# NaFORRI

# TECHNICAL PROGRESS REPORT

# 2013/14

## Agricultural Technology Agribusiness Advisory Services (ATAAS) Implemented Projects at NaFORRI

**Compiled by**

**NaFORRI Report Writing Committee**

**August 2014**

## 1.0 Introduction

The National Forestry Resources Research Institute is one of the Public Agricultural Research Institutes in the NARS system implementing the ATAAS project in Uganda. During the 2013/14 financial year, a total of eleven projects were implemented at NaFORRI. The four research programs at NaFORRI are: i) the Forest Conservation and Management research Program (2 projects), ii) the Agroforestry Research Program (3 projects), iii) the Forest Products and Services Research program (2 projects) and iv) the Tree Improvement Research Program (2 projects). Additionally, there is the Institutional strengthening and capacity development program that supports the four research programs, focusing mainly on institutional infrastructure development and administrative issues. The main funding sources are IDA, Government of Uganda development and Government of Uganda Recurrent. This technical report presents progress on implementation of the eleven projects under ATAAS, highlighting major achievements and the research activities in progress. Each project highlights the rationale, methodology, key outputs, gaps and the planned activities and budgets for the 2014/15 financial year.

# ACHIEVEMENTS BY PROGRAMS

# PROGRAM 1: FOREST CONSERVATION AND MANAGEMENT RESEARCH PROGRAMME

## INVESTMENT ANALYSIS OF PLANTATION FORESTRY FOR IMPROVED PROFITABILITY AND LIVELIHOOD IN UGANDA

**Kiyingi et al (2013/14)**

### 1.0 Introduction/Background

Many potential investors have not committed their resources to plantation forestry development because of scarcity of information supporting forestry investment (MWLE, 2001; NFA, 2006).This is exacerbated by the long term nature and high expenses associated with forestry investment. As such, alternative land-use options are obvious choices to farmers.Yet there is a sharp increase in the demand for woody forest products as the remaining forests are being degraded.There is need to help farmers identify investment opportunities and risks in the forestry sector. This will attract more investment in plantation forestry sub-sector and enable tree farmers to choose the most profitable tree species together with a set of silvicultural practices for a given management objective. Investment analysis of commercial plantation forestry aims at improving the profitability of commercial plantation forestry.

### 1.1 Project objectives

1. Characterise commercial plantation forestry investment in Uganda
2. Determine investment efficiency of plantation forestry in Uganda
3. Determine current and projected production potential, demand, supply, price and markets for plantation forest products in Uganda.
4. Assess the feasibility, cost-effectiveness and economic potential of environmental service payments in planted forest systems
5. Assess the impacts of policies (grants, and leasing arrangements) in the plantations forestry sub sector.

### 1.2 Expected Project Outputs

1. The plantation forestry investment profile compiled (distribution, categories of tree farmers, average acreage, factors influencing private tree investment, species planted)
2. Investment efficiency of plantation forestry in Uganda (NPV, IRR, economically optimal rotation of common plantation species, annual allowable cut/ MSY) determined.
3. Current and projected production potential, demand, supply, prices and markets of plantation forest products determined
4. The feasibility, cost-effectiveness and economic potential of environmental service payments in planted forest systems evaluated.
5. The impacts of forest sector policies (grants, and leasing arrangements) on plantation forest investments assessed.

## 2.0 Project focus during the period (2013/14)

The project focused on:

- Determining the national plantation forest stock
- Determining the growth performance of *P. caribaea* var. houndurensis(PCH) in different sites in Uganda

## 3.0 Methodology

Plantation stock inventory secondary data was collected from forestry agencies and forestry companies. The data obtained was used as a basis for planning subsequent fieldwork for assessing growth performance. Data for growth performance of PCH was collected from plantations in south western Uganda, Northern Uganda, Central region and Busoga sub-region. Tree growth parameters were measured based on the Temporary Sample Plot (TSP) technique. The size of each sample plot was 0.0225 ha. Where more than 1 sample plot were established in the same plantation, they would be laid at least 100m between them with emphasis onminimizingedge effect. All trees in each plot were measured for dbh, stem quality was recorded using various codes, and heights estimated.

