that farmers transferred 90% of the training and 78% shared the knowledge they received. A strong predictive ability was found between trainee characteristics (readiness to learn, performance self-efficacy) and transfer of training which explained up 21% of the

variance among trainee (Annex 107842-041). The proportions of different actors trained and areas of training are shown in Table 4.

Table 4: Capacity building to facilitate quality bean production

Training Type	Critical area for production	Men	Women	Pooled
Capacity building	Agronomy	5,090	7,016	12,106
	Collective Marketing & PHH	4,153	3,598	7,751
	Records & financial management	457	921	1,378
	Safe handling of chem. inputs	481	1,185	1,666
Trainer of Trainers	Platform formation	224	568	792
	EAC grain standards	42	35	77
	Variety maintenance	33	29	62
	PHH technologies	218	632	850
	Leadership & gender	133	188	321

1.3.2.4. Awareness creation for increased production

In total 52,802 people (24,240 men and 28,562 women) were reached with information through various dissemination channels including sensitization sessions, trainings, agricultural events, social media, print media, radio and Tele vision among others as shown in Table 5. The dissemination events targeted technical staff at district and lower local government levels, farmer organizations, seed companies and NGOs engaged in agricultural development interventions.

Table 5: Number of farmers reached using different information sharing methods.

Method	Number		Participation		Total Attendance
	No.	MALE	FEMALE	Total	
Sensitization on varieties	-	11,447	12,428	23,875	
Farmer trainings	-	6,667	7,862	14,529	
Seed fair	10	2,244	2,528	4,772	
Field days	19	1,688	3,529	5,217	
Agricultural Show	6	1,987	2,034	4,021	
Participatory M&E (Follow up	56	155	134	289	
Platform Meetings	2	52	47	99	
Radio programs. **		-	-	-	
Total		24,240	28,562	52,802	

** - information from the radio stations is being awaited and is linked to Farm radio international

The campaigns increased demand for seed of bean varieties targeted for precooking. Participant knowledge on good bean production practices and growth characteristics is being appreciated and utilized across the value chain. There is improved lobbying ability among stakeholders during technical planning meetings as evidenced by inclusion of varieties for precooking in district/county seed procurement and supply plans. For example, Masaka district in Uganda supplied 19 tons of NABE 4 and 7

tons of NABE 19 under the Operation Wealth Creation (OWC) program. The County Director of Agriculture of Machakos through KALRO supplied 300kg of KAT B1 while Dryland Seed Company sold 600 kg of KAT B1 and 300 KAT B9 in Machakos, Makueni and Homabay through agro dealers. Catholic diocese of Homabay purchased and supplied 735Kg of KAT B1 and 224Kg of KAT B9.

1.3.2.5. The role of the innovation bean platform in technology promotion

Three Bean Innovation Platforms (BIP) to facilitate linkages, information sharing and easy access to production inputs and structured market systems are operational. The platforms facilitated establishment of forty-five (45) result demonstrations to expose members to improved bean crop growth practices. The platform, on its own, supported 146 farmers (62 men and 84 females) who produced 20,134 kgs of bean seed and earned about USD 10,596.84. Farmers working through the platforms are accessing loans at an interest rate of 3% from micro finance institutions and USD 13,157.89 has been lent to farmers so far. The other benefit that has accrued to platform members was having their soils analyzed by Makerere University and IOWA State University (USA) who are also platform partners.

1.3.2.6. Employment opportunities that were created by project interventions

Through its operations, the project directly or indirectly created employment for 24,615 people. The employment opportunities were created for different categories of actors as shown in table 6. There was an increase of the number of people employed from for example, CEDO in 2015 worked with 33 aggregators and increased these to 55 aggregators. Similarly, Smart logistics in Kenya started with no aggregators but brought on board 16 aggregators through the project. At intermediate processing level of bean seed (sorting, winnowing, grading and packaging), the number of persons employed increased from 46 (6 men and 40 women) in 2015 to 177 (32 men and 145 women) in 2017. This more than tripled the number of persons employed by the project at intermediary processing levels. Details of employment opportunities and changes are shown in table 6.

Table 6: Contribution of the project to employment at different levels of the bean value chain

Value chain level/Actor	Baseline	End line	Change
Aggregators	33	71	115.2%
Employment intermediate processor level	46	187	306.5%
<i>Male</i>	6	32	433.3%
<i>Female</i>	40	145	262.5%
Farmers	14943	23875	59.8%
<i>Male</i>	6752	11447	69.5%
<i>Female</i>	7840	12428	58.5%
Employees at Aggregate Centers	132	492	272.7%
<i>Male</i>	11	137	1145.5%
<i>Female</i>	121	355	193.4%
Total	14,803	24,615	

1.3.3. To assess demand, identify promotion mechanisms and widely promote the consumption of precooked beans for different consumer groups

1.3.3.1. Bean consumption and segmentation of potential bean consumers

An Ex ante analysis of the potential demand for precooked beans was conducted among urban, peri urban and rural consumers. Findings indicated that precooked beans will be readily accepted by consumers with acceptance levels of up to 89.1%. Study findings also showed that consumers can be classified in 3 segments. The segment with the likely consumers of precooked beans (with the highest propensity to consume) accounted for 44.4 percent of the consumers. The first segment that was most likely to consume the products had had the smallest household size. Consumers in this group also reported the highest expenses (USD 0.5) for preparing a meal of beans. Their choice could, thus, be reflecting cost saving behavior since they are already buying the beans they consume (are not self-sufficient in bean supplies) and have nothing to lose trying out new precooked bean products. The segment also had households that faced the furthest distance to the nearest bean market and water sources (Details in Annex 107842-009)

Further analysis of consumer willingness to pay (WTP) for precooked bean showed that consumers are willing to higher premiums to consume precooked beans if they are nutritionally enhanced, save time and fuel. The WTP varied by precooked bean product attribute and by consumer segment. The highly probable consumers are willing to pay an average price increase of 31 percent (an additional USD 0.24) and this can go to as high as 41 percent (an additional USD 0.3). The prices that consumers are willing to pay for precooked beans will mostly depend on their incomes, previous bean prices and the quality of the proposed product. Supermarkets and retail outlets including kiosks and shops (mom and pop) were the major preferred outlets for buying precooked beans.

