



GLOBAL ENVIRONMENT FACILITY
INVESTING IN OUR PLANET

Naoko Ishii
CEO and Chairperson

September 28, 2015


Dear LDCF/SCCF Council Member:

UNIDO as the Implementing Agency for the project entitled: *Uganda: Reducing Vulnerability of Banana Producing Communities to Climate Change Through Banana Value Added Activities - Enhancing Food Security And Employment Generation*, has submitted the attached proposed project document for CEO endorsement prior to final approval of the project document in accordance with UNIDO procedures.

The Secretariat has reviewed the project document. It is consistent with the proposal approved by LDCF/SCCF Council in January 2014 and the proposed project remains consistent with the Instrument and LDCF/SCCF policies and procedures. The attached explanation prepared by UNIDO satisfactorily details how Council's comments have been addressed. I am, therefore, endorsing the project document.

We have today posted the proposed project document on the GEF website at www.TheGEF.org. If you do not have access to the Web, you may request the local field office of UNDP or the World Bank to download the document for you. Alternatively, you may request a copy of the document from the Secretariat. If you make such a request, please confirm for us your current mailing address.

Sincerely,


Naoko Ishii
Chief Executive Officer and Chairperson

Attachment: GEFSEC Project Review Document
Copy to: Country Operational Focal Point, GEF Agencies, STAP, Trustee



REQUEST FOR CEO ENDORSEMENT

PROJECT TYPE: Full-sized Project

TYPE OF TRUST FUND: LDCF

For more information about GEF, visit TheGEF.org

PART I: PROJECT INFORMATION

Project Title: Reducing Vulnerability of Banana Producing Communities to Climate Change Through Banana Value Added Activities - Enhancing Food Security And Employment Generation			
Country(ies):	UGANDA	GEF Project ID: ¹	5603
GEF Agency(ies):	UNIDO (select) (select)	GEF Agency Project ID:	140015
Other Executing Partner(s):	Ministry of Agriculture, Animal Industry and Fisheries (MAAIF); Ministry of Industry Trade and Cooperatives (MTIC)	Submission Date: Resubmission date	05/21/2015 08-13-2015
GEF Focal Area (s):	Climate Change	Project Duration(Months)	36 month
Name of Parent Program (if applicable): ➤ For SFM/REDD+ <input type="checkbox"/> ➤ For SGP <input type="checkbox"/> ➤ For PPP <input type="checkbox"/>		Project Agency Fee (\$):	253,800

A. FOCAL AREA STRATEGY FRAMEWORK²

Focal Area Objectives	Expected FA Outcomes	Expected FA Outputs	Trust Fund	Grant Amount (\$)	Cofinancing (\$)
CCA1	Outcome 1.1: Mainstreamed adaptation in broader development	Output 1.1.1: Adaptation measures and necessary budget allocations included in relevant frameworks	LDCF	182,000	323,700
	Outcome 1.2: Reduce vulnerability in development sectors	Output 1.2.1: Vulnerable physical, natural and social assets strengthened in response to climate change impacts, including variability	LDCF	809,000	4,583,700
	Outcome 1.3: Diversified and strengthened livelihoods and sources of income for vulnerable people in targeted areas	Output 1.3.1: Targeted individual and community livelihood strategies strengthened in relation to climate change impacts, including variability	LDCF	1,160,000	905,700
CCA2	Outcome 2.3: Strengthened awareness and ownership of adaptation and climate risk reduction processes at local level	Output 2.3.1: Targeted population groups participating in adaptation and risk reduction awareness activities	LDCF	232,000	1,128,700

¹ Project ID number will be assigned by GEFSEC.

² Refer to the [Focal Area Results Framework and LDCF/SCCF Framework](#) when completing Table A.

CCA3	Outcome 3.1: Successful demonstration, deployment, and transfer of relevant adaptation technology in targeted areas	Output 3.1.1: Relevant adaptation technology transferred to targeted groups	LDCF	437,000	123,702
Total project costs				2,820,000	7,065,502

B. PROJECT FRAMEWORK

Project Objective: To support vulnerable communities in Western Uganda to better adapt to the effects of climate change (CC) by providing greater opportunities for income generation, poverty reduction and food security, through banana value addition activities						
Project Component	Grant Type	Expected Outcomes	Expected Outputs	Trust Fund	Grant Amount (\$)	Confirmed Cofinancing (\$)
Component 1: Climate Change Adaptation (CCA) and gender equality for adaptation mainstreamed into National Development Policies/Strategies.	TA	Outcome 1: CCA strategies coupled with appropriate action on gender equality are incorporated into developmental policies and implemented by stakeholders in the various sectors	Outputs 1.1 National policy documents such as the Agriculture sector strategic plan updated with action on CCA and gender mainstreaming for adaptation Output 1.2 CCA coping strategies including gender equality for adaptation promoted among investors and other stakeholders in the agro-industries and rural enterprise development sector.	LDCF	140,000	200,000
Component 2: CC resilience building of vulnerable communities in major banana producing regions and contribute to	INV	Outcome 2: Vulnerable targeted communities are increasingly participating in resilience building activities for	Output 2.1 Sensitization of female and male farmers in the target district on CCA coping strategies to build resilience to CC	LDCF	2,205,000	6,247,000

food and income security thorough livelihood diversification.		income diversification and adopting alternative agricultural practices to tackle the high incidence of diseases affecting bananas, maintain soil fertility and sustain their agriculture based livelihoods	<p>Output 2.2 Small scale processing facilities established in target regions for vulnerable communities to engage in income diversification banana value addition activities</p> <p>Output 2.3 Banana-based products from income diversification activities effectively marketed in locations with good marketing potential</p> <p>Output 2.4 Community-based banana Tissue Culture (TC) industry established to support the demand generated from CCA coping livelihood diversification activities introduced to the vulnerable farming community</p> <p>Output 2.5 Biodigesters to convert banana waste into biogas established to support income diversification activities, and the resulting digestate used for soil fertility</p> <p>Output 2.6 Water purification and water harvesting technologies to support livelihoods diversification and income generating activities promoted</p>			
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Component 3: Dissemination of information and expansion of the strategy and project benefits	TA	Outcome 3: Lessons learned and best practices from policy changes, capacity development initiatives and pilot plants disseminated	Output 3.1 Guidelines on best practices and project knowledge disseminated within the country and the sub- region through websites, publications and communication products in various languages	LDCF	150,000	412,000
Component 4: Quality Control Monitoring and Evaluation	TA	Outcome 4: Quality control and efficient monitoring of project intervention to support adoption by CC vulnerable communities	Output 4.1 Timely quarterly and annual reports prepared; midterm and final evaluation [using Adaptation Monitoring and Assessment Tool (AMAT)] of project activities completed	LDCF	120,000	106,502
Subtotal					2,615,000	6,965,502
Project management Cost (PMC) ³					205,000	100,000
Total project costs					2,820,000	7065,502

C. SOURCES OF CONFIRMED COFINANCING FOR THE PROJECT BY SOURCE AND BY NAME (\$)

Please include letters confirming cofinancing for the project with this form

Sources of Co-financing	Name of Co-financier (source)	Type of Cofinancing	Cofinancing Amount (\$)
GEF Agency	UNIDO	Cash	44,248
GEF Agency	UNIDO	In-kind	188,254
National Government	MAAIF	Cash	6,090,000
National Government	MAAIF	In-kind	36,000
Private Sector	Agro Genetics Technologies Ltd (AGT)	Cash	120,000
Private Sector	Afri Banana Products Limited (ABP)	Cash	12,000
Private Sector	Afri Banana Products Limited (ABP)	In-kind	150,000
Private Sector	Forest Fruit Foods Ltd	Cash	15,000
Private Sector	Forest Fruit Foods Ltd	In-kind	410,000
(select)		(select)	
Total Co-financing			7,065,502

D. TRUST FUND RESOURCES REQUESTED BY AGENCY, FOCAL AREA AND COUNTRY¹

GEF Agency	Type of Trust Fund	Focal Area	Country Name/ Global	(in \$)		
				Grant Amount (a)	Agency Fee (b) ²	Total c=a+b
(select)	(select)	(select)				0

³ PMC should be charged proportionately to focal areas based on focal area project grant amount in Table D below.

(select)	(select)	(select)				0
(select)	(select)	(select)				0
(select)	(select)	(select)				0
(select)	(select)	(select)				0
(select)	(select)	(select)				0
(select)	(select)	(select)				0
(select)	(select)	(select)				0
(select)	(select)	(select)				0
(select)	(select)	(select)				0
Total Grant Resources						

¹ In case of a single focal area, single country, single GEF Agency project, and single trust fund project, no need to provide information for this table. PMC amount from Table B should be included proportionately to the focal area amount in this table.

² Indicate fees related to this project.

F. CONSULTANTS WORKING FOR TECHNICAL ASSISTANCE COMPONENTS:

Component	Grant Amount (\$)	Cofinancing (\$)	Project Total (\$)
International Consultants	237,000	80,000	317,000
National/Local Consultants	256,700	20,000	276,700

G. DOES THE PROJECT INCLUDE A “NON-GRANT” INSTRUMENT? No

(If non-grant instruments are used, provide in Annex D an indicative calendar of expected reflows to your Agency and to the GEF/LDCF/SCCF/NPIF Trust Fund).

PART II: PROJECT JUSTIFICATION

A. DESCRIBE ANY CHANGES IN ALIGNMENT WITH THE PROJECT DESIGN OF THE ORIGINAL PIF⁴

- Changes in project structure since PIF
1. The structure of the proposed LDCF project remains largely the same as at the PIF stage except for a few changes. The proposal was strengthened during the PPG stage and is reflected in the project document
 - i) The objective statement and the definition and numbering of some outcomes and outputs have been modified slightly for better clarity.
 - ii) The project has a significant gender focus in that it focuses on communities; the project intervention provided an opportunity for gender mainstreaming. Component 1 on mainstreaming CCA and output 2.1 under component 2 outcome 2 have therefore been further elaborated to capture gender mainstreaming for adaptation. Outcome 2 and 3 has been merged to correspond to the relating component 2 on supporting the vulnerable communities to build resilience to climate change. In addition, the outputs under Outcome 4 have been redefined into one comprehensive output to better reflect the scope of the project.
 - iii) The PPG studies revealed the need to support the water supply for the sustainability of the project intervention (see project submission package documents Annexes J-N). Water supply also has implications on the gender mainstreaming aspects of the project. A new output has therefore been included under Component 2, to address this. The cost has been made possible through a new UNIDO is implementing in the region which will provide complimentary activities to the project. .
 2. The total co-financing has also changed from \$7,737,533 to \$7,065,502 mainly due to the MAAIF actual budget in 2015. However, new partners that were not captured at PIF stage and the UNIDO PPP project have been identified.
 - A.1 National strategies and plans or reports and assessments under relevant conventions, if applicable, i.e. NAPAS, NAPs, NBSAPs, national communications, TNAs, NCSA, NIPs, PRSPs, NPFE, Biennial Update Reports, etc
 3. The Uganda National Adaptation Programme of Action (NAPA) on CC is the main national strategy document upon which this LDCF project is aligned. Uganda is a Least Developed Country (LDC) which is identified as one of the countries most vulnerable to the adverse effects of CC. As such, Uganda is eligible to receive support from the LDCF for the implementation of urgent and immediate adaptation measures, as described in its NAPA.
 4. According to the NAPA, the western and south western highlands are some of the areas which are most vulnerable to CC and variability, as the predominately poor people are not able to cope with and recover from the predicted adverse effects of CC. The NAPA describes the urgent interventions for priority sectors such as agriculture, to improve the adaptation of the communities in terms of food security and ensure the long-term resilience of such communities to CC.
 5. The core activities of this LDCF project are in line with two priority projects of the NAPA. It will contribute to the NAPA priority project 6 – “Drought Adaptation Project”, which aims to enhance the adaptive capacity of the vulnerable communities in drought-prone parts of Uganda in order to cope with the increasingly frequent droughts. The project will also contribute to the NAPA priority project 7 – “Vector, Pest and Disease Control” which aims to enable subsistence farmers to cost effectively manage disease outbreaks, including disease affecting crops, with a special emphasis on vulnerable communities. In addition, the project will contribute to project 5 – “Water for Production Project” of the NAPA, which aims to promote appropriate and sustainable water harvesting, storage and utilization technologies.
 6. The project will promote some key CCA strategies (food preservation, alternative livelihood systems, including water harvesting and changes in agricultural practice), identified by the NAPA, to provide greater opportunities for

⁴ For questions A.1 –A.7 in Part II, if there are no changes since PIF and if not specifically requested in the review sheet at PIF stage, then no need to respond, please enter “NA” after the respective question.

income generation for men and women, poverty reduction, enhanced food security and enable the local communities, whose livelihoods depend on banana production for their income and food security, to better adapt to the adverse effect of CC.

7. Uganda has also prepared the Second National Communication (SNC) to the United Nations Framework Convention on CC (UNFCCC), which provides general and specific data on CC in Uganda, interventions made and/or proposed in adapting to and mitigating CC. The project interventions will contribute to addressing some of the additional national needs outlined in the SNC such as: promotion of renewable energies technologies and adopting sustainable agricultural practices at community; aligning national policies and legislation with action on CCA; and promoting, PPPs for action on CCA at the sector level.
8. The project is also in line with the national policy on CC, which aims to ensure a harmonized and coordinated approach toward a climate-resilient and sustainable low-carbon development path. Lastly, the project is in line with Outcome 2 on “Livelihood Benefits of Vulnerable Segments of the Population” of the United Nations Development Assistance Framework (UNDAF) 2010/11 – 2014/15, and the National Developmental Objective (NDP), Objective 1 on “Increasing Household Incomes, and Enhancing the Availability of Gainful Employment”, as well as, the Government of Uganda’s (GoU) strategic goals in Vision 2040.

A.2. GEF focal area and/or fund(s) strategies, eligibility criteria and priorities.

9. The project will contribute to the LDCF goal, notably to objective CCA-1 on “Reducing Vulnerability” in that the project will provide opportunities for income diversification through banana value addition activities among the resource-poor banana producing communities in order to build resilience to CC. The project will also contribute to objective CCA-2 on “Increasing Adaptive Capacity” in that it will increase knowledge and understand of the CC concerns and also strength awareness along the whole spectrum of value chain actors in the agro industry subsector on adaptation to the climate risk.
10. Lastly, the project will also contribute to objective CCA-3 on “Adaptation Technology Transfer” by supporting the banana TC industry to ensure the sustainability of the sector. It will set up community owned banana TC plantlet outlets to maintain and distribute clean planting material to the farmers. The project will also setup banana waste utilization facilities to generate biogas for use in the income diversification value addition activities as well as promote it for domestic use, hence addressing women’s access to safe and clean energy sources, where the use of peels for biogas will not only supplement the energy, but would also aid in the reduction of waste in the urban areas. Communities will be encouraged to use the digestate as a soil improver / fertiliser. In addition, the project will support the communities using the facilities with safe portable water by setting up water harvesting facilities and efficient and cost effective water purification systems. This aspect also addresses gender mainstreaming, in that it will help reduce the burden of women with the responsibility to go in search of water.

A.3 The GEF Agency’s comparative advantage:

11. UNIDO’s comparative advantage to implement this project within the LDCF Programme is that its overall mandate is to promote and accelerate sustainable industrial development in developing countries and economies in transition. It provides technical assistance services that transfer scientific and technical knowledge, ensure compliance and standards setting and conducts analytical and policy advisory services, in the industrial and manufacturing sectors. In recent years, UNIDO has assumed an enhanced role in the global development agenda by focusing its activities on poverty reduction, inclusive globalization and environmental sustainability of industries. With the climate sensitive agriculture and agribusiness sectors being fundamental to the livelihoods and food security of populations of women and men worldwide, as well as, the backbone of the economies of many developing countries, agribusiness development is a strategic priority of UNIDO’s Inclusive and Sustainable Industrial Development (ISID) mandate for poverty reduction. UNIDO also has extensive knowledge of supporting the integration of small and medium enterprises (SMEs) into national and global value chains through the establishment of pro-poor business linkages.
12. Over the years, UNIDO has, proved its competences in involving the industrial sector in GEF projects, in the areas of industrial energy efficiency, renewable energy services, water management, chemicals management (including

POP and ODS) and biotechnology. Since 2013, UNIDO has included CCA in its operations with the focus on increasing CC resilience of productive value chains.

13. With respect to this project, UNIDO has competences in supporting livelihoods diversification and income generating activities including among vulnerable groups. Under its thematic programme C.1 “Poverty Reduction through Productive Activities”, UNIDO works to combat poverty and food insecurity in developing countries, especially in LDCs and transitional economies, by strengthening agricultural value chains through inclusive agribusinesses that ensure increased income for female and male farmers, reduced food losses, and increased availability of nutritious food products.
14. From its interventions in Africa, Asia and Latin America, UNIDO has developed robust methodologies for industrial value chain diagnosis and inclusive agribusiness development, particularly in the African context.
15. In response to global trends and Member States’ request, UNIDO, within its programme component C.1.3 “Agribusiness and Rural Entrepreneurship Development” emphasises: the nutritional and qualitative aspects of food processing as a critical element to food security; economic inclusion of vulnerable groups and the promotion of social standards to lift them out of poverty and malnutrition; and an innovative adaptation approach to CC and strengthening the resilience of smallholder farmers. Its projects on this, within the programme C.3 on “Environment and Energy”, deploy cross-disciplinary teams around greening value chains and creating green jobs, measuring carbon footprints, and promoting increased synergies in the food-energy-water nexus in general. To further ensure the inclusion of considerations for gender equality, UNIDO will comply with its gender mainstreaming policy for agribusiness development projects.
16. In implementing the proposed project, UNIDO will draw on its in-house and global network of expertise to ensure the sustainability of the livelihoods diversification for women and men and the adaptation strategies that the project will introduce to the target vulnerable communities.

A.4. The baseline project and the problem that it seeks to address:

A.4.1 Baseline problem

17. Over the past 100 years, rising temperatures of about 0.5 °C have been recorded in East Africa and a mean annual temperature between 0.7 °C - 1.5 °C is predicted by the 2020’s⁵. The mean annual temperature for Uganda is reported to have increased by 1.3°C since 1960, an average rate of 0.28°C /decade. This increase has been most rapid in the January-February months at a rate of 0.37°C /decade⁶. Annual temperatures between 1951-1980 and 1981-2010, showed a notable increase of approximately 0.5-1.2°C for minimum temperatures and 0.6-0.9°C for maximum temperatures. The warming trend is projected to continue, with some models projecting an increase of more than 2°C by 2030. In the south western region of Uganda where the project is located, average temperature of the coolest and hottest month of the year are expected to rise from 18.7°C to 19.27 °C in the past decade (1980-1999) to, 19.92°C to 21.07 °C during 2020-2039 (Figure 1). The region, among the most vulnerable in East Africa to the adverse effects of increased weather variability and CC, also has the highest population growth rate in the country of 6-9.7% per annum. Coupled with the near subsistence livelihoods of the predominantly agriculture dependent population, a significant segment of women, children and men live in absolute poverty, which is recognized as a contributor to reducing the population’s adaptive capacities, increasing their vulnerability to the deleterious effects of CC and limiting their ability to cope with and recover from the shocks.

⁵ LTS International (2008) Climate Change in Uganda: Understanding the implications and appraising the response Scoping Mission for DFID Uganda

⁶ McSweeney, et al., (2010). The UNDP Climate Change Country Profiles: improving the accessibility of observed and projected climate information for studies of climate change in developing countries. Bulletin of the American Meteorological Society, 91, 157–166.

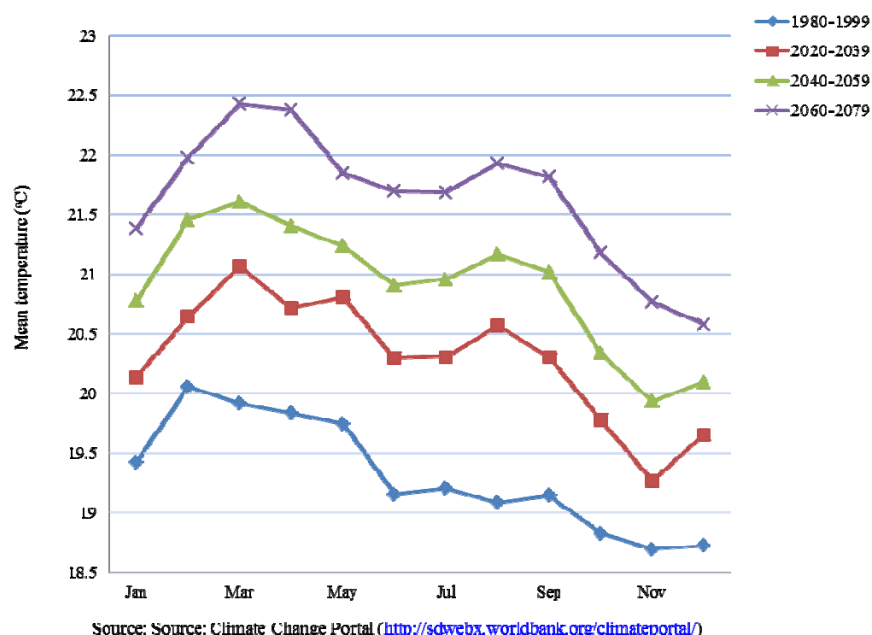


Figure 1 Historical modelled temperature for project location in Uganda

18. Uganda is the second largest producer of bananas in the world, with an estimated annual production of 10 million MT. Banana production occupies 30% of the cropped land and is produced by some 934,558 farm households, representing 24% of the agricultural households. As such, banana production is a major source of rural income. The ability to produce fruits all year round makes bananas an important food security crop and cash crop. The East African Highlands banana varieties traditionally called *matoke* is a major staple, the average daily per capita consumption averages 0.61kg/person. Other widely cultivated types include the dessert bananas, juice/beer bananas and plantains known as “roasting bananas” and traditionally called *gonja*.
19. Over the years banana production in Uganda shifted from the central to western regions as conditions became adverse with declining soil fertility and pest and disease problems. Currently, the western region accounts for over 67% of all the bananas produced in the country, followed by the central region, eastern region and northern region, respectively. Among the western region districts, Isingiro, Mbarara, Bushenyi, Ntungamo, Rukungiri and Ibanda are the major banana producing districts in the region (Figure 2). The majority of the producers, however, depend on near subsistence agriculture for their livelihoods and food security, leading to reduced adaptive capacities. A large number of women are engaged in banana farming. The region also has a very high fertility rate, which limits education and income generating activities, especially among women, and also causes tenure insecurity issues and opportunities for farming for both men and women.

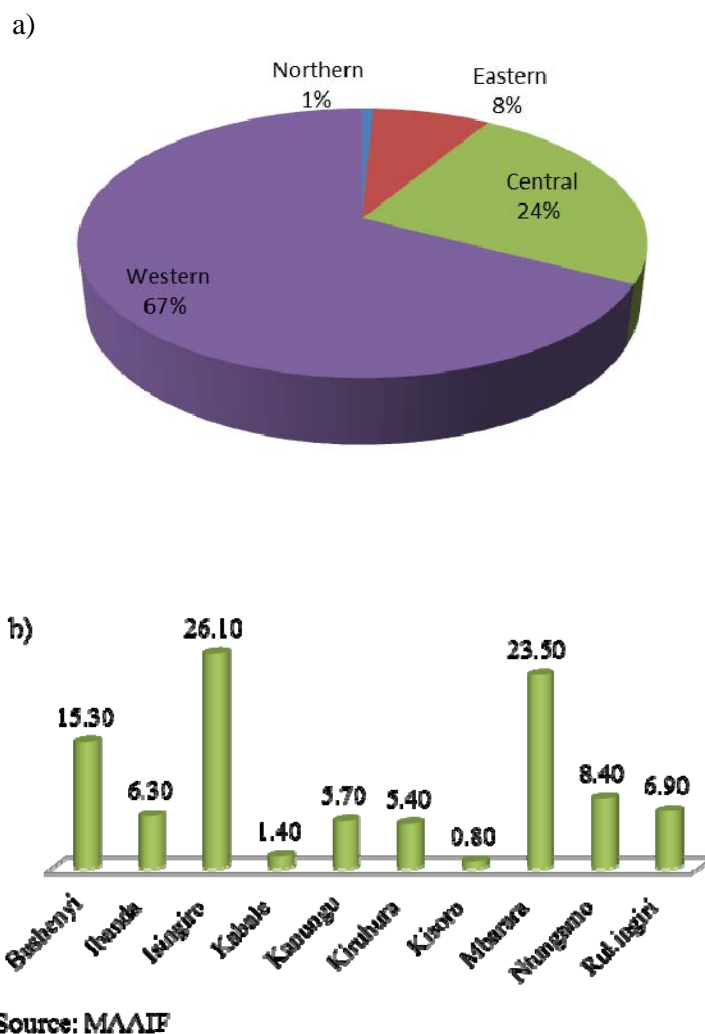


Figure 2 Percentage of total banana production a) across Uganda and b) by top 10 districts in Western Uganda

20. The vulnerability assessment of the banana sector and banana producing communities in the target region conducted during the PPG, showed that while the region currently accounts for the highest production of banana, the outset, CC vulnerability threatens the sustainability of the supply and value chains, in the target region particularly, among farmers and processor (refer to Annex K). In Bushenyi for example, banana is cultivated on 170,000ha of land (40% of the total area), mainly by smallholder farmers. The bananas are mainly sold fresh and the farmers receive very little from sales, typically approximately 2 USD for one bunch in the rural markets, compared to the market prices in Kampala (the capital city) of 9 - 15 USD. Mature bananas ripen in three to five days after harvesting. Even before the effects of CC, huge postharvest losses were incurred during transportation due to ripening and rotting. The rising temperatures and consequently, humidity due to CC, are expected to exacerbate these losses. The problem of postharvest losses resulting in a decline of income for poor small farmers is further compounded by reductions in productivity. The optimum temperature for banana growth is 20-30°C and total yields per ha through time is generally stable within that range. It is predicted that due to CC there will be extended periods of temperatures above 30°C, which will result in a general decline in productivity. The sustainable supply of fresh bananas for the income-dependent communities and the country, will further be affected by increased weather variability and CC, as seen by changes in the onset of and duration of the rainy seasons, more frequent and severe droughts and floods, resulting inter alia in increased incidences of pests and diseases such as the Banana Bacterial Wilt (BBW) disease and anthracnose.

21. Furthermore, a 2011 vulnerability assessment of the agriculture sector in Uganda, covering six USAID/Feed the Future priority districts including Mbale, Isingiro, and Kasese in the western region, revealed the absence of buffers against challenges associated with CC⁷. The report further indicated that the systemic vulnerability of households studied also stems from the fact that these households depend heavily on crops whose value chains are sensitive to climate variability and change; any change in food production critically increases overall vulnerability.
22. The PPG vulnerability study showed that at the central government level action on CC actions are recognised in the medium term and long-term development plans and there are plans for further mainstreaming CCA in planning arrangements of different sectors at the central government level and District Local Government planning and budgeting processes. Isingiro District Local Government within the study area has already initiated mainstreaming of CC into its District Development Plans. However, for all the districts covered in the study, the most rudimentary coping measures to cope with droughts and increased food insecurity such as by adjusting the number of meals and quality of the food, selling some household assets such as cattle, and household items to buy food, are those adopted by the poorest households.
23. In light of the country's population growth rate of 3.2% per annum, one of the highest in the world⁸, there will be an increase in future demands for bananas and banana-based products, and employment in both the rural and urban populations for men and women. Urban growth will demand a shift from fresh to processed foods and beverages. Recently, scientists of the CGIAR's CC, Agriculture and Food Security research group (CAAFS) predicted that CC will decrease availability of other annual staple crops such as maize, rice and wheat, thereby, further raising the demand for bananas⁹. It is therefore critical that vulnerable communities are enabled to engage in alternative livelihoods activities, adjust/update agricultural practices and food preservation systems, to ensure their food security and additional income, to better cope with the higher food prices and scarcity, in the wake of CC.
24. The GoU has therefore requested UNIDO to implement a climate-resilient livelihoods diversification project within its banana value chain development programme, incorporating CCA strategies, in order to achieve a number of key national adaptation goals, as outlined in its NAPA.
25. In line, with the NAPA identified key coping strategies of *food preservation, alternative livelihood systems* and *changes in agriculture practices*, the project will develop capacities for communities to engage in livelihood diversification value addition activities, such as, vacuum packing and solar drying of fresh bananas, banana juice and wine making. The additional income created through these activities will enable further investments into CCA coping strategies by communities, such as on improving agricultural practices, construction of reservoirs for *water harvesting* and *soil conservation*, to strengthen adaptive capacities and resiliency to CC.
26. In addition, the project will support the closed-loop banana production through the conversion of banana waste to biofuel for the processing facilities as well as domestic use. The project will also support the development of the banana TC industry for the benefit of the communities and promote investment and access to finance to support the cottage industries that this project will develop.

A.4.2 Baseline projects

A.4.2.1: Government interventions in the banana sub-sector and rural development

27. Recognizing the socio-economic importance of the banana industry and the potential for poverty alleviation, banana value chain development is a major priority of the GoU. As such, a number of initiatives are in place to ensure the sustainable production and use of banana in the country and improve the livelihoods of the resource poor female and male farmers in the target districts of Western Uganda. Adaptive research and innovation by the country's main universities and research organisation and their collaborating partners worldwide, has led to recent private sector involvement in the banana value chain. The main ongoing interventions are described below.

⁷ USAID 2013. Uganda climate change vulnerability assessment report. USAID African and Latin American Resilience to Climate Change (ARCC)

⁸ United Nations (2009) United Nations Development Assistance Framework (UNDAF) for Uganda, 2010-2014

⁹ CGIAR (2011). Crop Adaptation Cases – Banana. <http://ccafs.cgiar.org/news/media-centre/climatecrops/cases-banana#.VTS4ZiGqpBc>

A.4.2.1.1: Policy framework to facilitate the development of agriculture and rural development

28. The GoU has over the years pursued agricultural development policies and strategies. The Plan for Modernization of Agriculture (PMA), which was a multi-sectoral framework implemented between 2001 and 2009 aimed at transforming subsistence farming to commercial agriculture. However, significant progress was principally made in only two of the seven investments pillars of the PMA:- agricultural research and agricultural advisory services. Following the government's 2006 vision of Prosperity for All (PFA), which required all governmental agencies and local governments to implement programmes in an integrated and coordinated manner to bring about economic transformation, especially in rural areas, the MAAIF developed the Agriculture Sector Development Strategy Investment Plan (DSIP), 2010/11-2014/15) to address four main challenges facing the agricultural sector in Uganda:- low production and productivity; low value addition to agricultural produce and limited market access; weak implementation of agricultural laws and policies; and weak public agricultural institutions. The DSIP objectives are: i) increased rural incomes and livelihoods, and ii) improved household food and nutrition security. Bananas have been prioritized among the ten strategic commodities under the DSIP. Under the programme MAAIF has emphasised both private and public sector investment.
29. As the DSIP is entering its fourth year, the government is planning a new policy document, Agriculture sector strategy document (ASSP) (2015/16-2019/2020)). There is the need to review and update this with specific action for adaptation and resilience building.

A.4.2.1.2: Increasing banana production to contribute to income security and poverty reduction in rural areas

MAAIF's major activities in the banana sector under the DSIP are aimed at improving farmer participation in the value chain in 60 districts in Western, Central and Eastern Uganda within the first three years duration of the programme, and then extended to one to three districts in Northern Uganda, for an overall increase in the national banana production by 30%.

30. In the western region, MAAIF in collaboration with FAO, is establishing farmer field schools (FFS) aimed at assisting farmers in the production of staple crops such as banana, beans and potato, sunflowers, as well as on the eradication of diseases. The group of farmers are provided with training on water harvesting technologies, agronomy, soil fertility, farm husbandry and sanitation practices to stop the spread of BBW. This is being supported by research conducted by the National Agriculture Research Organisation (NARO). NARO has capacities to produce new banana varieties including new high value CC resilient varieties with early maturing (drought and high temperature avoidance), dwarf types (providing resilience to falling during storms) and disease resistance traits through plant breeding, soil analysis and disease diagnosis. Their technologies are disseminated to farmers through the MAAIF and the extension service provided by the National Agriculture Advisory Services (NAADS) and NGO's working in the region.
31. In addition, MAAIF has supported the established of a number of mother gardens for the supply of disease-free planting materials from tissue culture; and promotes the control of banana pests and diseases through routine banana extension services, monitoring and evaluation activities in cooperation with NAAD and the respective district local governments (DLG).
32. Some of DLGs in Western Uganda have also shown a clear and practical demonstration for the need to sustain the banana industry through the zeal to fight BBW and other banana diseases. Some of the districts have enacted by laws to address the problem. This not only demonstrates their commitment but also is an indication of their support for any initiative that will contribute to sustaining the banana industry.
33. This therefore provides an opportunity to create awareness of and promote CCA action, which can further ensure the sustainability of the banana subsector in terms of banana production and maintenance of genetic stocks.

A.4. 2.1.3: Reduction of post-harvest losses and value addition:

34. In general, most of the bananas produced in Uganda are sold and consumed fresh. Whole bunches are collected on the farms and transported to the local markets, which are quickly saturated and therefore most production has traditionally been trucked / transported to the urban areas. There is also some exporting of fresh matoke to Europe, USA and regionally, particularly to South Sudan, where prices on many different types of food are higher. Traditional banana juice, beer and gin are produced, however, the processing is largely unhygienic and where spear grass and bare hands are used to extract the juice, the processor is prone to cuts and tears, rendering the juice

susceptible to contamination, which deters consumers from patronizing the product. Without much value addition, the bananas are susceptible to over-ripening and rotting, during storage and transportation, resulting in substantial losses in income to farmers (who already receive very little for their produce) and shortages of supply in the market. With further reductions of post-harvest losses expected in the face of CC, there is a need to support the people who depend on bananas for their livelihood and food security with technologies that ensure preservation and value addition of the fresh banana fruits.

35. A number of adaptive research programmes have been undertaken in Uganda over the years, to improve technologies for traditional banana products as well as introduced novel products, including red wine, banana starch and flour. The Department of Agricultural Sciences and Food Technology of Makerere University, has developed refined technologies for the extraction, pasteurisation and packaging of banana juice -although not yet commercialised. This and other enabling technologies need to be made available to the resource poor banana producers to improve efficiency of and add value to traditional processing activities to generate additional income and enable resilience building.
36. Other government interventions to address agriculture value addition include a number of presidential initiatives such as the “Presidential Initiative for Banana Industrial Development” (PIBID) and improving infrastructure of the rural markets and installations storage structure, to strengthen farmers’ access to national and regional markets for the sale of fresh and value added agricultural products. PIBID in Bushenyi which is modelled around rural Technology Business Incubators (TBI) and Industrial Technology Parks (ITP), set up a pilot processing plant for the production of high quality banana flour (HQB) for production of banana based starch product was officially opened on October 6th, 2014. PIBID sources its supply of fresh bananas for its processes from local farmers, and in turn, provides inputs and agronomic extension services to its cluster of farmers.
37. With support from the Swedish International Development Cooperation Agency, the MTIC developed a five year comprehensive programme, the Quality Infrastructure and Standards Programme (QUISP), to support the cross-cutting of standards and quality infrastructure. The programme seeks to develop a market-driven, holistic and coordinated institutional framework for Ugandan quality infrastructure and standards, which supports trade, industry, health, safety, consumer protection and a sustainable environment, while at the same time, promoting the use of best practices in the production and service sectors.
38. To reduce post-harvest losses, the proposed project will work within the QUISP framework to ensure the harmonisation of the livelihoods diversification activities with national quality standards.

A.4.2.2: Private sector investment in the agroindustry and banana subsector

39. See Annex J which describes the activities of the banana based SME’s, banana value added activities, actors and estimated capacities based in Western Uganda

A.4.2.2.1: Financing of agribusinesses

40. Recently, a number of donor-supported programmes have been established to provide technical assistance and extend credit to microfinance institutions (MFIs) and Savings and Credit Cooperatives (SACCOs), to enable the support to micro, small and medium sized enterprises, including those in the agribusiness sector. Uganda’s Micro Finance Support Centre (MFSC) is a government institution that provides financial services for productive activities to all Ugandans, especially the rural poor. It lends about 8 million USD every year and it is funded by the GoU and the African Development Bank (AfDB). It provides the cheapest source of finance, at rates not exceeding 9%, to the following key activities/ sectors: i) agriculture/agro processing; ii) SMEs, and iii) employment related activities and loans for vulnerable categories.
41. To ensure the sustainability of any investment in a livelihoods diversification system for the vulnerable smallholder farming communities, there is the need for support in terms of enabling farmers including those most vulnerable to CC to gain access to finance and credit.

A.4.2.2.2 Private sector engagement in the value chain

42. Private sector investment is also crucial for an inclusive and sustainable growth of the banana subsector and especially in the face of CC. A number of SMEs in the agro industries are engaging banana producers in the supply of fresh banana or semi processed for their industries in Western Uganda.

A.4.2.2.2.1 Banana juice processing

43. Forest Fruit Foods Ltd in Bushenyi and Excel Hort Consult in Mbarara, are the commercial banana juice processors. Under the brand name Forest Fresh, Forest Fruit Foods Ltd is producing and marketing Eshandy juice. The juice is processed from the beer banana known as Mbide. Forest Fruit Foods Ltd has a juice processing plant located on 7 acres of land in Nyabicerere Ward II, Central Division of Bushenyi-Ishaka Municipality (1km along St Kagwa – Rwakiwire Road). The company produces 5000ltrs of juice per week from 3000 l/ week and 800 l/ week in 2013 and 2012 respectively. The company targets to produce 9000ltrs/ week in the next 2 years. The product has not yet been certified by the UNBS.
44. Excel Hort Consult a private firm incorporated in 2003 is located in Kakoba division, Mbarara municipality. The company produces a number products but banana juice from matoke is their lead product. The juice production capacity is said to be 1000 l/week. Although the juice is not certified by UNBS it is marketed in major towns of 1 Ugandan towns and has a 6 month shelf life.
45. About 1200 farm families are contracted to supply banana juice as a raw material for banana juice production in Western Uganda

A.4.2.2.2.2 Banana wine processing

46. In recent times, small scale cottage industries and individual or household scale businesses have emerged, producing red and white wine made from bananas in the districts of Bushenyi, Sheema, Mitooma, Rubirizi, Isingiro, Mbarara and Ntungamo. It estimated that the region produces about 460,000 litres of banana wine in a year with Bushenyi district producing over 85% of that wine. Nonetheless, the baseline studies conducted under the PPG (refer to Annex J and M) indicate that capacities and scales differ slightly in each district. There are nineteen (19) community based organizations, nineteen (19) individuals (also producing wine from pineapples) and two (2) companies involved in banana wine production in the target districts. Female headed enterprises have also been identified. Banana wine is processed from cooking bananas, dessert banana (Bogoya) and FHIA (17, 21 and 25) bananas. The lead firm for this product group is Tigebwa Development Association, which was trained by the Uganda Cooperative Alliance (UCA) on wine making

A.4.2.2.2.3 Sun dried banana chips and banana slices

47. Majority of farmers involved in banana chips/ crisps processing are found in Ntungamo and Mbarara Districts with a few in Isingiro District. In Ntungamo district, processors are clustered into 14 clusters; Rutungulu, Kamunyiga, Ihunga, Rwenfunjo, Kiyoola widows, Kiyoola central, Rwoho, Kyabashenyi, Kyaruhunga, Kirera, Nyakasa, Kibingo, Nyakigufu & Kyakabanda under Ntungamo Fruit Dryers Association, a registered CBO. Fruits of the Nile is the sole buyer of the products which they export to Europe. Production from clusters is between 70kg/ month to 200kg/month. This production seems to be quite low although some clusters have a good number of solar driers. Fruits of the Nile buys sun dried Ndiizi and Bogoya at UGX6000/kg and UGX 4800/kg respectively. The company organizes the farmers, provides solar driers, trains farmers and ensures that they meet both fair trade and organic certification.
48. Solar fruit drying is an affordable technology, uses only renewable energy (the sun), adds value, extends shelf life, and makes fruits more transportable, retaining waste at the point where it is grown. Fruits are sun dried when fresh and fully ripe so capturing flavour and are free from added sugar and preservatives. As they are dried at temperatures lower than 420°C, sun-dried bananas are suitable for a raw food diet. This method can be used on a commercial scale as well at the village level or household level. Indeed Fruits of the Nile works with a network of farmer suppliers who are both fair trade and organic certified.
49. Recently Excel Hort Consult started a pilot production of dried banana chips and crisps (fried chips). The baseline studies conducted during the PPG (see Annex J) show that together, Forest Fruit Foods Ltd and Excel Hort Consult, engage 1200 farmers in their total operations. Fruits of the Nile (FoN) works with some 200 farmers in Western Uganda (Ntungamo and Mbarara districts) to dry and package sun dried dessert bananas, which are exported to the EU;

A.4.2.2.2.4 Freshly Packed Matoke (FPM)

50. Afri Banana Products (ABP) Ltd is the only facility processing vacuum packed bananas (Matoke) for export to the UK and USA market in western Uganda. This not for profit organization is located at the Mbarara SME Park, Nyakabungo cell, Kakiika sub-county, Mbarara District with a head office in Kampala. It was initially funded by GoU under the Presidential Support to Scientists through Uganda National Council for Science and Technology (UNCST) and now it is supported by DANIDA. Although the firm has equipment that packs 1 ton/day, only 1 ton of matoke in a month is exported as per current. The product is not certified by UNBS but it is certified by US Food & Drug Authority under UIRI. The facility also operates as an incubation centre.
51. The Vacuum Packed Matoke process is semi-manual; Matoke is all manually received, sorted, washed, peeled, trimmed, and treated with sodium metabisulphate, drip dried, packed, weighed and vacuum sealed. The Vacuum sealing machine was supplied by The Tamales, a local trading firm. The company employs six workers (one female and five male). The Vacuum Packed Matoke process is semi-manual; Matoke is all manually received, sorted, washed, peeled, trimmed, and treated with sodium metabisulphate, drip dried, packed, weighed and vacuum sealed. The Vacuum sealing machine was supplied by The Tamales, a local trading firm. The company employs six workers (one female and five male).
52. In order to enable SMEs to meet their targets and improve the delivery efficiency of banana based products, there is a need to engage more farmers in the supply of primary processed banana products. As such, this provides opportunities to build capacities of some of the most vulnerable farmers, by enabling them to engage in banana value addition as alternative livelihoods activities to generate additional income. In addition, the SMEs will be sensitized on CCA coping strategies and will acquire the necessary support and knowledge to be able to build these CCA coping strategies into their operations.
53. Common constraints, harping operations of SMEs, household or individual businesses identified during the PPG (refer to Annex M) include: i) organised growth and harvesting to ensure sturdy supply; ii) collection and transport of suitable raw or semi processed material; iii) inefficient processing technology and inadequate processing facilities, especially for primary processing; v) limited access to clean/ potable water, and vi) access to clean, reliable and affordable energy. Other major problems include: i) absence of an efficient marketing strategy and branding; ii) inadequate packaging, and iii) poor standard and quality control.
54. As a means to building adaptive capacities and resilience to CC through alternative livelihoods and income diversification activities, the need to further support the ongoing activities to address the constraints related to value addition, persists. Further support will ensure improved participation of the smallholder farmers, including women and female headed farming households, and value chain actors in the vulnerable communities and improve product quality, which in turn leads to high market value for additional income.
55. Under UNIDO's "*African Agribusiness and Agro-industries Development Initiative (3ADI) to promote agribusiness development in Africa through supporting innovative Public Private Partnership (PPP)*", a new project, funded by the Government of Japan, was recently initiated in three pilot countries, including Uganda. In Uganda, the project seeks to promote private sector (both foreign and local) investment in banana based food and beverages products for domestic and export markets. UNIDO has also been conducting the "*Investment Promotion Technical Assistance Programme (ITAP) for Uganda*" and supporting the UIA to attract greater flows of investments to various sectors, including agribusiness. Attracting investors to support climate resilient livelihood values activities would further ensure CCA coping strategies are promoted in the country.