## 4.0 Results

*Plantation stock inventory*

National plantation stock inventory data was collected from key stakeholders. The presented acreage data (Table 1) are based on pure stands that were identified. In many cases, *P. caribaea* and *Eucalyptus grandis* were found to be grown by farmers in mixed stands with other closely related species. For instance, *P. caribaea* could be found mixed with *P. Oocarpa* and *P. Patula* while *E. grandis* was found mixed with *E. camaldulensis*, *E. tereticomis*, *E. Urophylla*. The underlying reason for this is that farmers do not have a reliable source of seedlings and tend to obtain their seedlings from the 'roadside' nurseries. In addition, they

do not have the technical ability to distinguish between closely related tree species. This can surely affect the management regime since different species call for different silvicultural regimes, thereby reducing yield of the final crop.

*Table 1: Preliminary results from the national plantation stock inventory*

| **Species** | **Ownership** | **Acreage (<5yrs)** | **Acreage (5-10yrs)** | **Acreage (>10yrs)** | **Total acreage** |
|---|---|---|---|---|---|
| *P.caribaea* var. hondurensis | NFA | 534.06 | 2221.16 | 41.96 | 2797.18 |
| | Private sector | 17348.8 | 8455.31 | 278.3 | 26082.41 |
| *Eucalyptusgrandis* | NFA | 202.44 | 113.8 | 65.44 | 381.68 |
| | Private sector | 4625.55 | 5934.02 | 3163.17 | 13722.74 |
| *Maesopsiseminii* | NFA | 0 | 41.57 | 0 | 41.57 |
| | Private sector | 40.81 | 247.02 | 76.36 | 364.19 |

*Growth performance of PCH*

*P.caribaea* var. hondurensis is the most productive of the three varieties of *P.caribaea* (the others being var. bahamensis and var. caribaea) and it's by far the pine suited to most sites in Uganda. The volume of wood in a tree is determined based primarily on the tree's height and diameter.Assuming the plantation has been well-established with good management, PCH can reegister a Mean Annual Increment (MAI) of 20-35$m^3$/ha/yrand between 400-700$m^3$/ha at rotation (Jacovelli et al. 2009). However, preliminary results (Table 2) indicate that the growth performance of PCH at 5 years across the study sites is quite below the expectations. The best performance is recorded in the North. We found-out that most of the plantations are not managed well. That is, they are not weeded on time, not pruned and with severe incidences of damage to crops from grazing animals and fires.

Table2: Growth performance of *Pinuscaribaea* var. hondurensis

| **Sub-region** | **Average stocking (trees per ha)** | **Average basal area (M2/ha)** | **Mean height (m)** | **Mean volume (m3/ha)** | **MAI (m3/ha/yr)** |
|---|---|---|---|---|---|
| South western | 800 | 12.08 | 9.68 | 38.98 | 7.80 |
| North | 930 | 21.98 | 12.40 | 90.88 | 18.18 |
| Central | 971 | 10.74 | 10.28 | 36.82 | 7.36 |
| Busoga | 1046 | 14.08 | 9.67 | 45.35 | 9.07 |

**References**

Jacovelli, P., Milligan, B., Amumpe, A., Nalwadda, C., Kakungulu, Z., Odeke, C., Atuyamba, A., Businge, T. (2009).Tree planting guidelines for Uganda.Sawlog Production Grant Scheme, Kampala.

National Forestry Authority (2005).Tree species for commercial timber production in Uganda.Plantation guideline,5.

