RESEARCH PROGRAM ON Roots, Tubers and Bananas

CGIAR

Technical report:

Cost-benefit analysis of cooking banana seed propagation methods

Expanding Utilization of Roots, Tubers and Bananas and Reducing Their Postharvest Losses

RTB ENDURE

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Enabling poor rural people to overcome poverty

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A broad alliance of research-for-development stakeholders & partners

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Expanding Utilization of Roots, Tubers and Bananas and Reducing Their Postharvest Losses (RTB-ENDURE) is a 3 year project (2014-2016) implemented by the CGIAR Research Program on Roots, Tubers and Bananas (RTB) with funding by the European Union and technical support of IFAD. http://www.rtb.cgiar.org/endure

The CGIAR Research Program on Roots, Tubers and Bananas (RTB) is a broad alliance led by the International Potato Center (CIP) jointly with Bioversity International, the International Center for Tropical Agriculture (CIAT), the International Institute for Tropical Agriculture (IITA), and CIRAD in collaboration with research and development partners. Our shared purpose is to tap the underutilized potential of root, tuber and banana crops for improving nutrition and food security, increasing incomes and fostering greater gender equity, especially among the world's poorest and most vulnerable populations.

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CBA	Cost Benefit Analysis
CIP	International Potato Center
IITA	International Institute for Tropical Agriculture
NARO	National Agriculture Research Organization
PH	Postharvest
PMCA	Participatory Market Chain Approach
RTB	CGIAR Research Programme on Roots, Tubers and Bananas

Executive Summary

During PMCA engagements, stakeholders identified four cooking banana cultivars, including *Kibuzi*, which combines longer green life and market preferred attributes, *Mbwazirume*, *Nakitembe* and *Musakala* which are liked in both local and export markets. Traders reported that though the four cultivars were required on markets, it was difficult to raise sufficient volumes from farmers. It was also confirmed by stakeholders that these varieties were in limited quantities in farmers gardens. Also, existing seed producers were not producing the preferred cultivars. It was therefore confirmed that access to seed of the preferred cultivars was one of the biggest challenges to farmers. The project then prioritized the establishment of clean seed sources of the four banana varieties. A total of 1,500 plantlets of the market demanded varieties were multiplied in a tissue culture laboratory and used to establish 10 mother gardens in the project sites. Three methods (corm split; decapitation and enhanced nutrition) were then used to increase access to planting material at community level. Farmers were trained in field banana planting materials multiplication techniques, establishment and management of macro-propagation chambers and business planning. Cost Benefit Analysis (CBA) for the three propagation techniques and distribution models was conducted. Results showed that the 'split corm' method was the most viable technique. The method is currently being used for commercial purposes in the community. Two community-based seed sharing models evolved: (1) *Recovery model* suitable for poor resource farmers and marginalized groups and (2) *Business model* which is a sustainable model.

Introduction

Banana is one of the main staple foods in Uganda consumed by almost 80% of the population (Nyombi, 2013). Uganda has remained food insecure because of low productivity despite the availability of new and improved technologies (Kaguongo *et al*., 2015). Seed is one of the most significant inputs in agricultural production that determines the quantity and quality of output (Kaguongo *et al*., 2015). Banana production moved from central to south-west Uganda due to deterioration in productivity. Decline in productivity was essentially due to diseases which resulted into scarcity of planting materials (Basengere and Birindwa, 2015). Traditionally farmers obtain planting materials from existing plantations in their own gardens or neighbors that could be limited in amount, infected by diseases thus reduce plantation life by spoiling the root system. The RTB-ENDURE Banana sub-project intervened by promoting seed propagation methods that enable the farmers to obtain clean planting materials of the market demanded varieties in a timely manner. These methods included the 'split corm' method, 'decapitation' and 'enhanced nutrition' which were piloted in Rakai and Isingiro districts of south-western Uganda.

Besides providing clean planting materials, seed propagation also presented a business opportunity to farmers in the pilot areas. This was expected to improve household income and overall livelihoods of both men and women farmers. Despite the expected benefits, the three methods had different costs associated with them, therefore there was need to determine the cost-effectiveness of these methods. This report presents findings of the costs and benefits associated with these propagation methods. Results from this study will thus inform the decisions of business oriented farmers whose main objective is to maximize profit.