A.4.2.2.3 Banana tissue culture industry to ensure the sustainability of the sub-sector:

56. Banana plantlet production and virus indexing methodologies are well established technologies and routinely used in the banana production systems of major producing countries such as India, China, Ecuador, and Brazil. In Uganda, NARO together with the MAAIF, have been carrying out demonstration trials within their FFS to show the profitability of using TC plantlets. A number of entrepreneurs are also supporting the efforts of increasing productivity through the banana TC industry. These include AGT, BioCrops Ltd. and Nsigotech Tissue Culture Laboratory (refer to Annex O).
57. However, opportunities for the banana producing communities to build resilience, through the use of disease free TC derived planting material when available, are still bleak, as the current price range from 1800-2200 Ugandan

Shillings (0.65-0.75 USD) for each plantlet is out of the reach of the resource poor farmer on an individual basis. In addition, the current capacities of the few companies producing TC banana plantlets are not sufficient to realistically meet the needs of all banana producers and sustain a banana value addition and product diversification programme.

58. There is the need to further strengthen the banana TC industry, by bringing its products to the reach of the resource poor and CC vulnerable female and male banana producers, to ensure a sustainable supply.

A.4.2.2.4 Banana and agriculture waste utilisation:

59. Banana stems, fruit stalks and leaves are a natural source of fibre for value added products or biomass for fuel. However, generally in Uganda, after the fruit has been harvested, millions of stems and stalks are thrown away as waste, with a very small proportion of the fibre being produced for making handcraft items like baskets, mats, table mats, decorations and cooking fuel.
60. Banana fibre extracted from banana stems can be used for the production of paper and textiles. The Uganda Industrial Research Institute (URI) has developed a prototype for the extraction of fibre from the stem for paper and fabric production. TEXFAD, a non-profit making business incubator, has been exploring the potential for utilizing the large quantities of waste that lie in the city and in the banana growing rural areas, in order to clean up the environment and create green jobs for the economically disadvantaged rural population of Uganda. The TEXFAD Banana Fibre project focuses on training farming communities especially the unskilled vulnerable people, women and youth on value addition to banana pseudostem, by extracting fibres and creatively producing cultural items that have market value within and outside their locality.
61. Although there is a large and untapped potential for the utilization of agricultural waste in biogas production, very little has been harnessed in Uganda to date (except with animal dung). The introduction of the biogas technology also reduces the daily labour of women and children, by eliminating the daily task of firewood gathering. One of the challenges with biogas systems is the relatively high upfront costs that are only compensated through fuel savings within 2-3 years. As the initial upfront investment deters many potential users, co-financing by financial institutions or donors is recommended to encourage the practice in Uganda. Since 2009, under the Uganda Domestic Biogas Program (UDBP), Heifer International and other partners have been implementing a project to install 12,000 biodigesters based on cattle manure as feedstock, in rural and peri-urban areas in Uganda. The biogas generated from these domestic biodigesters is sufficient for the daily domestic needs of typical rural households and the digestate can be used as compost to improve soils for crops. The target groups for this biogas programme are farming households with more than two zero-grazed cattle, where the beneficiary contributes to the cost of the installation of the biodigesters. While some banana producers in Western Uganda have already benefited from the project, the majority of the resource poor farmers, particularly female headed households, without the basic number of cattle requirement and financial means to raise the initial investment cost, have not been eligible and/or benefitted for the programme.
62. Currently, organic waste from bananas (including peelings) is not routinely composted in either rural or urban areas. As fresh bananas from the major producing districts like Isingiro, Bushenyi and Mbarara are mainly consumed in Kampala, the nutrients are removed from the farm and remain dispersed in heaps of garbage (from which recycling back into agricultural fields not feasible). If the crop nutrients passed on from crop fields are not restocked, it will lead to the depletion of soil nutrient stocks and a decline in crop yields.
63. The basic protocol to convert banana waste to biofuel exist has been discussed (refer to Annex N). The use of banana waste as biomass for biofuel within a primary processing site (farm household or community level), or at secondary processing facility (factory level using large amounts of raw banana) will add value to the process by supplementing the energy needs. In addition, it will ensure environmental sustainability in that, crop nutrients can be transferred back into the fields, reducing the need for large amounts of inorganic fertilisers.

A.4.2.3 Gender and vulnerability to CC in Uganda

64. Due to the different roles, needs, capacities and positioning of men and women in society, the risks and vulnerability to CC affect women and men differently. In Uganda, the integration of gender into CC related interventions is a key recommendation of the NAPA projects. The CC Department (CCD) of the MWE has produced a training manual "*Gender and Climate Change in Uganda –Who should carry the burden?*" to build

knowledge and understanding of CC and its impacts on development and gender, and to build local capacities in Uganda to design and implement gender responsive CC policies, strategies and programs.

65. The current Uganda National Industrial Policy (UNIP) places an emphasis on promoting gender balance and gender sensitive industrial transformation, while the Agriculture Sector Development Strategy included specific gender mainstreaming action for some commodities including coffee, dairy and rice. However, in Uganda, agricultural labour is generally supplied by women and children. While women may be the main contributors to agricultural production and productivity, they are usually marginalized when it comes to decision making concerning the revenue generated from the sale of agricultural products. In fact, women account for only 16.3% of the agriculture holders in the country¹⁰. The Western region of Uganda also has a very high fertility rate, which limits education and income generating activities, especially among women, and also causes tenure insecurity issues and opportunities for farming for both men and women.
66. A gender impact analysis (refer to Annex L) of the proposed LDCF project conducted during the PPG phase showed that, while women provide the bulk of agricultural labour and are responsible for providing food and other necessities for their families, they do not have any control over the money they earn from other income generating activities such as petty trade. In addition, service provision is also biased towards the “better off” and to some extent neglects the issues of marginalized categories of the population.
67. Since the impacts of CC affect women and men differently, with the poorest or less well off, being the most vulnerable, the proposed LDCF project therefore offers an opportunity to further enhance the national gender equality agenda. All these effects are threats to human security, with significant gender implications, due to the different roles, needs, capacities and positioning of men and women in society. As a consequence, women and men are exposed to different risks and vulnerabilities.

A.4.2.5 Civil Society Organisations (CSOs).

68. A number of CSOs and not-for-profit organisations are operating in Western Uganda to support communities to improve their livelihoods and overall quality of life through activities in health, agriculture, and biodiversity conservation and education sectors.
69. In Bushenyi District for instance, Farm Radio International provides advisory services to farmers through regular radio program on banana enterprise. The UCA supports entrepreneurs/ processors to aggregate production through formation of cooperatives as well as training of processors on product improvement, basic business management. Their major support has been to the dairy enterprise and more recently, to wine processing.
70. The activities of these organisations present opportunities to promote awareness on livelihood diversification activities as adaptation coping strategies to CC.

A.4.2.6 GEF supported LDCF programmes.

71. The GEF, through FAO, is supporting a regional project entitled “*Transboundary Agro-ecosystem Management Programme for the Kagera River Basin*”. The Kagera River Basin lies within Burundi, Rwanda, Uganda and Tanzania. In Uganda, the project covers communities in the Kabale and Mbarara Districts. The programme responds to key priorities of the countries sharing the Kagera river basin and is generating local and national benefits and global environmental benefits by promoting sustainable land and agro-ecosystems management (SLaM) across the basin, including the use of FFS approaches. The programme started in 2010 and is scheduled for completion in August 2014. Lessons learned and best practices in promoting CCA strategies in FFS from the programme project will be applied for this proposed project.

A. 5. Incremental /Additional cost reasoning: describe the incremental (GEF Trust Fund/NPIF) or additional (LDCF/SCCF) activities requested for GEF/LDCF/SCCF/NPIF financing and the associated global environmental benefits (GEF Trust Fund) or associated adaptation benefits (LDCF/SCCF) to be delivered by the project:

¹⁰ <http://www.fao.org/gender-landrights-database/data-map/statistics/en/>

A.5.1 Incremental /Additional cost reasoning

72. The proposed LDCF project aims to build resilience to CC among vulnerable communities in Western Uganda, and contribute to their income and food security. The project will be fully integrated into existing national processes and programmes, and will avoid the creation of parallel structures. More specifically, the project will rely on the following operational principles:

- Ensuring national leadership and ownership – High degree of participation and engaging stakeholders will ensure high-level support and a strong sense of ownership;
- Ensuring multi-stakeholder participation and consultation – Participation is critical to generate sense of ownership. A detailed stakeholder analysis was developed during the baseline assessment and will be reviewed and updated during the inception phase. This will help determine appropriate level and types of participation;
- Building on existing and on-going work – Avoiding duplication and maximising past investments by GEF, UNIDO, the government and donor community in relevant areas of support. This principle will ensure that synergies and complementarities are identified and fully realized;
- Adopting a long-term approach – Finding strong links with critical development policy frameworks for long term policy change, developing critical capacities at local and national levels and leveraging a follow-up funding.

73. The project will work in Isingiro, Mbarara, Ntungamo, Bushenyi, Sheema, Rubirizi, Mitooma and Buhweju districts in the Western region where banana farming is heavily concentrated and is experiencing increased post-harvest losses as a result of CC, as well as increased disease pressure with rising temperatures (Figure 3). Together these eight districts produce about half of Uganda's bananas. The main banana types produced are the EHBs matoke and beer bananas for local gin. Dessert bananas are also an important consumer product from the area.

74. The LDCF financing for the project will support the interventions described in section B part I as detailed below.

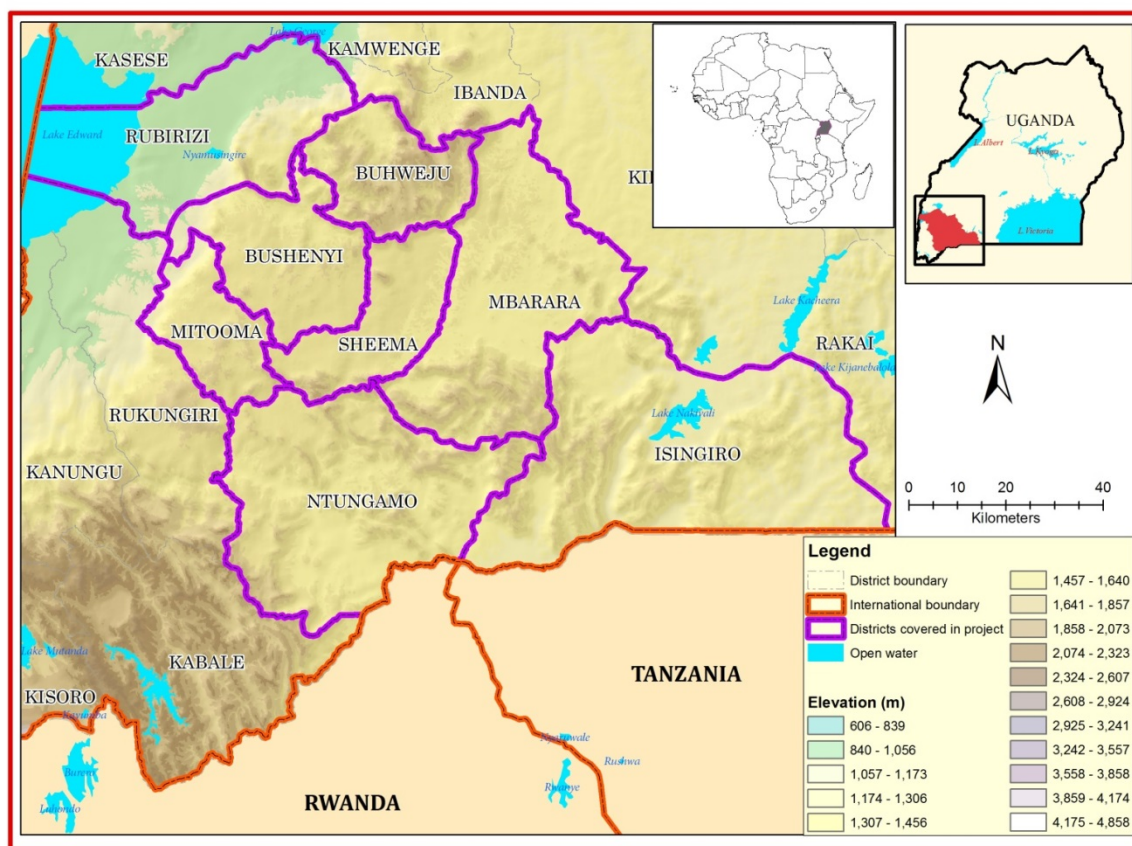


Figure 3. Map of Uganda showing district where the LDCF project is located

Component 1: Climate Change Adaptation (CCA) and gender equality for adaptation mainstreamed into National Development Policies/Strategies.

Outcome 1: CCA strategies coupled with appropriate action on gender equality are incorporated into developmental policies and implemented by stakeholders in the various sectors

Outputs 1.1 National policy documents such as the Agriculture sector strategic plan updated with action on CCA and gender mainstreaming for adaptation.

75. The LDCF funds under this component of the project will build on ongoing initiatives by the GoU to develop the agriculture and agro-industry sector and support the implementation of the National CC Policy. Key activities under this component are:

- a. Experts will be recruited to assist in updating the new Agriculture sector strategy document (ASSP) (2015/16-2019/2020)) and the National Industrial Sector Strategic Plan (NISSP) being developed by MAAIF and MITC respectively with action on CCA, identify source of and allocation of funds for these activities.
- b. A validation workshop will be held to enable staff of the ministries and their implementing agencies better understand the concept of adaption and how it relates to their work and to enable proper monitoring and evaluation of adaptation activities.

Output 1.2 CCA coping strategies including gender equality for adaptation promoted among investors and other stakeholders in the agro-industries and rural enterprise development sector.

76. The project will mobilise public and private sector value chains actors to develop CCA action in their operations to ensure the sustainable growth of the sector, including activities that support gender equality with CCA coping strategies.

- a. At least one stakeholders' sensitization workshop will be held at the start of the project to promote the concept of CCA and the coping strategies proposed in this project. Participants will include beneficiary community representatives, the DLGs; private sector SMEs in agribusiness and the banana subsector. At least five SMEs already identified during the PPG will be targeted for this activity; others are expected to be identified during the project execution.
- b. Experts will be recruited to assist DLGs and beneficiary communities to develop community adaptation plans, including a focus on the empowerment of women. This will enable DLGs and beneficiary communities to build on the CCA coping strategies proposed within the scope of this project and adopt other CCA opportunities to further build resilience, through ongoing or future programmes beyond the scope of this project.

Component 2: CC resilience building of vulnerable communities in major banana producing regions and contribute to food and income security thorough livelihood diversification.

Outcome 2: Vulnerable targeted communities are increasingly participating in resilience building activities for income diversification and adopting alternative agricultural practices to tackle the high incidence of diseases affecting bananas, maintain soil fertility and sustain their agriculture based livelihoods

77. Based on the stakeholder consultation during the PPG, Isingiro, Mbarara, Ntungamo, Bushenyi, Sheema, Rubirizi, Mitooma and Buhweju districts in the Western region, where banana farming is heavily concentrated and is experiencing increased post-harvest losses as a result of CC, as well as increased disease pressure with rising temperatures (Figure 3), were selected as the project locations. Together these eight districts produce about half of Uganda's bananas. The main banana types produced are the EHBs *matoke* and beer bananas for local gin. Dessert bananas are also an important consumer product from the area.

78. Though faced with an array of constraints, the baseline studies conducted during the PPG phase clearly show that banana wine, juices, sun dried chips, sliced banana fruits and crisp/chips represent underexploited market opportunities, with both national and international market prospects (refer to Annex J). The gender analysis also showed a clear opportunity for achieving greater gender equality for the earning of additional income through off-

farm value addition, enabling a gender balanced resilience building for livelihoods and food security (refer to Annex L).

79. Component 2 of the LDCF project will therefore build on the existing structures along the banana value chain in the eight districts to support value chain actors especially female and male smallholder farmers and female headed households in the vulnerable communities. It will provide opportunities for livelihood diversification activities and additional income, improve product quality, which leads to higher market values and further improves the income generation potential for the value chain actors.

Beneficiaries

80. During the project inception, MAAIF in consultation with the DLGs will select the beneficiary farmer households/processing groups for the value added products (juice, wine, FPM and dried chips/sliced fruits) identified during the PPG baseline study (Annex J). The selection of beneficiary farmer households/processing groups will be based on their vulnerability in terms of adaptive capacity as described in the PPG vulnerability study (Annex K). The numbers of beneficiaries listed below are indicative and following the establishment of MOUs with project partners during the project inception phase, clarification on the precise number of beneficiaries will be determined.
81. The project will support this process through a validation assessment of the vulnerability of identified beneficiaries and will establish the baseline on the adaptive capacities in terms of income, use of banana/agriculture waste for biogas and fertilization, use of tissue culture material/disease free planting material, water harvesting and purification systems.
82. During the project inception phase the identified beneficiaries will be aggregated into processing groups for the various products, based largely, on already existing cooperates. The inclusion of more members into exiting cooperates will enlarge and strengthen these cooperates.
83. The hosts of the processing facilities will be selected from among the identified beneficiaries during at project inception, based on their existing facilities and the potential for them to be used as training/incubation centres for a wider participation of other farmer households. These are essential micro and small scale enterprises with up to ten employees or use family/group labour.
84. At least 2,500 farming households, from the eight districts, will be targeted for support under this project intervention. Partnerships will be established and/strengthened between the aggregated groups and the identified partner SME's already engaged in processing of banana juice, solar dried banana chips and FPM, to purchase the products from the beneficiary groups. Attention will be paid to ensure equal representation of females and males in these groupings.
85. Farmer households/processors will be grouped according to district and product/processing category. Based on the initial PPG baseline assessment (Annex J) it is estimate that at least: i) 497 farming households will be aggregated into banana wine processing cooperatives from the districts of Bushenyi, Mbarara, Isingiro, Ntungamo, Sheema and Mitooma; ii) 250 farming households will be supported for the integration into the existing banana wine processing cooperative in the districts Rubirizi and Buhweju; iii) 1,200 farming households will be supported for the integration into the existing banana juice processing cooperatives in the districts Rubirizi and Buhweju; iv) 675 farming households from the districts of Ntungamo, Mbarara and Isingiro will be aggregated into banana chips and dried fruit processor groups (some farmers in this region are currently already being incubated by identified SME's). The number of groups and farming households/processors beneficiaries will be confirmed during the project inception phase.

Output 2.1 Sensitization of female and male farmers in the target district on CCA coping strategies to build resilience to CC

86. This output will deliver the sensitization of the larger farming communities in the eight districts on CCA coping strategies to build resilience to CC as well as sensitization workshops targeted at banana producer groups and processors along the value chain on CCA coping strategies and on the type and benefits of technologies/systems to be deployed in support of building resilience to foreseen CC risks.

- a. With the support of MWE (CCD) and NAADs, the farming community of the eight districts will be sensitized on CCA coping strategies. Among other initiatives to raise awareness on the issue, at least two community sensitization events will be held.
 - b. Two farmer/processor based sensitization workshops will be held for the banana producer/processor groups per district. At least 10 farmers/processors from each group, who are identified as group leaders, will participate in the 2-3 day event. Participants will disseminate the information within their groups.
 - c. Beneficiaries and secondary processing partners will be sensitized on the need to implement food safety management systems (FSMS) along the banana value chain and acquisition of UNBS certification for their products. The training and capacity needs of the partner secondary processors are being addressed through the UNIDO 3ADI PPP project.
87. This aspect aims to i) increase the capacities of existing primary processing facilities for efficient operations to supply quality products; ii) enable a wide participation of farming households in the communities engage in livelihood diversification activities and iii) scale up from small-scale processing system to intermediate-scale processing.
88. A key aspect of the project intervention is to ensure the beneficiaries of the project engaging in livelihood diversification banana value addition at the primary processing level (farm gate/community level) and the partner secondary level processors to whom the products from the beneficiaries will be supplied to produce safe and quality products.

Output 2.2 Small scale processing facilities established in target regions for vulnerable communities to engage in income diversification banana value addition activities

89. This output will realise the upgrading/establishment of primary processing facilities for solar dried banana chips; banana wine, FPM and banana juice (primary extraction) in the identified districts according to the concentration of banana varieties suitable for the products. At least two to three primary processing facilities (farm gate/community level) will be selected as host facilities for each of the four values added products. The extent of renovation and minor construction work will be based on the recommendations for the minimum operational facilities described in the PPG report on capacity needs of the processing facilities (Annex M) and to enable at least the following production quantities:
- a. Banana juice – 3,000 l/week
 - b. Banana wine – 5,000 l/week
 - c. Solar dried fruit – 250kg/week
 - d. FPM – 250kg/week
90. Technologies and equipment to improve the efficiency of and add value to traditional processing methods will be introduced. The facilities will be upgraded with adequate testing facilities and will introduce the certification of products and processes (MITC co-financed) according to national rules and regulations for food handling and marketing (the development of standards or specifications for particular banana products, such as Standard Operating Procedures (SOP), Good Hygienic Practices (GHP) and Good Manufacturing Practices (GMPs), will be facilitated). Emphasis will be placed on labour saving devices and protective clothing to allow both men and women to participate in any given activity in the processing line.
91. Fresh bananas for primary processing will be acquired from farmer households within the aggregated groups and from other farmers within the communities. The primary processed products in the case of juice, solar dried sliced fruits and chips will be supplied to the partner SME's. Proceeds from the processing will go into the running and maintenance of the facilities and profits shared proportionately between members.
92. The host facilities will be managed by the identified host groups. The facilities will, in addition to processing the respective products, serve as training centres (and owners of the training packages produced through this project), where people from the communities can come to learn how to process the different products and also can be further incubated within the facility. The host groups will be provided with the necessary training on management and operating equipment. Additional staff will be engaged from among eligible persons within their communities.

93. At least ten onsite training workshops will be organised at each facility on food safety management systems (FSMS) to ensure that safe and quality products are produced, as well as, basic business management skills including the preparation of business plans, financial planning among others. At least 90 participants representing individual processors, processing facilities and leaders of the farmers / primary processors groups will be trained at each event. These workshops will serve as a train the trainer events and participants will disseminate the information in the groups and provide guidance to the group members on good practices.

Output 2.3 Banana-based products from income diversification activities effectively marketed in locations with good marketing potential

Promoting investments and access to financing of resiliency building diversified livelihoods activities – ensuring sustainability

94. The LDCF project will build on the existing structure to support agribusiness in Uganda. Partnerships will be established with the existing commercial and donor backed micro finance institutions and schemes to facilitate access to credit for the growth and maintenance of the income diversification activities of farmers.
95. A series of at least ten training events (by trained trainers) will be conducted for the farmers/processing groups on basic business management skills including the preparation of business and financial planning. Training will be tailored to suit beneficiaries with or without basic formal education so as not to exclude any specific group or persons, particularly women
96. To promote the products and create awareness on the benefits of engaging in such livelihood diversification activities, at least 20 open days targeting the envisaged end-users and stakeholders from the food and beverages industry, financial institutions and UNSB, will be held at the processing facilities.
97. To assist the beneficiaries to gain access to credit from commercial banks and the existing micro finance institutions and schemes that supporting SMEs in agribusiness, a series of skills training events will be conducted for the farmers/processing groups on basic business management skills including the preparation of business and financial planning. Training will be tailored to suit beneficiaries with or without basic formal education so as not to exclude any specific group or persons, particularly women.
98. Based on UNIDO's ongoing experiences and network of domestic and international investors in agro-industries, the project will organize an investment forum to promote investments into the income diversification activities of the smallholder farmers and CCA strategies that enable resilience building of vulnerable people in general

Output 2.4. Community-based banana Tissue Culture (TC) industry established to support the demand generated from CCA coping livelihood diversification activities introduced to the vulnerable farming community

Support for a sustainable banana industry

99. With the resurgence of the BBW disease, some of the districts in Western Uganda have demonstrated the zeal to fight BBW and other banana diseases by enacting by-laws to address the problem. These initiatives demonstrated government commitment and support towards curbing the spread of disease and ensuring the sustainability of the sector.
100. The project will support the ongoing initiatives to facilitate the uptake of disease free TC derived planting material to further build resilience in the banana producing communities and ensure the sustainability of the banana industry.
101. A study tour for beneficiaries to enlighten them on a sustainable banana production systems from use of tissue culture derived planting material, sustainable agronomic practices, value addition and product marketing in other countries with successful banana based industries will be organised for up to 20 participants from the DLGs, and beneficiaries communities.
102. Central banana TC nurseries will be setup/upgraded within existing farmer groups in each of the districts for hardening-off, and supply of disease-free planting material to farmers. There will be at least one nursery each with capacity to hold 20,000 plantlets per annum or planting season per district. 5,000 households are expected to benefit from this intervention.

103. A subcontract will be awarded to the identified partner (refer to section B 1.3 below) to supply high quality and indexed (certified disease-free) banana plantlets of varieties used in target communities.
104. The farmer groups to host the nurseries will be selected during the beneficiaries' selection process at inception and additional staff will be engaged from among eligible persons within their communities.
105. Through the services of the technology providers, MAAIF and NAAD, at least six training sessions will be provided on the management of the nurseries, minisetting to rapidly multiply the healthy plantlets, sales and distribution. This will also be extended to the multiplication of conventional clean suckers (from non- diseased banana trees). Female farmers will be offered equal opportunities to be trained and to participate in the management of nurseries.
106. The nursery sites will also serve as multiplication/demonstration gardens within the baseline project. The project will in addition support the nursery hosting group to maintain banana conservation plots for biodiversity conservation and also as a means of storing desirable banana varieties.
107. In the long term, these facilities will further serve the dissemination and introduction of new varieties including CC resilient, vitamin A and iron rich varieties, when these are developed by the researchers.

Output 2.5. Biodigestors to convert banana waste into biogas established to support income diversification activities, and the resulting digestate used for soil fertility

Promoting banana waste utilization for biogas and for soil fertility

108. To further add value to the livelihood diversification banana processing activities mentioned above, the project will support the use of biogas technology at the processing facilities. This aspect of the project will draw on expertise from ongoing initiatives as well as private companies that can promote sell and provide maintenance service for biodigesters in Uganda. Women will be provided equal opportunities to join these activities.
109. The project will install Biogas digester plants will be installed at each of the banana processing facilities supported in the project. The fixed dome types are recommended for the banana processing facilities. It is expected that the minimum amount of waste generated will be about 40 kg, suitable for a digester with capacity of 30-50m³. Awards for the construction and installation will be undertaken through competitive international bidding.
110. In addition, the project will support 320 individual households (and six processing facilities) involved in the project with domestic biodigesters of about 9m³ in size and provides about 2,500 litres of biogas per day based on banana waste and other domestic organic waste. The identified households will be selected based on their need and as incentive for their willingness to adopt climate adaptation coping strategies proposed and the improved primary processing technologies introduced.
111. Through the services of the successful technology provider, at least 6 training events will be provided on the use (preparation of banana waste and co-digestion with cow dung) and maintenance. This will also facilitate widespread use of banana waste in existing domestic biodigesters.
112. Within MAAIF's ongoing projects on improved agronomic practices and farm sanitation, demonstrations on the benefits of using the resulting digestate as organic fertilisers on agriculture fields will be carried out.

Output 2.6 Water purification and water harvesting technologies to support livelihoods diversification and income generating activities promoted

113. The PPG studies indicated that one of the constraints to the banana value addition, especially at the primary farm level, is the access to potable water. Culturally, women and children go out to fetch water for all household activities as part of the daily chores. However, water resources are diminishing in most areas where swamps have been tampered with and because of land fragmentation that has interfered with consolidated land use planning within the area/ landscape
 - To further add value to the livelihood diversification banana processing activities mentioned above, and ensure that water used at all stages of value addition meet the minimum water quality standards of potable water, water purification systems will be set up consisting of basic UV treatment and further chemical treatment where necessary.

- The LDCF project will setup rain harvesting technologies and water purification systems at all the primary processing facilities in areas with an acute shortage of water resources where potable water needed for processing is absent.
- The identified partner processing companies will also be supported to improve their water quality. This aspect will start with an awareness raising campaign on the importance of using safe potable water for the processing as well as the benefits for drinking. It will be conducted with the UNBS, the processing companies and the DLGs. The exact chemical treatment needed for the water at the different locations will be determined during the inception phase by testing of the current water sources.

Component 3: Dissemination of information and expansion of the strategy and project benefits.

Outcome 3: Lessons learned and best practices from policy changes, capacity development initiatives and pilot plants disseminated

Output 3.1 Guidelines on best practices and project knowledge disseminated within the country and the sub-region through websites, publications and communication products in various languages

114. Lessons learned and best practices from policy changes, capacity development initiatives and the processing plants will be disseminated throughout Uganda and within other countries with similar banana-based agro-ecosystems. Cooperation with CSOs, such as The Uganda Cooperative Alliance (UCA) and Farm Radio International, for example, will be sought, to expand dissemination activities to a much larger audience. Project publication material in the form of newsletters, flyers, USB sticks and DVD's will be produced and a project webpage on the UNIDO website. The webpage will be linked to the website of the executing agencies and project partners and updated with regular information on the project activities.
115. In addition, the project will identify and participate, as relevant and appropriate, in at least five national and regional scientific, policy-based and/or any other networks, which may be of benefit to project implementation through lessons learned; and also as a means of disseminating project results.
116. The project will identify, analyse, and share lessons learned that might be beneficial in the design and implementation of similar future projects. There will be a two-way flow of information between this project and other projects with a similar focus.

Component 4: Quality Control Monitoring and Evaluation.

Outcome 4: Quality control and efficient monitoring of project intervention to support adoption by CC vulnerable communities

Output 4.1 Timely quarterly and annual reports prepared; midterm and final evaluation [using Adaptation Monitoring and Assessment Tool (AMAT)] of project activities completed

117. A Project Management Unit (PMU) will be established and will be responsible for the day-to-day implementation of all project activities, including the direct supervision of those activities contracted to responsible parties. This will include a National Project Coordinator (NPC), a project administrator and a clerk/driver. To facilitate implementation and monitoring at the project sites, a vehicle will be acquired and maintained throughout the project.
118. Annual project monitoring reports will be done in accordance with UNIDO's regulations and GEF's RBM and AMAT. Independent mid-term and final evaluations of the project will also be conducted. The monitoring and evaluation plan is described in detailed under section C.

A.5.2 Adaptation Benefit

119. The project is expected to have an impact in the country by contributing to an increased resilience of small holder farming households to CC, and contribute to income and food security. The benefits from the four project

components described above will be reflected at the national, sectorial, local government and community levels. The direct adaptation benefits envisaged from the LDCF interventions are described in Table1 below.

Table1. Expected Adaptation Benefit from the LDCF Intervention

LDCF Intervention	Expected Adaptation Benefit
Mainstreaming CCA and gender equality for adaptation to National Development Policy/Strategies.	<ul style="list-style-type: none"> • Agriculture, Industry and District Administrative Government policy documents updated with actions on CCA
	<ul style="list-style-type: none"> • Male and female value chain actors in the agro industry sector acquire knowledge and skills on CCA
	<ul style="list-style-type: none"> • Female and male agro industry value chain actors practice CCA coping strategies to build resilience of the sector to adverse effects of CC
Building resilience of vulnerable communities in major banana producing regions to CC through livelihood diversification.	<ul style="list-style-type: none"> • Information and knowledge of CC, CCA coping strategies available to target beneficiaries and applied in their activities
	<ul style="list-style-type: none"> • CCA strategies applied by female and male farmers and their communities in their activities
	<ul style="list-style-type: none"> • Target beneficiaries improve their income and food security through their engagement in sustainable value addition activities in equitable ways. In addition to providing the added income to reduce the vulnerability and enable beneficiaries to build resiliency to CC, the new products will also supplement the diets contributing to food and nutritional security and impact positively on women and children
	<ul style="list-style-type: none"> • Target beneficiaries, including women, empowered economically to acquire additional CCA intervention which otherwise would be too expensive from them to afford.
	<ul style="list-style-type: none"> • Genetic stocks from which banana plantations can be replaced in the event of losses due to the adverse effects CC will be readily available.
	<ul style="list-style-type: none"> • Ensure a synchronised and sustainable supply of bananas for food and as a raw material.
	<ul style="list-style-type: none"> • Reduced effect of nutrient depletion in banana fields and plantations due to the transportation of fresh bananas to markets ensuring the long-term environmental sustainability of the intervention.
	<ul style="list-style-type: none"> • Reduced impact of banana waste in markets in urban cites and the associated negative effect on sanitation
Dissemination of information and expansion of the strategy and project benefits	<ul style="list-style-type: none"> • CCA coping strategies based value addition to build resilience among vulnerable agriculture dependent communities documented and potential replicated or adopted in similar settings.

A.6 Risks, including climate change, potential social and environmental risks that might prevent the project objectives from being achieved, and measures that address these risks:

120. The major risks envisaged to prevent the project objectives from being achieved and detailed in the PIF are grouped into:

- i) Risk that will impact the banana supply and value chains from biotic and abiotic stress resulting in production failure which would be further aggravated with CC (i.e. banana crop failure due to CC and insufficient supply of raw material for the banana value addition;

ii) The risk of social and cultural behaviors hindering adoption of strategies (i.e. low rate of consumption of traditional banana beverages, particularly in urban areas with high market potential, adoption of TC derived clean planting material and utilization of banana waste for biogas and fertilization.

iii) The risk of inadequate supply of energy for processing.

121. The potential risk to the project activities are further discussed in Table 2 below.

Table 2 Risks and Mitigation Measures

Expected Results	Assumption	Risk	Mitigations
Outputs 1.1 National policy documents such as the agriculture strategic plan updated with action on CCA and gender mainstreaming for adaptation	Baseline projects preparing and upgrading national strategies are implemented	CCA will not be adequately captured in strategy documents for agriculture, industry and other sectors <u>LOW</u>	<ul style="list-style-type: none"> • The project is designed with the key involvement of MAAIF and MTIC as well as close cooperation with the MWE, which will be represented in the PSC • Other relevant sector ministries will be involved in workshops, meetings and awareness raising events
Output 1.2 CCA coping strategies including gender equality for adaptation promoted among investors and other stakeholders in the agro-industries and rural enterprise development sector.	Stakeholders and project beneficiaries interested in the sustainable growth of the sector in the face of CC	Lack of interest among stakeholders and beneficiaries on promoting awareness on CC and CCA coping strategies to build resilience <u>VERY LOW</u>	Stakeholder and beneficiaries, including women, will be sensitized through open days, workshops and meetings
Output 2.1 Sensitization of female and male farmers in the target district on CCA coping strategies to build resilience to CC			
Output 2.2 Small scale processing facilities established in target regions for vulnerable communities to engage in income diversification banana value addition activities	<ul style="list-style-type: none"> • There will be sufficient raw material for the banana value addition income diversification activities • Adequate supply of energy to power the processing plant in the communities where there is little or no electricity 	<ul style="list-style-type: none"> • The potential impact of pests and diseases on the crop. • Inadequate supply of energy to power the processing plant in the communities where there is little or no electricity. <u>MODERATE</u>	<ul style="list-style-type: none"> • As a sturdy perennial crop, banana is relatively less vulnerable compared to maize and coffee for instance • MAAIF and its partners in the baseline project are developing and introducing new varieties improved agronomic and farm sanitation measures. • The processing facility will be set up in major banana production areas, which characteristically suffer losses when they are unable to sell their fresh bananas. • The project will also introduce the use of the banana waste for biogas production as an energy source for the processing plant and also domestic use for farmers willing to acquire them. • Solar dryers will also be used for drying
Output 2.3 Banana-based products from income diversification activities effectively marketed in Bushenyi, Kampala and	• Beneficiaries adopt the new technologies and protocols the project will	• The current social stigma associated with the consumption of traditional banana	<ul style="list-style-type: none"> • The project will work with the UNSB to ensure quality and safety standards of the products • Open days will be held at the processing facilities as part of

other locations with good marketing potential	provide to improve quality and quality of value added banana products • End-users accept and patronize the products from the target beneficiaries	juice and wine due to the perceived unhygienic means of processing, could pose a risk to purchasing and consumption of the products in the urban areas. <u>LOW</u>	information dissemination activities, marketing and to further attract investments in the livelihood diversification activities the project aims to promote.
Output 2.4. Community-based banana TC industry established to support the demand generated from CCA coping livelihood diversification activities introduced to the vulnerable farming community	• Communities will be willing to maintain the nurseries and use the material • Producers will accept to use the issue culture derived planting material	A low rate of adoption of clean TC derived planting material could be a risk to the expansion of the banana TC industry <u>LOW</u>	• The MAAIF and FAO are providing farmers' knowledge and skills on good agronomic practices including demonstrations on the benefits of the use of TC plant material. • The project will in the first instance work within this network of communities, provide them with skill on how to run their own plantlet outlets as a business. • The project will also contract a supplier to supply plants of the desired banana varieties, the starting material will be taken from the communities.
Output 2.5 Biodigesters to convert banana waste into biogas established to support income diversification activities, and the resulting digestate used for soil fertility	• Feasible system to convert banana to waste into biogas • Sufficient banana waste generated to supply the biodigesters	• As the existing domestic biodigesters are based on cow dung as the feedstock, there is the risk that the system will not be compatible with banana waste • A low rate of adoption of the derived digestate from banana waste biodigesters for soil fertilization. <u>LOW</u>	• An assessment during the PPG established the feasibility of a banana waste system • The study also showed the benefit in soil fertility and environmental sanitation • The project will set up demonstration facilities among processing groups which produce sufficient quantities of banana waste daily to ensure the sustainable production of biogas
Output 2.6 Water purification and water harvesting technologies to support livelihoods diversification and income generating activities promoted	Processors at both the primary and secondary levels will be willing to use the new technology and/or additional processing steps in their operations	A low rate of adoption of clean TC derived planting material could also be a risk to the expansion of the banana TC industry <u>VERY LOW</u>	• The intervention will start by raising awareness on the benefits of using potable water for the processes as well as drinking. • Water harvesting will allow closer proximity to water sources, saving time and energy used in collecting water

Output 4.1 Guidelines on best practices and project knowledge disseminated within the country and the sub-region through websites, publications and communication products in various languages	Project results are consistently documented to generate information for dissemination	Project results will not be disseminated <u>VERY LOW</u>	Reports manuals and other communication material will be routinely produced and disseminated
Output 5.1 Timely quarterly and annual reports prepared; midterm and final evaluation (using AMAT) of project activities completed	Project will be monitored and evaluated according to schedule	There is a very low risk that the project will not be monitored and reported <u>VERY LOW</u>	<ul style="list-style-type: none"> • The PMU is responsible for the day-to-day execution of all project activities including oversight of the monitoring and verification of indicators by stakeholder will be established. • Stakeholders at the community, district and national levels will be trained on the verified indicators at inception

A.7. Coordination with other relevant GEF financed initiatives

122. With financing from GEF through UNEP, Uganda prepared the second national communication (SNC) to the UNFCCC, which essentially summarizes up to date information as well as general and specific data on CC in Uganda, the national greenhouse gas inventory, interventions made and/or proposed in adapting to and mitigating CC. This LDCF project will to the extent possible, utilize the information and data in the SNC and build collaboration with other interventions in CCA. In addition, the present project will seek collaboration and coordination with the following, GEF funded projects:

1) The proposed project will build on the technical capacities and growing experience of the GEF funded FAO-led regional project “*Transboundary Agro-Ecosystem Management Programme for the Kagera River Basin (Kagera TAMP)*” (GEF ID 2139). This project aimed at adopting an integrated ecosystems approach for the management of land resources in the Kagera Basin that will generate local, national and global benefits including: restoration of degraded lands, carbon sequestration and CCA and mitigation, protection of international waters, agrobiodiversity conservation and sustainable use and improved agricultural production, leading to increased food security and improved rural livelihoods.