The average household weekly consumption frequency of beans was 4.2 bean meals with an average of 0.64 kg consumed per meal. When extrapolated to a year, the per capita consumption of beans stood at 22.41 kg per person per year. When asked about their likely consumption of precooked beans, households indicated that they are willing to buy an average quantity of 0.71 kg per meal at a consumption frequency of 4.05 bean meals per week. This brings the per capita consumption of precooked beans to 24.9 kg per person per year.

1.3.3.2. Processed bean product value chain analysis

A study was conducted targeting supermarkets in Uganda to assess available bean value added products. The findings show that canned/tinned beans, bean flour, instant bean sauces, frozen beans, and graded and packed beans are the main bean products on the market. The canned bean products are mostly consumed by institutions including hotels and government security agencies. The production of products like bean flour, instant bean sauces and sorted and packaged beans is still at low scale. This implies that unprocessed dry bean grain will be the main competitor of the precooked beans since it's the most traded bean product. Given the factors that consumers reported long cooking time, high costs of fuel and limited availability of beans, precooked bean products, with a time and fuel saving element, will play a major role in bridging the gap.

To assess the performance of the bean value chain and its structure, a value chain analysis was conducted in Kenya (Annex 107842-011 and Annex 107842-030). Findings indicate that trade remains largely informal, and underdeveloped with limited value addition along the bean value chain. The leading 2 processing firms of beans in Kenya control over 70 percent of the entire market. This is a clear

manifestation of a monopoly or duopoly. The major barriers to entry into bean processing sector include; lack of capital, the low interest to invest both at production and distribution level and the general lack of incentives and detailed information at both levels which drives away potential investors who would wish to join the market in fear of using very high starting capital. The results also, show that although most of the bean grain suppliers (79%) to processors are based in Kenya, a considerable amount of the grain processed (52%) is imported. The limited local demand was attributed to limited supply abilities and poor quality of bean supplied. Figure 3 shows the flow and utilization of beans along the bean value chain in Kenya.

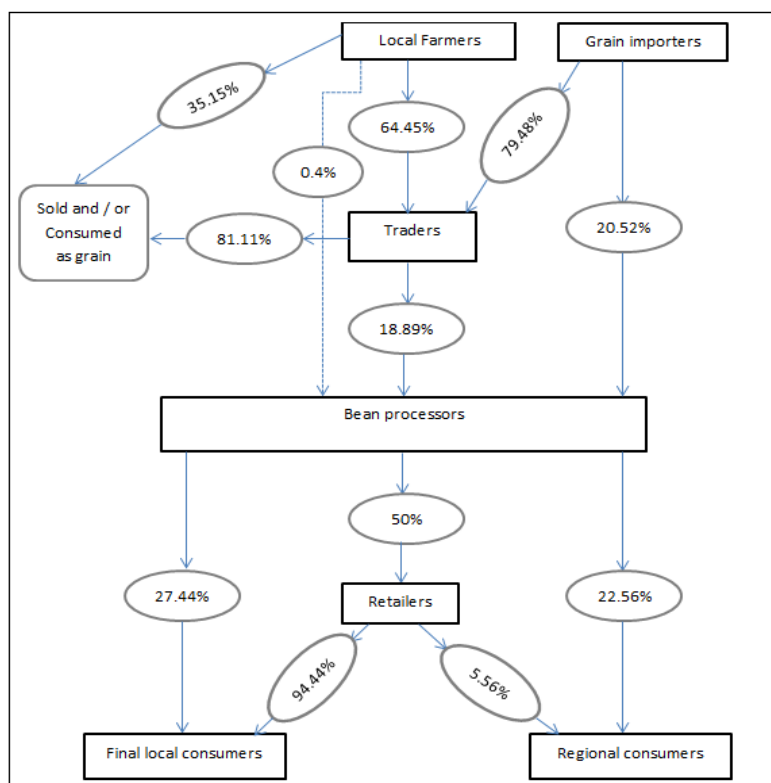


Figure 3: Flow of processed beans by percentage traded along the value chain.

1.3.4. Gender analysis and mainstreaming in the precooked bean value chain

1.3.4.1. Gender analysis

A baseline study was conducted and gathered information from men and women on their access to production resources, participation in different bean production and marketing activities and in decision making in the use of key bean production resources. It was observed that in the project areas, bean is considered a crop that is managed by both men and women though with different degree of intensity depending on the crop production activities as shown in Figure 4 and 5. In a number of occasions, a greater proportion (Greater than 60%) of men and women reported participation in different bean production activities (see details in annex 107842-007 and Annex 107842-014). Generally, the proportion of men and women that participated in activities; like fertilizer application and pest and disease control, that were less frequently reported in 2014 increased in 2016. This can be attributed to projects intervention that encouraged farmers to manage pests and diseases and also the fertility of

their soils if they were to boost their bean yields.