# Enhancement of silviculture for improving productivity of Melia volkensii and Terminalia ivorensis

**Okullo *et al* (2013/14)**

## 1.0. Background

At present, Uganda has approximately 25,000 ha of dedicated timber plantations and the establishment continues (SPGS 2012). Establishment of plantations has been strengthened by the numerous government efforts and political will. The Uganda National Forest Policy, The National Forestry Authority and the Tree Planting Act are all national initiatives with a common message to increase plantation areas to mitigate natural forest degradation and promote forestry as a business enterprise. The expansion in plantation acreage however is not backed up with comprehensive research on appropriate tree management (silvicultural) practices. Tree farmers have inadequate knowledge regarding species, site and tending operation. Lack of appropriate management has implication on the quantity and quality of the future products and services. With the increased involvement of the private sector in forestry there is a need to address the silvicultural practices of the plantation forest for improved productivity, profitability and environmental services. This project aims at providing silvicultural strategies that ensure the growth and development of forests for improved productivity, profitability and conservation in three agro ecological zones of Eastern highlands, Western highlands and Mid northern.

## 1.1 Project objectives

i). To raise planting material and promote *Melia volkensii* and *Terminaliaivorensis* in three agro-ecological zones
ii). To determine the effects of spacing regimes on stand development and productivity of *Terminalia ivorensis* and *Melia volkensii*
iii). To assess growth performance of *Terminalia ivolensis*and *Melia volkensii*, in three agro ecological zones
iv). To model the effects of farmers plantation management regimes on soil quality and water quantity

## 2.0 Activities implemented during 2013/14

- The main activities involved germination/propagation trials, establishment and maintenance of permanent sample Plots (PSPs) / trial plots for monitoring growth performance of key plantation species

- Trial assessment for survival, crown diameter, height and monitoring for pests and diseases incidences.

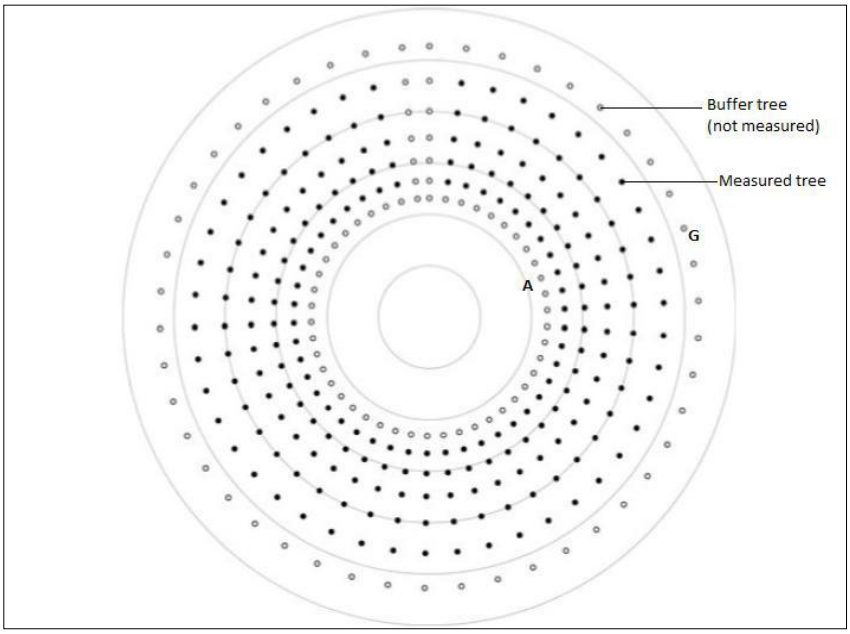
**3.0 Methodology/ Experimental design**

The experimental design, titled 'Nelder' after its originator (Nelder, 1962) was used to set up the trials. The design provides an effective means of studying growing space/growth relationships in tree plantations. The design can be used to test multiple tree spacings in a single plot.

The design used in this study is characterized by equal angles between the spokes and a geometrically increasing distance between the arcs. The trees were planted on each intersection of spokes and arcs (See diagram below).

The characteristics of this Nelder plot design are (a) the shape of each growing space is constantly approximately quadrangular; (b) the size of the growing space per tree increases from the center to the periphery; (c) all plants along one arc are characterized by the same growing space; and (d) the information gathered along one arc or one spoke respectively represent a repetition of the different categories established. With the exception of the outermost parts of the spokes and arcs, edge effects are minimized because the plants of each arc show only slight differences in growing space compared to those of the neighboring arcs.