2) The Ugandan “*Sustainable Land Management Country Program*” (GEF ID 3392). The project’s objective is to increase agricultural productivity and incomes of participating households by improving the performance of agricultural research and advisory service systems. The project timeframe is from 2010 until 2016, and is being implemented by the World Bank (WB). The reinforcement of the extension systems might be successfully realised in collaboration with the proposed LDCF project. The proposed LDCF project will seek to establish a partnership with the WB to promote its successfully tested technologies in the proposed project.

3) The “*Enabling Environment for Sustainable Land Management (SLM) to Overcome Land Degradation in the Cattle Corridor Districts of Uganda*” (GEF ID 3393) aims to support the local government and communities in the cattle corridor to have in place policies and practices that ensure good and sustainable use of their land to mitigate both degradation and CC, while at the same time, supporting economic activities that improve their lives. The project is implemented by the MAAIF in partnership with the Ministry of Lands, Housing and Urban Development, MWE, MTIC, Ministry of Energy and Mineral Development, NARO and the DLGs of Kamuli and Nakasongola.

4) “*Strengthening Climate Information and Early Warning Systems in Eastern and Southern Africa for Climate Resilient Development and Adaptation to Climate Change*” (GEF ID 4993). The project is part of the UNDP Climate Information and Early Warning Systems Africa Regional Initiative which covers 10 Countries in Africa. In Uganda, the project is being implemented by UNDP in partnership with MWE. The project intends to enhance the capacities to monitor extreme weather, hydrology and CC and promote efficient and effective use of hydro-meteorological and environmental information for making early warnings and long-term development plans.

Additionally, the project is expected to integrate weather and climate information into national policy plans such as the National Development Plan and the local government development plans.

123. The project will build synergies with these ongoing projects; in particular, it will draw on the results from the early warning systems project, which will strengthen the meteorological system, including the placement of automatic weather stations across the country.

124. In addition, where applicable, synergies will be established with new and ongoing projects. These include:

1) Integrating climate resilience into agricultural and pastoral production in Uganda, through an Agro-pastoralist/FFS approach. This project seeks to build climate resilience into the agricultural sector as an effective means for reducing vulnerability and disseminating community-level adaptation measures. The project will target vulnerable districts in at least five of eleven agro-ecological zones, within the central cattle corridor and the Karamoja region through 13 districts (Nakasongola, Nakeseke, Luwero, Kiboga, Mubende, Ssembabule, Abim, Amudat, Kaagon, Kotido, Moroto, Nakapiripirit, and Napak).

2) The project “*Building Resilience to Climate Change in the Water and Sanitation Sector in Uganda*” is financed by the AfDB and GEF and is executed by the MWE. The project aims at building resilience to CC in the flood-prone areas of Mount Elgon;

3) “*Enhancing Adaptation to Climate Smart Agriculture Practices in the Farming Systems of Uganda*” is a UNDP– Common Market for East and Southern (COMESA) project, which started in June 2014 and is scheduled to end in December 2015. The project is being implemented in the five districts of Namutumba, Bugiri, Budaka, Busia and Buyende, where land productivity is decreasing at a fast rate due to the high population and poor farming methods. The project, which is a scale up of previous sustainable land management projects focuses on building the capacities of farmers and extension officers at local government level in an effort to build a CC resilient society. This project is intended to specifically increase the numbers of farmers using “Climate Smart” agricultural practices and putting in place measures to improve input supply and produce markets and economic sustainability for farmers.

4) Uganda’s NARO is currently implementing two long-term CCA projects directly relevant to the proposed LDCF project: i) Conservation agriculture for improved land management and livelihoods of smallholder farmers, and ii) Sustainable land management (SLM) research at the National Agricultural Research Laboratories (NaRL), Kawanda. The objective of the agriculture conservation project is to increase agricultural productivity and improved livelihoods, while the objective of the SLM research is to generate CCA technologies for sustainable land management.

5) The Uganda “*Information System for Food and Nutrition Security*” project (2013-2015), funded by the FAO, aims to generate data that will be utilized for designing and implementing development oriented projects to improve household food security and the livelihoods of food insecure and vulnerable people. The main component is the establishment of an integrated information system that enables the monitoring of multiple environmental, climate, geological, and socio-economic threats for a more comprehensive understanding of, and response to, food and nutrition insecurity. The lessons learned on the integrated information system will be utilized towards improving the design and establishment of the knowledge management system under the project proposed LDCF.

B. ADDITIONAL INFORMATION NOT ADDRESSED AT PIF STAGE:

B.1 Describe how the stakeholders will be engaged in project implementation.

B 1.1 GEF Implementation Agency (IA)

125. UNIDO is the GEF Implementing Agency. UNIDO will be responsible for the overall implementation, monitoring and reporting of the project according to GEF procedures and established UNIDO rules and regulations. UNIDO will fulfil this responsibility by appointing a Project Manager and mobilizing services of its other technical, administrative and financial branches at UNIDO Headquarters and the UNIDO field office in Uganda.
126. UNIDO will be responsible for the following inputs:
- Overall project implementation, monitoring and reporting
 - Recruitment and remuneration of all experts and consultants required for the project. Experts will be identified in consultation with the National executing partners (NEPs). In all the recruitments, due attention will be given to have a gender balance, subject to the availability and suitability of the resource.
 - Procuring international service needed for delivering of the planned outputs;
127. UNIDO will fulfil this responsibility by appointing a Project Manager and mobilizing services of its other technical, administrative and financial branches at UNIDO Headquarters and the UNIDO Field Office in Uganda. All procurement will be done in accordance with UNIDO established regulation. Partnership agreements will be made with the NEPs.
128. Any amendments to the project will be done in accordance with the GEF policy C.39.09 and UNIDO rules and regulations.

B 1.2 National executing partners (NEPs)

129. The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and the Ministry of Trade, Industry and Cooperatives (MTIC) will be the two main executing agencies coordinating with UNIDO.

B.1.2.1 Ministry of Agriculture, Animal Industry and Fisheries (MAAIF)

130. MAAIF will be the Lead NEP and will be responsible for the delivery of the project outputs and will be accountable for resources provided, in accordance with UNIDO rules and procedures. The Ministry has the responsibility for providing national level coordination of project activities and their integration into other agro industries and initiatives on building resilience at the national level.

B.1.2.2 Ministry of Trade, Industry and Cooperatives (MTIC)

131. The Ministry is responsible for promoting trade, industry and cooperatives for the development of the country. MTIC through its Department of Industry & Technology and its affiliate institutions will execute activities relating to value chain development. Other roles include policy development and project quality assurance through monitoring.

B.1.3 Other project implementation partners

132. Ministry of Finance, Planning and Economic Development (MFPED) is the signatory of the project on behalf of the GoU (GEF focal point) and the Ministry of Water and Environment (MWE) coordinates the implementation and monitoring of national CC actions on mitigation and adaptation in different sectors.
133. Other public and private sector stakeholders include: Uganda National Bureau of Standard (UNBS); Uganda Industrial Research Institute (UIRI); Micro Finance Support Centre (MFSC); Agro Genetics Technologies Ltd (AGT); Fruits of the Nile (FoN); Afri Banana Products Limited (ABP); Uganda Cooperative Alliance (UCA); Uganda Export promotion board (UEPB); District Local Governments (DLGs) of Isingiro, Mbarara, Ntungamo, Bushenyi, Sheema, Rubirizi, Mitooma and Buhweju districts.
134. The project will also partner with the relevant CSOs such as UCA and Farm Radio International to provide services on information dissemination, training and incubation of farmers in aggregated processing groups.

135. More detailed information on project stakeholders is presented in Annex H.

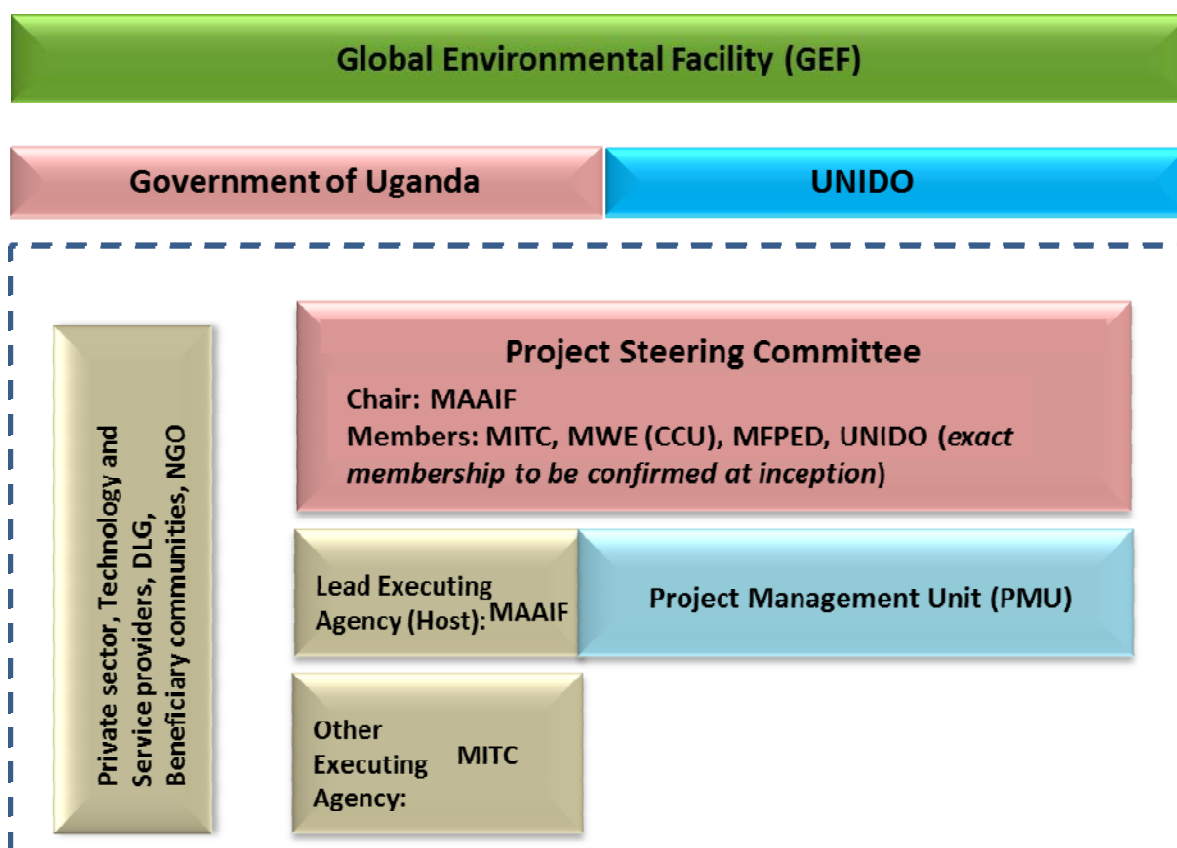


Figure 4 Diagrammatic representation of project structure

B.1.4 Implementation arrangements

B.1.4.1 Project Steering Committee (PSC)

136. The PSC will be established with the responsibility of coordination among Government agencies and will provide the necessary guidance on project execution. The PSC will steer the project to make sure that project resources are allocated effectively and efficiently in accordance with the approved project document to achieve the stated outcomes. Acting in accordance with the UNIDO and GEF (GEF/C.39/Inf. 3) policies and procedures, the PSC will also ensure the high level support and participation of key stakeholders both at national and sub-national levels.

137. The PCS will have three roles:

- (1) Executive role - The Permanent Secretary of the MAAIF or any other official delegated by him to chair the PSC, will assume the executive role. MTIC will co-chair the PSC The Executive's function is to represent project ownership on the PSC.
- (2) Representatives from key beneficiaries and stakeholders - This will include MAAIF, MWE (CCD, MTIC) and the eight districts where the project is implemented.
- (3) Oversight - UNIDO's primary function within the PSC is to provide guidance regarding the project including the appraisal and approval of the activities, oversight of project performance and quality assurance.

138. The membership and specific ToRs for the PSC will be reviewed and finalized during the inception phase. PSC Meetings will be held once in every six months. The PSC will invite members and experts for specific meetings, as needed.

B.1.4.2. Project Management (PMU)

139. The PMU will be established and will be responsible for the day-to-day execution of all project activities,

including direct monitoring of those activities contracted to consultants and other vendors. The PMU will be hosted by MAAIF, in Entebbe. The PMU will consist of a National Project Coordinator (NPC), a Project/ Administrative Assistant, Office Attendant and a Project Driver, as well as, international and national experts, as required.

B.1.5 Inception Phase

140. During the project inception phase the PMU and the project governance structure will be established. An inception workshop to present the project objectives (key expected results, implementation modality, M&E framework, risk management strategy, work plan and budget) to stakeholders will be organised to mark the launch of the project and to raise awareness and build partnerships for CCA mainstreaming into the national poverty reduction programmes at national and local government levels.

141. Activities foreseen to be concluded during the inception phase include, but are not limited to:

- Establishing the project governance structure
- Inception workshop - The key results the Inception Workshop is expected to achieve are:
 - i. All partners fully understand and take ownership of the project. The roles, functions, and responsibilities of partners, the PSC, reporting and communication lines, and conflict resolution mechanisms, will be clarified.
 - ii. Based on the AMAT, indicators, targets and the means of verification are presented to stakeholders and the schedule for field monitoring visits, agreed upon.
 - iii. The First Year Work Plan of activities to be carried out in accordance with the project framework (described in Annex A) will be agreed upon.
 - iv. The budget breakdown of the project will be presented and the financial reporting procedures and obligations, and arrangements for annual audit will be discussed.
 - v. The plan and schedule of the PSC meetings will be discussed.
- Training stakeholders on baseline targets for monitoring during project implementation - The baseline targets and vulnerability indicators identified during the PPG will be set and monitored during the project. Stakeholders will be trained to include such indicators in their immediate and long-term plans for the target regions and the banana production system in general.

142. The Inception Report (IR) will be prepared immediately following the inception workshop. It will include a detailed work plan for year one in quarterly time-frame detailing the activities and progress indicators/ milestones to be achieved in the first year. The IR will also include the detailed project budget for the first year of implementation, and based on the agreed annual Work Plan. The IR will also include a more detailed narrative on the institutional roles, responsibilities, coordinating actions and feedback mechanisms to project related partners. In addition, a section will be included on the progress to date, project establishment and start-up activities, and an update of any changed external conditions that may affect project implementation. Prior to adoption of the IR, the PSC and UNIDO will review the document.

B.1.6 Implementation Phase

143. During this phase, all technical activities foreseen by the project (relevant for all four project components) will be undertaken. This phase will cover the activities under Components 1-3 and some of the activities under Component 4 described above. Estimated timeline is illustrated in Annex D.

B.1.7 Project completion/ final phase

144. This is the final phase of the project and therefore all project activities under all components and outputs must be completed at the end of this phase. Activities under this phase include but not limited to:

- Documentation of the lessons learned and best practice
- Dissemination of lessons learned and best practices on policy changes, capacity development initiatives and pilot demonstrations, through the project website and other media and networks.

- Undertake terminal evaluation (end of project/ terminal evaluation) of project success against agreed indicators.

B.2 Describe the socioeconomic benefits to be delivered by the Project at the national and local levels, including consideration of gender dimensions, and how these will support the achievement of global environment benefits (GEF Trust Fund/NPIF) or adaptation benefits (LDCF/SCCF):

145. It is well documented that agriculture (and the agroindustry sector in general) plays a significant roles in the socio-economic development of Uganda. The proposed LDCF project has a strong socioeconomic dimension, in that it is centred on the banana sub-sector and its value chain actors. An important group of these actors are the small holder farmers with extremely low adaptive capacities in terms of financial, physical, and environmental capital. The project is expected to have an impact in the country by contributing to an increased resilience of small holder farming households to CC, and contribute to income and food security. The benefits from the four project components described above will reflected at the national, sectorial, local government and community levels.
146. On the national level, the project will contribute to the GoU's overall DSIP on the agriculture and agribusiness sectors, as it prioritises the participation of the private sector in value addition activities and investment for the country's economic growth and poverty reduction.
147. At the local district level, the economic benefit to the target vulnerable small holder farmers and their communities from engaging in the livelihood diversification activities cannot be overemphasized. There will be direct addition income to the households. For instance, with an initial investment of US\$ 160 on inputs for processing and bottling, a single bunch of banana yields a profit of US\$ 95 as banana wine compared to US \$ 3 from the sale of the same bunch at farm gate or US \$10 in an urban market. In addition, new jobs will be created in the communities where primary processing facilities and TC nurseries will be setup enabling employment opportunities for the youth and women that do not own their own land for farming. Through the introduction of labour saving technologies, both men and women will have equal opportunities to be engaged in the various stages of the value chain.
148. Water harvesting technologies are an important CCA strategy. The PPG demonstrated a clear need for this in the project activities. Making the water harvesting available at the processing facilities will reduce the time needed to go out in search of water. To further promote this practice among the vulnerable communities will has positive implications, in particular, to the wellbeing of the women and young people who, culturally, are the ones assigned the task of fetching water.
149. In line with the ISID mandate of UNIDO, the project will allow for an environmentally sustainable growth of the banana industry in the target districts, by supporting additional value added technologies. The use of TC derived planting material to replace disease plantation, will ensure the sustainable supply of fresh bananas for food security and to the envisaged demand for value added banana products. The use of banana peels (waste) for biogas will reduce the dependency on other traditional so protection of the environment. The resulting digestate from the biodigestion process, when used as organic fertiliser, will restore soil fertility and contribute to recycling the nutrients back into the farm lands.
150. It is envisaged that, as a result of improved income and financial status, the target beneficiaries will be able to afford other innovative adaptation strategies at the household level. These include strategies such as the construction of reservoirs for water harvesting and adopting soil conservation strategies to increase resilience to the increasingly frequent landslides and CC exacerbated soil degradation, and engaging in other forms of value addition to build further resilience.
151. In terms of the global adaptation benefit, the project component on mainstreaming supports one of the key functions of the LDCF, which is to help integrate adaptation into national policy and planning. It envisaged that by engaging a diverse range of stakeholders at the national government level (agriculture, industry, water and environment), DLGs, as well as national agencies and institutions, will result in harmonised action plans on CCA and facilitate the actual implementation of activities.
152. By engaging the value chain actors in the private sector, they will also become sensitized on CCA strategies and especially how to support those value chain actors who dependent on the primary natural resources of their

businesses. It is envisaged that, this, will lead to private sector investments in agroindustry in line with CCA strategies, further resulting in building resilience of agro value chains to CC.

153. Lastly, DLGs will gain first-hand knowledge and experience on implementing and promoting CCA coping strategies (and their associated benefits) within their communities and thus, will be better equipped to implement CCA actions throughout their jurisdiction.

B.3. Explain how cost-effectiveness is reflected in the project design:

154. Cost effectiveness is ensured throughout the project in that the project interventions are structured around ongoing initiative and programmes rather than setting up completely new initiatives. The project will be fully integrated into existing national processes and programmes of Uganda and will avoid the creation of parallel structures.
155. The component of mainstreaming will result in comprehensive sector strategies covering their primary mandate and other key development issues include adaptation to CC, and is more cost effective than having separate strategies for each developmental issue related to a particular sector. This in turn will allow institutions to more efficiently plan and implement activities with a broader view of CCA for sustainable development.
156. Within the component on resilience building thorough livelihood diversification by vulnerable communities, cost effectiveness is attained by engaging value chain actors already operating in the target areas. By upgrading the facilities of primary processing centres and building the capacities of the smallholder farms for improved value addition and linking them with the processing companies with factories where the value added products will be further processed, is more cost effective than setting up new facilities from scratch. Furthermore, most of these SMEs are currently operating under their potential capacities and is cost-ineffective. Therefore, by being associated with this LDCF project, cost-effectiveness is translated into the operations of the SMEs.
157. The project also includes cost effective options for the waste utilisation/biogas production demonstration. The fixed dome digesters with a long lifespan (30 years) and low maintenance costs will be installed. These digesters maintain stable temperatures. This system results in fuel savings within 2-3 years of use.
158. The long term benefits and cost-effectiveness of the use of banana plant TC derived material cannot be overemphasised. While the initial cost of healthy disease-free plantlets from the entrepreneurs such as AGT will be out of the reach of small holder and climate vulnerable farmers. Typical interventions when there are outbreaks of crop disease or other disasters is to distribute new seed or clean planting material to replace lost crop. The approach taken in this project, which will setup nurseries and provide skills to run them as community based enterprises, is more cost-effective in ensuring the long term use of disease free planting material.
159. The information dissemination component will be executed in a cost effective manner in that it will combine traditional print material with electronic and web based material.

B4. Sustainability strategy and potential for scale up

160. The project has been designed in such a way that GEF resources and matching funds from other donors and stakeholders will set up systems and approaches that lead towards the sustainability of project interventions in the banana value chain. The proposed project will demonstrate the efficacy and profitability achieved through the introduction of the described coping strategies, within organized farming groups, that can also be scaled-up and replicated in other districts of Uganda and more widely, other banana-based agroecosystems of the region.
161. The project is innovative as it does not focus on the production system alone, but also on the value chain. By establishing profitable value-addition activities coupled with sound business management skills in normal banana production and the subsistence farming routines of the communities, that would otherwise become increasingly food insecure due to CC, will ensure their food security.

162. A second point of innovation involves the enablement of communities to better adapt to CC in that the resulting wealth created from the introduction of the CCA strategies described (food preservation, alternative livelihood systems and changes in agriculture practices), will enable communities to afford more changes in agricultural practices including the routine use of disease free TC planting material to replace older trees for sustainable high productivity, construction of reservoirs for water harvesting and adopting soil conservation strategies. Furthermore, the intervention will ensure food security through a continual supply of the staple banana and additional income to afford a variety of nutritional foods.

163. This LDCF project will be fully integrated into existing national processes and programmes of Uganda and will avoid the creation of parallel structures. More specifically, the project will rely on the following operational principles:

Ensuring national leadership and ownership

- Project execution by MAAIF and MTIC ensures that project initiatives, lessons and best practices easily become focal areas for government to build on in their future plans and programmes.
- Co-financing from partners and beneficiaries included in project budget
- High degree of participation and engaging stakeholders will ensure high-level support and a strong sense of ownership;
- Ensuring multi-stakeholder participation (e.g. Steering Committee) and consultation – participation is critical to generate the sense of ownership. A detailed stakeholder capacity analysis (and the elaboration of detailed partnerships and collaborative arrangements) was developed during the baseline assessment and will be reviewed and updated during the inception phase. This will help determine appropriate level and types of participation;
- Building on existing and on-going work – avoiding duplication and maximizing past investments by GEF, UNIDO, the government and donor community in relevant areas of support. This principle will ensure that synergies and complementarities are identified and fully realized. E.g., collaboration with NAADS activities
- Adopting a long-term approach – Finding strong links with critical development policy frameworks for long term policy change, developing critical capacities at local and national levels and leveraging a follow-up funding.

Training/ capacity building for farmers/SMEs and local Government

- Capacity building through training of DLG, processors and farmers in CCA strategies will increase confidence by all in addressing CC challenges.
- Capacity building to support access by the vulnerable communities to CC technologies in banana value addition and the whole banana value chain will strengthen the viability of interventions supported by the project.
- Human resource capacity strengthened through training in value addition processes, quality control, and business management.

Income diversification and adoption of alternative agricultural practices to tackle the high incidence of diseases affecting bananas, maintaining soil fertility and sustaining agriculture based livelihoods

- TC planting materials for addressing CC vulnerability for bananas will ensure the sustainable supply of bananas as raw materials in the banana value addition initiatives of the project.
- A substantial portion of Western Ugandans depend on banana farming for their livelihoods. The sustainability of banana production through soil nutrient enhancement by waste from banana processing and bio digesters plays an important role in ensuring continuous production.
- Access to potable water is a major constraint hindering the upscale and sustainability of banana value addition in Uganda. Water purification systems will be introduced to support the livelihoods diversification of banana processing activities.

Product competitiveness

- Certification of products provides an incentive for processors to keep in the market (US-mark) and encourage process to get the Q-mark. By supporting banana based products to meet national standards ensures creating products that meet consumers' safety and builds trust and confidence that comes with economic rewards as well as motivation for processors to stay in the market.
- Access to finance - Lack/limited access to micro finance is one of the hindrances for SMEs to take and retain their products in the market due to limitations in capitalization of their investments. Building partnerships with the existing commercial and donor backed financial institutions and schemes to facilitate access to credit for the growth and maintenance of the income diversification activities of the farmers will contribute to addressing the gap.
- Branding and marketing.

C. DESCRIBE THE BUDGETED M &E PLAN

164. Project M&E are conducted in accordance with established UNIDO and GEF procedures. The M&E activities are defined by project component 4 and the concrete activities that are specified and budgeted in the M&E plan. Monitoring will be based on indicators defined in the strategic results framework (which details the means of verification), and the annual work plans. M&E will make use of the GEF Tracking Tool, which will be submitted to the GEF Secretariat three times during the course of the project: at CEO Endorsement, at mid-term review, and at project closure. UNIDO as the IA Agency will involve the GEF Operational Focal Point and project stakeholders at all stages of the project M&E activities in order to ensure the use of the evaluation results for further planning and implementation. According to the M&E policy of the GEF and UNIDO, follow-up studies like Country portfolio evaluations and thematic evaluations can be initiated and conducted. All project partners and contractors are obliged to (i) make available studies, provide reports or other documentation related to the project and (ii) facilitate interviews with staff involved in the project activities. The M&E budget is presented in Table 4. The following M&E activities will be conducted:

Periodic monitoring and site visits

165. The UNIDO Project Manager and the NEPs will conduct visits to the project sites based on the agreed schedule in the project's Inception Report/Annual Work Plan to assess first hand project progress. Other members of the PSC may also join these visits. A back-to-office-mission report will be prepared by the NPC and will be circulated no less than one month after the visit to the project team and PSC members.

Annual reporting

The project status will be monitored each year through an Annual Monitoring Review (AMR) exercise covering the activities of the previous reporting period. The APR activities to be carried out include, but are not limited to following:

- Review of the progress made towards project objective and project outcomes - each with indicators, baseline data and end-of- project targets (cumulative)
- Project outputs delivered per project outcome (annual).
- Expenditure reports
- Lesson learned/good practice.
- Risk and adaptive management

Midterm review

166. The project will undergo a mid-term review at the mid-point of project implementation. The mid-term review will determine progress being made towards the achievement of outcomes and will identify course correction if needed. It will focus on the effectiveness, efficiency and timeliness of project implementation; it will highlight issues requiring decisions and actions; and will present initial lessons learned about project design, implementation and management. Findings of this review will be incorporated as recommendations for enhanced implementation during the final half of the project's term. The organization, ToRs and timing of the mid-term evaluation will be

decided upon after consultation between project partners. The ToRs for the evaluation will be prepared by the UNIDO Project Manager. The review will also include the LDFC/SCCF AMAT update at midterm.

End of Project

167. An independent terminal evaluation will take place during the last quarter of the project implementation prior to the final PSC meeting and will be undertaken in accordance with UNIDO and GEF guidance. The terminal evaluation will focus on the delivery of the project's results as initially planned (and as corrected after the mid-term review, if any such correction took place). The evaluation will look at impact and sustainability of results, including the contribution to capacity development and the achievement of global environmental and adaptation benefits/goals. The LDFC/SCCF AMAT will also be completed during the terminal evaluation cycle. The ToRs for this evaluation will be prepared by the UNIDO Project Manager based on guidance from the UNIDO evaluation group.

Learning and knowledge sharing:

168. The projects interventions will result in a wealth of information and knowledge on ways in which vulnerable communities can sustainably engage in livelihoods diversification income generating off-farming activities, and thereby build CC resiliency. In addition, information on how the use of technologies such as clean planting material derived from TC and organic soil composite from biodigested banana peels, aid in building resilience of the agriculture production system, will be disseminated. The Lessons learned and best practices will be disseminated widely within and beyond the project intervention zone (nationally, regionally and internationally) and through existing information sharing networks and forums, as described under section A. 5.4 above.

Table 4 Project Monitoring and Evaluation

Description	Budget US\$	Responsible Parties	Time frame
Means of verification of project results (experts to conduct studies and training on indicators)	20,000	UNIDO PM; PMU;	Start of project and if required following midterm review
Periodic site-visits /monitoring of result/status reports	Covered under project travel in components 1-3	PMU; NEPs project teams	Continuous
Midterm Review	40,000	UNIDO PM; PMU; external consultants	Midway through the project
Independent Terminal Evaluation	60,000	UNIDO PM; PMU; external consultants	during the last quarter of the project
Terminal Report	included in cost of review	UNIDO PM; external consultants	At least one month before end of project
Subtotal	120,000 USD		

PART III: APPROVAL/ENDORSEMENT BY GEF OPERATIONAL FOCAL POINT(S) AND GEF AGENCY(IES)

- A. RECORD OF ENDORSEMENT OF GEF OPERATIONAL FOCAL POINT(S) ON BEHALF OF THE GOVERNMENT(S):** (Please attach the [Operational Focal Point endorsement letter\(s\)](#) with this form. For SGP, use this [OFP endorsement letter](#)).

NAME	POSITION	MINISTRY	DATE (MM/dd/yyyy)
Mr Patrick Ocailap	Deputy Sectary to Treasury	MINISTRY OF FINANCE, PLANNING AND ECONOMIC DEVELOPMENT	08/05/2013

B. GEF AGENCY(IES) CERTIFICATION

This request has been prepared in accordance with GEF/LDCF/SCCF/NPIF policies and procedures and meets the GEF/LDCF/SCCF/NPIF criteria for CEO endorsement/approval of project.

Agency Coordinator, Agency Name	Signature	Date (Month, day, year)	Project Contact Person	Telephone	Email Address
Mr. Philippe R. Scholtès, Managing Director, Programme Development and Technical Cooperation Division -UNIDO GEF FocalPoint		08-13-2015	Yvonne LOKKO	+43 1 26026 3737	Y.Lokko@unido.org

ANNEX A: PROJECT RESULTS FRAMEWORK (either copy and paste here the framework from the Agency document, or provide reference to the page in the project document where the framework could be found).

Intervention logic	Verifiable indicators	Sources of verification	Assumptions
Impact			
Increased resilience to CC, income and food security of small holder farming households in Western Uganda	<ul style="list-style-type: none"> At least 5000 small-holder farmers disaggregated by sex with improved assets* (such as soil and water conservation structures, water harvesting structures) to adapt to CC At least 5000 small-holder farmers disaggregated by sex reclassified as income and food secure 	<ul style="list-style-type: none"> Baseline and Impact assessment study UNBS 	
Objective			
To support vulnerable communities in Western Uganda to better adapt to the effects of CC through banana value addition activities, to provide greater opportunities for income generation, poverty reduction and food security	<ul style="list-style-type: none"> Average income of banana producing households in target districts increased by 30% at project completion (baseline will be established at inception phase); disaggregated by sex of head of household 30% increase in the banana value addition in the target region (baseline will be established at inception phase) 	<ul style="list-style-type: none"> Inception baseline, midterm and final reports MTIC, MAAIF reports 	<ul style="list-style-type: none"> Government continuous to prioritise development of the agro industries as a means to poverty reduction
Component 1:			
CCA and gender equality for adaptation mainstreamed into National Development Policy/Strategies.			
Outcome 1: CCA strategies coupled with appropriate action on gender equality are incorporated into developmental policies and implemented by stakeholders in the various sectors	<ul style="list-style-type: none"> CCA captured in the new Agriculture Sector Strategy Plan (ASSP) (2015/16-2019/2020); the National Industrial Sector Strategic Plan (NISSP); and District level strategies on adaptation produced Eight DLG development plans setting priorities on reducing vulnerability to CC along the value chain 	<ul style="list-style-type: none"> Actual policy documents/ strategies 	<ul style="list-style-type: none"> Government stakeholders and private sector partners are willing to engage in the development of CCA strategies
Component 2:			
Climate Change resilience building of vulnerable communities in major banana producing regions and contribute to food and income security thorough livelihood diversification.			

<p>Outcome 2. Vulnerable communities are increasingly participating in resilience building activities for income diversification</p>	<ul style="list-style-type: none"> • 30% increase in number of farming households, disaggregated by sex of head of household, engaged in banana value addition (baseline established at inception) • 40% increase of banana wine and juice, 40% increase in of banana chips produced in the target area per annum and reflected in the expansion of local and regional markets (baseline established at inception) • # of banana based products from the target region meeting Uganda Bureau of Standards • # of processors meeting minimum requirements (UNBS food Safety and quality standards (US;2002) • # of UNBS certified products from beneficiaries on the market(baseline established at inception) • Number of TC derived plant material purchased/year by smallholder farming households, disaggregated by sex of head of household, from established nurseries/mother gardens (baseline at PPG zero). • Number of farming households, disaggregated by sex of head of household, applying biodigestate residue in fertilisation of banana plantations and adopting improved farm management practices • Increase in number of water harvesting facilities setup in vulnerable communities (baseline established at inception) 	<ul style="list-style-type: none"> • Project, midterm and final reports • UBS certificates awarded to project beneficiary and processors • NAAD, MTIC, MAAIF reports 	<ul style="list-style-type: none"> • It is much more profitable for farmers to participate in value addition activities compared to selling fresh banana bunches on the markets • Commitment of service providers, and beneficiaries to adopt proposed technologies for planting material and banana waste utilisation • Higher profit margins for banana due to value addition activities will provide an incentive for investing in increased banana production incl. disease free plant materials
<p align="center">Component 3: Dissemination of information and expansion of the strategy and project benefits</p>			

Outcome 4. Lessons learned and best practices from policy changes, capacity development initiatives and pilot plants disseminated.	<ul style="list-style-type: none"> • Number of similar project and initiatives started as a direct result of or citing the project • Number of external events, conferences, and show where project results are highlighted 	<ul style="list-style-type: none"> • MAAIF, MWE reports 	<ul style="list-style-type: none"> • Successful implication of proposed project and demonstration of easy of replication
<p align="center">Component 4: Quality Control Monitoring and Evaluation</p>			
Outcome 5. Quality control and efficient monitoring of project intervention to support adoption by CC vulnerable communities	<ul style="list-style-type: none"> • Baseline assessment of measurable indicators in the eight Districts • Number of communities based primary processing /farming groups, district and governmental agency staff, disaggregated by sex, trained to monitor the project(baseline established at inception) 	<ul style="list-style-type: none"> • Baseline assessment study • Project reports • Project training certificate 	<ul style="list-style-type: none"> • Key stakeholders actively participate in the project inception study • Stakeholders at national district and community levels able to implement recommendations of baseline/inception study

* Assets defined as environmental, social, human, financial, and physical capital resource base with which the community is able to adapt to CC. The stronger the asset base the higher the adaptive capacity of the community while a poor asset base indicates high vulnerability to CC and an urgent need for planned adaptation.

ANNEX B: RESPONSES TO PROJECT REVIEWS (from GEF Secretariat and GEF Agencies, and Responses to Comments from Council at work program inclusion and the Convention Secretariat and STAP at PIF).

n/a

ANNEX C: STATUS OF IMPLEMENTATION OF PROJECT PREPARATION ACTIVITIES AND THE USE OF FUNDS

PPG Grant Approved at PIF:			
<i>Project Preparation Activities Implemented</i>	<i>GEF/LDCF/SCCF/NPIF Amount (\$)</i>		
	<i>Budgeted Amount</i>	<i>Amount Spent To date</i>	<i>Amount Committed</i>
Determination of baseline scenario, identification of project location	20,000	20,000	
Vulnerability assessment, determination of indicators and gender analysis	20,000	20,000	
Identification of project stakeholders, partners and securing commitment	30,000	30,000	
Determination of facilities needs and preparation of project document	30,000	25,095	4,905
Total	100,000	95,095	4,905

ANNEX D: TIMELINE OF ACTIVITIES

Output	Main Activity	Year 1			Year 2			Year 3		
		Month 1-4	Month 5-8	Month 9-12	Month 1-4	Month 5-8	Month 9-12	Month 1-4	Month 5-8	Month 9-12
Outputs 1.1 National policy documents such as the Agriculture sector strategic plan updated with action on CCA and gender mainstreaming for adaptation	1.1.1 Facilitate the development/updating of key policy documents of related sectors									
Output 1.2 CCA coping strategies including gender equality for adaptation promoted among investors and other stakeholders in the agro-industries and rural enterprise development sector.	1.2.1 Conduct sensitization workshops for SMEs and other agro based value chain actors on incorporating CCA strategies in their operations									
Output 2.1 Sensitization of female and male farmers in the target district on CCA coping strategies to build resilience to CC	2.1.1 Sensitize female and male farmers in the target districts on CCA coping strategies to build resilience to CC									
	2.1.2 Conduct sensitization workshops for banana producer groups, processors along the value chain on the project intervention n and benefits of the technologies/systems to be introduced									
Output 2.2 Small scale processing facilities established in target regions for vulnerable	2.2.1 Upgrade/establish primary processing facilities for banana wine, juicing and chips									

communities to engage in income diversification banana value addition activities	2.2.2 Facilitate development of standards or specifications for particular banana products (Establish Standard Operating Procedures (SOP) and provide training in Good Hygienic Practices (GHPs) and Good Manufacturing Practices (GMPs))								
	2.2.3 Train banana processors in basic business management skills including preparation of business plans, financial planning among others.								
	2.2.4 Upgrade/Equip the centre with adequate testing facilities, certify the products and the processes according to national rules and regulations for food handling and marketing								
	2.2.5 Train processors on the aspects of quality control and quality assurance								
	2.2.6 Provide information on the business plan, what training the centre can provide, where to source technology and how to access credit for investing banana processing equipment.								
	2.2.7 Facilitate certification of products (MITIC co-financing activity).								
Output 2.3 Banana-based products from income diversification activities	2.3.1 Promotion and marketing of the banana-based products with project specific branding								

effectively marketed in Bushenyi, Kampala and other locations with good marketing potential	2.3.2 Conduct open days and promotion events in the processing centre for banana-based products among retailers, wholesalers, marketing agents and other traders									
	2.3.3 Develop contractual agreements for marketing of products between the primary processing centres (target vulnerable communities) and partner processing SMEs identified in the project									
	2.3.4 Build partnerships with the existing commercial and donor backed financial institutions and schemes to facilitate access to credit for the growth and maintenance of the income diversification activities of the farmers									
	2.3.5 Organise an investment forum to promote investments into the income diversification activities of the smallholder farmers and CC adaptation strategies that enable resilience building of vulnerable people in general									
Output 2.4. Community-based TC industry established to support the demand generated from CCA coping livelihood diversification activities introduced to the vulnerable farming community	2.4.1 Study tours for beneficiaries, stakeholders on banana value chain – commercial low-cost tissue culture, value addition & product marketing									
	2.4.2 Establish weaning and distribution nurseries in the identified districts									

	2.4.3 Training on handling plantlets, weaning and distribution									
	2.4.4 Demonstrate to other farming communities the advantages of using disease free planting material in combination with best agricultural practices as demonstrated in FFS (superior yield, mitigation of disease spread) (MAAIF financing activity)									
Output 2.5 Biogas digesters to convert banana waste into biogas established to support income diversification activities, and the resulting digestate used for soil fertility	2.5.1 Construction of Biogas digesters at primary processing facilities and at households of target beneficiaries									
	2.5.2. Training on banana waste preparation and use in digesters									
	2.5.3. Demonstration on application of banana waste based fertiliser and sound agronomic practices (MAAIF financing activity)									
Output 2.6 Water purification and water harvesting technologies to support livelihoods diversification and income generating activities promoted	2.6.1 Baseline water purity testing at secondary processing sites and water sources at primary processing sites									
	2.6.2. Installation of water harvesting and water purification systems at processing sites for processing and other domestic use (at primary processing sites)									
Output 3.1 Guidelines on best practices and project	3.1.1 Project website and regular updates									

knowledge disseminated within the country and the sub-region through websites, publications and communication products in various languages	3.1.2 Publication of promotional material, guidelines, communication and material									
	3.1.3 Global forum activities									
Output 4.1 Timely quarterly and annual reports prepared; midterm and final evaluation of project activities	4.1.1 PSC meetings									
	4.1.2 Mid and Annual review exercise using Adaptation Monitoring and Assessment Tool (AMAT)									

ANNEX E: BUDGET

Budget breakdown in US dollars

TABLE 1 GEF GRANT BUDGET BREAKDOWN

		GEF Grant Budget Component 1			
Component 1	Type of Expense	Year 1	Year 2	Year 3	Output Total
<i>Output 1.1</i>	International Expertise	18,000	25,000		43,000
	Training/Workshops		10,000		10,000
	Subcontract (editing/publishing)		10,000	12,000	22,000
	<i>Output sub-total</i>	<i>18,000</i>	<i>45,000</i>	<i>12,000</i>	<i>75,000</i>
<i>Output 1.2</i>	Local Travel	5,000	5,000		10,000
	National Expertise	3,500	15,000	15,000	33,500
	Training/Workshops	5,000		5,000	10,000
	Miscellaneous (printing material)	6,000		5,500	11,500
	<i>Output sub-total</i>	<i>19,500</i>	<i>20,000</i>	<i>25,500</i>	<i>65,000</i>
		GEF Grant Budget Component 2			
Component 2	Type of Expense	Year 1	Year 2	Year 3	Output Total
<i>Output 2.1</i>	Local Travel	5,000	2,400	2,400	9,800
	National Expertise	9,000		16,200	25,200
	Training/Workshops	25,000	10,000	10,000	45,000
	<i>Output sub-total</i>	<i>39,000</i>	<i>12,400</i>	<i>28,600</i>	<i>80,000</i>
<i>Output 2.2</i>	International Expertise	12,000	36,000		48,000
	Contractual Arrangement	240,000	30,000		270,000
	Training/Workshops	15,000	70,000	20,000	105,000
	Equipment	100,000	340,000		440,000
	Miscellaneous (procurement of supplies/consumables)	15,000	15,000	25,000	55,000
	<i>Output sub-total</i>	<i>382,000</i>	<i>491,000</i>	<i>45,000</i>	<i>918,000</i>
	International Expertise		15,000	15,000	30,000
<i>Output 2.3</i>	Local Travel		5,000	5,000	10,000
	National Expertise	9,000	7,200		16,200
	Contractual Arrangement		15,000		15,000
	Training/Workshops	5,000	5,000	5,000	15,000
	International Meetings/Workshops			30,000	30,000
	Miscellaneous (procurement of supplies/consumables)	8,800	20,000	10,000	38,800
	<i>Output sub-total</i>	<i>22,800</i>	<i>67,200</i>	<i>65,000</i>	<i>155,000</i>
<i>Output 2.4</i>	Local Travel	5,000	5,000		10,000
	Contractual Arrangement	120,000	30,000		150,000
	International Meetings/Workshops	50,000			50,000
	Miscellaneous (procurement of supplies/consumables)	5,000	10,000	5,000	20,000

	<i>Output sub-total</i>	<i>180,000</i>	<i>45,000</i>	<i>5,000</i>	<i>230,000</i>
<i>Output 2.5</i>	International Expertise		9,000	9,000	18,000
	National Expertise		5,000	5,000	10,000
	Contractual Arrangement or Procurement	200,000	100,000		300,000
	Miscellaneous (procurement of supplies/consumables)	6,000	10,000	6,000	22,000
	<i>Output sub-total</i>	<i>206,000</i>	<i>124,000</i>	<i>20,000</i>	<i>350,000</i>
<i>Output 2.6</i>	Contractual Arrangement	25,000	25,000		50,000
	Equipment	100,000	280,000		380,000
	Miscellaneous (procurement of supplies/consumables)	20,000	12,000	10,000	42,000
	<i>Output sub-total</i>	<i>145,000</i>	<i>317,000</i>	<i>10,000</i>	<i>472,000</i>
		GEF Grant Budget Component 3			
Component 3	Type of Expense	Year 1	Year 2	Year 3	Output Total
<i>Output 3.1</i>	International Expertise			18,000	18,000
	Local Travel	2,500	2,500	5,000	10,000
	National Expertise	16,200			16,200
	Contractual Arrangement			20,000	20,000
	Training/Workshops	10,000	5,000		15,000
	International Meetings/Workshops		15,000	20,000	35,000
	Equipment	5,000			5,000
	Miscellaneous (printing/communication material)	3,800	15,000	12,000	30,800
	<i>Output sub-total</i>	<i>37,500</i>	<i>37,500</i>	<i>75,000</i>	<i>150,000</i>
		GEF Grant Budget Component 4			
Component 4	Type of Expense	Year 1	Year 2	Year 3	Output Total
<i>Output 4.1</i>	International Expertise		35,000	45,000	80,000
	National Expertise		15,000	20,000	35,000
	Miscellaneous (printing material)		2,500	2,500	5,000
	<i>Output sub-total</i>		<i>52,500</i>	<i>67,500</i>	<i>120,000</i>
		GEF Grant Budget PMC			
PMC	Type of Expense	Year 1	Year 2	Year 3	Output Total
	National Expertise	40,200	40,200	40,200	120,600
	Training/Workshops	10,500	4,300	3,000	17,800
	Equipment	50,000			50,000
	Miscellaneous (operational cost)	6,000	6,000	4,600	16,600
	<i>Output sub-total</i>	<i>106,700</i>	<i>50,500</i>	<i>47,800</i>	<i>205,000</i>

TABLE 2 CO-FINANCING BUDGET BREAKDOWN

Proposed Co-financing Budget						
	Co-financing Budget Component 1					
Component 1	UNIDO	MAAIF	AGT	ABP	FFL	Output Total
<i>Output 1.1</i>		200,000				200,000
<i>Output 1.2</i>						
TOTAL Component 1		200,000				200,000

	Co-financing Budget Component 2					
Component 2	UNIDO	MAAIF	AGT	ABP	FFL	Output Total
<i>Output 2.1</i>		1,000,000			5,000	1,005,000
<i>Output 2.2</i>	150,000			150,000	410,000	710,000
<i>Output 2.3</i>	50,000			12,000	10,000	72,000
<i>Output 2.4</i>		4,340,000	120,000			4,460,000
<i>Output 2.5</i>						
<i>Output 2.6</i>						
TOTAL Component 2	200,000	5,340,000	120,000	162,000	425,000	6,247,000

	Co-financing Budget Component 3					
Component 3	UNIDO	MAAIF	AGT	ABP	FFL	Output Total
<i>Output 3.1</i>	12,000	400,000				412,000
TOTAL Component3	12,000	400,000				412,000

	Co-financing Budget Component 4					
Component 4	UNIDO	MAAIF	AGT	ABP	FFL	Output Total
<i>Output 4.1</i>	20,502	86,000				106,502
TOTAL Component 4	20,502	86,000				106,502

	Co-financing Budget PMC					
PMC	UNIDO	MAAIF	AGT	ABP	FFL	Output Total
		100,000				100,000
TOTAL PMC		100,000				100,000

ANNEX F: LEGAL CONTEXT

The present project is governed by the provisions of the Standard Basic Cooperation agreement between the Government of the Republic of Uganda and UNIDO, signed on 27 May 1994.