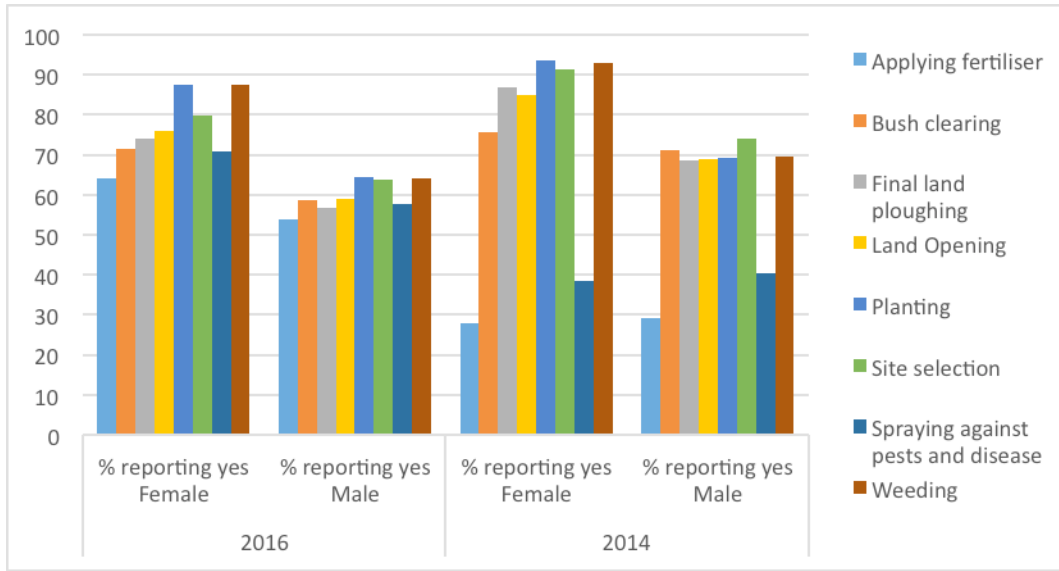


Figure 4: Percentage of households and gender participation in bean cropping (pre harvest) activities

While men and women participate in different bean production activities, women still stand out as more visible actors in the bean production chain. Women’s participation in bean production remained higher than that of men in almost all bean all activities (Figure 4 and 5).

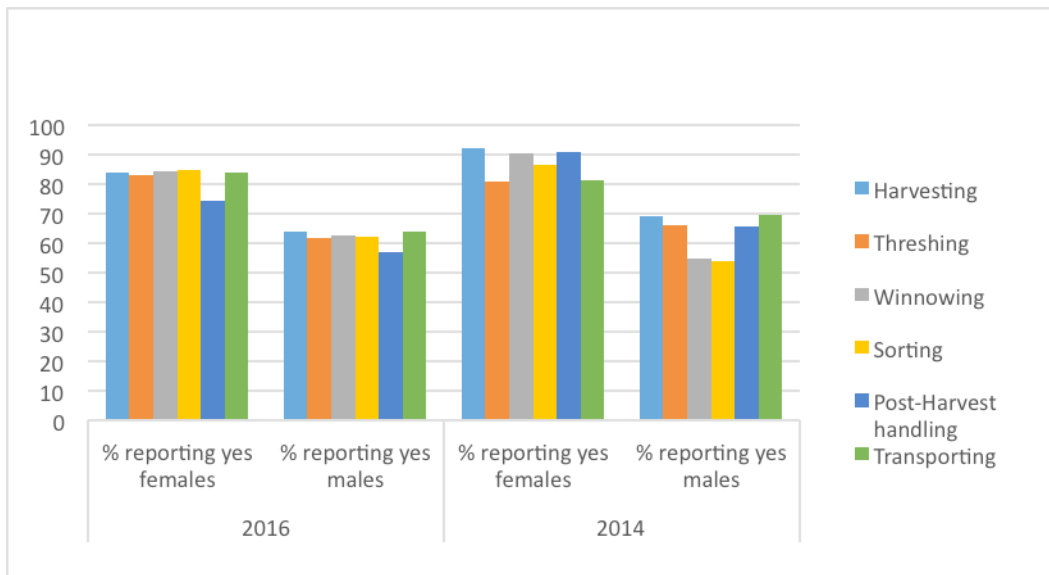


Figure 5 percentage of households and gender participation in bean cropping (post-harvest) activities

Some disparities between men and women with regard to decision making still exist. Men still dominate decisions on use of land, application of fertilizers and decisions of whether or not to seek for credit (Table 7). In nearly 20 percent of the households, women reported that they have minimal influence on the use of land for bean production while this percentage is only about 10 percent for males.

Table 7: Persons who make decisions on access/control of household productive resources in male headed households Uganda

Decision	Male respondent					Male respondent					Female respondent					Female respondent				
	N	Husband	Wife	Both	other	N	Husband	Wife	Both	other	N	husband	Wife	Both	Other	N	husband	Wife	Both	Other
	2014					2016					2014					2016				
Use of HH land for bean	464	46.8	11.6	40.1	1.5	176	41.5	2.3	55.1	1.1	496	32.5	28.8	37.9	0.8	127	36.2	3.1	59.8	0.8
Choosing bean varieties to grow	464	34.4	21.1	42.7	1.8	160	33.8	18.8	46.9	0.6	498	17.5	44.8	36.4	1.4	108	19.4	19.4	61.1	0.0
Allocating time for bean	468	34.4	22.2	42.1	1.3	159	28.9	7.5	62.3	1.3	498	18.1	42.8	37.6	1.6	113	15.0	15.9	69.0	0.0
Seek credit services	222	55.4	9.5	35.1	0.0	102	29.4	3.6	66.7	0.0	230	32.2	29.1	38.7	0.0	69	26.1	11.6	60.9	1.4
Use of fertilizers	177	57.6	10.7	31.6	0.0	112	65.2	3.6	31.3	0.0	183	43.7	19.7	33.9	2.7	85	52.9	2.4	44.7	0.0
How much beans to save for food	467	20.1	45.2	33.2	1.5	144	17.4	22.2	59.0	1.4	498	9.4	60.2	28.9	1.4	101	9.9	28.9	61.4	0.0
How much beans to sell	460	38.5	14.8	46.1	0.7	152	30.9	9.2	59.2	0.7	483	23.4	35.6	40.2	0.8	103	21.4	9.7	68.9	0.0
Use of income from sell of beans	455	33.4	11.7	54.3	0.7	148	23.0	2.7	73.6	0.7	484	23.4	27.1	48.8	0.8	102	19.6	6.9	73.5	0.0

The study provided valuable insights on intra-household decision making for bean production and utilization as well as disparities between men and women that were relevant to project objectives. Generally, women in a number of households, reported that they jointly make different decisions (on varieties to grow, allocating time for bean activities, how much of the bean harvest to sell and also on use of proceeds from beans) with men. However, when it came to sole decision making, men reported higher intensity of participation in making a number of decisions (Table 7).