A diagrammatic sketch of a Nelder plot design




## 4.0 Outputs/Results

Initial results show little difference in heights between spacing regimes but this may change over time. It is anticipated the greatest changes will be observed in DBH. Results from survival assessments

indicate that on average *Maesopsis emnii* has the highest survival while *Melia volkensii* the lowest. Results from crown density assessment indicate that crown density increases with spacing. There were no signs of pests and disease incidences

Table 1: Variation of crown diameter with spacing

| Spacing | 2x2 | 2x3 | 2x4 | 3x3 | 3x4 | 4x4 |
|---|---|---|---|---|---|---|
| Mean crown density (m) | 2.000 | 2.220 | 2.075 | 2.300 | 2.200 | 3.700 |

**Planned Outputs/Activities/Budget for 2014-15**

| **Quarter 1** | **Quarter 2** | **Quarter 3** | **Quarter 4** |
|---|---|---|---|
| 1. Acquisition of 5 Kgs of M. *Volkensii*seedand*5 kgs T. Ivorensis* seed.<br>2. Procurement of nursery chemicals, poylthene pots and sheeting, soil, sand, tools and equipment | 1. 15,000 seedlings of M. volkensii and T. Ivorensis produced and distributed<br>2. 2 Trial plots each in Serere and Buginyanya established and maintained. | 1. Acquisition of 5 Kgs of M. Volkensiiseed and 5 kgs T. Ivorensis seed.<br>2. Procurement of nursery chemicals, poylthene pots and sheeting, soil, sand, tools and equipment | 1. 15,000 seedlings of *M. volkensii* and *T. Ivorensis* produced and distributed<br>2. 2Trial plots each in Abii and Ngetta established and maintained |
| Activities.<br>1. Germplasm acquisition<br>2. Land preparation<br>3. Procurement of nursery inputs.<br>4. Prepare reports | Activities.<br>1. Seed sowing,<br>2. Survival and growth measurements<br>3. Maintenance of seedlings<br>4. Trial monitoring and maintenance<br>5. Prepare reports. | Activities.<br>1. Germplasm acquisition<br>2. Land preparation<br>3. Procurement of nursery inputs.<br>4. Prepare reports. | Activities.<br>1. Seed sowing,<br>2. Survival and growth measurements<br>3. Maintenance of seedlings<br>4. Trial monitoring and maintenance<br>5. Prepare reports |

## Budget 2014/15

| Output target<br><br>Qtr. 1 | Budget (000) | Output Target<br><br>Qtr. 2 | Budget (000) | Output Target<br><br>Qtr. 3 | Budget (000) | Output Target Qtr. 4 | Budget (000) |
|---|---|---|---|---|---|---|---|
| Acquisition of 5 Kgs of M. Volkensiiseed and 5 kgs T. Ivorensis seed, procurement of nursery chemicals, poylthene pots and sheeting, soil, sand, tools and equipment | 11,400 | 15,000 seedlingseach of M. volkensii and T. Ivorensis produced and distributed. | 9,300 | Acquisition of 5 Kgs of M. Volkensiiseed and 5 kgs T. Ivorensis seed, procurement of nursery chemicals, poylthene pots and sheeting, soil, sand, tools and equipment | 8,880 | 15,000 seedlings each of M. volkensii and T. Ivorensis produced and distributed, | 9,490 |
| | | 2 Trial plots each in Serere and Buginyanya established and maintained. | 22,130 | | | 2Trial plots each in Abii and Ngetta established and maintained | 20,370 |
| | **11,400** | | **31,430** | | **8,880** | | **29,860** |

### References

Nelder, J.A. 1962. New kinds of systematic designs for spacing experiments.*Biometrics*18:283-309.