ANNEX G: ENGAGEMENT OF NATIONAL STAKEHOLDERS

Outcome	Output	Lead national institution	Key national partners	Key re
1: CCA strategies coupled with appropriate action on gender equality are incorporated into developmental policies and implemented by stakeholders in the various sectors	1.1 National policy documents such as the Agriculture sector strategic plan updated with action on CCA and gender mainstreaming for adaptation	MWE (CCD)	MAAIF, MITC, MFPED	<ul style="list-style-type: none"> • Rev • Fac • kno • Ens • dev • wo
	1.2 CCA coping strategies including gender equality for adaptation promoted among investors and other stakeholders in the agro-industries and rural enterprise development sector.	MAAIF, MITC	MWE (CCD), UCA, DLGs	<ul style="list-style-type: none"> • Mo • cha • Ass • trai
2. Vulnerable targeted communities are increasingly participating in resilience building activities for income diversification and adopting alternative agriculture practices to tackle the high incidence of diseases affecting bananas, maintain soil fertility and sustain their agriculture based livelihoods	2.1 Sensitization of female and male farmers in the target district on CCA coping strategies to build resilience to CC	MAAIF, MITC	MWE (CCD), DLGs, NAADs, CSOs*	<ul style="list-style-type: none"> • Mo • dist • wo • Ass • trai
	2.2 Small scale processing facilities established in target regions for vulnerable communities to engage in income diversification banana value addition activities	MAAIF, MITC	UNBS,UIRI,MFSC, UCA, Processing SME's (FoN, FF, ABP)	<ul style="list-style-type: none"> • Ide • pro • juic • esta • Ass • star • Ass • trai • Ov • cen • Bac • qua
	2.3 Banana-based products from income diversification activities effectively marketed in locations with good marketing potential	MAAIF, MITC	UNBS,UIRI,MFSC, UCA Processing companies	<ul style="list-style-type: none"> • Fac • inv • Mo • act

	2.4 Community-based banana TC industry established to support the demand generated from CCA coping livelihood diversification activities introduced to the vulnerable farming community	MAAIF	NARO, NAADS, Biotech/TC SMEs (AGT)	<ul style="list-style-type: none"> Identify locations where the nurseries will be set up Facilitate training on handling plantlets, weaning and distribution to identified groups Mobilise farmers to use TC products
	2.5 Biodigesters to convert banana waste into biogas established to support income diversification activities, and the resulting digestate used for soil fertility	MAAIF, MITC	DLGs, NAADS	<ul style="list-style-type: none"> Oversee construction of biogas digesters at primary processing facilities Facilitate training/demonstration workshops on application of banana waste based fertiliser and sound agronomic practices
	2.6 Water harvesting technologies to support livelihoods diversification and income generating activities promoted	MAAIF, MITC	MWE, UNBS, Processing SME's (FoN, FF, ABP)	<ul style="list-style-type: none"> Oversee construction of reservoirs and installation of tanks and water purification systems at primary processing facilities
3. Lessons learned and best practices from policy changes, capacity development initiatives and pilot plants disseminated.	3.1 Guidelines on best practices and project knowledge disseminated within the country and the sub-region through websites, publications and communication products in various languages	MAAIF, MITC	MWE (CCD), DLGs, NAADS	<ul style="list-style-type: none"> Oversee project website and its regular updates Assist in production of publication of promotional material, guidelines, communication and material
4. Quality control and efficient monitoring of project intervention to support adoption by CC vulnerable communities	4.1 Timely quarterly and annual reports prepared; midterm and final evaluation (using AMAT) of project activities completed	MAAIF, MITC	MWE (CCD), MFPED	<ul style="list-style-type: none"> Assign institutional focal points for the project Assist in identification and recruitment of suitable experts (national and international) for the project Assist in monitoring and reporting activities

*CSOs will be identified at inception



UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION



GENDER ANALYSIS REPORT

**Technical Assistance Programme on Reducing Vulnerability of Banana Producing Communities
to Climate Change through Banana Value Added Activities in Uganda
Ministry of Agriculture Animal Industry and Fisheries
Lugard Avenue, ENTEBBE
Entebbe, Uganda**

March 2015

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SUMMARY

Gender analysis for the project design phase of “the Uganda Banana Livelihoods Diversification Project” was conducted so as to ensure that the needs and priorities of women and men are taken into consideration during the implementation of the project. Ensuring gender equity is part and parcel of the project for banana value chain development building on activities based in eight Districts of south-western Uganda; Isingiro, Mbarara, Ntungamo, Bushenyi, Rubirizi, Mitooma, Sheema and Buhweju. Principally the gender analysis was composed of: a sex-disaggregated analysis of the micro-medium sized enterprises in the region; determining the gender issues that the project will address and applicable outputs and activities; and indicators to monitor and evaluate gender mainstreaming activities of the project. The primal focus of the gender analysis were the four leading banana value chains and the service providers. The value chains were for banana wine, juice, chips and peeled and preserved matooke while the service providers were Agro-Genetic Technologies (AGT), Afri-banana products and Jakana Foods. Additional interviews and/or discussions were held with the Uganda Export Promotion Board (UEPB), and the analysis benefited from project stakeholder feedback conducted in March 2015 in Mbarara Municipality.

The results are presented based on the main project objectives, and they showed as follows:

Sex-disaggregated analysis of the micro-medium sized enterprises

Banana wine;

- Women are more involved in processing and they offer long hours of commitment for the wine processing.
- The processing of banana wine involves considerable physical lifting and stirring processes that generally reduce the involvement of women.
- Several groups and cooperatives have a strong representation of men and women, and the rules suggest an equal treatment of members.
- A lot of wine processing is also undertaken at the domestic household level and generally involve women, men and children in the process.
- The gender constraints for the wine value chain comprise: (i) the smaller market size because of limited appreciation of the wine in the larger supermarket and hotel outlets that reduce income opportunities for both men and women; (ii) participation by women is also affected by low education and skills, land ownership and/or assets; (iii) likely disruption of domestic roles for women due to long hours of work; and (iv) a lot of the wine domestically produced did not seem to reach the market denying a lot of income to households.

Banana chips

- The processing of banana chips involves small women’s only groups. The emergence of groups was also based on the need to provide income for widows.
- The work is done domestically with very little external inputs and the involvement of children who provide labour, often at the expense of school.

- The manner in which the chips are processed involves a lot of losses, and the actual processed output is quite low.
- The value chain is dominated by one exporter, Fruits of the Nile and the primary processors groups are concerned at the prices they are offered are quite low compared to the fresh fruits market.
- There are very few men involved in the value chain.
- The management capacity and capital investments in the banana chips value chain is quite low, which limits capacity to expand and/or improve operations.
- The raw materials for banana chips; apple bananas and Gonja variety are in very limited supply within the area

Banana juice

- The issues surrounding the processing banana juice involve primary processors working in cooperatives and selling their raw juice to a larger processor to complete processing to achieve a market readiness for the juice. The major gender based constraints for juice processing are:
- The limited availability of water for processing, households need to move long distances of one to three kilometres in search of water. The water that is available is of a poor quality and the factor often has to provide water for juice processing. Women and children are responsible for collecting water;
- Many households struggle with working capital. The low capitalisation problems are much harder on women who have few physical assets to use to access capital; and
- Regularity of processing is also affected by the low supply of raw materials, the Mbidde variety that is used for juice processing and this reduce the overall turnover, productivity and gross revenue;

Peeled and preserved Matooke

- The peeled and preserved matooke is a new product in the domestic market. Only one consortium under Afri-banana undertakes such processing and exports the bananas on a limited trial basis to the United States. AGT a local banana agribusiness enterprise is considering processing and exported of peeled and preserved matooke.
- Discussions held with UEPB suggest strong promise for the peeled and preserved matooke with efforts of product development first concentrating on the domestic market. The peeled and preserved bananas are expected to achieve export potential based on progress in the domestic market.
- The peeled and preserved matooke processing is likely to involve a lot of women given the high physical labour requirements for peeling, which culturally a specialisation for women.

Gender issues that the project will address, applicable outputs and activities

The gender issues to be addressed by the project are categorised in terms of issues that address value chain inputs, processing capacity, marketing and welfare and livelihoods of project beneficiaries:

Inputs

The interests with regard to inputs will be towards:

- Water access and availability for processing and other uses for beneficiaries, especially women;
- Regularity and/or stability of raw materials supply; i.e. bananas for processing chips, juice and wines;
- Equity of access and availability of working capital for women and men
- Access to land and other physical assets for women; and
- Alternative technology options for physically labour demand functions in the supply chain for raw materials e.g. donkeys and trolleys.

Processing capacity

- Increased processing and reported processing of all targeted banana processed products;
- Increased organisation and gender equity and equality for processors groups, by commodity;
- Management capacity of women in the supported value chains;
- Streamlining and integrating opportunities for peeled bananas in a manner that empowers participating groups of women; and
- Reduced physical labour demand in the processing chain

Marketing

- (i) Increased number of outlets and market share for domestically processed banana products in the national supply chains with equality in participation for men and women;
- (ii) Level of market development for women dominated value chains like banana wines, peeled bananas and banana chips; and
- Marketing training, skills and capacity of women in the supported value chains.

Welfare and livelihoods of beneficiaries

- Declining involvement of children in heavy and time consuming labour, especially if it reduces their ability to attend school and play with other children;
- Proportion of revenue from the value chain that is retained by primary processors especially women;
- Improvements in livelihoods and welfare indicators such as household income and food security; and
- Influence of women in value chain investment decisions at household and processing level.

Indicators to monitor and evaluate gender mainstreaming activities

The indicators for monitoring and evaluating gender mainstreaming are summarised in the matrix below. A list of five indicators are proposed to monitor and evaluate gender. It envisaged between the period of start and completion of the project the indicators to be monitored and evaluated can be reduced to a concise list as follows:

Gender equality in the input cycle of the banana value chain

- (i) Equity of access and availability of working capital for women and men.

Gender equity in banana processing

- (ii) Management capacity of women in the supported value chain.

Gender equality in banana marketing

- (iii) Increased number of outlets and market share for domestically processed banana products in the national supply chains with equality in participation for men and women.

Gender equity in welfare and livelihoods in the banana value chain

- (iv) Involvement of children in heavy and time consuming labour.
- (v) Proportion of revenue from the value chain that is retained by primary processors especially women.

The recommendations for enhancing gender equality and equality were:

- Support for increased water access and availability, banana planting materials and physical and working capital access for women, and access to energy sources.
- Concentrating banana value chain development efforts may on the newer peeled banana/matooke product, and the banana chips, replicating the successful banana wine cooperatives and clarifying the gender participation in the banana juice value chain.
- Enhancing directly measurable welfare benefits for households such as food security and income will allow the success of the projects to have long-term impacts. This can be consolidated with establishing the income drawn from the value chain by women and the influence women have over the use of the revenue acquired at household and business level.
- Building the management capacity for women and their role within the marketing processes. Because the specialised participation starts off from a lower base gender equality would be enhanced by increasing the management capacity of women in all four banana value chains.

Full list of proposed indicators, proposed targets & estimated baseline

Likely Indicator	Target	Baseline
Inputs & primary processing		
1. % available clean easily accessible water source/ household of beneficiaries	45%	20%
2. %increase in banana production available for processing	40%	20%
3. % access to working capital/financing for women	40%	15%
4. % access to working capital/financing for men	40%	25%
5. % participation in decisions over land use for banana enterprise	30%	<10%
6. % processing facilities employing labour saving technologies	30%	<10%
Processing cycle		
7. % increase in processed banana products, reported by women beneficiaries	60%	20%
8. % participation of women in management roles and decisions	30%	10%
9. % increase in physical labour saving technologies by processing facility	30%	<10%
Marketing		
10. % increase in outlets & market share for processed banana products for women	20%	<5%
11. % number women trained in specialised value chain development capacities	30%	<10%
Welfare and livelihoods of beneficiaries		
12. % reported cases of child labour in the banana processing cycle	<20%	>45%
13. % of banana value chain revenue retained by women	30%	<10%
14. % Improvements in household income;	50%	>30%
15. % Improvements in household food security;	50%	>30%
16. % women reporting increased participation in decision making	50%	10-20%

1. INTRODUCTION

1.1 Scope of Gender Analysis

The United Nations Industrial Development Organisation is implementing a Technical Assistance programme in Uganda for “Reducing Vulnerability of Banana Producing Communities to Climate Change through Banana Value Added Activities in Uganda” with financial support from the Global Environment Facility (GEF). The programme focuses on banana value chain development building on activities based in eight Districts of south-western Uganda; Isingiro, Mbarara, Ntungamo, Bushenyi, Rubirizi, Mitooma, Sheema and Buhweju. In this report the consultant provides an interim assessment of gender issues based largely on literature review and discussions with other UNIDO consultants. The focus of this report is on the status of value chain development for bananas and the findings are solicited from background studies supporting the project design.

From the outset, it is important to establish common definition and conceptualisation of issues regarding gender analysis as used in this report. The definitions used are largely based on the UNIDO “Guide on Gender Mainstreaming – Agribusiness Development projects” (UNIDO 2015). Gender equality means creating equal opportunities for women and men by allowing them to contribute on equal terms economically, politically, socially and culturally. Gender equality implies that the interests, needs and priorities of both women and men recognise the diversity of different groups of women and men. The development of agricultural value chains with an emphasis on value addition and agro-processing leads to an improved employment in both rural and urban areas, offers market access to smallholders and creates business links for SMEs. It builds up better relationships along the chain and enhances food security by reducing post-harvest losses (UNIDO 2015). However, Uganda, like other developing countries suffers from unequal access to property and land, poor access to capital for women, which limits their ability to invest in technology, and limited representation of women in management and positions of power.

1.2 Purpose and objectives of the study

The aim of UNIDO’s assistance in this project is to assist the Government of Uganda (GoU) to support vulnerable communities in Western Uganda to better adapt to the effects of climate change (CC) through banana value addition activities, to provide greater opportunities for income generation, poverty reduction and food security. There is however the need to ensure that a gender perspective in accordance with UNIDO and the GEF’s gender mainstreaming policy is integrated in the project.

The objective of this consultancy is to conduct a gender analysis of the intended project activities based on the draft project document and PPG reports. The study is required to identify the potential of the proposed project activities, in ensuring equal CCA benefits for both men and women. The specific tasks for the consultant were to:

- (i) Plan and conduct a sex-disaggregation analysis of the micro –medium sized enterprises in the target regions engaged in banana value addition for juice, wine, dried chips and vacuum packed banana products. Analysis is based on roles, needs, access and control of resources (financial, natural, physical etc.)
- (ii) Based on the draft project document, the baseline data and reports collected for the project, determine the gender issues which the project will address and propose where applicable outputs and activities to address identified gender issue(s).
- (iii) Based on the findings, formulate the gender-responsive targets and indicators to monitor and evaluate gender mainstreaming activities of the project.
- (iv) Provide input in the form of a final report of the study

1.3 Context of the Gender Analysis

The Uganda Banana Livelihoods Diversification project intends to reduce vulnerability to climate change of banana producing communities through banana value addition activities; thereby increasing opportunities for income generation, poverty reduction and food security. The project has identified the priority banana value chain to comprise of four products; banana wine, banana chips, banana juice and vacuum packed banana products. The report establishes data that exists on proportion of women in the banana agro-food value chain, and equity concerns with regard to payment, working conditions, among others. Planned interventions such as technology support for process would then address the different roles of men and women and the specific gender-based support needed to improve livelihoods and well-being.



Plate 1: Workers labelling banana juice products at Forest Fruits factory in Bushenyi District

This gender analysis study is taking place at the stage of policy formulation and will include among others: a description of the context; roles of stakeholder – women, men, children; the current status especially for natural assets and financial assets and access; status of different gender groups in decision making; and who is likely to benefit and how to ensure greater equity in benefit of the planned interventions. Indicators for measurement will be developed in a manner that will allow for use in project formulation.

1.4 Methodology

The study has been conducted through key informant interviews and literature review. Primary data was collected based on key informant interviews with stakeholders in the existing value chains for bananas (*Table 1*).

Table 1: Data collection schedule

Face to face key informant interviews	Website information.	Telephone interviews
1. Kano Naijuka - Resident Partner/ Manager, Forest Fruit Foods Limited	6. Agro-Genetic Technologies Limited (AGT)	1. Tumuramye Chris - Assistant production manager: Fresh vacuum sealed Matooke (FREVAEMA), Mbarara District
2. Paul Kwagala – Tigebwa Development Association (TDA)	7. Excel Hort Consult	2. Karugaba Edith –Kamunyiga Cluster: Ntungamo Fruit Driers Association, Ntungamo District
3. Amelia Atweta – Sales person Nyabubare Area Cooperative Enterprises Ltd.	8. Afri Banana Products	3. Sarah Tusingwire – Gender focal person: Excel Hort Consult (EHC), Mbarara District
4. Executive Director Uganda Export Promotions Board - Emmanuel Mutahunga	9. Jakana foods Kampala	4. Kwagala Paul – chairman: Tigebwa Development Association, Bushenyi District (Banana wine Processor)
5. Stakeholder Feedback for the project conducted in Mbarara, in March 2015		5. Angelo Ndyaguma Liaison Person: Fruits of the Nile

Secondary data was collected by reviewing District Development Plans, project formulation reports, baseline reports, the vulnerability assessment report and the current Draft Project Identification Form (PIF). The analytical approach comprises of a stakeholder analysis and gender-based elaboration of the value chains proposed for the project, and based on the UNIDO Guide on Gender Mainstreaming Agribusiness Development Projects.

2 STATUS OF GENDER EQUITY IN BANANA VALUE CHAIN

2.1 Introduction

In this section gender issues are described based on literature review and elaboration of the value chain(s) based on available reports and key informant interviews. Gender issues are described in terms of roles, needs, access and control of resources (financial, natural, physical etc.). The analysis is based on the four key products selected for development, although the assessment will also consider other value chains that are potentially compatible with the four proposed. The gender assessment builds on components of adaptive capacity for the banana value chain.

Adaptive capacity refers to the adequacy of five characteristics of; asset base, institutions and entitlements, knowledge and information, innovation and flexible forward looking decision-making and governance (Levine et al. 2011) of the banana value chain. The gender perspective would then be whether women and men have an equal chance to participate in the value chain based on their ability to contribute to all the five characteristics of adaptive capacity. Since adaptive capacity reflects the intrinsic qualities of a system that make it more or less capable of adapting to climate change and its impacts, the role of men and women can be articulated and opportunities for enhancing contribution of those weakly represented can be highlighted. This next section describes the status adaptive capacity issues of the four banana products whose value chains are earmarked for development. The constraints by gender and innovations for narrowing the inequalities are also highlighted.

2.2 Banana Wine

A review of the value chain for banana wine showed that value addition activities are being undertaken by groups or cooperatives as well as individual farmers. The group or cooperative largest processor identified is Tigebwa Development Association (TDA). The association has 55 members. The group employs eight of their members, five men and three women, to undertake wine processing on a regular basis (*Table 2*). Another large player, Jakana Foods, is largely based in central Uganda and has no direct link with south western Uganda. Nonetheless, Jakana Foods can be envisaged supporting the technology development and skills training as it has a more advanced and experienced process line and system than its contemporaries. Kyenshaki Elders group also produces wine but it is a small group of just 15 persons with three women. Several other small processors of wine exist within the landscape examples mentioned include Masheruka GNA Wine processors in Sheema and Kasozi Group which is based in Isingiro who produce Swagga wine and several individual processors. The assessment of the gender considerations was largely based on the case studies of Tigebwa Development Association and Nyabubaare Area Cooperative Enterprises Ltd. as well as secondary data from baseline report and the vulnerability assessment report.

Table 2: Banana wine production, location and preliminary gender information

Name of Factory	Product Processed	Location	General Characteristics
Tigebwa Wines Development Association	Banana Wines	Bushenyi Kanyeghero	26 Male; 29 Female 20,000 litres per month 55 members Annually, TDA is able to produce as much as 244,000 litres of wine
Kyenshaki Elderly group	Banana Wines	Ntungamo, Kyeshaki Rwashamaire Town council	12 Male 3 Female
St. Peters Rock hill organic processor	Banana Wines	Isingiro Isingiro town council	
Jakana Foods Limited	Banana Juice Banana Wine	Luwero Nakaseke Produces in Bushenyi	460,000 litres Banana wine Per year.

Source: UNIDO 2014A; 2014C

2.2.1 Banana production to harvesting and transportation to processing area

Traditionally land in Uganda belongs to men. Even though women can own land and their right of ownership is protected by the law (Land Act Cap 227), and many households report that husbands and wives jointly own the land, women are still less likely to be listed on ownership documents, especially titles, and women have fewer land rights. The current status of land ownership especially the focus on titles to land misses much of the reality regarding land tenure and could especially have an adverse impact on women's land rights (Bomuhangi et al. 2011). Many traditional systems are wary of handing ownership or titles to women for fear of losing them when the woman is married to another family (District Agricultural Officer – Bushenyi, Pers. Comm. 2014). The vulnerability assessment for the banana value chain showed that women are the main providers of labour. However, their limited rights on the land reduce their claim over earnings from the bananas produced. Despite this apparent lack of power of tenure over land women were found to be active in banana production and sale throughout southwestern Uganda, particularly at the farm and the local markets.

In the banana wine value chain, farmers' associations buy bananas from members and only buy from outside the membership when the bananas among members are exhausted. The association picks the bananas on-farms. Even though farmers do not incur the transportation costs, the casual labour hired to transport the bananas is mostly composed of men. The bananas are transported by bicycle to the central place where the banana processing begins at the yard next to the winery. The compound is located at the home of the Chairman of the group. Mature bananas of the improved cultivars of FHIA (Honduras Foundation for Agricultural Research) 17, 21 and 25 are used for wine making.



Plate 2: Men transporting bananas from farm, Mitooma District

2.2.2 Processing cycle

When bananas are brought to the processing compound, they are first hang in a store room next to the kitchen, a role performed by men. The men are also responsible for boiling the bananas. On the other hand, women are responsible for washing, peeling and a lot of the activities in the winery are undertaken by women. Therefore, the regular processing activities are dominated by women. Members are paid for the labour they contribute. The payments may range between UGX 200,000 and 600,000, only less when the production is very low. The majority of the labour used in wine processing is from women.

At peak production, the processing working done in a single day could involve processing of up to 29 women working on 30 bunches of banana, from morning to evening. When it is just one or to bunches, then only one or two women are involved in the processing work. Because many of the group members joined as husband and wife the revenue often ends up in the same families. The community members who can join the association can learn how to process wine and start own processing processes.



Plate 3: Bananas hung in room next to kitchen, under Tigebwa Development Association

Inputs from processing and costs for labour have continually been growing as deductions from the income earned from the sale of wine. Originally, the working capital was obtained from the membership fees contributions of members. Although new members still contribute membership fees, the enterprise has grown and the profitability of the enterprise determines what is kept behind for production.

2.2.3 Marketing and sales for wine

The wine is sold at the winery and at a shop, operated with a partner cooperative association, Nyabubare Area Cooperative Enterprise Ltd. The wine is sold in three measures of branded bottles 750mls, 350mls and 200mls. Only about 10% of the wine is sold at the winery the majority is sold at outlet shops operated by the Nyabubare Area Cooperative Enterprise. The Area cooperative is a model that brings together such similar enterprises of wine makers within Bushenyi, Mitooma, Sheema and Isingiro Districts to enable them to sell their processed products. The membership of this cooperative arrangement is up to 2,450 farmers across the covered Districts. The association largely focuses on provide an outlet where the farmers sell their produce. The products sold include wine, honey, juice, and soap and millet flour produced by farmers. The shop also sells inputs for processing to farmers. The shop sells bottles, caps, stoppers, labelling materials and similar materials similar materials for farmer associations.



Plate 4: Family members show wine processed with their help, Sheema District

TDA wine was displayed in the shop and it occupied about 50% of the shelf space, also the shop manager indicated that it has the highest turnover as follows: (i) 50-60 bottles/week for the 750 mls at UGX 10,000; (ii) 20 bottles/week for the 350 mls at UGX 5,000; and (iii) 120 bottles/week for the 200mls at UGX 3,000. The shops serves as a wholesale outlets for larger buyers including supermarkets and bars although people within the area of Ishaka Town where the shop is located.

The qualities that make TDA stand out are: the good aroma of the wine and the bottle appearance, it looks better than competitors. Women are not major buyers of the wine, perhaps because the wine is associated with people who also go to the bars and supermarkets.

2.2.4 Capacity building activities

One of the key activities undertaken by TDA is the practical skills training provided under the auspices of the Ministry of Education and Sports (MoES). Tigebwa Development Association has, over the last five years, been selected as a training centre for a Certificate Course on Wine making. The training is conducted for youth as a vocational skills building experience. The youths are often aged between 18 years and above. In 2012, the records seen for 2012 show that 70 students comprising 24 girls and 46 boys were trained at the centre and all 70 students passed their course.

The students are recruited under a scheme by the MoES, so TDA only serves as a practical skills training centre, and a curriculum is run for three months with the students. The curriculum consists of training on:

- (i) Equipment and materials
- (ii) Ingredients for wine making
- (iii) Selection of bananas and ripening
- (iv) Extraction of juice
- (v) Adding ingredients and fermentation process
- (vi) Packing
- (vii) Labelling
- (viii) Marketing
- (ix) Hygiene in wine production (personnel hygiene, hygiene in the fermentation room, hygiene for machinery equipment and materials)
- (x) Quality Assurance

The instruction or trainings are conducted by the Chairman of the Association and Two other members who have also be trained elsewhere on wine making as well as instructors from the Directorate of Industrial Training. The examinations are conducted and supervised by the Directorate of Industrial Training independently under the auspices of the Ministry of Education and Sports.



Plate 5: Shop run by Nyabubare Area Cooperative Enterprise, Ishaka Town, Bushenyi District

2.2.5 Emerging constraints

Local wine brands versus international brands

- There are still strong sentiments among the potentially large outlets such as Hotels and Supermarkets that the wine produced by small local processors may not be of good enough quality. Therefore, the locally produced wine has not been a major product on the supermarket shelves and larger hotels. Potential large processors such as Forest Fruits in Bushenyi District have been deterred by concern that the wine produced locally will not match the quality standards required for larger markets.

Education status of women

- The women tended to be less educated than men and generally record keeping is poor. The association may be able to maintain some records but the long-term sustainability may be at risk since the management is limited to a few people that have the skills for record keeping. The prospects of ensuring high quality wine are compromised due to the strong need for a high quality data management system as well as the need to master instructions and make adjustments for maintaining the standard of the wine.

Scaling up and gender roles

- The expansion of associations such as the TDA model is likely to occur through replicating the model in different places as opposed to expanding the current group as the management requirements may be excessive for the current group. The current model is built on profitability and satisfaction built into shared profits from a largely local market.
- Whereas women provide a lot of labour the model allows for payments during wine processing. The risk of losing income because of non-participation and a disruption of roles within the household is countered by the income from the labour provided. As the operations grow, the association may have to consider permanent employees and the long-term sustainability of groups and wine processing may be compromised.
- It is not very clear where the rest of production, done domestically by farm families outside the control of association, ends up. The observations show that a lot of the wine is consumed at small private functions through informal purchases. Formalising this value chains may be difficult.

2.3 Banana Chips

Banana chips are a very promising product for both export and local market growth. The export value chain for chips is dominated by Fruits of the Nile as an exporter. The exporter buys from farmers in small groups in Ntungamo District (*Table 3*). Fruits of the Nile, the exporter, buys already processed chips and only works on ensuring the quality meets international export standards

through supervision of the producers as well as its own quality assurance system. The exporter employs only three permanent staff who are men while 25 staff entirely women are outsourced to undertake sorting and packaging as and when it is required.

Table 3: Banana chips production, location and preliminary gender information

	Name of Factory	Product Processed	Location	Characteristics
1.	Excel Hort Consult	Banana Juice Banana Chips Banana Crisps	Mbarara Mbarara Municipality- Kakoba Division	3 Male 4 Female 1000 litres per week 4000 litres per month
2.	Isingiro District multi stakeholder Agribusiness initiative (IDMAI)	Banana Chips	Isingiro Nyakitunda	
3.	Rutunguru Tukwatanise Tukore Banana Group	Banana Chips	Ntungamo Rutunguru Ihunga Sub-county	6 Male 1 Female
4.	Fruits of Nile (Ntungamo Fruit dryers association)	Dried Apple Bananas	Jinja Njeru Working with Ntungamo & Mbarara District	3 permanent staff
5.	Ntungamo Banana Fruit Dryers Association	Dried Banana chips/ slices	Ntungamo District	

2.3.1 Processing and marketing cycle

At the field level, nearly all chips production is done by small disparate groups that are organised by the major buy an exporter such as Fruits of the Nile and Excel Hort Consult. Forest Fruits Ltd. have also expressed an interest in joining the chips processing both for local and international markets.

The key respondent association considered Ntungamo Fruit Driers Association in Ntungamo District has 13 women and two men. There group started as a women's enterprise with support from a USAID funded international non-governmental organisation, Afri-care. The initiative was meant to help mostly the unmarried women especially the widows. Instead of paying salaries members share the income according to the sales made. If they make more sales they get more. The groups have not progressed considerably and the banana chips supplies have remained modest at about 6,000 tons of dried banana chips annually, although the demand is reported to be at least six times higher.

The association also indicated that they work with children from the farm family members of the association. The use of children is usually because the families have to replace the costs associated with the production chain where in the past Africare provided motivation such as paying tuition fees for their children when the project ended the expectation stayed. The children therefore work as a way of contributing to their own school fees.

2.3.2 Emerging constraints

Working conditions and capital

- The continued use of children threatens the envisaged support of reducing pressure on families of widows and orphans to ensure education support for children. The loss of leadership provided by Africare has not been replaced by the association or external support.
- The poor working capital available to widows and orphans has not allowed them to develop capacity. Similarly the small size of groups means that it will be difficult for them to achieve sustainability because a critical mass of stakeholders has not been built.

Management capacity

- The capacity of the women's groups to undertake management actions such as revolving capital funds and achieving large volumes of production is limited. The entry of more organised stakeholders may lead to the collapse of existing groups as it seems the market size may be strong enough to allow larger players yet the small groups seem less competitive.

Prices for chips versus market prices for fresh bananas

- Whereas the chips have potential to provide a long-term market and income for farmers, they continually get seduced by the incomes from fresh fruits banana markets where the prices could be two times as high as that for the dried chips (dried chips are bought at UGX 6000/kg or \$2.25 versus fresh bananas UGX 8,000 to 12,500 or \$3 to \$4.2 for the same volume).
- The capital investments and maintenance of quality for the banana includes hour away from household chores, and provision of security and storage for the chips. Moreover, when the chips are not well dried they could be spoiled leading to a loss of income for the farmer.
- The labourious nature of producing and drying banana chips means more women are likely to be involved than men. Children are also involved in helping out their parents, although this unlikely to violate children's rights to education and play, among others.

2.4 Banana Juice

There are only two banana juice processors covered in the baseline surveys. The two processors are Forest Fruits Limited and Excel Hort Consult (*Table 4*). Forest Fruit has attained a moderate scale of production by working with 1,200 farmers to produce 5000 litres of juice per week while employing 16 permanent staff. The data for staff is not disaggregated.

Table 4: Banana juice production, location and preliminary gender information

	Name of Factory	Product Processed	Location	General Characteristics
1.	Forest fruit Limited	Banana Juice Banana Wine	Bushenyi Ishaka Nyabicerere Municipality Ward II central division	1200 famers 10000 liters per month. Juice-5000 liters per week 16 permanent staff.
2.	Excel Hort Consult	Banana Juice Banana Chips Banana Crisps	Mbarara Mbarara Municipality- Kakoba Division	3 Male 4 Female 1000 liters per week 4000 liters per month

2.4.1 Banana juice production and processing cycle

The factor picks up fresh extracted banana juice concentrate (nectar) from the farms; the concentrate is prepared using the factory's own facility that is transported and used remotely with a cluster of farmers. The farmers' contribution involves harvesting the bananas, transporting them to a single homestead. The bananas are withered in the sun and stored to ripen. The extraction which is undertaken under the instruction of factory extension staff involves peeling and extraction of the concentrate using the factory set up facility that is transported from one site to another. During the extraction process the farmers only contribute to peeling and the extraction is done by factory staff.

The farmers who supply the factory are in three clusters: (i) Farmers whose own plantations are enough to supply the bananas needed for making juice concentrate; (ii) Farmers who buy and collect bananas from several small holders to one homestead where the factory comes and undertakes primary processing; and (iii) the third cluster consists of farmers who own some bananas but also buy from within the community.

Box 1: Capitalisation and capacity of Forest Fruits Banana Juice Factory in Bushenyi District

The Directors of Forest Fruit Foods Ltd. have invested capital of over UGX 700 million since the factory started as a cottage enterprise in 2003. The company has received technical support from Danish International Development Agency (DANIDA) and from the United Kingdom Department of International Development (DFID) funded Business Uganda Development Scheme (BUDS) project; both have since ended.

Current processing capacity is growing exponentially from 2000 litres/month of banana juice in 2014 to 5000 litres/ week. The projections for the company is that with improved marketing and extending good quality water supply to households the family ought to be increasing processed output to 10,000 litres/week and a storage capacity of at least 20,000 litres in reserve.

A large size extraction site would lead to processing of about 1,000 litres of juice and only five of these exist. To increase production, the factory has established collection routes where farmers with smaller production can have their produce processed and sold to the company.

The growth of the collection routes is based on extension work done by the factory. Such collection routes are composed of at least 10 farmers pooling their production at one homestead.

The factory currently used 25 to 4 hours from the time of picking up the juice concentrate to full processing. With technology support this time can be reduced by 6 hours. This reduction in time would free up resources for extension support and integration of more farmers in banana juice processing.

Source: Kano Naijuka Managing Director (Pers. Comm. 2015)



Plate 6: Inside the factory at Forest Fruits Ltd Bushenyi District

Men are involved in transportation of bananas on bicycles from farms. The average bunch weighs 35 to 40 kg and farmers transport five to six bunches at a time. Therefore, the activity is dominated by men. The women provide garden labour. Usually households are composed of extended families where a family extends from the parents to include sons and their wives therefore adult family could comprise about three women, at least three (unmarried) girls within the homestead and three to four men. The women are involved in peeling, which traditionally is an activity undertaken by women.

Forest Fruits Ltd has seven Directors, two of whom are women. The management team has seven people three women and four men. The company is planning to expand its line into banana chips. Other current products are lemon grass which is planted by women. The factory runs a nursery for plants that provide essential oils and natural flavourings and farmers serve as out growers – these are used in juice processing; these include plants include: cinnamon and lemon grass.

Specific women's roles

- At on-farm processing level, cleaning, scrubbing, and sweeping at the household to ensure that there is adequate hygiene at the homes where the primary processing for the banana juice is undertaken. The factory conducts trainings on the activities to ensure hygiene by farmers.
- The extension support is conducted in groups and it involves formation of leadership involving record keeping and treasurers for the groups. The two roles are often given to women because they are considered trustworthy
- The women are also the major stakeholders in managing household payments from the factory. The payments are conducted through mobile money (money transmitted by phone) transactions.

2.4.2 Marketing

The banana juice is often taken to supermarkets and hotels in the urban areas of Mbarara Municipality, Bushenyi Town and other towns within the area. The outlets are dominated by women. The factory has found that women have more attention to detail and loyalty.



Plate 7: One of the main products from Forest Fruits Ltd, Nyabiceere, Bushenyi, District

The factory has plans of setting up stalls in urban areas and at exhibition shows. The marketing strategy aims at increase sales and distribution, and formal demand creation (demand activation). Women have patience and persistence and they are able to support the marketing strategy.