1.3.4.2. Interventions to address gender biases through capacity building

The project promoted the following interventions to foster youth and women participation in bean production and marketing: (1) facilitating and strengthening collective marketing, (2) targeted trainings in bean production, marketing, group dynamics, (3) promoting internal saving and lending skills to ease access to credit, (4) adopting attitudinal change campaigns to reduce stereotyping that still dog's participation of different gender groups in bean production and marketing activities and (5) offering seed on credit to facilitate access to quality seed of improved bean varieties (ANNEX 107842- 008).

Facilitating and strengthening collective marketing. Collective marketing and introduction of aggregation centers near farmers supported women to access and participate in bean marketing. The groups ensured that the crop owner was the one paid for their beans and that they are available during the time of marketing. This approach increased the proportion of women that participated in bean marketing from 50% in 2014 to 55% in 2016 (Figure 6). Though the proportion of women improved, men were reported to participate more in marketing because; they knew the traders, are better at bargaining, less cheated in the market and can travel long distance to access markets.

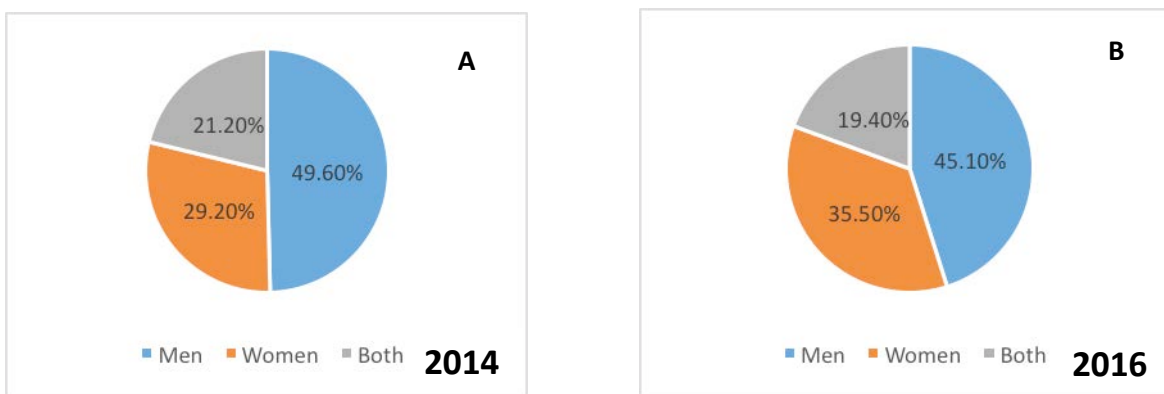


Figure 6: A comparative analysis: Proportion of men and women farmers that participate in bean marketing 2014 (A) and 2016 (B)

Payments were done using mobile phone payments (Mpesa, Kenya and Mobile money, Uganda) to ensure recipients were those that delivered produce, especially the women. In occasion were the farmer required cash, they were paid on cash basis.

During the project cycle, women's average incomes from bean sales significantly increased from US\$126 in 2014 to US\$170 in 2016 and the volume of beans sold by women increased by 8%, from 290 kg in 2014 to 314 kg in 2016.

Qualitative data from 12 focus group discussions (four mixed, four women only and four men only groups), with 176 women and 174 men, revealed that collective marketing improved women’s access to agricultural production and market information.

Although there are clear benefits of women’s increased participation in bean marketing, there were some challenges that emerged within households. From the sex disaggregated and mixed FDGs, it emerged that in many households where women sold their beans through the group, men withdrew financial support to their wives. In such cases, women were forced to pay for outgoings, such as school fees, hospital bills and general household needs that were usually covered by men. In other instances, men borrowed money from their wives and never paid them back. During men-only FDGs, men claimed to intentionally ignore their monetary responsibilities to ensure their wives spent the money they earned on requirements concerning all household members.

Promoting internal saving and lending skills to ease access to credit. To help hasten women and youth access to credit, the project facilitated and promoted savings and credit for production through Village Saving and Loaning Associations (VSLAs) and groups level savings. This resulted in the proportion of farmers that reported improved access to credit increasing between 2014 and 2016. The proportion of women that are now accessing credit is reported to be slightly higher than that of men (Figure 7). There are 33 VSLAs with both men and women membership and of the 33 VSLAs, 24 have been linked to input dealers to foster access to quality inputs. A total of 1418 women have opportunities for accessing credit through the system.

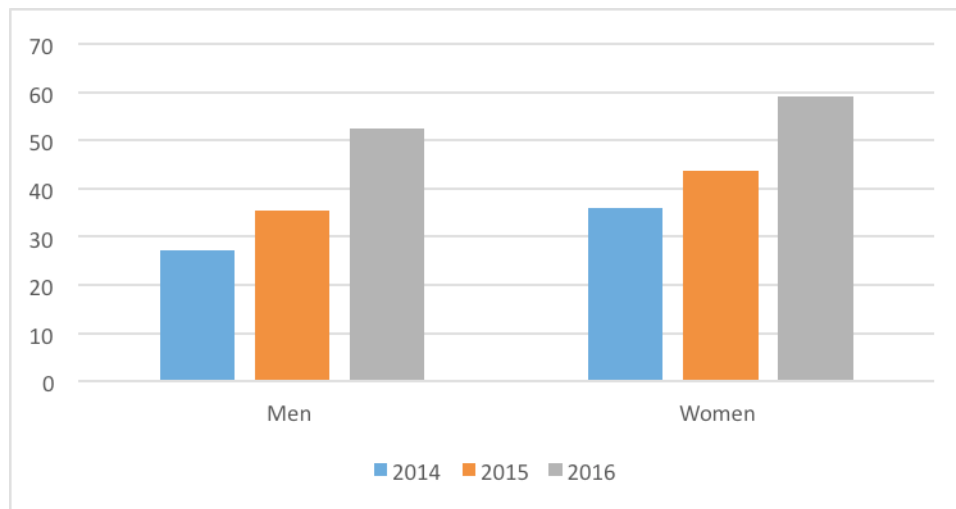


Figure 7: Proportion of Men and women farmers that accessed to credit (2014 - 2015)

The credit accessed by men and women farmers was mostly invested in acquiring inputs and in hiring labor as shown in figure 8.