Objectives of the study

The objectives of the study were:

- To determine the costs and benefits associated with the propagation methods
- To establish the cost-effectiveness of the propagation methods

Methodology

A total of 1,500 plantlets of *Kibuzi, Musakala, Nakitembe* and *Mbwazirume* were multiplied in a tissue culture laboratory at the National Agricultural Research laboratories, Kawanda. They were used to establish 10 mother gardens, five at each of

the two project sites (Dwaniro in Rakai District and Rugaaga in Isingiro District). At each site, the mother gardens were hosted by farmers representing groups. The host farmers were selected by fellow farmers themselves. At each site the host farmers included at least two women. Prior to establishment of the mother gardens, the host farmers, together with other farmers surrounding the sites were trained in basic banana agronomy and field seed multiplication techniques. Farmers were introduced to three banana seed multiplication methods: 'split corm' where a split corm multiplication chamber was established at each host farm; 'decapitation' and; 'enhanced nutrition', through hands-on training sessions.

Figure 1: Plantlets developing from a corm

In the 'split corm' method, healthy corms were selected, cleaned and the outer sheath removed. Thereafter the apical meristem was destroyed. They were then incubated in saw dust in a humidity chamber. In the enhanced nutrition technique, higher than usual amounts of organic manure were provided to the healthy young plants. For the 'decapitation' method, a healthy young plant measuring one metre in height was

selected after which an opening was then made near ground level to access and remove the growing tip (breaking apical dominance).

Each method produced a given number of suckers. However, basing on only the number of suckers from each method was not sufficient to make conclusions on the best technique usable by farmers because the three methods had different costs associated to them. Therefore, there was need to determine the cost-effectiveness of these methods.

The study conducted a cost-benefit analysis (CBA) to assess the cost effectiveness of the three banana seed propagation methods. It is the best approach for interventions where the design of optimum technologies that would improve the livelihoods of poor communities require a comprehensive conceptualization and valuation of the level and distribution of costs and benefits that accrue from different intervention strategies.

To pilot the 'split corm' method, six host-farmers (three from each district) were selected to host the macro-propagation chambers. To pilot 'decapitation' and 'enhanced nutrition', ten mother gardens were established (five in each district). Data regarding the costs and benefits were then collected from all the sites through interviews with host-farmers and field observations.

The CBA was used to estimate the total equivalent money value of the benefits and costs to the farmers of the cooking banana crop. This approach focused on establishing whether the interventions are worthwhile to the farmers. By assigning benefits and costs to the various items associated with the technologies, the CBA emphasized weighing advantages and disadvantages associated with the interventions. In assessing the benefits, the assumption made was that individual decisions are concerned with private welfare effects on profits that accrue from banana plantlet sales rather than wider social effects. Therefore, the evaluation of benefits and costs associated with the various propagation methods involved costs and benefits that accrue to individuals (producers) that participated in the project. The decision of whether the propagation methods are viable or not viable is based on the following computation:

$$B/C = \frac{\sum_{t=1}^{T} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{T} \frac{C_t}{(1+r)^t}} \quad \text{..... (1)}$$

Future costs and benefits were discounted to their present values for two-year period using the current interest rate of 15% (BOU, 2016).

Outputs

Trainings

A total of 54 farmers (38 men and 18 women) were trained in banana agronomy, 26 farmers (15 men and 11 women) in field banana planting materials multiplication techniques, 250 (70 men 180 women) in establishment and management of macro-propagation chambers and shade) while 110 (71 men, 39 women) farmers were trained in business planning.

Community seed production

A total of seven banana seed producer groups (five in Rakai and 2 in Isingiro) are functional. Two of them were started by farmers themselves as commercial enterprises after experiencing the benefits. Farmers can now access seed from these groups through the two seed access models (Table2). The models were non-discriminatory because they were based on inputs of members, benefiting both male and female farmers.

One group of farmers (Bakyala Kwekulakulanya), after experiencing the field-based seed multiplication techniques, established their own experimental mother gardens where they tested the three field multiplication plots. They have gone ahead to become commercial seed producers.