## BIOLOGICAL CONTROL OF *LEPTOCYBEINVASA* ATTACKING EUCALYPTS AND EVALUATION OF MANAGEMENT OPTIONS AGAINST *CINARACRONORTII* A PEST OF PINES

**Kiwuso et al (2013/14)**

### 1.0 Background

Plantation forestry is a key approach for increasing supply of tree products and services. SPGS (2005) estimates forest plantations in Uganda to be 25,000 ha with Pines occupying 65%, Eucalypts 18% and other exotics 17%. Forest Plantations have an indicative return value of 10-14% (Hardcastle 2005). They provide fuel wood, timber, poles and also stabilize soils. In addition they sequester carbon from the atmosphere.

Due to their exotic and monoculture nature, forest plantations are susceptible to pests. *Leptocybeinvasa* Fisher & La Salle is causing damage in Eucalypts, with some establishments having 100% damage. Pines have been attacked by *Cinaracronortii*Tissot and Pepper with an infestation level of up to 23% (NaFORRI Quarterly Report 2013, unpublished) Moreover, the pest population is

increasing. The two pests have been observed in all areas where their hosts grow. These pests unless managed could worsen the shortage of wood products in Uganda.

**1.1. Project objectives**

i). To manage *L. invasa* using *S. neseri*
ii). To establish the biology, behavior and management options for *C. cronortii* in Uganda
iii). To build capacity of stakeholders in management of pests of forestry importance

**2.0 Key activities undertaken**

i). Population dynamics, natural enemies, damage levels, incidence and behavior of *C. cronortii* determined
ii). Identification of release sites for management of *L. invasa*

**3.0 Materials and methods**

**3.1** Biology and behavior of *C. cronortii* in Uganda

The studies for biology of C.cronortii were conducted in four trials: Mafuga and Kiriima in Kabale S.W. Uganda and Mabuye and Mpoma in Central Uganda. The tree species studied were two year old seedlings of *P.patula,Pinus caribea* and *PinuscaribeaCaribea.* The plots studied had (400 trees). One hundred (100) tree seedlings were selected at random for sampling from each of the plots and for each tree seedling ,the crown was examined for aphid abundance, size of aphid colonies and associated natural enemies. In addition the damage category of the crown was recorded using a modified five point scale developed by (Innes 1990) as in table 1 below:

Table1: Damage classification

| Category | Damage |
|---|---|
| 1 | 0% crown brown |
| 2 | 0-10% crown brown |
| 3 | 11-25% crown brown |
| 4 | 26-60% crown damage |
| 5 | 61-100% crown brown |

3.2 Identification of release sites for management of *L. invasa*

The sites studied were located in Kyahi Central Forest reserve Mbalala for monitoring and Nandagi Central Forest reserves in Central Uganda.

Suitable release sites were identified basing on damage level and percentage of trees infested by *Leptocybe invasa* as the amount of damage corresponds to the population of *L.invasa*. The method uses damage levels rather than populations because *L.invasa* lives inside the galls.

**4.0 Findings/Results**

4.1 Population levels

Table 1 shows both population and damage levels by *Cinaracronortii*

| Site | Tree species | Mean aphid count per tree | Mean damage level |
|---|---|---|---|
| Mafuga | *Pinuspatula* | 3.5 | 2 |
| Kiriima | *Pinuspatula* | 4.5 | 2 |
| Mpoma | *Pinuscaribea* | 0.085 | 0 |
| | *Pinuscaribeacaribea* | 0 | 0 |
| Mabuye | *Pinuscaribea* | 0.07 | 0 |
| | *Pinuscaribeacaribea* | 0 | 0 |

Key

- Damage level 0= 0% crown damage for the sampled trees(No symptoms associated with aphid)
- Damage level 1=1-10% crown damage for the sampled trees (Low damage)
- Damage level 2=11-25% crown damage for the sampled trees (moderate damage)
- Damage level 3=26-59% crown damage for the sampled trees (High damage
- Damage level 4=60-100% crown damage for the sampled trees(Very high damage)

4.2 Natural enemy complex

Natural enemy complex encountered are shown in table 2 below

Table 2: Natural enemy complex

| Family | Species | Predatory stage | Remarks |
|---|---|---|---|
| Coccenellidae (Coleoptera) | *Exhocomus*spp,*Chemonespropingua, Platynapsisspp* | Larval and adult | Most abundant family encountered attacking *C.cronortii* |
| Crysopidae | Crysopacanea (lace wing) | Larval and adult | Least abundant |
| Aranea(spiders) | | All mobile stages | abundant |

4.3: Damage levels by *Leptocybeinvasa*

Table 3 below shows damage levels in Nandagi and Kyahi Central forest reserves. These reflect population levels in the study sites.