The factory intends to reach 2000 to 3000 farmers starting in 2016, this will be through expansion of banana juice and diversifying into banana chips and other products like honey.

Variance (the difference between expected processing quantity and quality attributes for banana juice concentrate achieved) – women have the smallest variance an indication of higher consistency in production cycle. Generally women seem to always be better at supplying the factory's raw materials.

2.4.3 Constraints:

Working capital

- An average farm household is paid UGX two million for their bananas contributed to the juice concentrate. Overall about 200 farm families are involved.
- The factory is seeking to increase the frequency of the extraction cycle and reduce the redundancy of the processing cycle.
- From time to time the contracted farmers advance money, under cluster II and cluster III, to the farmers from whom they buy bananas as a means of booking. Therefore for a farmer to join in the production of banana juice concentrate they require working capital of UGX 300,000 to UGX 600,000 per round of juice concentrate production.



Plate 8: Forest Fruits Ltd. staff inspect a farmers raw materials, bananas before processing juice concentrate

- In addition, farmers need working gear such as boots, overalls and gloves. The gear is a requirement to ensure hygiene and bananas ripen under hygienic conditions. If more farmers have access to working gear the number of farmers contracted would increase as

more and more farmers would meet the necessary requirements.

Water Quality

- Culturally it is women and children who fetch water. But water resources are diminishing because swamps have been tampered with and because of land fragmentation that has interfered with consolidated land use planning within the area/ landscape.
- Forest Fruits Ltd. provides water for processing for banana juice because farmers are allowed to access water that is brought by the factory. The alternative processing undertaken in the community for alcohol imposes a lot of labour requirements as families have to travel up to 1 km in search of water

Security

- Given the capital investment that households put in the bananas they cut, wither and ripen for processing, many communities have acquired dogs to ensure their investment is not tampered with. This additional requirement for security has increased the role of women at household level. From time to time households have stock valued at between UGX 400,000 – 500,000. If the factory deems that the raw materials have been tampered with and cannot produce quality banana juice at the required levels of hygiene. The women are often in control of the caring for dogs.

Transportation and access routes within the communities

- Men are much stronger at labour and related issues such as carrying and transporting the bananas, maintaining access of the factory trucks and extension staff, and men usually own the land by traditional extension therefore control the production of bananas.
- Access – trucks have to reach family household and the factory often has to negotiate with troublesome neighbours to convince them to support farmers obtain access. This has often led to introducing the troublesome neighbours into the banana juice value chain.
- The factory is using extension support to reach out to troublesome groups and sometimes laws have been used for enforcement of the law where there is need to prosecute people who tamper with farmers' produce in case malicious damage occurs.

Raw materials production

- Factory believes there is a need to supply Mbidde, Kayinja and Musa suckers and facilitate increased production of these banana varieties within the area. If production is increased Mbidde, Kayinja and Musa can be more significantly produced within the area instead of being minor crops often growing on their own without management.
- Because the average size of the banana farm is 0.8 acres the right variety of bananas for juice (Mbidde, Kayinja and Musa) are not always available. The landscape is dominated by unproductive banana forests that can be converted into banana production if farmers are supported to provide additional support.

Marketing and selling stalls

The stage for expanding market outlets and hiring sales people is proving reasonably expensive. The options available where stall owners have their own capital is difficult because many of these are young people who do not have capital. The factory then has to set aside some resources which also distracts from the primary activity of processing and maintaining the supply chain.

2.5 Vacuum packed banana

Vacuum packaging for bananas was reported by two companies; Fravaserma and Afri-Banana Products Ltd. The information shows a very low employment of just four workers for the former and six workers for the latter. In both cases just one female employee (*Table 4*). The prospects of vacuum packaging can be assessed on the basis of expected growth sector. Additional field visit are earmarked.

Table 5: Vacuum packed banana production, location and preliminary gender information

Name of Factory	Product Processed	Location	General Characteristics
Fravaserma (An Incubator under Afri-banana Ltd).	Vacuum Packed Bananas	Mbarara Mbarara Municipality	3 Male 1 Female
Banana vacuum Packing and marketing(ABP)-Afri Banana products Limited	Vacuum packed Bananas (matooke)	Mbarara District Kakiika Sub-county	6 Workers 1 Female 5 Male

The discussions below are based on discussions held with Fraverserma which is a vacuum banana producing factory based in Mbarara Municipality, Mbarara District. FREVASEMA refers to Fresh Vacuum Sealed Matooke. The incubation unit supports ABP entrepreneurs in the production of vacuum sealed matooke, Banana wine, Banana vinegar and enriched animal feeds. The incubation unit also offers training facilities for interns and students on industrial attachment. FREVASEMA is an incubator under Afri-banana.

Production and processing

The product concept is for fresh bananas acquired from the farm that is peeled and stored under vacuum conditions. The bananas are stored under freezing conditions of between -4 to -18°C or chilled between 0-4°C. This storage would increase the shelf life of frozen vacuum packed bananas to 6 months, if chilled, 1 month. The period would be sufficient to transport peeled bananas to urban markets and sell in a supermarket and/or export.

Gender issues and concerns

The characterisation of gender issues for vacuum packed banana processing is current limited to the working conditions within the factories. Currently, there are less women than the men because the work which is done is very physical as it involves lifting heavy material thus they need more men than women. Nonetheless, there are cross-cutting concerns that emerged such as dealing with physical

work for women in active child bearing age if they give birth by caesarean section and are unable to recover the same strength they had before.

The experience with banana vacuum packing factories showed that there was equity on salaries regardless of gender. Instead the payments were based on staff qualifications of staff. Farm families supplied the raw materials (bananas) to the factories. The suppliers do their activities as a family so may find that there are children involved in the work but their participation is on a small scale.

2.6 District level concerns

Several District level concerns also affect the performance of the banana value chains. The main concerns are water access, education levels for women compared to men, exposure to knowledge, women's involvement in labour, land ownership and access to social services, among others.

Water access

In all eight Districts water access is likely to affect women more than men. In Buhweju, Bushenyi, Mitooma and Sheema was access involved women walking over one kilometre in search for water.

Education

There is a higher drop-out rate for girls than boys from schools. As a result early marriages reduce labour sources for farms and large families lead to land fragmentation which reduces area productivity.

Exposure to knowledge women do not generally attend sensitisation meetings

Women tend to be domesticated and generally are less likely to attend sensitisation meetings on development related activities. As such women who are also engaged in production are also less likely to contribute to adaptation activities that improve the value chain.

Women and casual labour

In addition to farm labour being dominated by women and productive assets by men, youth are not involved in road maintenance and the roads are mainly tendered by men who only hire women to work

Land ownership

High population is due to fertility rate which limits commercial farming and causes tenure insecurity for many local family members in Mitooma district.

Environmental degradation

Environmental degradation; increased population leads to land conflict hence deforestation, encroachment on wet lands.

Service provision

Gender impact analysis: service provision is biased towards the better off and to some extent neglects the issues of marginalized categories of the population. While women provide the bulk of agricultural labour and are responsible for providing food and other necessities for their families, they do not to some extent control money they earn from other income generating activities such as petty trade.



Plate 9: Production staff meeting for Rubirizi District

3. PROSPECTS AND PROPOSALS FOR GENDER MAINSTREAMING

3.1 Introduction

In this section stakeholder and institutional analysis and preliminary logical framework analysis will be undertaken to establish likely outputs, activities, roles and responsibilities for mainstreaming gender in implementation of the project. The focus of the assessment of prospects and proposals will be based on value chains and proposed interventions as well as simplified institutional analysis. The institutional analysis will identify stakeholders who serve different roles especially within the setting of District Local Governments, Non-Governmental organisations and Central Government, especially the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF).

3.2 Issues emerging from the value chain

General

- Traditionally land ownership is heavily tilted in favour of men. Most communities including men and women would prefer that titles were given to men to avoid loss of wealth from one family into another when the woman married.
- Women still provide the majority of labour in production, and also have a fair participation in local banana markets. At farm level, their reduced rights over land ownership reduce their rights over earnings obtained from the farm
- Whereas not generally mentioned there is not specific gender policy in all the facilities visited. Therefore, while there is effort to create separate bathroom areas for women and men, this is not widespread. There is also a need to distinguish gender roles and responsibilities so that women can work at full scale when available and also care for children and other personal concerns peculiar to women.

Banana wine

- (i) The roles in banana wine processing seem to be strongly gender segregated. While men engage in the more manual labour of transporting bananas and hanging them to dry as well as boiling the peeled bananas, women are more engaged in peeling, collection of juice and winery processes as well as labelling of the final product. The assignment of duties during processing is based on the assumption that the activities that require a lot of strength should be undertaken by men while those that may not require a lot of strength but are often laborious are left to women.
- (ii) The wine shops and wine selling is divided between men and women with a higher likelihood of findings women sellers compared to men. The women are considered for favourably for

wine shops because of their patience and honesty in the transactions as well as communications to customers.

- (iii) Tigebwa Development Association also supports training activities for practical skills under the auspices of the Ministry of Education and Sports (MoES). The practical training is undertaken by a team of four people, one of these four trainers is a woman. This distribution of men and women also occurs when it comes to management roles within the association and the number of young people trained. It seems that women seem to contribute only one-third or less to more specialised skills and activities undertaken by the association.
- (iv) the Chairman of TDA indicated that the women in their group struggle more with activities such as records and book keeping than men, and this would likely also affect their ability to utilise financing opportunities. Although the group seemed generally poorly prepared in terms of records and book keeping.
- (v) The wine value scores on gender equity in terms of encouraging members to train their households on wine making. The profits from the wine are shared equally among all the members without exception of whether one is male or female, and women are also more likely to benefit from recurrent earning from the labour they provide during processing.

Banana chips

- (i) The producers are mostly small groups started were supported in the start-up by donor projects under the United States Agency for International Development (USAID) and DFID, among others. These groups have stayed small and they sell to international exporters are semi-processed product.
- (ii) Whereas the chips have potential to provide a long-term market and income for farmers, they continually get seduced by the incomes from fresh fruits banana markets where the prices could be two times as high as that for the dried chips (dried chips are bought at UGX 6000/kg or \$2.25 versus fresh bananas UGX 8,000 to 12,500 or \$3 to \$4.2 for the same volume).
- (iii) The capital investments and maintenance of quality for the banana includes hour away from household chores, and provision of security and storage for the chips. Moreover, when the chips are not well dried they could be spoiled leading to a loss of income for the farmer.
- (iv) The labourious nature of producing and drying banana chips means more women are likely to be involved than men. Children are also involved in helping out their parents, although this unlikely to violate children's rights to education and play, among others.
- (v) The capacity of the women's groups to undertake management actions such as revolving

capital funds and achieving large volumes of production is limited. The entry of more organised stakeholders may lead to the collapse of existing groups as it seems the market size may be strong enough to allow larger players yet the small groups seem less competitive

Banana juice

- (i) For farmer to join in the production of banana juice concentrate they require working capital of UGX 300,000 to UGX 600,000 per round of juice concentrate production. Women are often cash poor and struggle to raise the necessary working capital to join the enterprise, although when the capital is raised by households, women still contribute much of the labour.
- (ii) Women are involved in most of the work that requires high hygiene such as peeling and supporting the processing for juice concentrate. They therefore require working gear but when this is expensive they find themselves being left out of the value chain.
- (iii) Culturally it is women and children who fetch water. As water resources diminishing the pressure to travel long distances for water will fall on women. This will reduce the productive time available for other activities.
- (iv) Security is required to protect the raw materials stock valued at between UGX 400,000 – 500,000 at a time. The women are often in control of the caring for dogs.
- (v) Men are much stronger at labour and related issues such as carrying and transporting the bananas, maintaining access of the factory trucks and extension staff, and men usually own the land by traditional extension therefore control the production of bananas. Innovation of using donkeys to transport bananas and inputs to and from the field. This can also be helpful for gathering raw materials and in the long-term perhaps transportation of other semi-processed products.
- (vi) The factory is using extension support to reach out to troublesome groups and sometimes laws have been used for enforcement of the law where there is need to prosecute people who tamper with farmers' produce in case malicious damage occurs. Whereas negotiations and community level agreement is better sometimes legal routes have to be used which then causes a disruption on community relations. In many cases women are most affected because they have to deal with the break down in relations on a daily basis.
- (vii) Factory believes there is a need to supply Mbidde, Kayinja and Musa suckers and facilitate increased production of these banana varieties within the area. If production is increased Mbidde, Kayinja and Musa can be more significantly produced within the area instead of being minor crops often growing on their own without management. This can be an opportunity of enterprise for women and men.

- (viii) The stage for expanding market outlets and hiring sales people is proving reasonably expensive. The options available where stall owners have their own capital is difficult because many of these are young people who do not have capital. The factory then has to set aside some resources which also distracts from the primary activity of processing and maintaining the supply chain.

Vacuum packed banana

- (i) The production of vacuum bananas involves a lot of lifting and the bananas are quite heavy, on averaging weighing between 35 to 50kg. Therefore, the physical work was generally restricted to men.
- (ii) Currently, there are less women than the men because the work which is done is very physical as it involves lifting heavy material thus they need more men than women.
- (iii) The experience with banana vacuum packing factories showed that there was equity on salaries regardless of gender. Instead the payments were based on staff qualifications of staff. Farm families supplied the raw materials (bananas) to the factories.
- (iv) The suppliers do their activities as a family so may find that there are children involved in the work but their participation is on a small scale.

3.3 Prospects and proposals for gender mainstreaming banana value chain

Natural assets: land tenure

Issue:

- The traditional and/or cultural concerns over land are important to the success of any intervention. But the existence of the law, the Land Act cap 227, should also be used at ensuring the strength of tenure for both men and women. Many development projects have realised that enterprises that are run as households with support of the local councils in confirming land ownership are able to maintain stability in the long-term.

Proposals/ prospects

- Women's rights can be strengthened through agreements with projects participating in project activities where land is a natural capital asset as their investment. In these agreements the decisions over the use of land have to include the husband, wife and children, with the three parties signing on the agreement to acknowledge participation in the decision.

- Project implementation activities ought to include trainings on equitable use of land and earnings from the land at household level. The project will also establish the level of involvement of women in decision making over income distribution and/or utilisation at farm household level.

Financial resources e.g. working capital

Issue:

- At farm level, working capital is quite small particularly for farm households that undertake primary processing. Women would participate but often at a small scale
- At processing level, the working capital requirement is usually high usually in excess of UGX 400,000 per processing cycle for banana juice and UGX 200,000 for banana wine. The processing cycles for banana chips also require capital, while vacuum banana processing can only be undertaken by an establish factory. The household set up is often the best option
- At marketing level, the capital requirement to set up a shop or stall for produce is quite high a simple assessment for Nyabubaare A.CE. Ltd and the banana juice with Forest Fruits showed that only large supermarkets, hotels and existing shops would have low entry costs. New start-ups would require capital in excess of UGX 1,000,000. Women often have little existing leverage in the current market

Proposals/ prospects

- Establishment of savings and credit cooperatives (SACCOs) and/or joining into existing SACCOs to support the banana value chain.
- At a smaller scale capacity building for revolving funds especially at farm level, wine, juice and chips processing could benefit some women
- Promotion of mobile money transactions among all project participants especially women

Transport & physical labour

Issues

- A physical strength is required in carrying bananas from the field and hanging them. This reduced the likely participation of women.
- Transportation is mostly by bicycle or head. While some women can ride bicycles, this has limited cultural acceptability especially if the women are married. Carrying on the head is not only tiring and time consuming but is inefficient as only one bunch can be carried at a time.
- Even within factories a lot of heavy lifting is done within the processing line when trolleys could easily reduce the need for lifting

Proposals/ prospects

- The use of donkeys for transport has been proposed. Donkey transportation would be cheaper than trucks and would work within a mountainous terrain.
- Introduce the use of carts and trolleys within the factories.

- Introduce training and demonstration on the use of appropriate gear (clothing, gloves and to ensure that women can have a stronger participation in the processing line

Security of investments

Issues

- Security is needed for raw materials that are brought to households are kept in the compounds/ verandas under shed or cover. There are some cases where stores have been built but the standard of practice for stores is poor that shades are sometimes preferred.

Proposals/ prospects

- Provide training on stores and their management, also set up communal arrangements of building cheap stores facilities throughout the community.
- Provide scale up training on how external security of dogs and feeding dogs can be a short-term solution.

Equity of prices

Issues

- Members involved in some value chains feel cheated about the price they receive. Where the products are female dominated such as banana chips the feeling of inequity is particularly high.

Proposals/ prospects

- Improve market information on prices
- Support alternative buyers of products so that there is competition and a fair price is passed on to farmers.

Supply of planting materials for processing

Issues

- There are not enough planting materials for Mbidde, Plantain and Kayinja for banana juice. This limits participation of community members in the banana juice value chain

Proposals/ prospects

- Support establishment of nurseries with varieties of Mbidde, Plantain and Kayinja, preferably from suckers.
- Encourage willing households to allocate a portion, at least 10% of their land to Mbidde, Plantain and Kayinja production.

Access to water access

Issues

- Concerns over water are associated with diminishing quantities in the local streams and distances travelled by women and children to fetch water.
- There is a poor rainwater harvesting culture within the community.

Proposals/ prospects

- A programme on environmental mainstreaming within the project to train on protection of wetlands and watersheds.
- Training and pilot demonstrations on rainwater harvesting within the community

Education and literacy

Issues

- Women tend to be less educated than men.
- Generally poor skills on book keeping and records keeping

Proposals/ prospects

- Support specific capacity building for adults under Functional Adult Literacy (FAL). The support should build skills on records and book keeping
- Mainstreaming a component on the need for educating education girls and children in general in the social and gender component of the project.

4. GENDER-RESPONSIVE TARGETS AND INDICATORS TO MONITOR AND EVALUATE GENDER MAINSTREAMING ACTIVITIES

4.1 Introduction

A central focus of the gender analysis was to identify the outstanding gender issues that would be the focus for “the Uganda Banana Livelihoods Diversification Project”. The key concerns are related to the current and proposed role of women and men in the banana value chain. Currently, many value chains are under developed and roles are dictated by cultural situations and access to resources. The characterised of adaptive capacity for the banana value chain for south western Uganda indicated that adaptive capacity is low because the resources required for adaptive capacity are poorly developed. But the resources are also inequitably distributed between men and women. In choosing indicators for enhancing gender equality and equity the emphasis might be placed on allowing women greater influence beyond that offer based on the current situation.

4.2 Targeted outputs/ outcomes and indicators

The key issues and likely gender indicators for the project are highlighted in the section that follows. Where a lot of the input, processing and marketing indicators will be direct output indicators associated with the project, it is also envisaged that the project will achieve specific impacts on the welfare of households, women and men. The indicators highlighted are in line with national criteria for at least one-third participation of women in leadership and public development activities. However, there will be higher targets set for access to inputs such as water, banana planting materials and working capital. Other higher targets will be for increased reported processing attained and reduced child labour. These higher targets are more in line with the objectives of the project.

4.2.1 Input indicators

Five issues were selected from the analysis of gender concerns, water access and availability for processing, stability of raw material supply for processing, equity in access to working capital access to land and other physical assets and options to excessive physical labour in the pre-processing phase, especially banana transportation. As indicated in Table 5, six accompanying indicators (two for access to working capital) were selected and the potential project targets set. The estimated baseline was based on field observation and discussions with stakeholders as described in the methodology.

Table 6: Input indicators for gender equity and/or equality in the banana value chain

Issue	Likely Indicator	Target	Baseline
Inputs			
1. Water access and availability for processing and other uses for beneficiaries, especially women;	%domestically available clean easily accessible water source per household of project beneficiaries	45%	20%
2. Regularity and/or stability of appropriate raw materials supply; i.e. bananas for processing chips, juice and wines;	%increase in banana production available for processing	40%	20%
3. Equity of access & availability of working capital for women & men	% access to working capital/financing for women	40%	15%
	% access to working capital/financing for men	40%	25%
4. Access to land and other physical assets for women	% participation in decisions over land use for banana enterprise	30%	<10%
5. Alternative technology options for physically labour demand functions in the supply chain for raw materials	% processing facilities employing labour saving technologies	30%	<10%

< - less than

4.2.2 Processing cycle

The gender mainstreaming issues for the processing cycle issues emerge from the input cycle component issues addressed above. Therefore, it is envisaged that the input cycle concerns refer mostly to the primary processing for crude, unrefined products with cooperatives while the processing refers to the secondary and improvement to achieve a certifiable standard for the market. Therefore, in addition to the indicators above, three other issues for increasing efficiency and output of product, enhancing the role of women in the processing cycle especially at management or administrative level and reducing physical labour demands to increase chances of women's involvement are highlighted (Table 6). The indicators below were based on discussions with stakeholders and discussions of the project design team.

Table 7: Gender indicators for the processing cycle of the banana value chain

Issue	Likely Indicator	Target	Baseline
Processing capacity			
1. Increased processing and reported processing of all targeted banana processed products;	% increase in processed banana products, reported by women of project beneficiaries	60%	20%
2. Management capacity of women in the supported value chains;	% participation of women in management roles and decisions	30%	10%
3. Reduced physical labour demand in the processing chain	% increase in physical labour saving technologies by processing facility	30%	<10%

< - less than

4.2.3 Marketing component

The marketing concerns are largely to do with increasing the number of outlets and share within formal markets as well as skills and capacity of both men and women. The current number outlets and shares based on shelf space for banana products (UNIDO Vulnerability Assessment 2014) is less than 5%. Similarly, the stakeholders highlighted very low technical capacity in marketing, especially for women. Moreover, there is a strong interest to involve women in marketing activities for the banana value chain. In Table 7, the proposed target for the project and estimated baseline are indicated.

Table 8: Gender indicators for the marketing component of the banana value chain

Issue	Likely Indicator	Target	Baseline
Marketing			
1. Increased number of outlets & market share for processed banana products with equality in participation for men & women	% increase in outlets & market share for processed banana products for women	20%	<5%
2. Marketing training, skills & capacity of women in value chains.	% number women trained in specialised value chain development capacities	30%	<10%

< - less than

4.2.4 Welfare and livelihoods of beneficiaries

At the end of the project, there are expectations on the likely contribution of the project on the welfare of communities. From the perspective of gender, it is expected that use of child labour will decline, revenue retained in the value chain, especially by women will increase, household income and food security will increase and the influence of women on investments undertaken within the value chain will also increase. The suggested targets are indicated in Table 8 below.

Table 9: Gender indicators for the welfare and livelihoods impacts from the banana value chain

Issue	Likely Indicator	Target	Baseline
Welfare and livelihoods of beneficiaries			
1. Involvement of children in heavy & time consuming labour,	% reported cases of child labour in the banana processing cycle	<20%	>45%
2. Proportion of revenue of value chain retained by women;	% of banana value chain revenue retained by women	30%	<10%
3. Improvements in livelihoods and welfare indicators such as household income and food security; and	% Improvements in household income; % Improvements in household food security;	50% 50%	>30% >30%
4. Influence of women in value chain investment decisions at household and processing level.	% women reporting an increased participating in banana value addition decision making	50%	10-20%

< - less than; > - greater than

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

- The gender disaggregated information on the banana value chains proposed for development suggests greater gender and equality for the banana wine because of the higher progress achieved for successful cooperatives such as Tigebwa Development Association (TDA). Indeed the capacity of cooperatives to create equality in revenue sharing and provide greater employment for women offer a good opportunity for employing women. Nonetheless even for seemingly gender equal value chains the balancing of gender roles and limited capital access and availability for men and women may slow the advance of gender equity.
- Moreover, the success of the banana wine is a little isolated because banana chips were deliberate gender emancipation practices has remained an under developed value chain. Potentially progressive value chains for banana juice and peeled bananas might be capital intensive potentially limiting the involvement of women.
- Across all value chain women had limited access to physical and working assets. Physical and working assets such as land, factory facilities and banana raw materials were more in the lands of men than women. Culturally, the setup allows men to own land and other physical assets. Therefore, often times external interventions and deliberate local affirmative action may be required to enhance the physical capital and working assets available to women.
- The welfare benefits for women and men are only clearly distinguishable for the banana value chain and banana chips. For banana wine there are signs of improvement while the latter value chain suggest declining welfare. For banana juice it is not immediately clear whether the welfare of women and/or men improves. Nonetheless, the incomes earned were reported to be higher. The peeled banana product is fairly limited in scope even though it has strong promise for participation of women.
- The absence of raw materials for banana juice and banana chips, and limited access to water for processing and domestic use, as well as energy constraints seem to have a greater impact on women than men. Traditionally, women fetch water and firewood for domestic use, and while men can buy raw materials for processing, women are usually cash poor and may suffer reduced involvement if they have to buy banana raw materials.

5.2 Recommendations

1. Support for value chain inputs ought to target increased water access and availability, raw materials (banana planting materials) and physical and working capital access for women. Additionally access to energy will also be an important intervention. Altogether these interventions will allow women to match the likely advantage that women have in the current banana value chains.
2. Banana value chain development efforts may have to concentrate on the newer peeled banana/matooke product, and the banana chips. These two products will likely continually be dominated by women. On the other hand, the participation of women in successful banana wine cooperatives can be promoted a model for achieving gender equity. The clarity of gender participation in the banana juice value chain can be a key intervention for the project.
3. Enhancing directly measurable welfare benefits for households such as food security and income will allow the success of the projects to have long-term impacts. This can be consolidated with establishing the income drawn from the value chain by women and the influence women have over the use of the revenue acquired at household and business level.
4. There are starting efforts to build management capacity for women and their role within the marketing processes. Because the specialised participation starts off from a lower base gender equality would be enhanced by increasing the management capacity of women in all four banana value chains.

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**REPORT ON THE CAPACITY NEEDS FOR THE TARGETED
BANANA PROCESSING ENTERPRISES IN WESTERN
UGANDA**

**Submitted to
UNIDO**

By

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List of Acronym

FON:	Fruits of the Nile
GHP:	Good Hygiene Practices
GMP:	Good Manufacturing Practices
HACCP:	Hazard Analysis Critic Control Program
IPR:	Intellectual Property Rights
MAK:	Makerere University, Kampala
MUBS:	Makerere University Business School
PPM:	Parts Per Million
SSOP:	Standard Sanitation Operating Procedures
RO:	Reverse Osmosis
SMEs:	Small and Medium Enterprises
UCA:	Uganda Cooperative Alliance
UNBS:	Uganda National Bureau of Standards
UNIDO:	United Nations Industrial Development Organization
US:	Uganda Standard
UV:	Ultra Violet (rays from the sun)

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1.0 INTRODUCTION

This is a report submitted by Mr. Ssonko Umar Lule, who was contracted by UNIDO as a consultant to assess the capacity needs for the targeted Banana processing facilities within Western Uganda. The consultancy contract commenced on 05th January 2015 and ended on 27th March 2015.

1.1 Background

The Programme Development and Technical Cooperation Division (PTC) is responsible for providing technical cooperation services on technological and economic issues in areas covered by UNIDO's mandate in developing countries and countries with economies in transition. In Uganda, UNIDO's position is to support the Technical Assistance programme on “Reducing Vulnerability of Banana Producing Communities to Climate Change through Banana Value Added Activities in Uganda”, and is backstopped by the Agri-Business Development Unit (PTC/AGR/ABD), of the Agri- Business Development Branch (PTC/AGR).

Specifically, UNIDO through the Banana Livelihoods diversification project aims to assist the Government of Uganda to support vulnerable communities in Western Uganda by strengthening their resilience to the effects of climate change through banana value addition activities so as to provide greater opportunities for income generation, poverty reduction and food security.

UNIDO is in the process of compiling a baseline report as well as preparing the project design for the Banana Livelihoods diversification project in Uganda. As part of this process, capacity needs of the targeted banana processing enterprises in Western Uganda in relation to equipment and training so as to improve their products' quality and quantity were assessed. This assessment was achieved through acquisition of a consultant for the exercise and the findings from the assessment are being reported in this report.

1.2 Objective

The objective of this study was to evaluate the capacity needs in relation to equipment and trainings for the micro –medium sized enterprises in the target region(s) engaged in banana value addition so as to improve their efficiencies in the banana value added industry.

1.3 Specific objectives

1. To design and administer questionnaires to the targeted enterprises to review constraints in processing of the different products; from primary processing through to packaging, certification and marketing.
2. To assess the operations of the existing enterprises including the farmer groups engaged in value addition.
3. To identify the major equipment needed by the micro-medium banana processing enterprises identified in the project for improved production of products in terms of quality and quantity including their estimated cost and potential suppliers.
4. To identify the training needs of the micro-medium banana processing enterprises identified in the project to ensure quality production and the potential training/service providers for the banana value addition aspect of the project.
5. To provide input in the form of a final report detailing the major findings of the study.

1.4 Scope

The study covered the identified SMEs, processors, enterprises and farming cooperatives/ groups that are involved in production of banana juice, banana wine, banana dried chips and vacuum sealed banana products. The area of coverage included the districts of Isingiro, Mbarara, Ntungamo and the greater Bushenyi districts of Sheema and Bushenyi.

The main core areas of assessment included: Enterprises premises characteristics, Banana product development/ value addition, Enterprise employees (group members) characteristics, Banana products marketing and required training.

2.0 METHODOLOGY

The methodology used in the data collection exercise consisted of use of questionnaires. Data needed for this gap filling needs assessment study were collected using questionnaires which served both as questionnaires and also guided the in-depth semi-structured interviews carried out by the author of this report.

The questionnaires were used to obtain a general understanding of the various Bananas processing enterprises' characteristics, processing activities, their capacities in terms of production, skills and training. The questionnaires were filled by the respondents in some cases

with the help of the interviewer while in other cases the interviewer did the filling when the respondent or respondents were hesitant to fill the questionnaire. Information obtained from the questionnaire was further enriched by Semi structured interviews and personal observations made by the author.

3.0 OBSERVATIONS AND FINDINGS

The observations, findings and recommendations for the banana processing facilities and banana processing equipment are discussed in the sections that follow.

3.1 Banana chips processing associations

All the banana chips processing was being done by farmer groups. Among the districts that were covered in the study, banana dried chips were being produced in Mbarara, Isingiro and Ntungamo districts only. Unlike the banana chips processing groups in Mbarara district, Ntungamo district banana processing groups had an umbrella association called Ntungamo Fruit Driers Association, under which sale of their products was done.

3.1.1 Assessment of the banana chips processing operations

The banana chips operations for the processing groups in the target areas were as shown in *table 1*, which also entails the recommendations for improved quality and quantity production of the banana chips.

Table 1: Current banana chips processing operations and recommendations

Process activity/ stage	Current operations	Recommendation
Criteria for purchase of raw bananas	Selection of banana based on personal perceived quality parameters	Development of standard quality criteria for raw material selection
Purchase of raw bananas	Most processors purchase in bunches	Purchase in Kilograms for all banana raw materials
Weathering	Most processors don't carry out this activity	Should expose the bananas in the sun for about 1 hour
Ripening	Majority carry out ripening in the open	<ul style="list-style-type: none"> – Small rooms with insulated doors and absence of air outlets or inlets – Use of a ripening aid
Cleaning	<ul style="list-style-type: none"> - Use plastic buckets - Use clean water 	<ul style="list-style-type: none"> – Stainless steel buckets or troughs should be used – Use of portable water
Peeling and slicing	<ul style="list-style-type: none"> - Peeling, slicing and other processing steps done in the same place including product packaging - Use stainless steel knives - Some use plastic buckets - Do not have working tables 	<ul style="list-style-type: none"> - Construction/ designation of a preparation room - Stainless steel buckets - Stainless steel working table
Drying of bananas	- End point determined visually by experienced members	- Provision of a moisture meter
Packaging	- Packaging in plastic sheet that are tied at the end results in fungal attack of the products when they check on them more than two times as they stock up to have the minimum amount of products to send to their buyer (FON).	- Self-sealing plastic bags would be more appropriate
Storage	- Product stored in the same room where the processing is done	- Should have separate rooms

The recommendations for the operations of the banana chips processing associations in *table 1* above will lead to the following:

- Purchase in Kilograms for all banana raw materials would lead to straight forward calculation of the yield and hence profitability
- Weathering through exposure of the bananas to the sun for about 1 hour would lead to:
 - Concentration of the contents of the bananas
 - Bananas absorb heat which improves their ripening
- Small rooms with insulated doors and absence of air outlets or inlets, and use of a ripening aid will result into:
 - More uniform ripening of the bananas

- Reduction of ripening time
- Use of portable water and stainless steel buckets or troughs are some of the prerequisites for UNBS certification and the latter eases the cleaning of the utensils
- Construction/ designation of a preparation room, use of stainless steel buckets and stainless steel working table will:
 - Minimize the risk of cross contamination of the products
 - Ease cleaning and lead to meeting one of the GMP requirements
 - Eliminate exposure to corrosion/ rust
- Provision of a moisture meter will lead to drying of products at to a consistent end point
- Self-sealing plastic bags will minimize moisture absorption when checking on the samples

3.1.2 Major equipment needed for improved production of banana dried chips

It is important to note that all the banana chips processing groups that were visited did not have grid power which limits the type of equipment that can be used by these groups. The major requirements for improvement of the banana chips production in terms of quality and quantity were as shown in *table 2*.

Table 2: Major equipment needed for quality production of banana chips by the farmer groups

Equipment	Specifications	QTY	Estimated cost	Potential supplier(s)
Improved solar driers	For recommended drier specifications (see <i>table 3</i>)	5	4,000,000/=	KACE
Work tables ¹ (non fabricated)	Stainless steelwork top, Dimensions (cm): 76 x 180 x 86 (H), Adjustable under shelves	2	2,500,000/=	The Tamales
Work tables (fabricated)	Stainless steelwork top (1 mm thickness), Dimensions (cm): 240 x 120 x 86(H), 1 level, Stainless steel stands(40 x 40 mm)		2,030,000/=	Aquva International Ltd
Stainless steel buckets	Standard with a carrying handle and nest, Capacity: 10-20 L	6	40,000/=	Kalambi General Agencies Snowmans (U) Ltd
Sauce pans	Stainless steel saucepans with covers, Capacity: ~20L	3	200,000/=	Kampala Kitchen Care
Moisture meters/ Analyzer ²	Accuracy: Typically 0.3 STD for %MC and 1.0 kg/hl STD for specific weight Repeatability: 0.05 to 0.15 STD		7,000,000/=	Precise Weighing Systems Ltd

Equipment	Specifications	QTY	Estimated cost	Potential supplier(s)
	for % MC, Measurement Range: 1-35% MC dependent on application, Operating Environment: 0 to +55°C, Dimensions: 325mm x 164mm x 120mm, Weight: 1.5 kg, Power Supply: 4 x C size 1.5V Alkaline Batteries, Sample Cell: 290ml Volume, 20 – 240g, Printer output: RS232C, 300 or 4800 baud, Resolution: Moisture 0.1%, Temperature 0.1°C, Temperature: °C or °F			
Weighing balance	Heavy duty mechanical suspended scale, Easy to read dial housed in a robust die cast casing, Low friction bearings, Accuracy: 0.002, Adjustment: up to 10% zero adjustment, Capacity: 100 kg x 200 g, Dial Size: ~254 mm, Case: Die-cast , Swivel top and bottom hooks	1	1,600,000/=	Avery East Africa Precise Weighing Systems Ltd

Note: 1- Ready-made or fabricated Stainless working tables can be used, 2- Suppliers should be requested to calibrate the moisture meter for banana chips

Driers are the main processing equipment for the production of banana dried chips. Driers of higher efficiency and durability are required by the processing associations to increase their processing capacity and quality. A comparison of the current driers and the recommended driers is in *table 3*.

Table 3: Current and recommended solar dryers comparison

Comparison parameters	Current driers	Recommended drier
Capacity per batch	20 kg fresh banana	50 Kg of fresh
Drying time	3-5 days	2-4 days
Drying air temperature	Not known	Not known
Air circulation	Natural circulation	Natural convention
Dimensions	1.2m x 2.4m	6.7m x 1.22m
No. of trays	8 but only 4 are effective	4 trays
Source of power	Solar energy only	Solar energy only
Colour of the dryer interior	Not dark	Has black surfaces in the interior
Heat collector	Absent	Present
Dryer wall materials	UV stabilized plastic sheets	Metallic walls, metallic frame with sponge insulator inside

Joining and fittings	Nails and metallic pins	Screws and plastic liner
Stands	Wooden stands	Brick stands
Estimated cost	About UGX 600,000	About UGX 4,000,000
Maintenance	Regular maintenance	No regular maintenance
Durability	About 5 years	More than 10 years

Apart from obtaining new driers like the ones recommended in *table 3*, improvements in the existing driers for the processing groups may be done as suggested in *table 4* so as to improve on their efficiency in case funds for provision of the new driers are limiting.

Table 4: Possible improvements to the existing solar driers

Drier part	Status	Recommended	Expected results
Drier trays	- Sliced bananas are loaded on trays made of wooden frames and plastic mesh	- Aluminium Tray frames should be used when affordable	- Ease of cleaning and eliminates water clogging & mold development within the frame
UV- stabilized plastic sheet	- Driers UV- stabilized plastic sheets used continuously even after their lifetime	- Plastic sheets should be changed every 5 years	- Higher drying efficiency due to higher intensity of heat in the drier
Drier stands	- Wooden, some with rodent blocks, many not re-oiled after fading of the oil	- All wooden stands should be fitted with rodent blocks and oiled regularly	- Effective prevention of insect and rodent attacks

It should be noted that the main materials used for the construction of the existing solar driers at the processing groups localities, are purchased from the sole buyer of their products such as the UV- stabilized plastic sheet and the plastic mesh used for the trays. However, the UV – stabilized plastic sheets can be obtained from suppliers of greenhouse materials though the banana chips processors are not aware of that. The UV – stabilized plastic sheets cost about 5,000/= per meter when supplied by the suppliers of greenhouse materials such as Balton Uganda Ltd.

3.1.3 Training needs for improved production of banana dried chips

The banana processing groups' training needs for improved quality and quantity production of banana dried chips were as shown in *table 5*:

Table 5: Training needs for improved quality and quantity production of banana dried chips

Category	Required training	Potential providers
Banana chips Processing	GMP and GHP	UNBS
	Quality Assurance and Food safety	
	Food processing	Food Science department, MAK
Business planning & management	Record keeping	MUBS,
	Marketing	N.C.C Consultancy Services

3.2 Banana juice processing enterprise

Banana juice processing is commercially done by one enterprise, which is located in Bushenyi district. Another entity involved in banana juice processing was located in Mbarara district, however, according to the assessment, their production was rather more research oriented than commercial. Thus, the findings that follow were based on the banana juice processing enterprise in Bushenyi district, which is a private limited company.

3.2.1 Assessment of the Banana juice processing operations

It is worth noting that the banana juice processing operations for the enterprise that was considered for this report are divided into primary processing and secondary processing. The primary banana juice processing, which involves juice extraction is done at the out growers premises after which the juice is transported to the factory premises, where the secondary processing is done. The banana juice processing operations for the enterprises were as shown in *table 6*, in addition to the recommendations for improved quality and quantity production of banana juice.

Table 6: Banana juice processing operations and recommendations

Process activity/ stage	Current operations	Recommendation
Criteria for purchase of raw bananas	Selection of banana based on personal perceived quality parameters	Development of standard quality criteria for raw material selection
Ripening	Majority carry out ripening in the open or dig holes in the ground where the bananas are ripened	<ul style="list-style-type: none"> – Small rooms with insulated ways and absence of air outlets or inlets – Use of a ripening aid

Process activity/ stage	Current operations	Recommendation
Cleaning	<ul style="list-style-type: none"> - Use plastic buckets - Use water from a water purification system 	<ul style="list-style-type: none"> - Stainless steel buckets or troughs should be used
Banana pulp weighing	<ul style="list-style-type: none"> - All use plastic buckets 	<ul style="list-style-type: none"> - Stainless steel buckets
Water boiling	<ul style="list-style-type: none"> - Use energy efficient fire wood stove - Use treated water 	<ul style="list-style-type: none"> - Water tests should be carried out to determine the appropriateness of the available treatment system
Juice extraction	<ul style="list-style-type: none"> - Use traditional juice extraction technique 	<ul style="list-style-type: none"> - Use of modern juice extraction techniques is recommended
Raw banana juice transportation from the out growers to the banana factory for secondary processing	<ul style="list-style-type: none"> - Using plastic tanks placed on trucks - Have one tank in the field 	<ul style="list-style-type: none"> - Use of stainless steel tanks - Need 3 haulage tank in the field to transport the different juice grades
Holding and storage of juice at the banana factory	<ul style="list-style-type: none"> - Holding and storage is in white plastic tanks 	<ul style="list-style-type: none"> - Use of stainless steel tanks
Juice blending	<ul style="list-style-type: none"> - Currently blending is done in sauce pans 	<ul style="list-style-type: none"> - Should use blending tanks
Pasteurization	<ul style="list-style-type: none"> - Use batch pasteurizer which takes 4 hours for the completion of the pasteurization 	<ul style="list-style-type: none"> - Need more efficient pasteurizer for incoming juice and juice to be filled in to containers
Filtration	<ul style="list-style-type: none"> - Using juice sedimentation 	<ul style="list-style-type: none"> - Use of clarifying enzymes and centrifugation
Filling into containers	<ul style="list-style-type: none"> - Mostly use the manual filling of the bottles - Use new plastic bottles as those used by other juices and concentrates 	<ul style="list-style-type: none"> - A semi-automated filling machine would be appropriate
Labeling	<ul style="list-style-type: none"> - Labels have the required information though its accuracy may be lacking 	<ul style="list-style-type: none"> - Equipping the in-house laboratory to carry out basic tests
Storage	<ul style="list-style-type: none"> - Product stored in the designated storage area 	<ul style="list-style-type: none"> -
Packaging	<ul style="list-style-type: none"> - Packing in boxes 	<ul style="list-style-type: none"> - Packaging in plastic cartons is recommended

The recommendations for the operations of the banana juice processing enterprise in *table 6* above will lead to the following:

- Weathering through exposure of the bananas to the sun for about 1 hour would lead to:

- Concentration of the contents of the bananas
- Absorption of heat by the bananas which improves their ripening
- Small rooms with insulated doors and absence of air outlets or inlets, and use of a ripening aid will result into:
 - More uniform ripening of the bananas
 - Reduction of ripening time
- Use of portable water and stainless steel buckets or troughs are some of the prerequisites for UNBS certification and the latter eases the cleaning of the utensils
- Use of stainless steel tanks for haulage and storage of the banana juice will lead to elimination of corrosion/ rust, ease of cleaning, minimization of product deterioration and higher juice shelf stability of at least 1 month as compared to 3-5 days for the plastic tanks.
- Use of blending tanks will minimize exposure to air and contamination.
- Use of efficient pasteurizer for incoming juice and the juice to be filled in containers will minimize change in the natural juice quality attributes such as flavor.
- Use of clarifying enzymes and centrifugation will lead to obtaining of clear juice more efficiently in terms of quality and process time.
- Packaging in plastic cartons will enhance portability

3.2.2 Major equipment needed for improved production of banana juice

The banana juice processing enterprise that was considered for the assessment below did not have grid power but uses fossil fuel generator for running the factory. The major requirements for improvement of banana juice production in terms of quality and quantity were as shown in *table 7*.