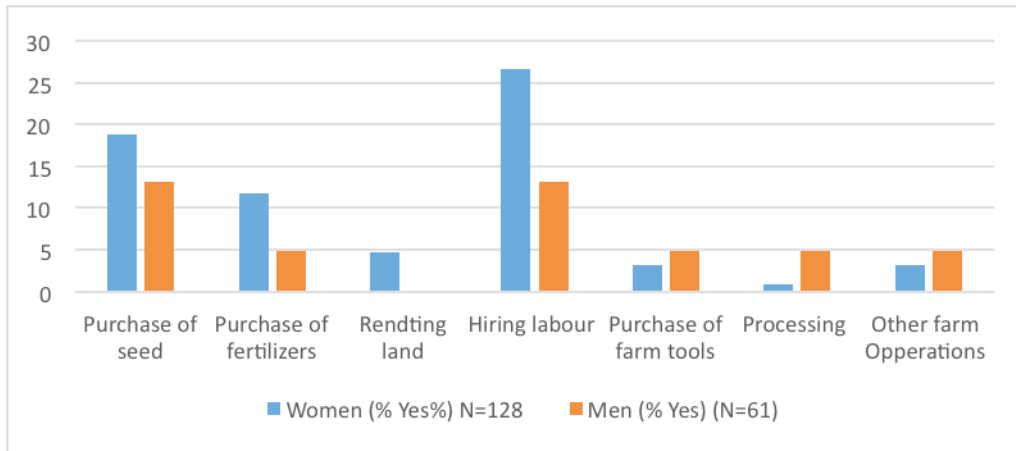


Figure 8: Bean activities to which credit received is utilized on

Also, the proportion of farmers that saved funds in formal institutions as opposed to saving from home was notably high as shown in figure 9 in 2016.

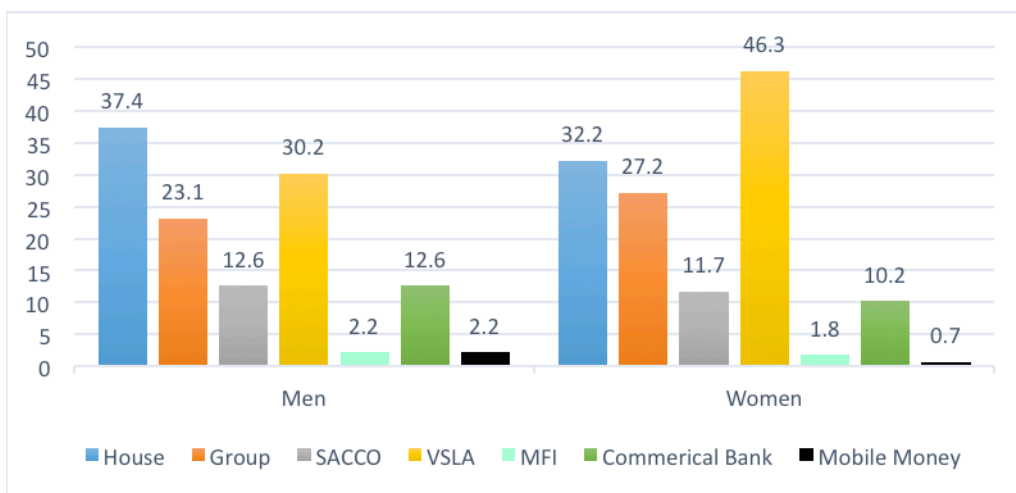


Figure 9: Forms of savings and institutions used by male and female bean farmers

Fostering access to quality seed through seed credits. The project introduced the seed credit approach for women and men farmers in Kenya and Uganda. In the model, men and women were allowed equitably access to bean seed on credit which is then recovered after harvest. In the arrangement, a total of 9,563 men and 9,526 women were able to access quality seed of improved high yielding bean varieties. In incidences where seed was insufficient, women were given priority in terms of quantities to acquire. The seed credit approach also enabled women take individual ownership of the bean crop and also take charge of its marketing. This was made possible by the fact that at aggregation time, the person who took the credit was recognized as the crop owner and was thus the bona fide recipient of the funds earned from bean harvest. It was only under agreed upon or exceptional circumstance was another person allowed to receive proceeds from bean sells.

Awareness raising on gender. Through targeted trainings, mentoring, information sharing and awareness raising session's issues of gender inclusiveness in bean production and marketing were tackled. Also during farmer feedback meetings, meetings with district officials, or farmer trainings among others, different gender aspects were deliberately included in discussions to raise awareness and to break the misconception that gender is all about women. A total of 3,346 farmers (1,196 men and 2,150 women) benefited from the 41 training sessions that were organized by the project. 510 TOTs including 296 women and 214 men and serving as community link persons were trained in gender and gender integration in bean production and agriculture. The different interventions improved stakeholder knowledge on gender. Constructions were asked to men and women to gage their perceptions of key gender issues in society. This was done to understand their level of awareness of the importance of gender. Generally, responses from men and women indicated that they are aware of the importance of gender and consider a number of gender issues as important. For example, 81.32% of males and 87.64% of females acknowledged that females and males should be engaged in decision making over production resources.