Seed production enterprise

As a way of scaling out, four commercial seed production sites have emerged. One commercial seed production farmer group emerged in the study site (Rakai) known as Bakyala Kwekulakulanya Community producers' group with 22 members (10 women, 12 men). The other three have been established in other districts, i.e., Mityana district (hosted by Joshua Misinguzi, a member of Kiryaburo Banana Improvement group in Isingiro), Mayuge district (hosted by Mr. Fred Magala, Musita Village who learnt about the technology from the Source of the Nile Agricultural Show, 2016), and Mbarara district (hosted by Vicent Mugabi, an extension worker). Table 1 below shows the number of plantlets sold by the commercial seed producers.

Table 1: Number of plantlets sold by farmer groups/individuals

Group/Name of individual	Gender of host farmer	Numbers of plantlet sold within 6 months *
Bakyala Kwekulakulanya group	F	3,200
Mbarara (Vicent)	M	1,200
Mityana (J. Musinguzi)	M	Just established
Mayuge (F. Magala)	M	Projected to produce 1,500 plantlets per month
Totals		4,400

** The plants were bought by farmers from outside their communities*

Two seed production business plans were developed by the Bakyala Kwekulakulanya (also known as Alinyikira) Community in Rakai and Kiryaburo Banana Improvement group in Isingiro.

Seed access models

Access to market-preferred banana planting materials: Over 200 farmers at project sites (66) and 134 outside project sites accessed planting materials from the mother gardens and macro-propagation chambers through different seed access models as shown in Table 2.

Performance of the three propagation techniques

The number of suckers produced by each technique was recorded for a period of three months. Table 3 shows the number of plantlets generated through each of the techniques. The results showed that the corm method produced the highest number of plantlets among the three methods whereas enhanced nutrition technique produced the lowest number of plantlets.

Table 2: Models and plantlets accessed

Models and groups/individuals	Number of farmers		Numbers of plantlets
	Men	Women	
A) Recovery model (Receive a plant, return a plant)			
1.Bakyala Kwekulakulanya group, Rakai	9	9	300
2. Kiryaburo Banana Improvement group-Isingiro	0	0	0
3. Kabuhembe Women group, Isingiro	0	0	0
4. Kacumu group, Rakai	1	0	90
5. Seruwu group, Rakai	5	3	65
6. Lwabanda group, Rakai	9	2	55
7. Kayonza group, Rakai	2	8	34
Sub-total	26	22	544
B) Business models (produce and sell)			
1.Bakyala Kwekulakulanya group, Rakai	8	6	3,200
2. Kiryaburo Banana Improvement group-Isingiro	1	0	200
3. Kabuhembe Women group, Isingiro	1	0	220
4. Kacumu group, Rakai	1	0	10
5. Seruwu group, Rakai	0	0	0
6. Lwabanda group, Rakai	0	0	0
7. Kabare Banana farmers group, Isingiro			270
8. Asimwe group, Isingiro	1	0	1,250
Sub-total	12	6	5,150
Grand Total	38	28	5,694

Table 3: Plantlet yield per propagation method

Method	Acreage	Number of plantlets
Split corm method *(100 corms)*	12*4ft	2,000
Decapitation *(100 plants)*	0.5 acres	600
Enhanced nutrition *(100 plants)*	0.5 acres	400

Cost Benefit analysis for the propagation techniques

Costs associated with production of plantlets using the corm method

The costs were divided into three categories; (i) construction of the propagation chamber (ii) construction of the hardening chamber and (iii) maintenance costs of the chambers. The total cost of construction of the propagation chamber was UGX 886,000 (Table 4) with the highest cost being manure (UGX 140,000). The total cost of the hardening chamber was UGX 319,000 (Table 5) with the highest cost being the cost of poles (UGX 180,000). Table 6 shows the maintenance costs associated with the corm method of propagation. There were significant differences in water and labor costs for Rakai and Isingiro (1% and 5% levels respectively). Isingiro incurred higher water costs than Rakai while Rakai incurred higher labor costs than Isingiro.