Table 3. Damage levels for various species in different sites

| **Site** | **Species** | **Damage level** | **Remarks** |
|---|---|---|---|
| Nandagi central forest reserve | *Eucalyptus grandis* | 1 -(60-100 of seedlings attacked by pest) | |
| Kyahi central forest reserve | *Eucalyptus camaldulensis* and *Eucalyptus grandis* | 4-(60-100 of seedlings attacked by pest) | *E. camaldulensis* most attacked |

**5.0 Discussion**

**5.1 Population levels**

As can be observed from Table 1,*C.cronortii*mean aphid counts (Population levels) were 3.8 and 3.2 aphids per tree for Mafuga and Kiriima respectively. Mean aphid counts for Kifu trials were: 0.08 on *Pinuscaribea* and 0 on Pinus*caribeacaribea*in Mabuye while for Mpomamean aphid count was 0. 09 on *P. caribaea* and 0 on *P.caribeacaribea*. Though the aphid population seems low they multiply and so the population is going to increase. This population thus has to be controlled hence the need for management options.The population in Kifu is still very low may be because the trials are isolated compared to Mafuga and Kiriima which are an expanse of forest, It may also imply that *Pinuscaribea* is less palatable compared to *Pinuspatula*. Infact there is no single aphid on *Pinuscaribeacaribea* and yet they are in the same plot.

**5.2 Damage levels**

Damage to seedlings was moderate (11-25% of seedlings with crown yellowing or browning) in both Mafuga and Kiriima but was 0 % in Kifu trial i.e. healthy (no symptoms associated with the pest). This implies that although there are aphids on *Pinuscaribea* they have not reached the threshold level to cause damage to the seedlings. It also means that *C.cronortii*damage is directly dependent on the population of the aphid. No damage has been caused to *P.caribeacaribea*since there was no*C.cronortii*population. The fact that there is no population and damage to *P.caribeacaribea*means that the latter is resistant to the pest.

**5.3 Natural enemies**

From table 3 only predatory natural enemies have been encountered attacking *C. cronortii*

They fall in three families namely:Coccenellidae (Coleoptera) Crysopidae (Neuroptera-lacewings) and aranea(spiders). These could be potential control agents for the pest as Penteado S.R.C (1995), observed that biological control of *C.pinivora* a pest related to *c.cronortii* was controlled in Brazil through the release of insect predators of the families Coccinellidae, Syrphidae, Chrysophidae, Staphilidae and Dermaptera . Thus these could simply be augmented e.g. through mass culture and periodic releases.

**5.4 Release sites for management of *L. invasa***

As can be seen from table 3,Kyahi has consistently had high population levels and damage levels of *L.invasa*. This is the best release site as natural enemies to be released have to find adequate hosts*(L.invasa*). Nandagi central Forest reserve is unsuitable as a release site due to low populations of *L.invasa*.

**6.0 Planned activities/outputs for 2014-15**

| **Quarter 1** | **Quarter 2** | **Quarter 3** | **Quarter 4** |
|---|---|---|---|
| One releaseprotocol for rearing | 1. Two experimental sites (Mukono and Mbarara ) | 1.5,000 S. neseri wasps released in Mukono and Soroti | 1.5,000 S. neseri wasps relesed in Arua and Mbarara sites; Damage |