Table 7: Major equipment needed for improved banana juice quantity and quality production

Equipment	Specifications	Qty	Estimated cost	Potential Supplier
Weighing balance	Heavy duty mechanical suspended scale, Easy to read dial housed in a robust die cast casing, Low friction bearings, Accuracy: 0.002, Adjustment: up to 10% zero adjustment, Capacity: 100 kg x 200 g, Dial Size: ~254 mm, Case: Die-cast , Swivel top and bottom hooks	1	1,600,000/=	Avery East Africa
				Precise Weighing Systems Ltd

Equipment	Specifications	Qty	Estimated cost	Potential Supplier
Weighing balance	Mechanical weighing scale, pedestal, Max: 30 Kg, d: 100g	1	700,000/=	Precise Weighing Systems Ltd
Stainless steel buckets	Standard with a carrying handle and nest, Capacity: 10-20 L	8	40,000/=	Kalambi General Agencies Snowmans (U) Ltd
Work tables (non fabricated)	Stainless steelwork top, Dimensions (cm): 76 x 180 x 86 (H), Adjustable under shelves	2	2,500,000/=	The Tamales
Work tables (fabricated)	Stainless steelwork top (1 mm thickness), Dimensions (cm): 240 x 120 x 86(H), 1 level, Stainless steel stands(40 x 40 mm)		2,030,000/=	Aquva
Trolleys	Stainless steel, 2 levels, Dimensions (cm): 95 x 50 x 81 (H),	2	900,000/=	The Tamales
Heavy duty platform trolley	Heavy duty platform, Dimensions (cm) 90 x 60, Handle height: 85 cm, Handle: metal, wheel: 4 wheels	1	800,000/=	The Tamales
Refractometer	0 – 32 degrees Brix	1	1,000,000/=	Packaging and processing Supplies Ltd Leo's wine accessories Ltd
Haulage tanks	Stainless Food grade steel, with stand, base discharge point, light weight, horizontal			Steel & Tubes Industries
	Capacity: 1000 L	3	950,000/=	
	Capacity: 2000 L	1	1,550,000/=	
Storage tanks	Stainless Food grade steel, with stand, base discharge point, light weight, Vertical			Steel & Tubes Industries
	Capacity: 3,000 L	2	1,300,000/=	
	Capacity: 5,000 L	2	2,000,000/=	
Filling machine	Semi-automatic level filler, 4 heads	1	29,000,000/=	F & B Solutions Ltd
Pasteurizer	Juice/ Milk pasteurizer, Vertical jacketed & insulated tank with propeller type of agitator, Power: 5.5. KW or higher, Revolutions: 1440 rpm or higher, Stainless steel 304, 220/50Hz,			Musa Body Machinery (U) Ltd, F & B Solutions Ltd, Snowmans (U)
	Capacity: 300 L	1	17,000,000/=	

Equipment	Specifications	Qty	Estimated cost	Potential Supplier
	Capacity: 500 L	1	32,000,000/=	Ltd
Carton shrink wrapping machine	Semi- automated	1	43,000,000/=	F & B Solutions Ltd
pH meter	Benchtop, pH Range:-2.00 to 16.00, Range (mV): ±2000, Temperature Range (°C):0 to 110, Accuracy (pH): ±0.01 pH Precision: 0.1, with buffers	1	3,000,000/=	Palin Diagnostics
Conductivity meter	Portable, Conductivity: 0 - 200 mS, TDS: 0-200 ppt, Salinity:0 - 50 ppt Temp (°C):-10-110, TDS Res: 0.01 ppm - 0.1 ppt, Automatic Temperature compensation, Backlit, custom LCD, USB, RS232, One point per range, Waterproof, Power: Two AA batteries, 1 AC adapter, Datalogging (points):500 data sets	1	3,000,000/=	

Note: Ready-made or fabricated Stainless working tables can be used

3.2.3 Training needs for improved production of banana juice

The training needs for improved quality and quantity production of banana juice were as shown in *table 8*:

Table 8: Training needs for improved quality and quantity banana juice production

Category	Required training	
Banana juice Processing	GMP and GHP	UNBS
	Quality Assurance and Food safety	
	Product development	Food science Department, MAK
	Sensory evaluation	
Business planning & management	Record keeping	MUBS,
	Marketing	N.C.C Consultancy Services

3.3 Banana wine processing enterprises/ Associations

Banana wine processing in the target area of the project is done by numerous enterprises and is mainly concentrated within Bushenyi district with a few scattered enterprises in the districts of Ntungamo, Isingiro, Sheema and Mbarara. Some banana wine processing enterprises operate as associations or groups while others are run by individuals as private limited companies. All

private limited companies involved in banana wine making were connected to the National grid power while the majority of the banana wine processing groups/ associations were not connected to the national grid power. Further, the private limited companies had substantial number of equipment in comparison to the processing groups/ associations. Notwithstanding, the above mentioned limitations for the processing associations/ groups, one processing association by the names of Tigebwa Development Association, had the highest banana wine production levels and also serves as the training centre for banana wine processing for south and western Uganda under the UCA arrangement.

3.3.1 Assessment of the banana wine processing operations

The banana wine enterprises processing operations and recommendations for improved quality and quantity production of banana wine by the enterprises were as shown in *table 9*. All the banana wine processing operations are done at the same locality where the banana wine is packed unlike the case for juice as discussed above.

Table 9: Banana wine processing operations and recommendations

Process activity/ stage	Current operations	Recommendations
Criteria for purchase of raw bananas	Selection of banana based on personal perceived quality parameters	Development of standard quality criteria for raw material selection
Purchase of raw bananas	Most processors purchase in bunches	Purchase in Kilograms for all banana raw materials
Weathering	Most processors don't carry out this activity	Should expose the bananas in the sun for about 1 hour
Ripening	Majority carry out ripening in the open	<ul style="list-style-type: none"> – Small rooms with insulated ways and absence of air outlets or inlets – Use of a ripening aid
Cleaning	<ul style="list-style-type: none"> - Use plastic buckets - Use clean water 	<ul style="list-style-type: none"> – Stainless steel buckets or troughs should be used – Should use portable water
Peeling	<ul style="list-style-type: none"> - Peeling and other processing steps done in the same place including product packaging - Use stainless steel knives - Some use plastic buckets - Others use wooden tables 	<ul style="list-style-type: none"> - Construction/ designation of a preparation room - Stainless steel buckets - Stainless steel working table
Weighing of peeled banana pulp	- All use plastic buckets	<ul style="list-style-type: none"> - Stainless steel buckets - Use a calibrated weighing balance
Boiling	- Use aluminium sauce pans without covering lids	- Larger aluminium sauce pans with covering lids

Process activity/ stage	Current operations	Recommendations
	- Using three traditional “three-stone fire place”	- Use energy saving wood burning stoves or highly efficient stove that use reusable charcoal and have a fanning system powered by solar energy
Pulping	- Done manually by most processors	- Fabricated motorized pulper for areas with electricity
Pressing	- Done manually by most processors	- Fabricated pressing/ straining unit
1 st Filing	- Some use hot filling while others wait to cool before filling	
Fermentation	- Most use same room for fermentation and aging - Most use plastic tanks/ drums with covers - All use air lock	- Should have separate rooms - Stainless steel food grade tanks - Use tubes immersed in water to eliminate oxygen
Aging	- Most use same room for fermentation and aging - Most use dark plastic tanks/ drums with covers - Transfer of fermented juice to the again tanks is manual	- Should have separate rooms - Wooden oak barrels most preferred but not easily available and are expensive - Transfer of juice should be by use of a transfer pump (Flowjet) for areas with power
Filling into bottles	- Mostly use the manual filling of the bottles - Use reusable bottles after thorough cleaning	- Should use a bottle filling machine - It would be most preferable to obtain a source of new bottles (<i>Although, all enterprises mentioned the unavailability of new bottle for wine, to the contrary, new bottles were found to be available at the 2 wine equipment and accessories shops indicated in equipment table although they cost almost double the price of the reused ones</i>)
Capping	- Mainly use metallic caps while some use plastic corks - For the majority capping is manual	- All should resort to metallic caps since world class wines are all resorting to the metallic caps instead of corks - Use of a hand operated capping machine
Sealing	- Majority use hot water	- A simple adjustable hand drier for areas with power
Labeling	- Most labels have the required information but alcohol content is not measured in most enterprises - Most don't have batch Numbers	- Should have all information including actual alcohol content - A systematic batch numbering system should be used
Storage	- Product stored in the same room	- Should have separate rooms

Process activity/ stage	Current operations	Recommendations
	where the aging and packaging is done	
Packaging	- Most do not have packing carton or crates for the wine bottles	- Use of plastic crates to house the wine bottles during transportation would eliminate breakages during transportation and ease handling

The results emanating from the recommendations in *table 9* include the following:

- Purchase in Kilograms for all banana raw materials would lead to straight forward calculation of the yield and hence profitability
- Weathering through exposure of the bananas to the sun for about 1 hour would lead to:
 - Concentration of the contents of the bananas
 - Absorption of heat by the bananas which improves their ripening
- Small rooms with insulated doors and absence of air outlets or inlets, and use of a ripening aid would result into:
 - More uniform ripening of the bananas
 - Reduction of ripening time
- Use of stainless steel buckets or troughs is one of the prerequisites for UNBS certification and eases the cleaning of the utensils
- Construction/ designation of a preparation room, use of stainless steel buckets and stainless steel working table would:
 - Minimize the risk of cross contamination of the products
 - Ease cleaning and lead to meeting of one of the requirements of GMP
 - Eliminate exposure to surfaces with corrosion/ rust
- Use of a calibrated weighing balance during the pulp weighing stage would lead to use of the correct measurements and product formulations
- Use of saucepans of higher capacity and energy saving stoves would lead to increased energy efficiency resulting in energy savings of up to 80% and minimize the introduction of smoke in the product.
- A fabricated pulper for areas with electricity would shorten the processing time and workload
- A fabricated manual or electric straining unit would lead to shortened processing time and decreased risk of contamination during the straining processing step

- Use of stainless steel food grade tanks for fermentation would ease the cleaning of the containers, eliminate possible reactions of the plastics with the fermenting juice which would cause deterioration in product quality
- Use of tubes immersed in water to eliminate oxygen instead of air locks would eliminate pressure build up in fermentation containers while providing means of monitoring progress of the fermentation process through the air bubbles in the water.
- Use of wooden oak barrels would eliminate addition of oak chips for flavor but these barrels are not easily available in addition to being expensive.
- Transfer of fermented juice by use of a transfer pump (Flowjet) in areas with power will minimize exposure of the fermented juice to contaminants and decrease the processing time as the filtering is done in the same process step
- A simple adjustable hand drier for areas with power used for sealing the banana wine bottles would eliminate wetting of the bottles after filling.
- Ability to have the correct information on the labels would facilitate the production of standard products.
- A systematic batch numbering system used on the labels would enable traceability of the products in case of a product recall is required.
- Use of plastic crates to house the wine bottles during transportation would ease handling of products during storage and transportation.
- Designated separate rooms for the different processing stages such as fermentation, aging, packaging and storage would limit cross contamination and create unidirectional flow process which is a standard requirement for food processing industries.

3.3.2 Major equipment needed for improved production of banana wine

As discussed earlier in section 3.3, the banana wine processing associations did not have grid power which may limit their ability to make use of equipment that require electricity. The major requirements for improvement of banana wine production in terms of quality and quantity are as shown in *table 10*.

Table 10: Major equipment needed for improved banana wine quantity and quality production

Item description	Specifications	Estimated cost	Qty	Potential Supplier
Weighing balance	Mechanical platform, Loose weight vibrating steelyard of corrosion – resistant metal, Raised graduations and figures (front and rear reading), Tumbler locking device, Capacity: 250 - 300 kg, Platform: 625 mm x 400 mm fitted with 29” solid steel back rail, Steelyard: 10 Kg x 100 gm, with proportional weights to full capacity, Four external wheels on continuous axles	3,000,000/=	1	Avery East Africa Precise Weighing Systems Ltd
Stainless steel buckets	Standard with a carrying handle and nest, Capacity: 10-20 L	40,000/=	6	Kalambi General Agencies Snowmans (U) Ltd
Work tables (non fabricated) ¹	Stainless steelwork top, Dimensions (cm): 76 x 180 x 86 (H), Adjustable under shelves	2,500,000/=	3	The Tamales
Work tables (fabricated)	Stainless steelwork top (1 mm thickness), Dimensions (cm): 240 x 120 x 86(H), 1 level, Stainless steel stands(40 x 40 mm)	2,030,000/=		Aquava
Trolleys	Stainless steel, 2 levels, Dimensions (cm): 95 x 50 x 81 (H),	900,000/=	1	The Tamales
Heavy duty platform trolley	Heavy duty platform, Dimensions (cm) 90 x 60, Handle height: 85 cm, Handle: metal, wheel: 4 wheels	800,000/=	1	The Tamales
Energy saving built stove ²	2 cookers in one, Built onsite, circumference: Used by a ≥ 200 L saucepan	8,250,000/=	1	Eco-group Ltd
		4,000,000/=		FOWE
Pulper ³	200 L capacity, fitted with mortar on top, Fitted at a lower level by 50-70 cm, Fitted with outlet	12,000,000/=	1	Tree Shade 2000
Straining unit ⁴	Capacity: 100 L, Manually operated, fitted with outlet	4,000,000/=	1	Tree Shade 2000
	Capacity: 100 L, Electric power operated, fitted with outlet	7,000,000		
Refractometer	0 – 32 degrees Brix	1,000,000/=		Packaging and processing Supplies Ltd Leo's wine accessories Ltd
Bottle drying racks	Fabricated by plastic factory, can be plastic like beer crates	20,000/=	100	Nice house of plastics
Super jet filter	Self-prime pump, filtering surface 1200 square cm, filtering time: ~ 270 L/ hour, 3 grades of pads:	2,500,000/=	1	Packaging and processing Supplies Ltd

Item description	Specifications	Estimated cost	Qty	Potential Supplier
	coarse, polish, and sterilizing, dimensions (cm): 49 x 26 x 46 (H), weight: 13 Kg			Leo's wine accessories Ltd
Bottle filler	4 head bottle filler, manual	1,600,000/=	1	Packaging and processing Supplies Ltd Leo's wine accessories Ltd
Large scale sauce pans ⁵	Aluminium sauce pans with covers		2	Shumuk Aluminium Industries Ltd
	Capacity: 85 L	400,000/=		
	Capacity: 110 L	500,000/=		
	Capacity: 140 L	600,000/=		
	Capacity: 210 L	850,000/=		The Tamales
	Capacity: 230 L	900,000/=		
	Capacity: 300 L	1,100,000/=		
Aging tanks				
Fermentation tanks	Stainless steel tanks, vertical, 450 L	300,000/=	10	Steel & Tubes Industries

Note: **1-** Ready-made or fabricated Stainless working tables can be used, **2 -** Energy saving built stove (Eco-group stoves use reusable charcoal that can be used for 2 years, have a solar powered fanning system that increases energy efficiency and the stove battery also powers a solar bulb and can be used also to charge mobile phones) **3 -** Pulper is only suitable for places with grid power, **4 -** Electric powered straining machine for enterprises with grid power and manual straining machine for enterprises with no grid power, **5 -** Different enterprises require Sauce pans of varying capacities.

3.3.3 Training needs for improved production of banana wine

The training needs for improved quality and quantity production of banana wine were as shown in *table 11*.

Table 11: Training needs for improved quality and quantity banana wine production

Category	Required training	Potential provider
Banana wine Processing	GMP and GHP	UNBS
	Quality Assurance and Food safety	
	Product development	Department of Food Science, MAK
	Sensory evaluation	
Business planning & management	Record keeping	MUBS,
	Marketing	N.C.C Consultancy Services

3.4 Banana (Matooke) Vacuum packing enterprise

Banana Vacuum packing is done by only one enterprise in the project target area and that enterprise is located in Mbarara district. This is registered company involved in banana wine production in addition to Vacuum packing of bananas (*matooke*). However, this enterprise does not operate on commercial basis as its funding is highly directed towards incubation services. The incubation is done in production of other products such as banana wine but not vacuum packed bananas. This enterprise exports 1,000 Kg of vacuum packed bananas a month during the peak production month and production is based on a placed order from the importing country and thus, production of Vacuum packed bananas is not done continuously every month. Vacuum packed *matooke* have a lot of market potential both locally and internationally which is yet to be tapped.

3.4.1 Assessment of the banana Vacuum packing processing operations

It is worth mentioning that the director of the company holds a patent about Fresh Vacuum sealed (*matooke*) Banana processing (UG/P/2007/00001). The claim or protection for which that patent holds entails inactivation of polyphenoloxidase using sodium metabisulphite at a concentration of 1000 ppm in fresh peeled *matooke* (bananas), then vacuum sealing the bananas to guarantee 7-10 days shelf life without alterations in the organoleptic quality of the fresh banana with a moisture content of 75-85%. The banana vacuum sealing operations are as shown in *table 12*.

Table 12: Vacuum Packed banana processing operations and recommendations

Process activity/ stage	Current operations	Recommendations
Criteria for purchase of raw bananas	Selection of banana based on personal perceived quality parameters	Development of standard quality criteria for raw material selection
Purchase of raw bananas	Purchase in bunches	Purchase in Kilograms for all banana raw materials
Cleaning	<ul style="list-style-type: none">- Use plastic buckets- Use water from water purification system	<ul style="list-style-type: none">- Stainless steel buckets or troughs should be used
Peeling	<ul style="list-style-type: none">- Peeling and other processing steps done in the same place including product packaging- Use stainless steel knives- Use plastic buckets	<ul style="list-style-type: none">- Construction/ designation of a preparation room- Stainless steel buckets
Treatment	<ul style="list-style-type: none">- Use water from a water treatment system	<ul style="list-style-type: none">- Water tests should be carried out to determine the appropriateness of the treatment system

Process activity/ stage	Current operations	Recommendations
Draining and Packing	- Use Stainless steel working table - Peeled banana pulp is packed in plastic bags	- Need a stainless steel table with drainage
Sealing	- Use vacuum pack plastic bags imported from Kenya - Use Bench top Chamber Vacuum sealer	-
Storage	-	- Requires refrigerators for storage and at the sales points

3.4.2 Major equipment needed for improved quantity and quality production of Vacuum packed bananas

The major equipment requirements for development of Banana vacuum packaging enterprises are as shown in *table 13*.

Table 13: Major equipment needed for improved banana wine quantity and quality production

Item description	Specifications	Qty	Estimated cost	Potential Supplier
Weighing balance	Mechanical platform, Loose weight vibrating steelyard of corrosion – resistant metal, Raised graduations and figures (front and rear reading), Tumbler locking device, Pressed steel pillar with cast iron top bracket arranged to carry proportional weights not in use, Capacity: 250-300 kg, Platform: 625 mm x 400 mm fitted with 29” solid steel back rail, Steelyard: 10 Kg x 100 gm, with proportional weights to full capacity, Four external wheels on continuous axles	1	3,000,000/=	Avery East Africa Precise Weighing Systems Ltd
Weighing balance	Mechanical weighing scale, pedestal, Max: 30 Kg, d: 100g	1	700,000/=	Precise Weighing Systems Ltd
Stainless steel buckets	Standard with a carrying handle and nest, Capacity: 10-20 L	4	40,000/=	Kalambi General Agencies Snowmans (U) Ltd
Stainless steel Saucepans	Capacity: ~20L, Have covers and handles	4	200,000/=	Kampala Kitchen Care
Work tables (non fabricated)	Stainless steelwork top, Dimensions (cm): 76 x 180 x 86 (H), Adjustable under shelves	2	2,500,000/=	The Tamales

Item description	Specifications	Qty	Estimated cost	Potential Supplier
Work tables (fabricated)	Stainless steelwork top (1 mm thickness), Dimensions (cm): 240 x 120 x 86(H), 1 level, Stainless steel stands(40 x 40 mm)		2,030,000/=	Aquava
Trolleys	Stainless steel, 2 levels, Dimensions (cm): 95 x 50 x 81 (H),	2	900,000/=	The Tamales
Heavy duty platform trolley	Heavy duty platform, Dimensions (cm) 90 x 60, Handle height: 85 cm, Handle: metal, wheel: 4 wheels	2	800,000/=	The Tamales
Refrigerators	Capacity: about 500 L	2	3,500,000/=	Anisuma Traders Ltd
				Prestige Electronics & computers Ltd
Vacuum sealers	Stainless steel construction, TWO 20" or bigger seal bars with double seal wire, Easy to clean chamber, See through heavy duty domed lid, For heavy commercial applications	2	5,000,000/=	The Tamales
				Kampala Kitchen Care

Note: 1- Ready-made or fabricated Stainless working tables can be used

3.4.3 Training needs for improved quality production of Vacuum packed bananas

The training needs for production of Vacuum packed banana are as shown in *table 14*.

Table 14: Training needs for Vacuum packed bananas

Category	Required training	
Vacuum packed banana Processing	GMP and GHP	UNBS
	Quality Assurance and Food safety	
	Food Preservation	Department of Food science, MAK,
	Vacuum packaging	Prof. Byarugaba - Bazirake George William
Business planning & management	Record keeping	MUBS, N.C.C Consultancy Services
	Marketing	

4.0 GENERAL REQUIREMENTS

Apart from the equipment and training needs for the banana processing enterprises, there are some general requirements which form the foundation on which the right equipment and skills are anchored in order to produce quality products. The main general requirements include the

processing environment (surroundings, processing housing structures, unit operations space area, e.t.c), general health of the individuals involved in processing of food products and the quality of water used for processing of the food products. Consequently, it is important to provide information on the status of the banana processing enterprises in the target area of the study in relation to the general requirements and recommend remedies to the status quo, which are discussed below.

4.1 Water purification systems

Water quality is a critical factor for food processing operations and is one of the determinants for production of quality food products. Water treatment is necessary for almost all food industries in Uganda, since the available water from the national water supply system does not meet portable water standards despite having been subjected to various treatments. Water from other sources of water such as protected wells also require water treatment but determining a water treatment unit necessary for a given industry requires one to have a water analysis report for the water source being considered so as to determine which corrective measures have to be taken in order to restore the water to the required standards.

The Triple UV purifier does remove sedimentation, odour and bacteria or organic matter while for salty water it has to be subjected to Reverse Osmosis before undergoing other purification steps. Therefore, a number of water treatment units have been identified in *table 15*, however, the exact suitability of each will depend on results from the water tests for a given water source. It is worth mentioning that all these water treatment systems require electricity to run and since most of the enterprises that require the systems do not have grid power, alternative means of powering these systems should be sought, if they are to be used. Alternatives would include purchase of fossil fuel generators or solar energy systems with inverters inclusive.

Table 15: Potential water treatment units for different water sources

Item description	Specifications	Estimated cost	Potential Supplier
Water treatment unit	Triple UV purifier ¹ , Capacity: 400L/day	750,000/=	Davis and Shirtliff
	Triple UV purifier ² , Capacity: 700L/hr	2,650,000/=	
	Pure water plant ³ , capacity: 500L/hour	11,500,000/=	
	Reverse Osmosis unit ⁴ , Capacity: 12L/ hour	2,500,000/=	
	Solar powered UV Purifier, Capacity 600L/ hr	15,000,000/=	Solar wave Uganda Ltd

1 & 2 - can be powered by a 16W solar panel which costs about 800,000/=, 3 & 4 - have pumps and can only be powered cost effectively by generators rather than solar panels

4.2 Banana processing enterprises general status against the Uganda Standard (US 28:2002)

The status of the banana processing enterprises was evaluated basing on the Uganda Standard (US 28:2002), Code of practice for hygiene in the food and drink manufacturing industry, which specifies the minimum requirements for factories and employees engaged in the manufacture, processing, packaging, storage, handling, treatment and delivery of foods intended for human consumption. This standard forms the basis on which permission is granted or not to use the Uganda Standard Certification Mark by UNBS.

A summary of the findings of the banana processing enterprises in general were as shown in *table 16*.

Table 16: General status of the banana processing enterprises in relation to US 28:2002 requirements

Requirements	Evaluation and comments
Management Policies and Objectives	Most processing associations have thin management policies in place. These were not found to be documented.
Duties authority and responsibilities of Quality Assurance Personnel	These were not clearly documented and defined and in most cases there were no quality assurance personnel.
Staff Training	At the time of assessment, there was no evidence to demonstrate that staff had been trained with regard to GHP.
Staff knowledge on UNBS requirements	Staff interviewed had limited knowledge about UNBS requirements

Requirements	Evaluation and comments
Quality Standards	There were no Quality Standards documents or other reference documents for any analyses being carried out.
Inspection and Test plans	There were no documented plans in place.
Sampling Plans	These were found to be inexistent which limits the evaluation of the product quality.
Test Methods and Procedures	A few processors were able to monitor a limited range of parameters on site while others rely on visual observations and experience.
Records of Test/Inspection Results	At the time of assessment only records of analysis done from the external laboratory of UNBS were available for some processors. Further, there was no procedure for handling non-conforming materials.
System for the segregation and handling of defective items	The processors had no HACCP plans in place to effectively handle defective items.
Availability of measuring equipment	The processors have limited capacity to monitor/measure chemical, microbiological and physical parameters of the product and available measuring equipment had not been calibrated.
Processing facilities' environment and production conditions	The processing environment was observed to be generally clean and organized. Some of the equipment and food contact surfaces were not of food-grade materials, the personnel had improvised safety wear, and processing members were conversant with their work. However, most processing facilities had no separate areas for different unit operations.
Outside environment of the Processing facilities	The external environments of the processing facilities were well maintained and kept clean for most enterprises.
Safety measures	The workers were provided with some improvised protective wear in some cases.
Labeling of final product	The final products were labeled in accordance to the National Standard except for: 1. The Expiry and Manufacture dates had been abbreviated as ED and MF respectively for some enterprises. This was

Requirements	Evaluation and comments
	<p>not a standard way of documenting these terms.</p> <p>2. The label of some of the enterprises did not contain the volume of the product in the bottles.</p> <p>3. There was no batch number indicated on the product of some enterprises.</p>

The recommendations for the main non-conformities found for the banana processing enterprises in general are as shown in *table 17*.

Table 17: Corrective actions for the main non conformities of the banana processing enterprises

Non-conformance	Recommendations
The few measuring equipment that were available at some of the processing facilities were not calibrated such as the weighing scales. This is contrary to the requirements of US 28: 2002 clause 14.3.3 b).	All measuring equipment at the processing facilities should be calibrated and certified by UNBS
<p>The following issues were noted in the production areas:</p> <p>1. The lights were not of safety type as per the requirements of US 28: 2002 clause 10.9.1 3.</p> <p>2. The Windows and other air intake points were not fitted with fly screens as per the requirements of US 28: 2002 clauses 12.8.2 and 7.3.2.</p>	<p>1. The lights should be of safety type, with covers to prevent contamination of the products in case of breakage of the glass for the bulbs or florescent tubes.</p> <p>2. All windows and other air inlet points should be fitted with fly screens to prevent contamination of the products by flies and insects</p>
There was no evidence in place to demonstrate that employees had been checked medically for fitness to handle food contrary to the requirements of US 28: 2002 clauses 5.2.1, 5.2.2.1, and 14.3.3c)	All employees or association members who are in contact with the banana products during processing should be examined at the district health centre and issued certificates indicating their fitness to handle food
There was no batch number and no volume of product indicated on the finished product labels for some processing entities contrary to the requirements of US	Batch number and volume should be included on the labels in addition to what is already on the labels

7: 2002 clause 4.6 and US 348: 2001 clause 9.1 v).	
The workers were provided with improvised protective wear.	There is need for provision of appropriate protective wear.
Some of the equipment and food contact surfaces were not of food-grade materials.	Equipment and food contact surfaces should be of food grade material
Processing facilities had no separate areas for different unit operations	Separate areas should be provided for different unit operations that promote uni-directional flow of the production process to avoid cross contamination

4.3 Recommendations for infrastructure upgrading of the banana processing facilities

The recommendations for upgrading of the banana chips, banana juice banana wine and processing facilities are as shown in *tables 18, 19 and 20* respectively.

Table 18: Recommended upgrades for the banana chips processing facilities

Item description	Specifications
Dressing room	About 16 Sq. M of room space
Ripening rooms	240cm (W) x 150cm (L) x 200cm(H), Walls insulated with card boards, sisal bags, entrance lined with rubber linins, Plastered walls, concrete floor.
Preparation rooms	About 20 Sq. M of room space, Concrete floor, stainless steel sinks
Packaging room	About 25 Sq. M of room space, concrete floor and plastered smooth walls
Product storage room	About 30 Sq. M of room space, concrete floor, plastered smooth walls, Shelves installed

Table 19: Recommended upgrades for the banana juice processing facilities

Item description	Specifications
Ripening rooms	240cm (W) x 150cm (L) x 200cm(H), Walls insulated with card boards, sisal bags, entrance lined with rubber linins
Light	All lights in the processing areas should be of safety type
Windows	Windows and other inlet points should be fitted with fly nets
Entrance	Fitted with PVC sheets

Table 2020: Recommended upgrades for the banana wine processing facilities

Item description	Specifications
Dressing room	About 16 Sq. M of room space
Ripening rooms	240cm (W) x 150cm (L) x 200cm(H), Walls insulated with card boards, sisal bags, entrance lined with rubber linins, Plastered walls, concrete floor.
Preparation rooms	About 20 Sq. M of room space, Concrete floor, stainless steel sinks
Boiling room/ kitchen	About 25 Sq. M of room space, Proximal to the fermentation unit/ room, chimney installed
Fermentation room	About 30 Sq. M of room space, Proximal to the boiling room/ Kitchen
Aging room	About 30 Sq. M of room space, concrete floor and plastered smooth walls
Packaging room	About 25 Sq. M of room space, concrete floor and plastered smooth walls
Product storage room	About 30 Sq. M of room space, concrete floor, plastered smooth walls, Shelves installed
Windows	Windows and other inlet points should be fitted with fly nets

5.0 CONCLUSION

From the findings, it can be concluded that Banana processing enterprises in Southern and Western Uganda have major needs in terms of equipment, training and skills as well as infrastructure development.

The banana dried chips processing associations requires designated stores and processing rooms that are to the standards and the banana dried processing associations visited had space for infrastructure development. The major equipment needed by the processing associations include: improved driers, stainless steel working tables and moisture meters while the training needs majorly fall in Drying technology, food hygiene and safety as well as business development and marketing.

The major banana wine processing association also has space for infrastructure development and at the time of assessment, they had already laid bricks for construction of bigger processing infrastructure. However, it is important for them to have guidance regarding the appropriate

design and requirements before they embark on the construction. The major equipment needed by the banana wine processing associations include: Large capacity aluminium sauce pans, energy saving stoves, weighing balances, pulpers, super jet filters, straining units, refractometers, bottle fillers, stainless steel working tables and heavy duty trolleys while the training needs majorly fall in Wine making, food hygiene and safety as well as business development and marketing.

The banana juice making enterprise has sufficient infrastructure with a total area space of 1,200m² and does not require major infrastructure developments. The major equipment needed by the banana juice processing enterprise include: weighing balances, refractometers, bottle fillers, pH meters, Haulage tanks, storage tanks, stainless steel working tables, pasteurizer, wrap shrink carton machine and heavy duty trolleys while the training needs majorly fall in product development, food hygiene and safety as well as business development and marketing.

Table 21: Potential Suppliers Contact details

Potential supplier	Contact details
Aquva International Ltd	Plot 37 – 43, Kabira Road, Industrial Area, Kampala
Anisuma Traders Ltd	Plot 65 / P.O Box 23136 Kampala Kampala Road, Kampala
Balton Uganda Ltd	Plot 47/51, Kibira Road Tel: 0312502 300
Davis and Shirliff	Main Office- Plot 53, Kitgum House Jinja Road, Kampala, Uganda Tel:+256 414 346337/8
Eco-group Ltd	1078 Ertec Lane, off Mbuubi Road, Wakaliga Rd, Lunguja, Mengo Tel: +256 200 905501 Mob: 0776 920 729, 0702 920 729
F & B Solutions Ltd	Madhvani Foundation Building, Plot 18, Jinja Road, Kampala, Uganda. Tel: 0 414 580 643 Mob: 0702 381 856, 0785 294 179, 0714 151 384,
FOWE	Kabakanjagala Road Opp. KCCA Lubaga Division Tel: 0312114438 Mob: 0772 593 219, 0701 593 219
KACE:	Kangulumira Area Coop-erative enterprise Mr. WafanaYahaya (Chairperson, KACE) Tel: 0776230395
Kalambi General Agencies	Plot 70, Ben Kiwanuka Street, Kampala Tel: 0414 340 622
Kampala Kitchen Care	Plot 2, Shop 5,Bombo Rd. Tel: +256 392 900 755
Leo's Wine Accessories Ltd	Mini Village, Kabalagala, Ggaba road Mob: 0775 967 730
N.C.C Consultancy Services	4 Km, Entebbe Road, Namasuba Tel: 0392 898 521
Packaging and processing Supplies Ltd	Plot No. 268 Ggaba Road 0782 406 376
Palin Diagnostics	25 Valley Road, Ministers Village, Tel: +256 414 285078
Precise Weighing Systems Ltd	Head office: Plot 20-24, Spring road, Bugolobi Behind Tuskys, Block 2 Suite No. G 03 Tel: 0392 901 018
Prestige Electronics & Computers Ltd	Plot No. 63 Kampala Road Tel: 0414 232 829
Shumuk Aluminium Industries Ltd	Plot 24 Mukabya Road, Nakawa Industrial Area Tel: +256 41 4286282
Snowmans (U) Ltd	Plot 89, 7 th Street, Industrial Area, Kampala, Tel: 0414 251800, 0414 237104, 0312 264786
Solar Wave Uganda Ltd	Plot 4 old port bell road, Industrial Area

	Tel: 0773 770 365
Steel & Tubes Industries	Deals House, Jinja Road, Nakawa Industrial Area, Tel: +256 414 287 950
The Tamales	Head Office / Show Room: Lweza – Entebbe Road, Tel: +256 414 342110
Tree shade 2000	Workshop located on Mwanga II Road, Kisenyi Contact Person: Mr. Kigongo Kaweesi Tel: 0712 567698



Utilization of Banana Waste in Uganda

Feasibility report on banana waste to biogas



**UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANISATION**

Prepared by: CREEC October 10th 2014

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1. Introduction

Uganda's energy sector is characterized by over dependence on biomass. The International Energy Agency (IEA, 2011) defines access to modern energy services as '*a household having reliable and affordable access to clean cooking facilities, a first connection to electricity and then an increasing level of electricity consumption over time to reach the regional average*'. "Clean cooking facilities" are referred to as 'biogas systems, liquefied petroleum gas stoves and advanced biomass cook stoves that have considerably lower emissions and higher efficiencies than traditional three-stone fires for cooking. According to IEA (2010), only a little more than 10% of the population of Uganda currently has access to electricity and only 2% of rural areas having access to electricity, mainly from hydro-electrical sources. Access to electricity is low due to the poor maintenance of the electricity network, low generation capacity, limited distribution network and unusually long drought of 2007 that led to significant drop in water levels in the Lake Victoria over the course of two years.

In Uganda, biomass contributes to over 92% of the total household energy consumed by households and small scale industries. The traditional ways of using biomass are 80% wood, 6% charcoal and 5% agricultural waste¹. Biomass is consumed by agro-based and small-scale industries to meet basic energy needs for cooking and water heating, while the transport sector accounts for 75% of the petroleum demand (AfDB, 2011). Biomass is mostly burnt directly for cooking purposes and most of the methods being used today are inefficient, causing rapid dwindling of the biomass resource especially wood fuel. The effects of increasing population and urbanisation of Uganda are increased demand for wood fuel leading to increasing scarcity of wood fuel in most parts of the country, increasing amount of time spent by women and children gathering firewood and resultant land degradation, deforestation and decline in agricultural production.

The continued use of inefficient energy technologies has the added adverse impacts of causing poor health conditions for users from indoor air impurities, for example, particulate matter and carbon monoxide emissions. Lack of access to clean and efficient energy in the household can impact health in many ways. In the 2006 World Health Organization report, the most important direct health impact is a result of air pollution brought about when solid fuels are burnt regularly indoors on simple stoves with open fire (Singh and Sooch, 2004). Globally, three billion people (Barnes et al, 1994) are exposed to biomass smoke in poorly ventilated rooms, making biomass smoke one of the most important sources of indoor air pollution. Poor household air quality is linked to pneumonia, lung cancer and chronic lung disease. It is estimated to result in approximately 1.4 million premature deaths annually (Ezzati et al., 2004). It is linked to poverty, with poor people more likely than richer people to use fuels that result in poor household air quality (animal dung, crops, wood and charcoal).

Biogas technology is an integrated waste management system (Verstraete et al., 2005) that is a clean, renewable, naturally produced and under-utilized source of energy. Biogas is produced in an air tight tank (or tube) from a variety of substrates, such as animal manure, food waste, energy crops and industrial wastes. As reported in the studies of Igoni, (2007) and Angelidaki et al., (2003), this is a multi-organism process in which the organic waste is converted mainly to a gaseous product composed of 50-70% methane (CH₄) and 25-30% carbon dioxide (CO₂) and traces of hydrogen sulphide and water vapour.

Further, biogas is produced mainly from raw materials that are locally available and can be harnessed in controllable, containable and useable quantities. In general, biogas energy production actually transforms a costly problem into a profitable solution. As reported by Kariko (2011), the use of biogas as a source of domestic energy in Uganda is relatively new although there have been a number of attempts in the past to introduce it.

The potential benefits of a biogas digester to the medium scale industries and household include diversification of energy supply, provision of an organic fertilizer (Rio and Burguillo, 2008) that is rich in crop-available nutrients, improved sanitation and indoor air quality, reduced eutrophication due to excessive nutrients in the water body from runoff from decomposing dumped organic wastes, greater rural district

¹ Ministry of Energy and Mineral Development report 2008

advancement prospects as it provides job opportunities (Vasudeo, 2005; Lantz et al., 2007).

Biogas adoption has been limited by prohibitive initial investment costs (Karekezi, 2002) and accessibility of materials for construction of digesters that will not leak materials or gases (Rabezandrina, 1990). Rabezandrina, (1990) suggested that the amount of fuel produced must be sufficient to meet the needs, and this depends on the availability of feedstock from human, animal and plant sourced organic wastes. The use of the fuel produced and the digested product should be socially acceptable to the rural community if digesters are to be adopted. Political measures may be needed to encourage adoption, including training and capacity building programmes, flexible financing mechanisms and dissemination strategies (Karekezi, 2002; Greben and Oelofse, 2009).

1.2 Factors affecting biogas production

1.2.1 Temperature

The physical environment provides the setting for the chemical reactions. Maintaining a constant temperature at the optimum range for the bacteria is critical for maximizing gas production. Anaerobic bacteria can endure temperatures alternating 0 to 57°C, but they flourish best at mesophilic temperatures around 36.7°C (the range for mesophilic bacteria is 30-37°C) or thermophilic temperatures around 54.4°C (the range for thermophilic bacteria is 50-60°C). However, digesters running in the mesophilic range are less sensitive to change in the operating routine than digesters operating in the thermophilic range, and so the mesophilic process can be more robust.

1.2.2 Carbon to nitrogen ratio

A C:N ratio, ranging from 20 to 30, is considered to be optimum for anaerobic digestion (AD). If the C:N ratio is excessive, then, methanogens will rapidly consume the nitrogen in order to fulfill their protein requirements, and decomposition of the left over carbon content of the material will be inhibited by lack of nitrogen. This results in a low gas production. In spite of this, a low C:N ratio results in concentration of ammonium, which results in an increased pH, also inhibiting gas production. Optimum C:N ratios for the feedstock can be achieved by mixing feedstocks of high and low C:N ratios.

1.2.3 Solid content

The total solid concentration (TS) in the feedstock is crucial to ensure sufficient gas production, as well as for easy mixing and handling; 8-10% total solids (TS) or 20 to 100 g dm⁻³ is the optimum range for biogas production (Bui Xuan An and Preston, 1999).