Table 4: Costs associated with the propagation chamber

Item	Quantity	Unit cost	Amount
Sawdust (bags)	5	6,000	30,000
manure (small lorry)	1	140,000	140,000
Poles	12	10,000	120,000
Bricks	500	200	100,000
Cement (bags)	1	35,000	35,000
sand (small lorry)	1	120,000	120,000
Drum	1	80,000	80,000
Firewood	1	70,000	70,000
Black polythene	1	50,000	50,000
White polythene	1	100,000	100,000
Nails	2	5,000	10,000
Knives	2	3,000	6,000
mason/labor	1		25,000
Total			886,000

Table 5: Costs associated with construction of the hardening chamber

Item	Quantity	Unit cost	Amount
Poles	18	10,000	180,000
Papyrus	6	5,000	30,000
Polythene (black)			50,000
Nails	3	5,000	15,000
Planting polythene (kg)	1	9,000	9,000
Construction cost			25,000
Oil	3	1,000	3,000
Watering can	1	7,000	7,000
Total			319,000

Table 6: Maintenance costs for the chambers

Item	Total cost
Repairs	5,000
Water (Rakai)	144,000
Water (Isingiro)	288,000
Labour (Rakai)	153,000
Labour (Isingiro)	110,000

Costs associated with decapitation and enhanced nutrition methods

Opportunity cost of land was the highest cost incurred in 'decapitation' and 'enhanced nutrition' methods (Table 7). This is because these methods are land intensive as they require at least half an acre to produce a considerable number of plantlets unlike the 'split corm' method which requires only 12*4ft. Therefore, for a farmer to adopt this method there must be willingness to forego at least half an acre of their productive land.

Table 7: Decapitation and enhanced nutrition costs

Cost item	Decapitation	Enhanced nutrition
Labor	530,000	10,000
Opportunity cost of land	1,170,000	1,170,000
Manure	-	20,000
Transport	-	5,000
Total	1,700,000	1,205,000

Benefits associated with the propagation methods

Benefits from all the three methods were mainly obtained from plantlet sales. Each plantlet was sold at UGX 1,000. Results showed that decapitation had the largest benefits and costs compared to enhanced nutrition and corm methods (Table 8).

Table 8: Benefits accruing from the propagation methods

	Decapitation		Enhanced nutrition		Split corm (Rakai)		Split corm (Isingiro)	
Year	1	2	1	2	1	2	1	2
Discount factor (15%)	0.8696	0.7561	0.8696	0.7561	0.8696	0.7561	0.8696	0.7561
Costs	1,700,000	1,700,000	1,205,000	1,205,000	1,507,000	546,000	1,603,000	642,000
Benefits	3,840,000	3,840,000	2,560,000	2,560,000	3,000,000	3,000,000	3,000,000	3,000,000
Present value of costs	1,478,320	1,285,370	1,047,868	911,101	1310487	412831	1,393,968	485,416
Present value of benefits	3,339,264	2,903,424	2,226,176	1,935,616	2,608,800	2,268,300	2,608,800	2,268,300

Benefit-cost ratios of the different propagation methods

The costs and benefits were discounted to their present values using the current discount rate of 15% (BOU, 2016). The discount factors were obtained from $\frac{1}{(1+r)}$ where r is the discount rate. The benefit-cost ratios (BCRs) were then computed.

Table 9: Benefit-cost ratios of the propagation methods

	Split corm (Rakai)	Split corm (Isingiro)	Decapitation	Enhanced nutrition
Period (years)	2	2	2	2
Present value of costs	1,723,318	1,879,384	2,763,690	1,958,969
Present value of benefits	4,877,100	4,877,100	6,242,688	4,161,792
Benefit-Cost Ratio	2.83	2.60	2.26	2.12

The BCRs were greater than one indicating that all methods were viable. However, the 'split corm' method had a higher value compared to 'decapitation' and 'enhanced nutrition' thus indicating that the 'split corm' method is the most viable. This method is more viable in Rakai than Isingiro because water is more expensive in the latter than in the former (UGX 1,500 vs. UGX 500).

Conclusions

Cooking banana varieties, *Kibuzi, Musakala, Nakitembe and Mbwazirume,* with a high market demand were identified. One of them, Kibuzi combines good market attributes and intrinsic longer shelf-life compared to others. A leaflet showing their names and attributes is available at the ENDURE website. Field-based banana seed multiplication methods were introduced on-farm and farmers trained to use them. The effectiveness in terms of amount of seed produced, costs and benefits were also compared, revealing the 'split corm' method as the most viable technique. Method is currently being used to produce commercial seed at the project and outside project site. Community based seed sharing models included (1) *Recovery model (Receive a plant, return a plant)* which is suitable for poor resource farmers and the marginalized groups and (2) *Business model* (production of banana planting materials for sale) which is a sustainable model.

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