| | | | |
|---|---|---|---|
| *Selictroides. neseri* accessed and customized | established and 1,000 Eucalypts per site identified and marked; | sites; Trends of damage reduction levels established | reduction levels established |
| 2.Two experimental sites (Soroti and Mukono ) and 1,000 plants per site identified and marked; | 2. *2000* imported and reared in Labaratory | 2. Establishment of *S. neseri* monitored | 2. Establishment of *S. neseri* monitored |
| .Import documentation completed and executed; | 3. *2000* imported and reared in Labaratory | 2. Efficacy of biological control agents against Cinarain field and laboratory determined | .Efficacy of biological control agents against Cinaracronortii in field and laboratory determined |
| **Actvities** | **Activities** | **Activities** | **Activities** |
| 1.Designing of rearing protocol for *Selectroidesneseri* | 1.Selecting experimental sites and host plants infested with Leptocybeinvasa (pest); Establishing site specific infestation baseline information | 1.Selecting experimental sites and host plants infested with *Leptocybeinvasa* (pest); Establishing site specific infestation baseline information<br>2.Importation and mass rearing | Selecting experimental sites and host plants infested with Leptocybeinvasa (pest); Establishing site specific infestation baseline information |
| 2.Importation of both S. neseri and its rearing | | 3. Identification and, evaluation of potential biological control agents against *C. cronortii.* | 2. Establishment of *S. neseri* monitored |
| 3.Raising the needed population for release | 2.Importation and mass rearing | | 3.Identification and , evaluation potential biological control agents against C. cronortii |
| 4.Selecting experimental sites | | | |

| | | | |
|---|---|---|---|
| and host plants infested with Leptocybeinvasa (pest); Establishing site specific infestation baseline information | | | |
| 5.Identification and, evaluation potential biological control | | | |

**6.0 Budget 2014/15**

The budget breakdown on quarterly basis:

| **Output target Qtr 1** | **Budget (000)** | **Output Target Qtr 2** | **Budget (000)** | **Output Target Qtr 3** | **Budget (000)** | **Output Target Qtr 4** | **Budget (000)** |
|---|---|---|---|---|---|---|---|
| one release protocol for S. neseri designed . | 3,000 | | | 5,000 S. neseri wasps released in Mukono and Soroti sites; Trends of damage reduction levels established | 3.500 | 5,000 S. neseri wasps relesed in Arua and Mbarara sites; Damage reduction levels established | 8,000 |
| Importation of S. neseri, selection of release sites | 3.500 | Rearing of S. neseri, selection of release sites | 2,000 | | | Establishment of *S. neseri* monitored | 6,000 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Data collected monthly in Mafuga and Katugo and Kifuon , Population dynamics,natural enemies and damage levels of *C. cronortii* . | 7,000 | Data collected monthly in Mafuga and Katugo and Kifu on, Population dynamics,natural enemies and damage levels of *C. cronortii.* | 6,000 | Establishment of *S. neseri* monitored | 3,000 | | 6,884 |
| Potential biological control agents Identified and evaluated*C. cronortii* | 4,000 | Potential biological control agents Identified and evaluated*C. cronortii* | 5,000 | Efficacy of biological control agents against Cinarain field and laboratory determined | 10,000 | Efficacy of biological control agents against Cinarain field and laboratory determined | 3,000 |
| **Total** | **17,500** | | **13,000** | | **17,500** | | **23,884** |

**7.0 Conclusion**

Population levels and damage in trials of pines in Mafuga and Kiriima Central Forest reserves though moderate is set to increase and warrants management. Thereexists indigenous natural enemies in the ecosystem which are playing a role in keeping populations low. Their effectiveness could be enhanced through augmentation. An exotic biological control agent (*Selictroidesneseri)* is to be imported for control of *L.invasa*namely has been proposed for release

**References.**

Hardcastle et al, 2005. Improving the investment Environment for private Sector development in Uganda.

Innes J.L; 1990.Assessment of tree condition. Commission field book 12 HMSO London.

Penteado, S.R.C. 1995. Métodos de amostragemparaavaliação de Sirexnoctilio F., 1793 (Hymenoptera: Siricidae) e de seusinimigosnaturais, emPinustaeda L. e aspectos do controlebiológico. Tese de Mestrado. Curitiba, Universidade Federal do Paraná, 92 p.