1.3.4.3. Capacity building for gender among project implementers

The capacity of project implementers to ensure gender mainstreaming and integration in the precooked bean project was undertaken. A total of 26 project implementers (14 women and 12 men) draw from all partnering project institutions were train in various aspects of gender. During the project period, one female project research staff won the Young scientist award that enabled her to participate and disseminate research findings in the World legume and cowpea conference that was held in Livingstone, Zambia. In addition, four of the project staff (1 Male: 3 female) were selected and represented the precooked bean project in gender mentoring session that was organized after the world legume and cowpea conference in Livingstone Zambia. The project also recruited and trained 1 male and 1 female in women and gender studies at master's degree level. The capacity acquired has been used to support a number of project interventions, such as in training farmers and other stakeholders, in designing and collecting sex disaggregated data and in analyzing and reporting the same.

The project created linkages with NGOs such as CONCERN, Lutheran World Relief, Farm Radio and Independent Development Fund (IDF) that engage in the promotion of human rights and advocacy and women empowerment. The aim was to share materials for gender mainstreaming, exchange knowledge and build synergies for wider reach and impact.

1.3.5. To test and assess different formal and informal uptake mechanisms and inform food and nutrition policies in the region

The analysis of existing policies and frameworks was done through a desk review of available literature. Findings from the reviews showed that the major policy issues that affect the bean subsector include; (1) a weak seed diffusion system and limited use of improved technologies, (2) lack of market led production in the bean industry, (3) general lack of storage facilities and fairly high post-harvest losses which were approximately 30% in Kenya, (4) limited value addition in beans, (5) limited application of quality standards for beans and (6) lack of a bean traceability system to ensure quality. Focus on this research area is being shaped by the policy environment.

These findings were used to shape project implementation and to engage policy makers and inform policy. The project strengthened the seed diffusion pathway by linking farmers to seed companies (that offered seed on credit) and research institutions. Through the collective marketing and aggregation framework, the project supported and assessed market lead production of bean seed and grain. Capacity of farmers in post harvest handling, storage and bean standards was built and a food safety and traceability tool kit developed and disseminated. Outcomes of the different interventions were shared with policy makers at different levels as an advocacy tool for further action and support.

1.4. Synthesis of results towards AFS themes

This section gives highlights of how the overall project is directly impacting on key **AFS themes**.

1.4.1. Increasing agricultural productivity (Availability)

- The project has improved the availability of improved new and quality seed of high yielding and early maturing bean varieties. Before the precooked bean project, farmers in the greater Masaka area, where the project now operates, had access to only two varieties suitable for precooking. They now have access to 8 varieties. In Kenya, farmers had 1 variety and now they have access to 4 varieties. Farmers have been able to access, 79,310 Kg of seed of improved bean varieties. These varieties have a yield potential of 1,500-2,500 kg/Ha compared to traditional varieties with 500 kg/Ha.
- Farmers have received training on the management of post-harvest processes and reduction of post-harvest losses. CEDO using its production master sheet and the destoner machine has observed that farmers at farm level have improved on their post-harvest management which has reduced losses at the processing facility level. Also, a total of 12,106 farmers (5,090 men and 7016 women) received training in good agronomic practices which are known to improve bean productivity.
- The project undertook awareness raising and training on effects of gender on household bean production. By sharing different gender productive and reproductive roles with men and women farmers, the participation of men in bean production has improved and men are now appreciating the roles played by men and women. This will tackle gender specific constraints. It is hoped that it will improve intra household sharing of roles and thus reducing the workload of women.
- As farmers adopt better farming practices and attain better yields, the project is contributing to household food security. Also men and women farmers are poised to earn more income from marketing of beans as they are facilitated to engage in profitable markets.

1.4.2. Improving access to resources, and/or markets and income (Accessibility)

- The innovation platform established by the project has created linkage between different stakeholders. Farmers working through the platforms are accessing loans at an interest rate of 3% from micro finance institutions so far, USD 13,157.89 has been borrowed. So far, 42 farmers (28 men and 14 women) have access seed credit through the platform arrangement.

- The project supported 33 Village Saving and Loaning Associations (VSLA) with a membership of both men and women. Twenty-four of the 33 VSLA were linked to input dealers to foster access to quality inputs. A total of 1418 women have opportunities for accessing credit through the system.
- There was a significant increase in women's average incomes from bean sales from US\$126 in 2014 to US\$170 in 2016 and the volume of beans sold by women increased by 8%, from 290 kg in 2014 to 314 kg in 2016.
- Through ICT based payment and extension systems, the project has reached 19,089 (9,563 men and 9,526 women) farmers with agronomic, pest and disease management information and market information.
- The project is promoting collective marketing not only to increase participation of women in bean marketing but also to encourage equity and transparency in the whole process. In total, 13,503 (6,445 men and 7,055 women) farmers supplying bean seed and 8606 farmers (5,396 women and 3,210 men) producing bean grain have benefited from collective marketing. They have been mentored and trained to market their bean produce collectively.
- Also, all farmers working under the project have been able to obtain seed on credit. This is easing access to improved and quality seed especially among vulnerable farmers that cannot afford to buy seed of improved varieties.

1.4.3. Improving nutrition (Utilization)

- The project has trained rural farmers on approaches of improving feeding habits for better family nutrition. For example, in Masaka area, nutrition education was led by 52 trained lead mothers who offered nutrition education to care givers of children below 5 years and to women of reproductive age. The key nutrition messages they are sharing include; food and its importance, balanced diet, encouraging households to grow quick maturing and nutritious foods rich in iron and vitamin A. They are promoting safe and diverse food preparation methods alongside boiling drinking water and maintaining hygiene and sanitation at household level
- The project is promoting safe storage methods to improve the quality and safety of beans households are consuming and supplying the market. The practices that are being promoted include; proper drying of beans before storage, zero use of toxic drugs in storage, timely harvesting of bean to minimize damages and infestation, avoiding mixing new and old bean stock, using pallets during storage and ensuring that domestic animals and produce do not share the same house. These practices have been shared with a total of 19, 090 farmers of whom 10,835 were women and were 8,255 men.
- To enable traceability of the product and to assess food safety issues, a framework for food assessment to address food safety issues at various levels of the value chain was developed. This framework is being used to assess potential hazards and critical points along the supply chain and the processing plant. It will also be used to access the product along its pathway up to the final consumer. Also, a Hazard Analysis Critical Control Analysis was conducted this helped identify 4 Critical control points where mitigation measures to reduce or eliminate the hazards can be applied. All this was to make sure that quality bean products are available to households at all levels of the bean value chain.