1.2.4 Hydraulic retention time

Hydraulic retention time (HRT) is the average period a given quantity of the feedstock takes to move from the inlet to the outlet pipes of a biogas digester. Hydraulic retention time estimated by dividing the digester capacity by the amount of feedstock fed into the digester per day. In general, the rate of digestion has a direct relationship to the retention time. Also, if the temperature inside the digester is raised, then the HRT is short.

1.2.5 Feedstock characteristics

Table 1 below shows the relationship between TS, volatile solids (VS) and biogas yield of different types of feedstock. The Food and Agriculture Organization of the United Nations (FAO) reported that biodegradable organic material can be used as inputs for processing inside the AD system. Most types of biomass can be used as substrates for biogas production (Mata-Alvarez, 2003). as long as they contain the main components (carbohydrates, proteins, fats, cellulose or hemicelluloses).

However, for economic and technical reasons, some materials are more favoured as inputs than others. Although existing household digesters commonly use animal waste for gas production, plant materials also serve as a viable input feedstock. Since different organic materials have different biochemical characteristics, their potential for gas production varies. Therefore, substrate materials can be mixed to achieve the basic requirements for gas production and normal growth of methanogens. One of the biggest challenges arising from this process is to accurately predict the amount of CH₄ produced based on the feedstock used. This is

because the nature and composition of substrate material dictates the microbial regime present, and no single set of parameters is valid for all situations (Bentley, 2010).

Table 1: The maximum gas yield according to the total solid and volatile solid content of different organic waste

Substrate	TS [%]	VS [%]	Biogas yield [m ³ /kg VS]	Source
Fresh cattle excreta	25 - 30	80	0.6 - 0.8	Deublein et al., 2008
Cattle liquid manure	6 - 11	68 - 85	0.35 - 0.55	Schillings & Tijmensen, 2004.
Kitchen waste	9 - 37	50 - 70	0.2 - 0.5	Eder & Schulz, 2006.
Market waste	28 - 45	50 - 80	0.45	Eder & Schulz, 2006.
Vegetable waste	5 - 20	79 - 90	0.2 - 0.3	Deublein et al., 2008 /Gunaseelan, 2004
Banana skins	8 - 20	86 - 94	0.2	Gunaseelan, 2004
Fruit waste	25 - 45	90 - 95	0.4 - 0.7	Deublein et al., 2008

Riuji, (2005) reported in his study that different feedstocks have different digestion properties, and result in biogas of different compositions and quality. Organic waste containing proteins, carbohydrates and fats, decompose easily, whereas organic wastes containing a high proportion of lignin, (Riuji, 2005) as found in wood products, are not easily broken down by AD. Choosing a stable mix of feedstock with superior energy content that is easily available to the bacteria, such as simple sugars and fats, maximises biogas production.

The amount of biogas that could theoretically be produced from manure depends on the type or breed of livestock and the livestock management system. Sufficient quantities of feedstock, especially animal manures, are needed to produce biogas. Brown (2006) suggested that 1-2 cows or 5-8 pigs produce sufficient feedstock to provide biogas for a typical household. Smaller particles increase the productivity of the digester due to the increased surface area for increased biological activity (Igoni et al, 2008).

Typical household waste in Uganda is mainly composed of animal manure, fecal matter, kitchen waste, food leftovers, vegetable and fruit peel and skins. A typical mix would include banana skins, stiff maize porridge (posho), rice and vegetables (often beans and spinach), fried potatoes and pieces of meat or fish with sauce.

1.2.6 Water availability

Water availability for biogas production has been discussed by Orskov et al. (2013). Rosen and Vincent (1999) stated that water is collected and used for; cooking, showering, washing hands, laundry and utensils by many households in sub Sahara Africa (SSA). Moisture is essential for bacterial activity; they are able to tolerate conditions ranging from small amounts of moisture to dilute solutions of nutrients. This means that very wet feedstock can be used without loss of energy consumed. Much of this water can be recycled into the biogas digester, so reducing additional labour for water collection. The amount of water required to run a biogas digester depends on the type and amount of feedstock. For optimal anaerobic fermentation, the dry matter content must be between 2 and 5% (Preston, 2011). This means that for each 10 kg of dry matter, there is a need for about 200 dm³ of water.

1.2.7 Concentration of microorganisms

Hydrolytic and acid forming bacteria have a short residence time compared to methanogenic microorganisms, whose residence time is between 10-15 days in the digester. These bacteria have a slow growth rate. Therefore, a new biogas digester requires about 3 months allowing time for the methanogenic bacteria to grow, (Deublein et al., 2008).

2. Programme background

Bananas in Uganda are intrinsic to the culture and traditions of the people accounting for about 30% of the food consumed in the country. They are predominantly grown in the central and western highlands by resource poor small-scale farmers. The western and south western regions of Uganda are among the most vulnerable regions in East Africa to the adverse effects of climate change, recording some of the most significant climate change indicators such as; increase in temperature (0.3 degrees per decade), more frequent and severe droughts, incidence of pests and diseases affecting agriculture production. A large number of people in the region who depend on agriculture especially banana production for their livelihood and food security live in absolute poverty increasing their vulnerability to climate change and limiting their ability to cope with and recover from the shocks. The bananas are mainly sold fresh to markets in Uganda and neighbouring countries and farmers receive very little from the sale of fresh banana, compared to the market prices in the cities. Furthermore, without much value addition, the bananas are susceptible to over-ripening and rot during storage and transporting, resulting in substantial losses in income and causing shortages on the markets.

Recognizing the socio-economic importance of banana in Uganda, its status as the main staple food cultivated in the country and as such it's potential for poverty alleviation, the government of Uganda committed to a policy to increase production, processing and marketing sustainably by 2018 and requested technical assistance of United Nations Industrial Development Organization (UNIDO) to support its initiatives and diversify the banana value chain to provide greater opportunities for income generation, poverty reduction and food security.

2.1 Objective

The objective of the assignment is to undertake a study to determine the feasibility of adding value to the banana waste generated from the livelihood diversification processing activities, by converting it into biogas to supplement the energy needs of the banana products' processing plants.

2.2 Banana value addition in Uganda

There is a great potential for further processing of the banana crop, not only to manufacture different foods and beverages from the fruit, but also to make use of the fibres from the stem for textiles, paper, accessories and craft. The peels can also be used as a base ingredient in soaps and other cosmetics, as fuel such as biogas feedstock and the sludge from that can be used as fertiliser. These opportunities are not currently fully exploited. Some value addition activities that can be expanded to provide avenues for employment, income generation and improved livelihoods in the banana developing communities include the following:

- **Banana juice:** Juicing is one of the most common traditional value added practices in Uganda, where the juice is produced largely in an unhygienic manner. The juice can be consumed fresh or fermented to a local beer. The technology and knowhow to produce and store the juice more hygienically exists in the country, but the commercialization of such technologies has not taken place.
- **Wine making:** There are small scale factories producing red and white wine made from banana, and these face a myriad of challenges including access to finance, availability of inputs such as wine yeast and starter cultures and lack of entrepreneurship skills to manage the business efficiently.
- **Fibre production:** A prototype to extract fibre from the stem for paper and fabric production has been developed. Efforts to commercialize the technology are currently on going.
- **High quality flour:** The Presidential Initiative for Banana Industrial Development (PIBID) is developing banana based starch products. A pilot processing plant for this purpose was officially opened on October 6th 2014.

3. Selection Method/ Protocol

The aim of the selection criteria was to do preliminary screening. A baseline questionnaire was administered to 15 small scale banana processing facilities in Mbarara, Bushenyi, Ntungamo and Isingiro. *List of facilities is provided in the appendix 1.*

3.1 Interviews and field visits

A questionnaire was used as a tool for data collection, 15 small scale banana processing facilities were visited and interviewed in a 45-minute structured baseline questionnaire, consisting of a list of closed questions. The data collected was used to generate fact sheets and to rank the small scale banana processing facilities using a simple selection tool while applying a multi criteria decision approach.

The following data was collected;

- amount and cost of biomass fuel used,
- distance covered to collect firewood,
- time spent collecting firewood,
- distance to water source,
- amount of water collected and used per household,
- labour required to collect water,
- availability of organic waste,
- organic waste management methods,

3.2 Evaluation criteria

In assessing the digester design and size, 4 factors interact to determine the optimum installation. The evaluation criterion was based on factors including;

3.2.1 Availability of organic feedstock

Feedstock is the material that is fed to the digester for the anaerobic digestion to take place. Different materials have different digestion properties, and result in biogas of different compositions and quality. In general, all types of organic waste can be used for anaerobic digestion as long as they contain protein, carbohydrates, fats, cellulose, or hemicelluloses. Lignin, however, as found in wood products, cannot be broken down via anaerobic digestion (Riuji, 2009). To maximize biogas production requires selecting a consistent mix of substrates with high energy content that is readily available to the bacteria.

For small farmers in Sub-Saharan Africa, the feedstock for biogas production is mainly manure from livestock e.g. cattle, sheep, goats, horses, donkeys, rabbits and chickens but also from humans if culturally acceptable (Jewitt, 2011). One of the most important factors to the successful implementation of biogas is the collection of the feedstock. The amount of biogas that could theoretically be produced depends on the type or breed of livestock and the livestock management system. For livestock kept in zero grazing conditions, the availability of that manure is 100% whereas for cattle those kept in stables at night, manure available is 50%. If the cattle are grazing for part of the day, manure can be collected from the fields, but this requires extra labour.

Assuming optimum conditions for biogas production (temperature 30-35°C; pH 6.8-7.5; carbon to nitrogen ratio 20-30; solid content 7-9% and retention time 20-40 days (Gutser et al., 2005)), biogas production is dependent on the proportion of volatile solids in the organic waste (Polprasert, 2007). Cow manure, rice straw and water hyacinth all yield high amounts of biogas, producing over 0.1 m³ (kg fresh waste)⁻¹.

In this study, amount and nature of feedstock available was the first driving factor and it was used to screen out small scale banana processing facilities who were interviewed. Waste from banana processing is dumped in either gardens or disposed to municipal dumping sites.



Figure 1: Banana waste in the garden



Figure 2: Banana waste dumped



Figure 3: Banana ready for peeling

Amount and nature of feedstock plays a major role in sizing a biogas digester, estimating the volume of water to be used and biogas to be generated. If the installation requires more feedstock every day than is available, the digester will not perform effectively (Smith et al., 2011). The generation of waste at the banana processing facilities visited varied a lot, the ability to generate waste depended on the demand for the made products like wine, juice, packed matooke, crisp and chips. The ability to generate waste from banana also depended on the banana harvesting period, during banana harvesting season; the cost of purchasing banana from farmers was low as compared to the post harvesting period.

3.2.2 Fuel

Data from the questionnaire shows that firewood was the major cooking and heating energy source for banana processing facilities visited whereas; kerosene was the major lighting fuel. Firewood consumption per day varied from one banana processing facility to another. During high peak seasons, banana processing facilities consumed more firewood compared to low seasons. All banana processing facilities with exception of Frevasema needed heat in order to boil water or dry or bake the bananas. Firewood was purchased from forest reserves and private plantations. Frequency of firewood collection was between 1-7 times per week with 28 percent of banana processing facilities moving over 1 km to access firewood whereas 72 percent of banana processing facilities moved more than 1.5 km to reach their firewood collection points. Properly dry wood fuel has moisture content in the range of 10-20% whereas, fresh cut wood fuel has a moisture content of more than 50% water by mass. Firewood had a moisture content ranging from 17–48%. High moisture reduces the efficiency and makes it harder to sustain a good secondary combustion. This is due to the expenditure of energy to drive off the water, slowing combustion and cooling the gases produced by pyrolysis.

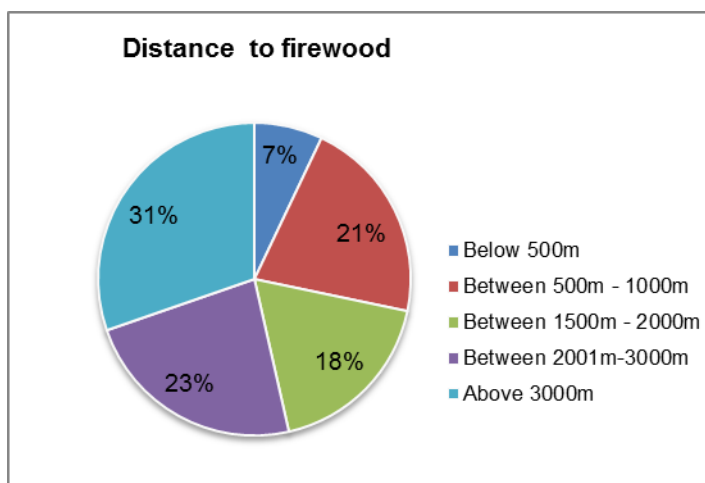


Figure 4: Distance to firewood



Figure 5: firewood storage

A digital weighing scale of 0-100 kg range was used to measure the weight of firewood consumed each day by the banana processing facilities interviewed. 4 percent of the banana processing facilities consumed less than 100 kg of firewood per week while 96 percent of the banana processing facilities consumed between 150-400kg of firewood per week. Energy consumption trends depended much on the ability to process bananas, hence, during the harvesting season, more energy was required. The traditional 3-stone fire is still the most common way to cook with firewood. Three bricks are assembled in a way which offer support to the pot, with the centre of the pot 9-15 cm above the ground. Having a biogas system could significantly reduce the firewood consumption.

3.2.3 Water availability

The amount of water required to run a biogas digester depends on the type and amount of feedstock. For optimal anaerobic fermentation the dry matter content must be between 2 and 5% (Preston, 2011). This means that for each 10 kg of dry matter there is a need for about 200 litres of water. Pandey et al. (2007) expressed this as approximately equal volumes of water and dung being fed into the digester daily. From this the daily requirement for water to run a biogas digester can be estimated. Water is used for drinking, cooking, hygiene (bathing, laundry, washing hands, food and dishes) and irrigation (Rosen and Vincent, 1999).

The amount of water used varied a lot, wine and juice processing facilities needed more water than banana crisp, banana powder and fresh peeling banana. All banana processing facilities collected more than 10 litres of water per day. This water was mainly used for cleaning the processing facility. Water was collected from a borehole, protected spring and open well, these water sources were distributed 0-2000m as shown in figure 6 below. For practical purposes, in view of the significant amounts of water needed, water should be within a distance of say 20 to 30 minutes from the installation, Batzias et al (2005). 41 percent of visited banana processing facilities had water sources distributed between 0-500m, the time taken to move back and forth is 20 minutes

It is anticipated that banana processing facilities selected for biogas installation will spend more time collecting the extra water required in a biogas digester. Whilst this may not be a problem in the wet seasons, it may be a problem in dry seasons, and the distance to water supply may become a limiting factor for parts of the year.

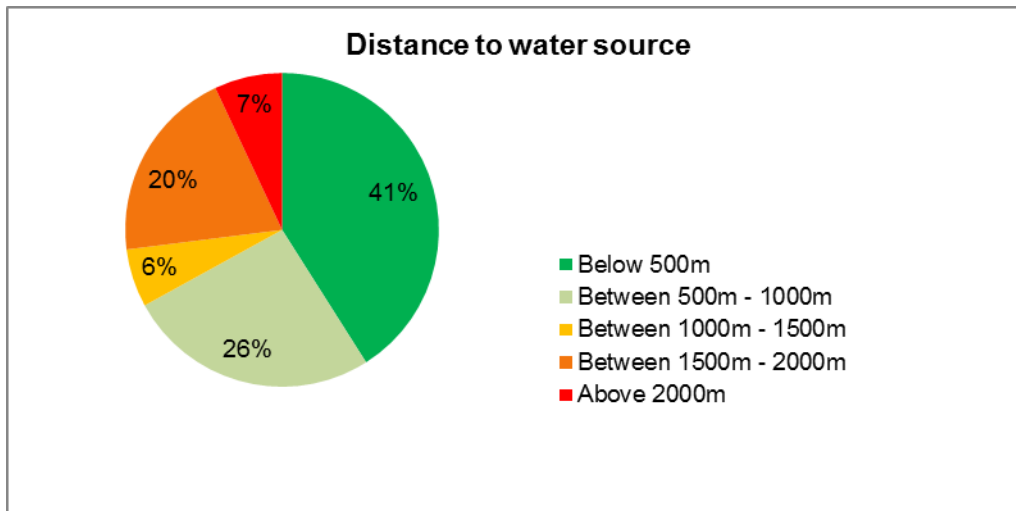


Figure 6: Distance to water

3.2.4 Potential biogas

The potential biogas production from the organic waste available in the household was estimated using the approach outlined by Chen (1983). The volume of CH_4 produced, V_{CH_4} ($\text{m}^3 \text{ day}^{-1}$), is given by

$$V_{\text{CH}_4} = P_c \times p_{\text{CH}_4} \times W_{\text{VS}} \quad 1$$

where P_c is the efficiency with which VS in the feedstock are decomposed (% VS decomposed); p_{CH_4} is the proportion of CH_4 produced when VS decompose ($\text{m}^3 \text{ CH}_4$ ($\text{kg decomposing VS})^{-1}$); and W_{VS} is the amount of VS in the feedstock (kg VS day^{-1}).

Please note, VS – Volatile solids; CH_4 – Methane;

The volume of biogas produced, V_{biogas} ($\text{m}^3 \text{ day}^{-1}$) is then given by

$$V_{\text{biogas}} = V_{\text{CH}_4} \times \frac{100}{P_{\text{CH}_4}} \quad 2$$

The amount of organic waste varied from as low as 40 kg to as high as 200 Kg per day. Other organic wastes like animal waste provide additional feedstock, it was also accounted for similarly. 4 out of 15 banana processing facilities generated less than 40 kg of organic waste per day, 8 of the 15 banana processing facilities generated 100-300 Kg of organic waste per day. The raw material for digestion must be conveniently available on a daily basis (Smith et al., 2011). Pre-treatment of the banana skin waste can be achieved by using a manual meat mincing machine (figure 8-10) which has the capacity to reduce the banana peel waste into particles of less than 1cm diameter; this increases the surface area for the action of hydrolytic bacteria. A mortar and pestle can also be used instead of the meat mincer especially for rural households with limited access to mincing machines.



Figure 7: Mincing machine



Figure 8: Macerated banana peel waste



Figure 9: Spent wine pulp

Banana skin waste (the peel), co-digested with other organic wastes produced in large urban areas offers a suitable energy source. In all the facilities visited, there are feedstock (banana peel, spent wine and juice pulp) which could potentially be available for the production of biogas. However, it can be co-digested with manure from near-by farms, care must be taken not to transport manure from long distances as this will increase the operation costs. Market food and vegetable wastes present an easier co-digestion feedstock in addition to the cow manure. However, acquisition of this waste material requires engaging relevant market or local government authorities depending on how they are currently handled.

UNIDO sites evaluation criteria: A simple Additive Weighting system is used																		
Factors		Sites															Notes	
No.	Factors	Max score	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14		B15
Firewood/Charcoal																		
1	Availability of cooking fuel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Each Banana Processing facility has a known source of firewood, The higher the ratio, the more likely the community will embrace the new fuel source. 8 is the highest score, 2 is the lowest score.
2	Distance _{to fire} to Distance _{water} Ratio	8	5	5	8	4	6	6	2	3	7	7	6	3	2	4	7	
sub total demand		9	6	6	9	5	7	7	3	4	8	8	7	4	3	5	8	
Feedstock																		
3	Availability	5	3	3	5	4	3	4	4	4	4	4	3	1	1	4	4	5 is the highest score, and 1 is the lowest. No village scored 5 since we did not visit a substantial number of households to verify the households with animals.
sub total fuel		5	3	3	5	4	3	4	4	4	4	4	3	1	1	4	4	
Water																		
4	Storage & water harvesting tanks	3	1	1	2	1	1	1	0	0	2	3	1	0	0	1	1	3 is the highest score and 1 is the lowest.
sub total fuel		3	1	1	2	1	1	1	0	0	2	3	1	0	0	1	1	
Need for biogas																		
6	Biogas needs	3	2	2	3	3	2	3	1	1	3	3	3	0	0	3	3	
sub total application		3	2	2	3	3	2	3	1	1	3	3	3	0	0	3	3	
Human factor																		
7	Composting in the garden	5	3	3	4	2	3	3	0	1	4	5	2	4	4	1	1	5 is the highest score, and 1 is the lowest.
8	Knowledge of biogas in the area	2	1	1	2	1	1	1	2	2	1	1	1	1	1	1	1	
9	Rented facility	5	5	1	5	1	5	5	1	1	5	5	5	1	1	5	5	5 is the highest score (for owned facilities, and 1 is the lowest (for rented facilities).
10	Willingness and ability to pay	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
sub total human factor		15	11	7	13	6	11	11	5	6	12	13	10	8	8	9	9	3 is the highest score and 1 is the lowest.
Total Score		35	23	19	32	19	24	26	13	15	29	31	24	13	12	22	25	
Percentage Score (%)			66	54	91	54	69	74	37	43	83	89	69	37	34	63	71	

Figure 10: A simple additive weighting

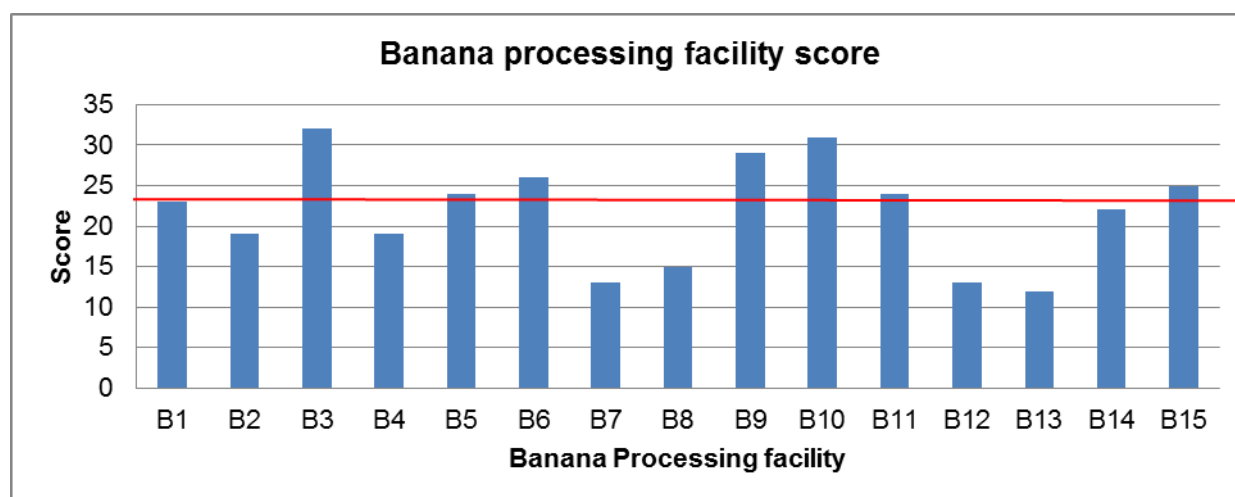


Figure 11: Banana processing facility score

From figure 10 and 11 above shows 7 (seven) banana processing facilities scored more the 23 points out of the possible 35. However, B3, Presidential Initiative for Banana Industrial Development “PIBID” is excluded in this study due to the fact that it's a government owned facility, the facility will be handed over to an investor

in the future. During the scoring exercise, factors like availability of fuel, feedstock, water ability to manage a biogas digester and biogas needs were considered.

4. Biogas digester

Small-scale anaerobic digesters are usually operated as semi-continuous systems. A biogas digester is a sealed tank where the anaerobic digestion takes place. The digester has a feeding point, a gas storage chamber and effluent exit unit. A fixed amount of organic material is mixed with the appropriate amount of water (or urine) and fed into the digester once a day. The biogas generated is used for cooking meals throughout the day. A quantity of semi-solid slurry is displaced through the exit pipe into a slurry holding tank. The slurry is often applied directly to fields, but can also be composted. The three designs of digesters currently available are the fixed dome, floating drum and the flexible balloon digester.

4.1 Fixed dome digester

This is the recommended digester type for the banana processing facilities in western Uganda. It is a below ground digester constructed of brick and cement. The digester is built on a circular concrete base using clay bricks (figure 11). The sides curve inwards to form a dome (figure 13) where the biogas collects and is stored. A neck is built onto the dome which is sealed by a cover to prevent gas leakage. This cover can be removed to conduct maintenance on the digester. A trained mason with proven experience is required to do the brick laying, plastering and fitting of the gas pipes. The digester is plastered inside with water-proof cement to make it gas-tight and to prevent leakage of the effluent. The outside of the dome is well plastered and the excavation site back-filled with soil and then landscaped (figure 15). These digesters are intended for large amounts feedstock and the ground level input makes it easy to feed in this way.



Figure 12: Foundation of a fixed dome



Figure 13: Gas chamber under construction



Figure 14: Complete fixed dome



Figure 15: Digester in the ground

Advantages of fixed-dome digesters are that the digesters have no moving parts, and the design lifespan is long (30 years) [Sasse et al., 1991], the maintenance costs are low, and it maintains stable temperatures

within the digester. These are some of the reasons this digester type is being proposed as a suitable design for the banana processing facilities. Disadvantages of fixed-dome digesters are that special water proof sealants are required, the costs of construction are relatively high, high technical skills are required for construction, and gas pressures fluctuate, which causes difficulties in the use of the gas [Sasse et al., 1991].

4.2 Benefits of biogas

The direct and indirect benefits of biogas are:

- An energy source for cooking and lighting, which reduces dependency on firewood and/or charcoal.
- Time and money that would have been spent on collecting conventional fuels such as wood is saved.
- Ensures environmental sustainability; reduces pressure on forest resources and biodiversity in protected areas and national parks. Methane is more potent as a climate gas than CO₂. Biogas use therefore combats greenhouse gas emissions.
- Furthermore, biogas provides environmental education and awareness through construction of e.g. school bio-latrines.
- Improved health conditions; the use of biogas reduces or eliminates indoor air pollution, reduction of diseases related to poor waste water and solid waste management, reduces ground and surface water pollution and exposure to smoke.
- Quality fertilizer; the slurry output of a biogas-digester is a high nutrient organic fertilizer that restores soil fertility.

4.3 Challenges of biogas systems

The use of biogas systems implies the following challenges:

- Biogas systems require in the beginning relatively high upfront costs that are compensated through fuel savings within 2-3 years. However, the initial investment deters many potential users, co-financing by financial institutions or donors is recommended.
- The construction of biogas systems requires special working skills, especially in respect of masonry and pipe installation.
- The well-being of the biogas-producing bacteria is the base for a proper functioning of the systems. A regular influx of appropriate feedstock is therefore key. In addition, the feeding-pipes need to remain clear and water is regularly to be removed from the gas-holder-stove-connection. Hence a relatively high degree of maintenance efforts are indispensable for keeping the biogas system going.

5. Biogas plant Capital Costs

Under this section, the biogas digester capital investment estimations of small scale digesters (for the thermal energy) are being discussed under this section. The ability to generate electricity did not turn out as a major need since majority of the banana processing facilities did express the need for heat. The standard cost of investment in an agricultural biogas digester is in the range of US\$300 – 500 per cubic metre of digester volume, however, an additional US\$500 – 1500 per kW_{el} of installed power generation from a combined heat and power system. These cost estimates take into account, the cost of the digester, holding tanks, slurry, gas storage, piping, fittings and pumps. Other than these figures; engineering design and construction fees of up to 30% of the total capital costs of the biogas plant and generation unit can be expected.

Table 2: Estimated cost of materials and labour

Description	USD per site	USD for 6 sites
Materials required		
Site preparation, land escaping, excavation works,	1,200	7,200
Biogas digester with the mixing unit and effluent tank	8,800	52,800
Biogas collection, storage unit and piping system	1,900	11,400
Carbon dioxide, Hydrogen Sulphide and water removing system	500	3,000
Labour	3,720	22,320
Contingency at 10 percent	1,600	9,600
sub-total	17,720	106,320
Capacity building operations' manual development for each user, technical support to end user for a year	5,000	30,000
Total	22,720	136,320

For the banana facilities generating 40 kg to as high as 200 per day, biogas digester plant capacity of 30-50m³ would be preferred and expended later by replication to the construction of a larger installation.

Table 3: Systems analysis estimate value of biogas

	B5	B6	B9	B10	B11	B15
Firewood requirement (kg yr ⁻¹)	5,400	6,300	9,600	10,240	7,500	8,000
Biogas produced (cubic metre yr ⁻¹)	1,020	1,530	22,100	2,380	1,700	1,530
Percentage energy requirement met	60%	60%	80%	70%	80%	80%
Economic value as a fuel (\$ yr ⁻¹)	1,296	1,512	3,072	2,867	2,400	2,560
Economic value as a fertilizer (\$ yr ⁻¹)	600	900	1700	1500	1600	1200
Total economic value (\$ yr⁻¹)	1,896	2,412	4,772	4,367	4,000	3,760

The total economic benefit of biogas digester is shown in table 3. The fertilizer benefit has been discussed in detail in section 5.2 below. Biogas energy could be a suitable alternative for cooking and heating energy and therefore is proposed as one of the approaches to reduce deforestation, particularly deforestation resulting from woodfuel consumption. By providing an alternative energy source that would otherwise be obtained from fuelwood or charcoal, it is widely assumed that biogas digesters could help to reduce the rate of deforestation in SSA.

5.1 Standard/expected running costs

The costs encountered while running a biogas digester will not be limited to:

- i. To manage a biogas digester at least one skilled technician, unskilled worker are required; however, from time to time, an engineer with better understanding of the installed digester would be needed. Overhead costs are usually calculated at 10 per cent of the labour cost.
- ii. A 5 per cent of the capital expenditure is used as maintenance cost and spare parts
- iii. Plant energy consumption for the secondary equipment in relation to projected energy production.
- iv. Contingency costs of 10 per cent.
- v. Loan interest or depreciation costs on the capital investment.

5.2 Value of bioslurry as an organic fertiliser

Replacement of inorganic fertilizers - Nitrogen and P are most required by plants, and as a result, these nutrients are most likely to limit crop growth (Williams et al., 1976). In SSA, crop yields can be substantially increased with fertilizer applications, especially N and P. In SSA, Vanlauwe et al., (2011) noted increases in yields of up to 40 kg per kg of applied N after analysis of data from 90 peer-reviewed journal papers and conference proceedings on control yields, yields after N application and fertilizer N rates in cropping schemes based on maize. Bationo et al. (1991a) also reported widespread limitation of P that can be reduced by use of organic fertilizers. Phosphorus deficient fields at Sadore in Niger, recorded a 250% increase in millet yield after application of P fertilizer (Bationo et al., 1991b). Assefa Abegaz (2008) reported increased in barley yields of; 90, 69 and 90 kg per kg of applied N, P and potassium (K) respectively in 3 soil highlands north of Ethiopia.

Increased use of the recycled nutrients and substitution of costly inorganic fertilizers through use of the digestate has the capacity to effect the nutritional status of crops, resulting in improve yields. Even though there are high possible economic benefits of increased crop yields after application of the digestate, it is challenging to calculate the possible increases in yield at a given location without a comprehensive dynamic simulation model with the ability to analyse the status of nutrients in soils and crops. Having said that, the value of application of the digestate to the farmer can be partially estimated from the potential savings of purchased inorganic fertilizer. This can be calculated from input values of the volume of fertilizer anticipated to be used, M_{fert} (t fertilizer yr⁻¹) and the cost of the fertilizer, S_{fert} (t fertilizer)⁻¹).

Use of the digestate to crop fields has a number of additional monetary advantages, however, these are ambiguous and difficult to quantify. There is a relationship between crop productivity and the soil organic matter content [Pan et al., 2009], this affects the physical, chemical and biological properties of the soil, in addition to the nutrient supply of indigenous soils (Bessam and Mrabet, 2003; de Ridder and van Keulen, 1990). Soil organic matter affects the overall losses of nutrients by erosion, leaching and gaseous emissions. Similarly, micro-organisms provide a slow release source of nutrients to plants during decomposition process. Lal (2004) estimated that 1 tonnes of C sequestered as soil organic matter will hold on average 80 kg N, 20 kg P and 15 kg K, and observed that an increase in arable soils of 1 t ha⁻¹ could increase crop yields by 20 to 40 kg ha⁻¹ for wheat, 10 to 20 kg ha⁻¹ for maize, and 0.5 to 1 kg ha⁻¹ for cowpeas. Significant improvements were observed in crop yields after application of fertilizer in a mulched crop field (Yamoah et al., 2002), trees (Sanchez, 2002) or with manure or compost (Vanlauwe et al., 2011). Assefa Abegaz (2008) observed increased in the agronomic productivity in fields with higher soil organic C contents after application of P and K fertilizers. Lengthy trials carried at Kabete, Kenya, resulted in increased yield of 0.85 t ha⁻¹ for 1g of soil organic C added per kg of soil (Janssen 2011). Other farm trails in different countries in SSA proposed that improved management of soil organic matter has the capacity to increase yields by up to five times.

The soils of SSA are often short of soil organic matter and have great ability to sequester C. Sub Saharan Africa was classified as a global hotspot of soil degradation with a great urgency for soil restoration and C sequestration (Lal 2004). Aune and Lal, (1997) reported that a 1.1% as a critical limit for soil organic C concentration in most soils of the tropics, on the other hand, a less than 1% of the organic C content of soils in SSA (Nyamangara et al. 2003). Similar results were reported by several local studies. For example, organic C in the 0.9 - 1.1% ranges was reported on continuously cultivated soil of the north highlands of Ethiopia (Assefa and van Keulen 2009). Alternating the decomposability of organic amendments to the soil has the ability to sequester additional C in the soil. Over time, additional value may be provided to the household through trading financing mechanisms. However, to date, these advantages are not appreciated. As a result, the possible financial value of C sequestration in the soil has not been used in this calculation.

6 Conclusion

This feasibility study has focused on determining the viability of using banana waste to generate biogas to serve the energy needs of the banana processing facilities in Uganda by reducing dependence on firewood and charcoal. Anaerobic digestion has the potential to offer the banana processing facilities a suite of economic, social, and environmental benefits beyond its obvious utility as a source of clean, renewable energy. The selected banana processing facilities were Kyenshaki elderly group (B5), St Peter's Rockhill organic processors (B6), Tigebwa wine (B9), Forest Fruit Ltd (B10), Excel Hort (B11) and Muramira wine (B15) which had potential to generate sufficient organic waste to run a biogas digester. The total estimated budget for construction is \$136,320. This study focused on alleviation of energy poverty (or shortage) by reducing excessive exploitation of forests as a fuel-source and retaining forests as a sustainable source of more valuable products. The issue of deforestation is of central concern to local people, who rely on forests as a daily source of fuel but see trees being cut down at an increasing rate and increasing time lost in wood collection every day. They identify the need to find ways of stopping this decline and discover long-term solutions to reducing availability of wood for fuel and land for farming.

Employing on-site anaerobic digestion can help banana processors with waste management while generating onsite fuel. The benefits of anaerobic digestion offer more indirect or secondary waste management benefits. Reduced agricultural run-off means cleaner public drinking and recreational benefits. In some cases, this waste management with anaerobic digestion results in direct energy savings by reducing dependence on firewood and charcoal consumption; the six selected banana processing facilities will save up to \$21,000 per year on firewood and fertilizer expenses. This is besides the additional environmental benefits that have been described.

Factors that control crop production include uptake of nutrients, water and oxygen, light interception, and temperature. The environmental constraints that directly impact these factors include availability of nutrients, organic matter content of the soil and water availability. The widespread introduction of biogas digesters is likely to have an impact on all of these environmental constraints. The yields of crops treated with bioslurry will be higher than the yields of crops treated with urea or chicken manure. Losses of N during anaerobic digestion also appear to be very low. Finally, the overall *E. coli* and total coliform loads in the digestate will significantly decrease hence an overall decline in loads in the wider environment as a result of widespread implementation of digestate and application of bioslurry rather than untreated waste is expected, especially in drinking water.

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8. Appendix 1: List of organization

Codes	Organization	Contact Person	Area in Uganda
B1	Rutunguru Tukwatanise Tukore Banana Group	Mr. Mujuruzi Salongo	Rutunguru , Ihunga Sub County, Ntungamo
B2	Isingiro District Multi-stakeholder Agribusiness Initiative (IDMAI)	Nyakitunda	Nyakitunda , Isingiro
B3	Presidential Initiative for Banana Industrial Development (PIBID)	K. Tumwebaze Nassan Ag. Administrator, 077-244-3820	Bushenyi,
B4	SILGAD Investments Ltd	Ghad Atuhaire	Mbarara Municipal Council, Mbarara
B5	Kyenshaki Elderly group	Mr. Kubiriba Enock	Kyenshaki Rwashamaire Town council, Ntungamo
B6	St. Peters' Rockhill Organic Processors	Bahirwa Petronella, 704729785	Isingiro town Council, Isingiro
B7	Afri Banana Products (U) Ltd – Banana value chain incubation centre	Mr. Kimani Muturi, afribananaproducts@g mail.com	Biharwe, Mbarara
B8	Fresh Vacuum Sealed Matooke	Dr. Bazirake Byarugaba G. gwbbazirake@gmail.co m	Mbarara,
B9	Tigebwa Wines	Kwagara Paul 0782963113	Kanyeghero, Nkanga, Nyabubare, Bushenyi
B10	Forest Fruit Ltd	Kano Naijuka 0772413736 or 0702413736	Nyabicerere Ward II Central Division, Bushenyi
B11	Excel Hort Consultants	Dr. Andrew Ainomugisha (Program director) and Anke Weisheit (National resource) aaainomugisha@excelhort.com	Mbarara,
B12	Mbarara District Farmers Association, MBADIFA	Mr. Asaph M. 077-235-0787	Mbarara/Ibanda
B13	Suppliers of Banana	Mr. Ronald Seguya 077-545-3408	Isingiro,
B14	Bushenyi Banana Wine Makers Association	Mr. Mwebaze Wilson	Mitooma, (Former Bushenyi),
B15	Muramira's Wine	Mr. Ndamira John 077-256-6706	Bushenyi,

9. Appendix 2: Fixed Digester Design

ASSESSMENT OF BANANA TISSUE CULTURE INDUSTRY IN UGANDA

Report of a Consultancy on Banana Tissue Culture

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June 2013

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LIST OF ABBREVIATION

AGT	Agro Genetic Technologies Ltd
BBW	Banana Bacterial Wilt
BIDS	Banana Industry Development Strategy
GDP	Gross Domestic Products
MAAIF	Ministry of Agriculture Animal Industry and Fisheries
NARL	National Agriculture Research Laboratory
NARO	National Agriculture Research Organisation
NGO	Non-Governmental Organisation
PAD	Poverty Alleviation Department
PIBID	Presidential Initiative on Banana Industry Development
TC	Tissue Culture

Assessment of banana tissue culture industry in Uganda

Executive summary

The banana industry in Uganda is threatened by banana bacteria wilt disease (BBW) which to date have no genetic control. *In vitro* tissue culture planting materials will therefore be needed to replant destroyed farms. It will also move the banana industry from subsistence level to plantation agriculture where large farms are planted with clones as compared to mixed varieties by the farmers. Currently, there are six TC laboratories in Uganda with only one (Agro Genetics Technologies Ltd (AGT)) producing banana plantlets on large commercial scale (3 million plantlets per annum). The remaining five laboratories are small with low capacities (below 500,000 plantlets per annum). Thus, it is recommended that additional two laboratories should be established in Isingiro and Bushenyi districts each with a capacity to produce at least 10 million plantlets of banana for farmers in Western Uganda and also to replace damaged farms in Central Uganda. In the short term, the five small privately or publicly owned laboratories should be assisted through credit facilities to expand their laboratories to produce at maximum capacities. It is also recommended that additional 40 TC plantlet nurseries each with a capacity of 50,000 plantlets at an estimated cost of one hundred and twenty eight thousand US dollars (US\$128,000.00) should be constructed in the Western and Central Regions to wean and harden plantlets for the farmers. For easy adoption of TC plantlets by farmers, especially in Western Uganda each nursery should have a demonstration farm. Nursery operators should be trained on postflask management of plantlets, best agronomic practices and climate change adaptations. The Ministry of Agriculture Animal Industry and Fisheries (MAAIF) should regulate the production of plantlets by TC industries by ensuring that the plantlets are indexed for viruses and other transmissible diseases before distribution to farmers.

1.0 Background to project

Agriculture is a major contributory sector to Uganda's economy accounting for about 23.7% of total GDP and employing almost 73% of the labour force, the majority of which are women living in rural areas. The banana industry is by far the most important employing about 60 to 70% of the rural population and producing about 30% of the food consumed in the country. It is a food security crop as well as foreign exchange earner as the country exports fresh bananas to South Sudan, DR Congo and Rwanda. Thus, the banana industry plays a highly significant role in the socioeconomic lives of farmers who currently produce an estimated 10 million tonnes annually mainly from Western and southern part of the country.

In spite of the high annual production, the banana industry is constrained by overdependence on rain-fed production leading to low productivity, slow adaptation of productivity enhancement technologies, lack of diversification among smallscale producers, poor access to market opportunities and price fluctuation, long market chain resulting in increased transaction costs and absence of processing industries. Another threatening factor to the banana industry is the emerging climate change coupled with its attendant drought and unpredictable rainfall patterns and emergence of new pests and diseases.

The banana plant is attacked by several pests and diseases which affect the supply of fresh bananas. These diseases include banana streak virus, bunchy top virus, *Fusarium* wilt and the banana bacterial wilt disease (BBW). In recent past, the banana bacterial wilt (BBW) has caused great damage to the banana industry destroying large plantations especially in Central Uganda. The problem is aggravated by lack of resistant varieties and periodic resurgence even in areas where the disease is under control. Thus, the only remedy is to destroy the infected plants from the field which is disincentive to farmers.