1.4.4. Informing policy

- Meetings are organized with district and lower level district technical officers and politicians to share project activities and targets and to inform them of available varieties for precooking, they were able to include key precooked bean varieties on their district procurement and bean seed supply plans. For example, Masaka district supplied 19 tons of NABE 4 and 7 tons of NABE 19 under the Operation Wealth Creation (OWC). The county director of agriculture of Machakos supplied 300kg of KAT B1 while Dryland Seed Company sold 600 kg of KAT B1 and 300 KAT B9 in Machakos, Makueni and Homabay through agro dealers. Catholic diocese of Homabay supplied 735Kg of KAT B1 and 224Kg of KAT B9. The supply of these varieties was influenced by the precooked bean project.

1.5. Project outputs

The project has different categories of outputs as listed in table 8 and attached in detail as annexes. A number of outputs are available online under open access and those that have not been completed have the completion date under the road map section. The project recognizes the open access policy and has emphasized and encouraged that all documents be available online and readily accessible through different for a.

Table 8: Summary of major project outputs, dissemination and dissemination plans.

Output type	Number	Dissemination plan
Peer reviewed journal article	2	Published under open access online
Research papers submitted under review	4	Published under open access online
Research papers under development and internal review	24	Published under open access online
Poster and poster papers	7	Presented in different conference and published online
Oral conference presentations	7	Presented in different conference and published online
Student thesis reports	12	Published under open access online
Technical publications and reports	12	Published under open access online
Documentaries	3	Online via you tube
Working papers/documents	11	
Other information materials	2	Printed and shared as hard copies

Note: See details of each in annex 107842-043

1.6. Problems and challenges

The project faced some challenges including delays, and in implementing research activities. Some of the challenges and solutions are highlighted in table 9.

Table 9: Problems and challenges encountered during project implementation and corrective actions taken.

Problem/risk	How it was dealt with
Delayed disbursement of funds to project implementers	A request for a no cost extension of the project was made to allow consolidation of project activities
Unfavorable weather that affected seed and grain production	Diversified production areas, staggered planting and strategically selected bean varieties that are quick maturing to plant in a season
No history of information on nutritive quality of the selected bean varieties (protein, total sugar, amino acids, fiber, iron, zinc, calcium, potassium). Local capacity for detailed nutrient analysis was missing and very costly. This has resulted in delay in screening of the varieties and subsequently product development	A full time analytical chemist has been engaged and BECA labs to use their facilities for analysis. Additional support was sought from SGS labs and Makerere University food technology department and at KALRO Njoro laboratories in conjunction with KEBS.
Lack of standards for precooked beans meant the project had to develop standards to be followed.	The project engaged national standards bodies (Kenya Bureau of Standards and Uganda National Bureau of Standards) to develop precooked beans standards
Water quality challenges arose in the setting of the pilot plant. The water had too much fluoride	A water purification plant was set up but this occasioned delays in the plant establishment
Differences in exchange rates caused some losses of funds which affected the funds available for some activities.	No action was taken
Delayed commercial production and marketing of the precooked bean product caused by bureaucratic processes in obtaining the quality marks, this delayed studies of (how many students were affected) students and other project activities (what activities were affected)	Two studies were changed to use surrogate products that could then be inferred to precooked beans.

1.7. Overall assessment and recommendations

Different ways of managing partnerships affected direct input and performance of the project. There is therefore need for joint management of partnership and also joint identification partners so as to streamline operations. Internal evaluation of partners is needed to ensure they do what is expected of them.

Disbursement of funds to partners needs to be changed. If possible funds should be channeled directly to partners or the project team should have full discretion in disbursement of funds, including

The margins on staff time should be made flexible to allow smooth operation of the project.

Generally, the project was implemented well and technical backing from IDRC was timely, beneficial to the project and was highly appreciated.

LIST OF ANNEXES

S/N	Annex Number	Title	Type
1	Annex 107842-001		
2	Annex 107842-002	Gender strategy for the precooked bean project	Working papers/documents
3	Annex 107842-003	Communications strategy/Guide for the precooked bean project	Working papers/documents
4	Annex 107842-004	Precooked bean project performance monitoring framework (PMF)	Working papers/documents
5	Annex 107842-004a	Precooked bean project implementation Plan (PIP)	Working papers/documents
6	Annex 107842-005	Bean variety catalogue	Other information materials
7	Annex 107842-006	Description of bean seed and grain production model	Working papers/documents
8	Annex 107842-007	Gender Baseline report	Technical publications and reports
9	Annex 107842-008	Issues of inclusiveness and gender interventions	Working papers/documents
10	Annex 107842-009	Ex ante analysis of the potential demand for precooked beans in Uganda	Student thesis reports
11	Annex 107842-010	Abridged Consumer analysis Report	Technical publications and reports
12	Annex 107842-011	Value chain analysis of processed bean products in Kenya	Student thesis reports
13	Annex 107842-012	Baseline Report on Value Chain Analysis	Technical publications and reports
14	Annex 107842-013	Evaluation of farmer participation in marketing arrangements for supply of common beans, central Uganda	Student thesis reports
15	Annex 107842-014	Analysis of the effect of project interventions on gender – End line project report	Technical publications and reports
16	Annex 107842-015	Is bean really a women's crop? Men and women participation in bean production in Uganda	Peer reviewed journal article
17	Annex 107842-016	Constraints of Bean Consumption among the Base of Pyramid (BoP) Consumers in Urban and Peri-Urban Kenya	Oral conference presentations
18	Annex 107842-017	Market structure and performance of processed bean products in Kenya: Implications for adopting countries	Oral conference presentations
19	Annex 107842-018	Ex-Ante Analysis of the Demand for new value added pulse products: A case of Precooked Beans in Uganda	Oral conference presentations
20	Annex 107842-019	Exploring the links between retailers and supply modalities of value added bean products in Kenya	Oral conference presentations
21	Annex 107842-020	The role of collective action in women empowerment: The case of bean production in Uganda	Oral conference presentations

22	Annex 107842-021	Linking research to product development: A case for new bean products in Uganda and Kenya -Panel presentation	Oral conference presentations
23	Annex 107842-022	The potential and limits of farmers' groups as catalysts of women leaders	Peer reviewed journal article
24	Annex 107842-23	Ex-Ante Analysis of the Demand for New Value Added Pulse Products: A case of Precooked Beans in Uganda	Research papers submitted under review
25	Annex 107842-24	Determinants of Household Income from Crop Sales: The Case of Common Bean	Research papers submitted under review
26	Annex 107842-25	Influence of Productive Resources on Bean Production in Male and Female Headed Households in Selected Bean Corridors of Kenya	Research papers submitted under review
27	Annex 107842-26	Bean Consumption and Dietary Quality among Base of Pyramid (BoP) Consumers in Urban Kenya	Research papers under development and internal review
28	Annex 107842-27	Precooked bean Journal outputs and Road map for publication of papers	Working papers/documents
29	Annex 107842-27b	Student Progress	Working papers/documents
30	Annex 107842-28	Exploring the links between Retailers and Supply modalities of value added bean products in Kenya	Research papers under development and internal review
31	Annex 107842-029	Socio-economic factors influencing Bean productivity in Homa-Bay County, Kenya	Research papers under development and internal review
32	Annex 107842-030	Market structure and performance of processed bean products; implications for Uganda and other adopting countries	Research papers under development and internal review
33	Annex 107842-031	Factors that affect male and female participation in common bean marketing	Research papers under development and internal review
34	Annex 107842-032	Proximate Analysis of selected bean accessions for precooked bean (<i>Phaseolus vulgaris</i> L.) grown in two agro-ecological areas of Katumani and Kiboko in Kenya	Research papers under development and internal review

35	Annex 107842-033	A rapid appraisal of bean marketing arrangements used by small scale bean farmers in Kenya: What needs to change?	Research papers under development and internal review
36	Annex 107842-035	Ability, motivation and trainee characteristic factors	Research papers under development and internal review
37	Annex 107842-036	Estimating Demand for Boiled common in Urban Areas of Nairobi Kenya	Research papers under development and internal review
38	Annex 107842-038	Precooked beans screening report	Technical publications and reports
39	Annex 107842-039	SGS -Nutrient analysis report	Technical publications and reports
40	Annex 107842-040	HACCAP Report	Technical publications and reports
41	Annex 107842-041	Ability, Motivation And Trainee Characteristics Factors	Student thesis reports
42	Annex 107842-042	Environmental impact assessment report	Technical publications and reports
43	Annex 107842-42b	Environmental impact assessment report Certificate	Working papers/documents
44	Annex 107842-043	Nutrient analysis of dry beans	Technical publications and reports
45	Annex 107842-044	Precooked bean products sensory evaluation report	Technical publications and reports
46	Annex 107842-045	Value chain map	Documentaries
47	Annex 107842-046	Nutrition documentary	Documentaries
48	Annex 107842-047	Challenges and Opportunities in Bean Production and Marketing in Selected Bean Corridors in Kenya	Poster and poster papers
49	Annex 107842-048	Factors influencing inputs use by small holders bean farmers: A case of selected bean corridors in Kenya	Poster and poster papers
50	Annex 107842-049	Effect of Access and Control of Productive Resources and Incomes on Bean Production in Selected Bean Production Corridors of Kenya	Poster and poster papers
51	Annex 107842-050	Private Sector Led Agricultural Innovation Platforms: Lessons in formation and operationalization	Poster and poster papers
53	Annex 107842-051	Intra-Household Gender Participation in Bean Production; the Case of Central Uganda	Poster and poster papers
54	Annex 107842-052	Gendered Nature of Common Bean Marketing in Uganda	Poster and poster papers
55	Annex 107842-053	Is bean really a women's crop Men and Women's participation in bean production in Uganda	Poster and poster papers
56	Annex 107842-054	Nutrition consumer survey report	Technical publications and reports

57	Annex 107842-055	Effectiveness of Mobile Phone in Dissemination of Information On Common Beans in Central Uganda	Student thesis reports
58	Annex 107842-056	Household decision making to sell bean: A case of male and female farmers in central Uganda	Student thesis reports
59	Annex 107842-057	Agronomic and Socio-economic factors influencing common bean (<i>phaseolus vulgaris</i>) productivity in Homabay County Kenya	Student thesis reports
60	Annex 107842-058	Consumption and consumer preferences for different bean types (Varieties) in Uganda	Student thesis reports
61	Annex 107842-059	A gendered analysis for choice of innovative food products for generation X and Y: Implications for precooked beans in Uganda	Student thesis reports
62	Annex 107842-060	Estimating the demand for boiled Common Beans in urban Areas of Nairobi County	Student thesis reports
63	Annex 107842-061	Detailed list of project outputs, documentation and corresponding annex numbers	Working papers/documents
64	Annex 107842-064	Policy Review of Beans Sub Sector Kenya And Uganda	Working papers/documents
65	Annex 107842-066	Food safety tool Kit	Other information materials
66	Annex 107842-067	Farmer group profile report	Technical publications and reports
68	Annex 107842-068	Cultiaf_Project_Endline_Farm Level Survey Report	Technical publications and reports