Recognising the socioeconomic importance of banana in Uganda, as a main staple food security crop with potential for poverty reduction through income generation especially among rural farmers, the Government of Uganda has instituted a policy to sustainably increase production, processing and marketing by 2018 through several initiatives. The government has set up the Banana Industry Development Strategy (BIDS) under the Ministry of Agriculture Animal Industry and Fisheries (MAAIF) to develop the banana industry. To further strengthen the industry, the Poverty Alleviation Department (PAD) set up the Presidential Initiative for Banana Industry Development (PIBID) which aims at developing the banana value chain and has established processing factory in Bushenyi district in Western Uganda. Additionally, the National Agricultural Research Organisation (NARO) has been tasked to increase banana production, develop climate resilient and disease resistant varieties.

Since there is no yet genetic solution to the BBW, the supply of disease free planting materials obtained by tissue culture is the immediate option to solve the menace of the disease as it prevents the dissemination of disease planting materials. Additionally, the production and distribution of tissue cultured plantlets has an inherent climate change adaptations because it encourages the use of greenhouse facilities for weaning and hardening of plantlets as well as production of plantlets throughout the year independent of the weather, thereby allowing for escape of drought effect on planting material production.

Although the tissue culture (TC) technique is being integrated into the traditional farming system, the current capacities in the country are not sufficient to realistically meet the large demand by farmers and also sustain the banana value chain and product diversification programmes. Thus, the expansion of the TC industry is needed not only to rapidly multiply disease free planting materials but also to create jobs and additional income for farmers. Thus, the government of Uganda is seeking the technical assistance of UNIDO to diversify the banana value chain to provide greater opportunities for income generation, poverty reduction and food security especially in the rural farming communities. Thus, this consultancy service is aimed at assessing the existing banana tissue culture (TC) industry, ascertain plantlet production constraints and make recommendations needed to upgrade the industry for sustainable supply of clean tissue culture planting materials to farmers, and the potential socioeconomic and climate change adaptation benefits of the banana TC industry. It also aims at identifying the target communities and make recommendations to expand nursery facilities, an important intermediate link between TC laboratories and farmers in the identified communities.

2.0 Identification of target communities

Banana is widely cultivated in almost all the districts in Uganda. However, production is mainly concentrated in the South West and Central districts of the country. The Central region was most hit by the BBW disease and has therefore lost a lot of the banana farms. The specific districts where banana farming is heavily concentrated and need immediate support are shown in Table 1 below (see Appendix 1 for location of districts). The banana growing communities are mostly peasant farmers who own small to medium size farm lands growing the crop mostly for domestic consumption or for income generation. There are also some large scale farmers, farmer based associations and non-governmental organisations (NGOs) that grow the crop for income generation.

Table 1. Districts identified for TC Plantlet nurseries establishment

Region	District	Specific communities/Subcounty	No of Nurseries
Western	Bushenyi	Kyeizooba, Kyamhunga, Kyangyenye	4
	Mbarara	Nyakayogo, Rubaya, Mbarara	4
	Rukungiri		3
	Isingiro	Masha, Kabingo	4
	Ntungamo	Rukomi	3
	Kabale		2
	Subtotal		20
Central	Masaka		4
	Mukono		3
	Luwero		3
	Mityana		3
	Kayunga		2
	Iganga		3
	Kabulasoke		2
	Subtotal		20
Grand Total			40

The varieties grown are mostly the East African Highlands banana varieties traditionally called *matooke* with a few of them planting dessert bananas for sale. Several varieties of the *matookes* are grown by the farmers depending on the district, cooking quality, market availability and products to be derived from the variety. For example, in Fort Portal the farmers grow *kitika* variety which is well adapted to the climate and for brewing local beer. For food security reasons, the farmers usually grow about four or five varieties on the same piece of land. Some of the varieties grown are *kibuzi*, *mbwazirume*, *kamenyamagali*, *mpologoma* and *Butande*. Farmers also grow *ndizzi* and *bogoya* for desserts, *kayinla*, *mbidde* and *kisubi* for juice making, brewing of traditional beer and for distilling wine.

The National Agriculture Research Laboratory (NARL) in Kawanda has also released the following varieties of *matookes* but they are yet to be fully adopted by the farming communities.

1. *Kabana* 6H and 7H (M9): These varieties are resistant to black sigatoka disease and it is also tolerant to nematodes. The yield is comparable to the local *matooke* varieties and the farmers prefer it but its preference is not as high as that of the local *matooke*.
2. M2 *Matooke* and M9 *Matooke* are also new varieties which have been released
3. FHIA 17 (this is not a *matooke* but a variety introduced by International Institute of Tropical Agriculture)

3.0 Inventory of Tissue Culture Facilities for banana plantlet production

In Uganda tissue culture technology has been well integrated into the farming systems indicating practical transfer of modern technology into traditional farming practices. Thus, tissue culture facilities exist in Uganda for rapid multiplication of disease free planting materials of banana, coffee and other crops. The driving force for TC planting materials is mainly due to the outbreak of the BBW disease (first spotted in 2001 in Kayunga district) which almost wiped out the banana industry. The absence of genetic solution to the BBW disease will continue to create opportunities for the tissue culture industry in Uganda for a long time to come. Currently, there are six Tissue Culture Facilities producing disease free banana planting materials and other crops in Uganda. They are as follows:

3.1 Agro-Genetic Technologies Ltd (AGT)

AGT is a well equipped large private commercial tissue culture (TC) laboratory in Uganda established in 2002 at Buloba, along Kampala - Mityana road. It is the biggest TC laboratory producing about 8 million planting materials (coffee, banana, and *Stevia*) for Uganda and also neighbouring countries such as South Sudan, DR Congo, Ethiopia and Rwanda. It has 14 laminar flowhoods in the transfer rooms, a well-equipped molecular biology laboratory for virus indexing and employs about 60 workers. AGT Ltd supplies banana plantlets to 27 nurseries scattered in the southern part of Uganda with each nursery having a capacity of 20,000 to 50,000 plantlets. The nurseries are owned by private individuals and non-governmental organisations (NGO) who buy the plantlets on discount and sell them to individual farmers. Thus, together with the nursery owners AGT Ltd employs about 200 people. The current capacity of AGT Ltd laboratory is 3 million banana plantlets per year but it has the capacity to produce about 5 million plantlets. Each plantlet sells at US\$0.80. In spite of this huge production capacity, the laboratory is not able to meet the demand for cleaned banana plantlets for farmers. As a regulatory measure each plantlet goes through 4 subcultures from initiation to weaning and hardening to avoid somaclonal variation among the plantlets distributed to the farmers. Secondly, they are indexed for viruses to ensure that the planting materials supplied to the farmers are free from viruses. The company has 2 mother gardens where explants are collected for multiplication to ensure that the company's *in vitro* plantlets are clones with known origin. The plantlets are supplied in trays

each containing about 1000 plantlets and are transported in vans to the nursery centres where they are weaned, hardened and sold to farmers. There are demonstration gardens attached to the nurseries to illustrate the resilience of TC plantlets to traditional farmers and also for training of farmers and nursery owners.

3.2 Makerere University Tissue Culture Laboratory

Makerere University has a teaching and semi commercial tissue culture laboratory which is located at Kabanyolo, about 20 kilometres from Kampala. Besides teaching, the laboratory is used for production of disease free planting materials of banana, cassava and sweetpotatoes for sale to farmers. The current production capacity is 15,000 plantlets per planting season and hopes to produce about 60,000 plantlets after expansion. The plantlets are bought by private farmers and non-governmental organisations (NGOs) who in turn sell them at subsidised price to private farmers. The cost per plant is US\$0.70. The laboratory also has a germplasm (or mother garden) where explants are collected for multiplication *in vitro*. It also has a small structure for post flask weaning and hardening of plantlets but there is no nursery as the hardened plantlets are supplied directly to farmers or non-governmental organisations. They also do virus indexing.

3.3 National Agricultural Research Laboratory (NARL), Kawanda:

The National Agriculture Research Laboratory at Kawanda has a well-equipped but very small TC laboratory used mainly for research purposes. It is principally used for rapid multiplication of newly developed crop varieties (coffee, banana etc) by the research laboratory. It has also developed a highly efficient system for virus indexing which could be expanded to provide virus indexing services for TC planting materials in other laboratories to curb the spread of viral diseases. Since it is a small laboratory it cannot be used for production of planting materials on large commercial scale for sale to farmers. The TC laboratory is funded by the Government of Uganda through its funds allocation to the research institute and also by donor support through research collaboration. It has well established mother garden of banana germplasm. It also supplies explants to BioCrops (U) LTD for micropropagation.

3.4 BioCrops(U) LTD

BioCrops (U) Ltd Company owns a tissue culture laboratory which was set up in July 2008 to produce banana plantlets for sale to farmers. It is located at Kitezi, a small town near Kawanda. Currently, BioCrops tissue culture laboratory produces 200,000 plantlets per annum since it has just been set up but has capacity to produce 800,000 plantlets when it becomes fully operational. They collect their

explants from the mother garden of National Agricultural Research Laboratory in Kawanda. Virus indexing is also done by scientists from NARL, Kawanda. The company sells one plantlet for 2,000 to 2,500 Ugandan shillings (approximately US\$0.70-0.80) depending on the quantity being bought by the client. It has a nursery with a capacity of 50,000 plantlets. It has fourteen workers who are solely responsible for micropropagation of banana.

3.5 Nsigotech Tissue Culture Laboratory

This is a small private commercial tissue culture laboratory owned by SCIFODE, a non-governmental scientific organisation with the aim of promoting science in traditional farming practices. It is located in Kasangati about 10km from Kampala. It has the capacity to produce about 10,000 banana plantlets annually.

3.6 National Crops Resources Research Institute (NCRI) Tissue Culture Laboratory

This is also a small research laboratory owned by NCRI in Namulonge. According to Dr. Titus Alicae, the laboratory is solely dedicated to cassava research and therefore does not produce banana plantlets for sale. It is equipped to do virus indexing.

4.0 Constraints in the Banana Tissue Culture Industry

The tissue culture industry in Uganda has shown practical demonstration that biotechnology can be infused into the traditional farming practices of the African to solve daring problems including climate change adaptation and mitigation. The tissue culture technology is playing a significant role in the control of BBW as it supplies clean planting materials in the banana value chain development. However, the technique is highly constrained by several factors and thus its full potential in the banana industry is not fully realised. With the exception of AGT Ltd, all the TC laboratories are small and their production capacities are too low to produce over 20 million banana plantlets needed annually in Uganda. Besides, the tissue culture laboratories of the universities and the research institutions are publicly owned, too small and are solely used for research, thus they do not multiply plantlets on commercial scale for farmers. Thus, the existing tissue culture laboratories are not enough to meet the deficit in banana planting material supply in Uganda which depends mostly on banana for food.

Since the technology is highly scientific, it requires highly skilled human labour. The industry lacks such highly trained personnel to do the micropropagation or multiplication of the plantlets *in*

vitro. Consequently, most of the laboratories spend a lot of time and resources to train newly employed staff to acquire skills in micropropagation in the laboratories.

The cost of production of TC plantlets is very high thus making it unaffordable by farmers. The high cost is attributed mainly to the importation of laboratory chemicals for preparation of basal media for culture initiation and multiplication and also the long distance of transporting plantlets from laboratories to nurseries for hardening. Currently, the unit cost of banana plantlet is between US\$0.70 to US\$0.80, making it very expensive for the rural farmer majority of whom has very low income. Rural farmers who cannot afford use the traditional mode of replanting their farms with free suckers from their neighbours' fields with or without diseases.

Tissue culture nurseries play a major role in the banana planting material production chain by distribution of plantlets as they serve as a link between the laboratories and the farmers. Currently, only a few tissue culture plantlet nurseries have been established in some districts. These few nurseries cannot meet the demands of farmers who plant at least 450 plantlets per acre. Secondly, the laboratories are far away from the nurseries and farmers and therefore the plantlets have to be transported through long distances to the nurseries. When the cost of transportation is added to the plantlets cost by the nursery operator, it becomes too high and thus unaffordable by the farmer. Secondly, the nursery operators are also neglected by the private sector, banks and donors and thus have no access to credit facilities.

Also, lack of optimised protocols for specific banana variety (or varieties) is a major constraint to TC laboratory operators. There are several varieties of banana (*matooke*) in Uganda with each district or region having its preferred variety for food. The farmers plant the variety for specific product development or market availability. However, there are no optimised protocols for each of these varieties. Thus, many of the TC companies spend a lot of time and resources developing and optimising variety specific protocols for micropropagation. Funds used for developing the protocols are transferred to the cost of the plantlets making them expensive, thus the low rural farmer cannot afford them.

There are also poor credit facilities to support both the existing and emerging TC laboratories. The resultant effect is that most of them find it difficult to operate at full capacity creating plantlet supply deficit during the planting season.

Lack of implementation of quality standards and plant health certification is a major threat to sustainable commercial tissue culture plantlet production. Of particular importance is virus indexing which is a necessary prerequisite for micropropagation of vegetative propagated crops (such as

banana) to ensure that plantlets produced are free of viruses. The various TC laboratories do their own virus indexing without the supervision from any centralised regulatory body to certify that plantlets are virus free. Thus, it is likely that some plantlets may be distributed to farmers without proper indexing. In addition to this is the lack of seed certification for vegetatively propagated crops. There have been instances where farmers have been supplied with plantlets which are of mixed varieties due to lack of regular supervision or regulation.

Furthermore, there is weak relationship between the private laboratories and public institutions. For instance, the development of variety specific protocols should be the responsibility of public universities and the research institutions who in turn should give them to the TC laboratories to be used for multiplication, but this is not the current practice.

Plants respond to lighting regimes in a variety of ways, thus occasional power outage especially when the growth room lights are supposed to be on adversely affects the growth of the plantlets. The use of generators by TC companies to support the national supply adds cost to the production of the plantlets.

Although there is huge domestic market for TC plantlets, it is seasonal and sometimes cannot be guaranteed since farmers may not buy the plantlets every year. Also, since the farmers do not order the plantlets ahead of planting season the managers of TC laboratories are put in a dilemma whether to produce or not. Additionally, they don't know the specific variety to multiply for the farmers if an order is not received prior to production.

4.1. Interventions for the tissue culture industries

Undoubtedly, tissue culture will continue to play highly significant role in the banana value chain development programme in Uganda due to the prevalence of the BBW and also its use in coffee multiplication. Even though there are intensified programmes for the control of the disease, its unexpected resurgence will require the use of cleaned *in vitro* planting materials for replacement. Besides, TC culture is the only technique that can be used to produce clones of specific varieties for specific products. Currently, farmers grow mixed varieties on their farms and it is very difficult for end users (consumers and product developers) to tell the differences from the morphology of the fruits on the market and this does not augur well for specific product development.

According to AGT boss, the current 3 million plantlets of banana produced per year by his laboratory is a drop in the ocean; it is woefully inadequate considering the fact that banana is grown almost everywhere in the country. It can be estimated that the current tissue culture planting materials

produced by all the laboratories is about 4 million plantlets per annum. Of this number, AGT Ltd produces about 3 million per year, while BioCrops (U) Ltd, Nsigotech and Makerere University Tissue Culture laboratories produce approximately one million. Considering the fact that almost all the districts grow banana, an estimated 20 million plantlets may be needed annually to meet the need of farmers during the planting season.

However, there are currently six tissue culture laboratories in Uganda as listed above (Section 3.0) and only three of these laboratories (AGT Ltd, BioCrops (U) Ltd and Nsigotech) are producing tissue culture plantlets on commercial scale. Among these three, only one laboratory (AGT Ltd) is producing appreciably large numbers of plantlets for sale. Although, BioCrops (U) Ltd and Nsigotech also produce on commercial scale their current production capacity of 200,000 and 10,000 plantlets respectively per annum is very low and cannot meet even 10% of the tissue culture plantlets demanded by farmers in a year. The remaining three laboratories (Makerere University Tissue Culture Laboratory, National Agriculture Research Laboratory Tissue Culture and National Crops Resources Research Tissue Culture Laboratory) are basically research laboratories and are therefore not producing on commercial scale even though they can establish commercial production lines in addition to their research activities.

Besides, all these laboratories are located in central Uganda, either in the capital, Kampala or few kilometres from Kampala. Thus, it is difficult for the subsistence farmers in the rural communities to have access to disease free tissue culture plantlets. The use of tissue culture planting materials by farmers declines as one moves from Kampala (central) to the remote part of the country. Most farmers interacted with from Masaka through Mbarara to Bushenyi are not growing tissue culture plantlets.

Although AGT produces about 3 million plantlets per year, it is woefully inadequate to meet the demand by farmers. Therefore to meet the deficit in banana planting materials demand, it is recommended that additional two tissue culture laboratories with capacity to produce five million (5m) plantlets each should be established by government, farmer based groups or other agro-based organisations in Mbarara and Isingiro which are the major banana growing districts. These laboratories should produce community, district or product specific banana varieties for distribution to farmers. They should also be linked with tissue culture plantlet nurseries in remote parts of the districts so that farmers could have access to the plantlets. As long as BBW has no genetic solution, tissue culture laboratories will continue to be a viable venture in Uganda who solely depends on banana for their food security. Besides, the current demand for tissue culture plantlets of coffee and other crops has also created market opportunities for the TC industry in Uganda.

It is also recommended that the existing small laboratories should be given credit facilities to support the expansion of their facilities in order for them to produce plantlets at their full capacities. They should also set up nurseries in the rural communities to make the plantlets available at the door steps of the farmers. Credit facilities should also be extended to the tissue culture nursery operators who are playing essential intermediary role in the banana production chain but are neglected by the private sector and donors.

The role of tissue culture plantlet nurseries in the banana planting material distribution chain is very critical to the adoption of the plantlets by farmers. The current nurseries are insufficient to meet the needs of farmers. It is recommended that there should be massive expansion of the nurseries in all the major banana producing districts. Thus, additional 40 tissue culture plantlet nurseries should be established in the identified areas (see section 3.0 above), to make planting materials available to farmers whose produce will feed the PIBID banana processing industry at Bushenyi. Each nursery should have a capacity for at least 50,000 plantlets annually (see the nursery design below). To facilitate the adoption of tissue culture plantlets by farmers, each established nursery should have a demonstration farm or a garden to exhibit the performance of tissue culture plantlets to farmers. This is very important in Western Uganda where the farmers seem to have had control of the BBW disease. The MAAIF should intensify education on the adoption of tissue culture plantlets in the remote banana planting districts. Additionally, the nursery operators should be adequately supported with credit facilities for the expansion of their nursery operations. The nursery operators should be organised to form associations through which they will be given periodic training on the programme of the banana value chain in Uganda, disseminate climate change information as well as other agribusiness practices.

As the tissue culture industry grows there will be the need for more highly skilled human labour. The public institutions especially the universities should include in their curriculum programmes to train more students on tissue culture techniques. The research institutions together with the Ministry of Agriculture Animal Industry and Fisheries (MAAIF) should organise periodic training workshops or farmer field schools on aseptic manipulation, micropropagation techniques, postflask handling of plantlets, best agronomic practices, virus indexing and soil management. Such training should also include climate change adaptation practices such as the use of drip irrigation, watering by using overhead sprinklers and control of soil erosion. The training can be done using the Farmer Field Schools, TV stations and FM radios.

PIBID should support the public research institutions and laboratories to develop variety specific protocols for the private laboratories to be used for large scale multiplication of these varieties.

Currently, emphasis of planting material production is only focused on few varieties of *matookes* which are the cooking types to the neglect of the dessert or the juice making varieties.

Since currently there is planting materials supply deficit, the small research laboratories should be assisted in the short term to set up production lines by acquisition of additional flowhoods and engagemore technicians to multiply banana plantlets. In the long term, they should develop disease resistant and/or tolerant varieties as well as drought tolerant bananas as mitigation against unexpected drought in the wake of climate change. Additionally, the research laboratories should assist NGOs, farmer-based organisations (FBOs) as well as private farmers to establish TC plantlet nurseries in the rural communities to serve as distribution centres for their plantlets.

Setting up a tissue culture laboratory is initially highly capital intensive but its long term benefits totally outweighs the initial capital cost. There should be credit facilities for large tissue culture companies and private individuals to expand their existing facilities as well as the nurseries so that they can produce more plantlets at full capacities. The government or NGOs should also subsidise the cost of plantlets for the rural farmer to serve as an incentive to use TC plantlets instead of suckers which will spread diseases. The current cost of UGX2,000-2,500 per plantlet at the nurseries is too high for farmers to afford.

The establishment of Regulatory Services within the ministry should be strengthened to supervise the production of tissue culture plantlets by agro-based industries. There should be well organised extension services to facilitate the use of tissue culture plantlets by farmers replanting their fields. The extension services staff should be trained on identification of off types or somaclonal variants and assist the laboratories to distribute only pure clones without mixtures to farmers.

4.2. Regulation of Tissue Cultureindustry and Virus Indexing

For long time to come, *in vitro* plantlets of banana will be needed to replace the use of conventional suckers to replant BBW destroyed fields and also to establish new farms for the banana value chain programme in Uganda. However, there is no centralised regulation of the activities of the laboratories yet as individual laboratories do their own virus indexing and check the health status of the plantlets as revealed by the interviews conducted. The Crop Protection Division within MAAIF has the mandate to regulate the production, sale and distribution of cleaned banana planting materials in Uganda. Information indicated that the department's activities include virus indexing, accreditation of laboratories, certification of nurseries and distribution of clean disease free tissue cultured planting materials. Although, a regulatory document on the above activities have been developed by the Department, it is not yet fully operational, thus the regulation of tissue culture plantlet is not stringent

as the laboratories currently do their own virus indexing. Although it is assumed that tissue culture produces disease free plantlets, virus indexing should not be taken for granted by the regulatory bodies as it may end up distributing viruses among farmers' fields. To ensure that plantlets produced by the laboratories are disease free, the department should be well resourced (with equipment and human resource) to regulate the production and distribution of tissue culture plantlets. They should also regulate the number of subcultures a plantlet goes through the multiplication cycle (subcultures) prior to weaning and hardening and periodically inspect nurseries to examine the performance of plantlets prior to supply to farmers.

5.0 Socioeconomic benefits of TC banana plantlets to farmers and climate change adaptation

Traditionally, subsistence farmers propagate banana using suckers obtained from their neighbours' farms. Additionally, they grow different varieties of banana on the same farm. Although, this conventional mode of planting is less expensive, as the suckers are free or bought at very low price (estimated to be below US\$0.50 for those who buy), it has an inherent limitation. They are not certified nor indexed for diseases and since they are vegetatively propagated, there is the risk of circulating diseases (particularly viruses and BBW) among farmers' field. Continuous planting of diseased suckers leads to high disease pressure build up which will consequently lead to low yield at maturity and poor income for farmers. Also, farmers do not get enough planting materials at planting season. Barring other factors, this is a contributory factor to the small farm size owned by farmers. The production of tissue cultured disease free plantlets will therefore prevent the spread of BBW and other viral diseases.

Integration of tissue culture into banana farming will also move the banana industry from the subsistence level to plantation agriculture where clones of specific varieties for specific products will be planted on large scale. Currently farmers at the subsistence level plant four or five varieties on the same farm.

Certified tissue cultured plantlets are disease free and this will prevent the spread of diseases on farmers' fields and lead to high yields. The plantlets also have vigorous growth and this leads to increased yield or bigger bunches. Consequently, there is increased market price for their produce thereby leading to poverty reduction among the farmers.

The introduction of tissue culture plantlets has also created jobs for both the skilled and unskilled people in the banana industry. While the laboratory offers jobs for the highly skilled graduates and technicians (currently, difficult to get) the establishment of nurseries has also created jobs for some private farmers. Many low level income farmers now own nurseries where they buy plantlets on

discount prices from the laboratories and sell them to farmers for profit. For example, a nursery operator at Mukono buys plantlets at UGX 1,200.00 and sells at UGX2,500.00 to farmers thereby making 48% profit. Thus, the economic life of the nursery operator is improved as a result of additional income generation from sale of plantlets from tissue culture.

The technique also enables the farmers to adapt to climate change since the production of the plantlets indoors is independent of climate changing scenarios. The establishment of nurseries by laboratories or nursery operators employ the greenhouse technique where the plantlets are nursed in plant barns with mesh which cut off some percentage of the sunshine to prevent desiccation. In the absence of rainfall the plantlets can be watered from either hand dug wells using watering cans or overhead sprinklers for those who could afford.

Also, the tissue culture technique ensures availability, efficiency and planned planting by farmers as their production is independent of the weather and farmers can have access to them throughout the year. A farmer can therefore get all the planting materials of a particular variety he or she needs to plant and can properly plan his farm. Since the plantlets are produced indoors in the laboratory, a farmer can collect them only when the rains have set in to avoid planting in the dry spells. Besides, small water collecting reservoirs such as ponds or small drip irrigation system can be constructed in the nurseries for irrigation of the plantlets to ensure vigorous growth even during the dry season so that farmers can collect them at the onset of the rains.

Additionally, the establishment of nurseries has resulted in formation of associations among nursery operators. These associations are best platforms for information flow, training and access to credit facilities. Through this association, farmers can be periodically trained on post flask handling of banana plantlets, best agronomic practices and management of agribusiness. Information on meteorology and climate change can be discussed to educate farmers on climate change adaptation strategies during their meetings.

6.0 Requirements for Expansion of Tissue Culture industry to support Banana value chain development

6.1 Location and capacity of plantlet nurseries

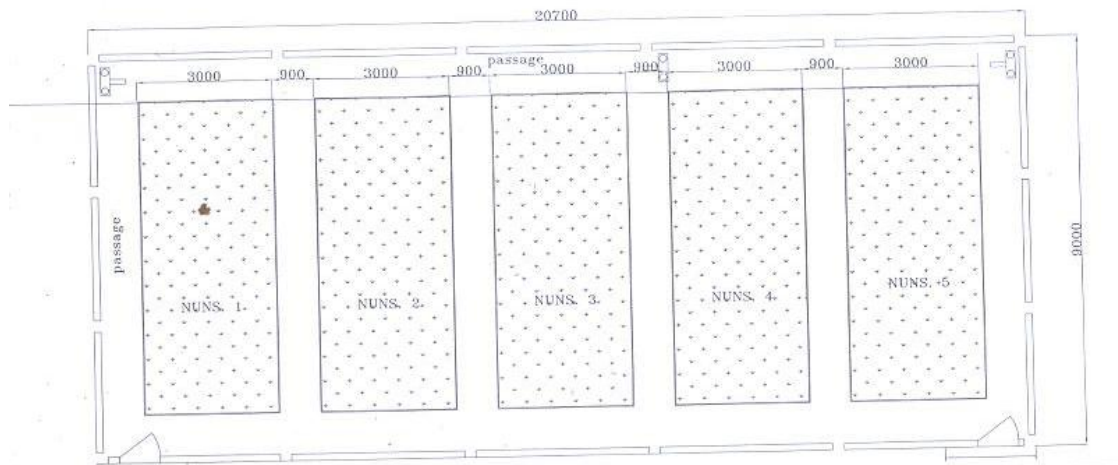
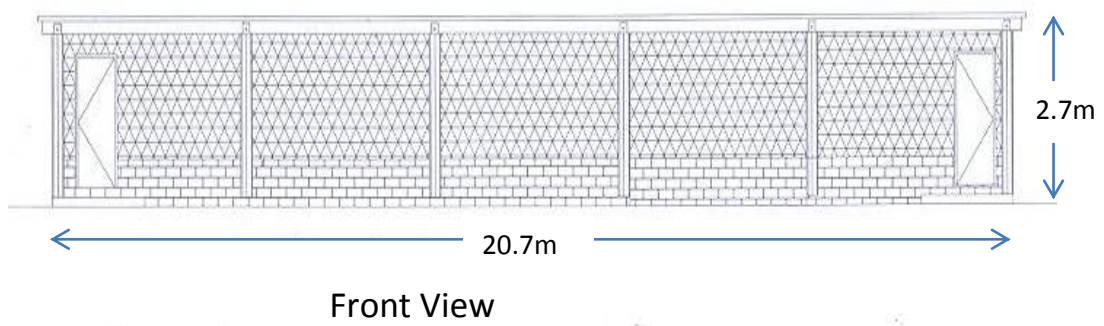
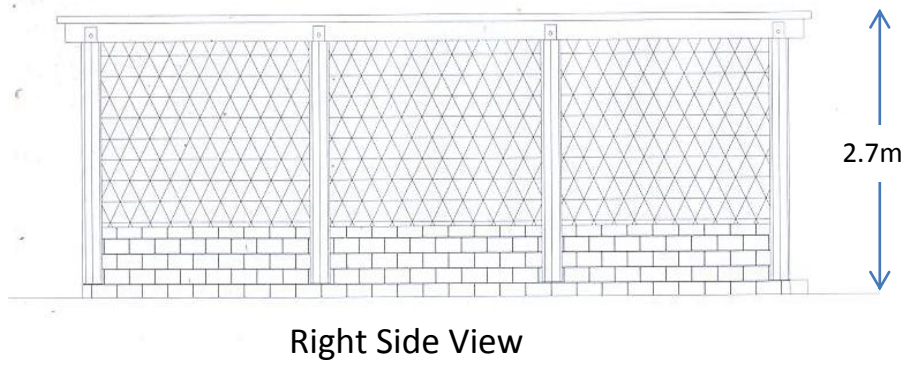
The proposed increase in number of commercial tissue culture laboratories will correspondingly require an increase in number of nurseries to wean and harden the plantlets for distribution to farmers. Therefore, there should be establishment of additional 40 tissue culture plantlet nurseries in the banana growing districts with capacities to supply over 20 million plantlets per annum for the farmers. In the

major banana growing districts such as Mbarara and Isingiro, at least 2 to 4 nurseries should be established per district. Each nursery should have a capacity of at least fifty thousand (50,000) plantlets per year. Ideally, the nurseries should be located near source of water for irrigation as a way of mitigation against climate change. However, where there is no source of water there should be extension of pipe lines to the nursery. Farmer based organisations or NGOs should include overhead sprinklers to their nurseries if they can afford. The distribution of the nurseries in the districts should be as shown in Table 1 above (See Section 3.0 above).

6.2 Nursery Design

- Location should be around a source of water where possible
- Capacity of nursery is 50,000 plantlet per annum or planting season
- Nurseries should be divided into chambers or sub nurseries for specific varieties (see nursery design below) with capacity for 10,000 plantlets.
- The dimensions are 20.7m x 9.0m x 2.7m with dwarf wall (see Figure 1 below).
- Pipes should be provided for irrigation. (Or overhead mist blower for irrigation/waterings should be provided where there is electricity supply).
- Roofed with black or green mesh with 30% of radiant sunshine cut off.

Figure 1. Nursery Design



6.3 Estimated cost of nurseries

1. Cost of one nursery is estimated at US\$2,000.00
2. Cost of Labour (welding and masonry work) is estimated at US\$1,200.00
3. Total cost per nursery is US\$2000.00 plus US\$1,200.00 = US\$3,200.00
4. Total cost for forty (40) nurseries=US\$3,200.00 x 40 =US\$ 128,000.00

Note: values are estimated cost.

6.4. Training skills for nursery operators

Effective distribution of tissue culture plantlets is very critical for efficient integration of the technology into small holder farming systems in Uganda. Tissue culture plantlets are fragile, and their survival on the field depends on good management by nursery operators and farmers, especially during the early stages of post flask weaning and hardening prior to field establishment. Nursery operators and farmers need to acquire the skills of handling the plantlets during transit, weaning and hardening and final distribution to farmers. The following training regime should be provided to nursery operators. The training will be more appropriate for nursery operators associations or NGOs who buy the TC plantlets in bulk and sell them to the farmers. The training should be done by resource persons from the research institutions or universities under the supervision of Crop Production division of MAAIF.

Steps

Introduction

- Explanation of tissue culture
- Comparison of conventional propagation and tissue culture (micropropagation),
- Advantages of TC plantlets over suckers (emphasis should be placed on disease transmission by conventional propagation and elimination by tissue culture.

Sterilisation of substrate and pot/tray filling

- Heat a mixture of loamy soil with cowdung(substrate) at a ratio of 2:1 to destroy fungal spores.
- Allow the substrate to cool.
- Using a hand trowel, fill 200-300ml polyethylene pots with the substrate.
- Perforate the basal portion of the pots to allow drainage should there be excessive watering.
- Water the pots slightly with NPK (15-15-15) solution.

Transfer of plantlets into pots

- Carefully remove the plantlets and put them into a plastic tray containing water (avoid submerging the plantlets in water).
- Separate the plantlets carefully and wash off any adhering agar (ensure that the roots are not destroyed).
- Group the plantlets according to sizes to ensure uniformity.
- Make a small hole in the pot with a rod or forefinger.
- Carefully insert one plantlet into one pot and press it gently.

Construction of Humidity Chamber

- Construct a humidity chamber under the plant barn or shade house using a transparent plastic sheets.
- Arrange the potted plantlets in the humidity chamber.
- Mist the humidity chamber with hand spray to ensure that the humidity is very high.
- Allow the plantlets to remain under the humidity chamber for one week.
- Transfer the plantlets into the plant barn or shade house.

Transfer of weaned plantlets to Plant barn/shade house

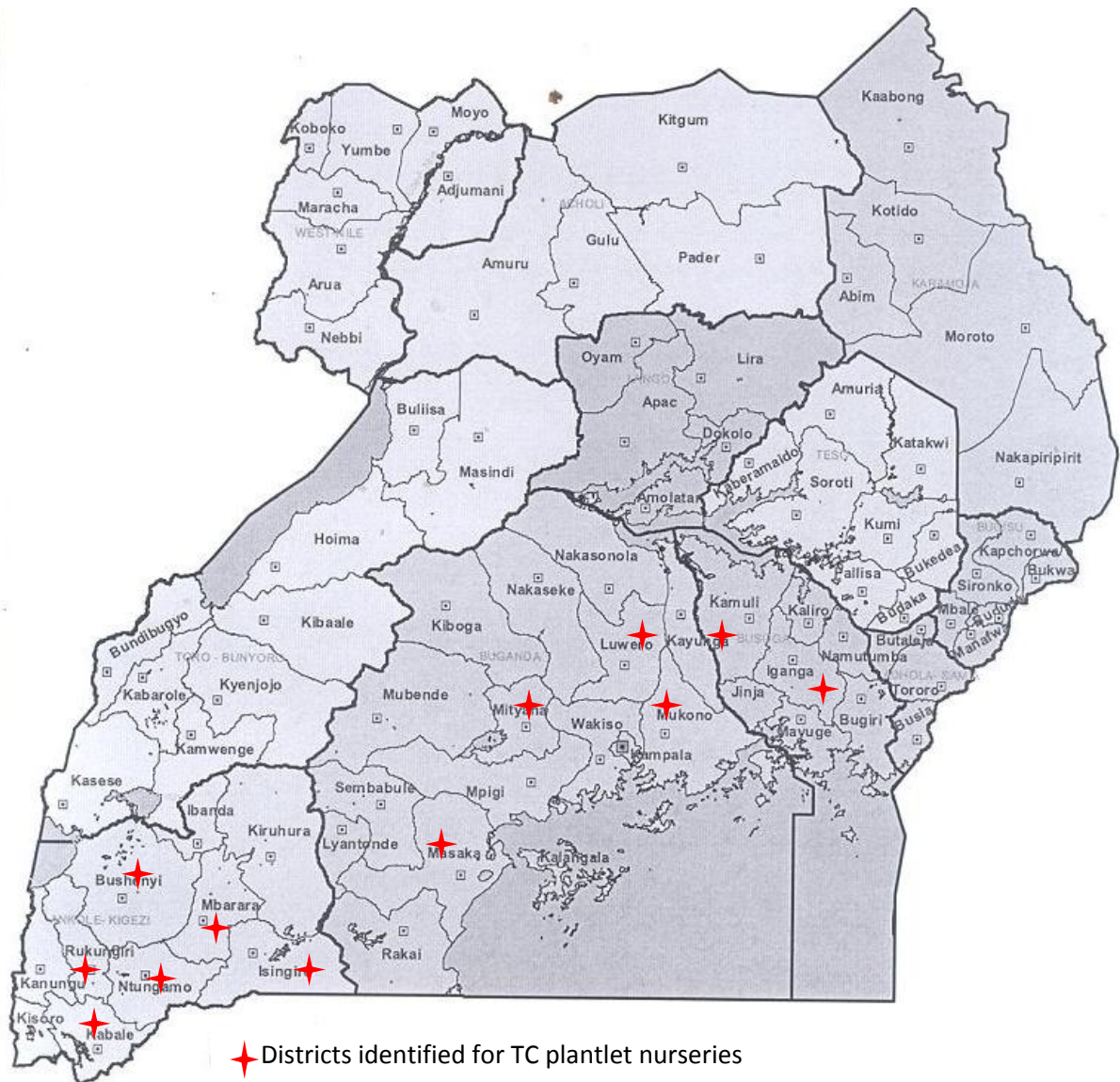
- Construct plant barn/shade house with a black mesh that cuts off 30% of sunlight.
- Arrange plantlets in rows allowing 6cm of space between the rows (See Figure below).
- Each block of rows (sub nursery) should contain 10,000 plantlets.
- Water the plantlets every other day (morning and evening) or as when it is necessary.
- Spray plantlets with insectides when necessary to avoid pests.
- Plantlets are ready for field planting after 8 weeks.
- Remove any abnormal plants or off types.
- Farmers should collected hardened plantlets in pots with well developed roots.
- Hardened plantlets should be planted by removal of the polyethylene bagsand gently placed in a hole.

Records

- Record the number of plantlets weaned under the humidity chamber.
- Record the number of dead plantlets after weaning in humidity chamber.
- Record the number of dead plantlets after hardening in plant barn/shade house
- Observe plantlets for any abnormality before transfer to the farmer

Appendices

Map of Uganda showing districts



Appendix II

A. Meeting with Bruno Otto at UNIDO (2nd May 2013, 11:00 AM)

Bruno briefed the consultants on the importance of the project to UNIDO and tasked us to work hard.

B. Meeting with MAAIF (2nd May 2013)

The Consultant Team (Prof William and myself) had a briefing meeting with the Technical Team from the Ministry of Agriculture Animals and Fisheries at the Ministries premises on 2nd May at 2:30 pm for discussions on our mission and to announce the formal beginning of our assignment. The Technical team comprises of experts from MAAIF office in Kampala and NARO institutes and also experts from private companies who are also involved in the banana value chain. The members at the meeting were:

1. Dr. K.E. Danso, Consultant
2. Prof. William Kyamuhagire, Consultant
3. Dr Jerome Kubiriba, NARO (National Agriculture Research Laboratory, Kawanda)
4. Dr Karuija Robert MAAIF
5. Wamatsembe Isaac, MAAIF
6. Divine Nakado, MAAIF
7. Biribonwa Stephen, MAAIF
8. Meg Jaquay, General Manager, Jakana
9. Dan Jakana, Jakana CEO, Jakana

Appendix II

Professionals/Scientists/Farmers interviewed or interacted with during the mission

1. Wamatsembe Isaac,
MAAIF
Officer in charge of Tissue Culture
2. Dr Jerome Kubiriba,
Research Scientists,
National Agriculture Research Laboratory
Kawanda
3. D. Alex Beriekyie
Plant Breeder
Research Scientists
National Agriculture Research Laboratory
Kawanda
4. Alex Bambona
MAAIF
Banana Desk Officer
5. Alexander Samula
Manager,
Makerere Tissue Culture Laboratory, Kabanyolo
6. Dr Geoffrey Arinaitwe
Managing Director
BioCrops (U) Ltd
P. O. Box 3016
Kampala
7. Dr. Erostat W.N. Nsubuga
C.E.O.
Agro Genetics Technologies Ltd
P.O. Box 11387
Kampala

- 8 Dr Settumba B.B. Mukasa
Plant Genetics and Virology, Plant Tissue Culture and Seed System
Makerere University
P.O. Box 7062
Kampala, Uganda
- 9 Matoru Leo
Farmer, Masaka
- 10 Tumusiime Moses
Afri Banana Products Ltd
Mbarara
- 11 Juda Bainomegi
Factory Technician
Banana Processing Factory
Presidential Initiative on Banana Industry development (PIBID)
Bushenyi
- 12 ImmacurateBiringa
Production Officer
Plantation Management
PIBID
Bushenyi
- 13 Kusrima Glorious
Production Officer
Plantation Management
PIBID
Bushenyi
- 14 ByaruhangaJoram (Secretary, Farmers Association)
NtegyezaBitookye PMCS Ltd 5331
Kyangyenye Sub County
- 15 Bwengye Polly (Farmer)
Kyangyenye Sub County

16 KiizaSympy (Farmer)

Kyangyenyi

17 Mugume B. Amos

District Agriculture Officer

Fort Portal

18 Sarah Nansubuga (Nursery Operator)

Ideal Farm Enterprises Ltd

NassuuliNakatabo Road

Off MukonoKayunga Road

19. Agaba Nelson

Extension Officer

PIBID

Bushienyi

20. Martin Jingo

Production Manager

PIBID Head Quarters

Kampala

Acknowledgement

I wish to express my profound gratitude to the Prof. William Kyamuhagiri, a member of the Consultant team for the project from Makerere University for his tremendous support during my stay and travel in Uganda. I also thank of Alex Bambona, Banana Desk Officer at Ministry of Agriculture Industry and Fisheries for his support

My deepest gratitude goes to Otto Bruno at the UNIDO office in Kampala and Yvonne Lokkoat UNIDO headquarters, Vienna for their support in diverse ways to make my consultancy a success.