## PROGRAM 2: AGROFORESTRY RESEARCH PROGRAMME

## IMPROVING FORAGE PRODUCTION AND UTILIZATION FOR INCREASED PRODUCTIVITY OF UGANDA'S SMALLHOLDER DAIRY SYSTEMS

**Sekatuba *et al* (2013-2014)**

### 1.0 Introduction/Background

Smallholder dairy development can be a catalyst to agriculture-led economic development. Planted grasses, forage legumes and improved fodder trees and shrubs on the other hand, can enhance forage availability and subsequently milk production. Forage legumes, shrubs and trees provide protein that is required for milk production and supplement animal diet, as well as reducing methane emissions. The relatively high biomass yield renders planted grasses and forage legumes reliable sources of vital nutrients for dairy cattle. Forage trees and shrubs can also withstand extended periods of water stress as their deep root systems enable tapping of water and nutrients from deep into the soil profile (Kabirizi, 2004). In spite of these attributes, use of improved forage in Uganda's livestock systems is limited, and animal feed supplies remain largely dependent on wildly existing stands, which limits livestock productivity (DSIP, 2010).

In Uganda, however, most smallholder farmers realise low milk production due to poor nutrient composition of the fodder used, which mainly comprises natural pastures, browse and crop residues. Seasonal shortage of such feeds, especially during dry spells, further impedes growth of the dairy sector in Uganda (DSIP, 2010).Though rich in fibre roughage, these feeds are deficient in proteins and other vital nutrients, which compromises the quality and quantity of milk produced (Gerrits, 1999). In addition, protein-deficient animal diets are not considered climate-smart since they result in high emission of methane as a by-product of digestion (Mugerwa et al., 2013). This study investigates current forage options and will inform farmers on the appropriate forage management practices to ensure optimal milk production.

The objectives of this project are:

1. To assess existing forage production and utilisation options and their contribution to milk production;
2. To determine the potential of forage species for increasing milk quality and quantity;
3. To develop management practices for optimal forage production and utilisation;
4. To build farmers' capacity for sustainable production and utilization of improved forage for increased livestock productivity.

### 2.0 Key activities undertaken during 2013-2014

1. Benchmarking of forage security status among smallholder dairy farmers in Uganda.
2. Prioritization of forage species for milk productivity.
3. On-station forage management trial (spacing and cutting height).
4. Demonstration of forage production and conservation.

5. Forage seed multiplication.

## 3.0 Methodology

In the analysis of forage production and utilization options and their contribution to milk production, formal surveys were conducted in L. Victoria Crescent and Eastern Highlands AEZs to determine baseline forage types, their sources, seasonality and farmers' perceptions on their contribution to milk production. A total of 208 interviews were conducted on smallholder farms in Masaka (100) and Mbale (108) in L. Victoria Crescent and Eastern Highlands AEZs respectively.

The search for appropriate forage management practices for optimal biomass production employed a completely randomised experimental design in an on-station trial at Kifu. Three species (i.e. *Calliandra calothyrsus, Morus alba* and *Vernonia amygdalina*) derived from the baseline survey are being assessed for their biomass production under different management regimes. These have been planted at 3 spacing regimes of 75 cm x 75 cm, 100 cm x 100 cm and 50 cm x 50 cm; and thereafter are to be subjected to 3 cutting heights at 25 cm, 100 cm and 50 cm (NaFORRI, 2013).

Enhancement of dairy farmer's capacity for sustainable production and utilization of improved forage bases on on-station demonstration of best practices in forage management as well as enhancement of smallholder dairy farmers' access to quality forage planting material through its multiplication and distribution. Technically verified and geo-referenced local sources are intended to supply seed requirements of centralised nurseries, from which quality planting materials are to be raised and disseminated through existing smallholder dairy farmers' networks.

## 4.0 Outputs/Results

a) Analysis of current forage production and utilization systems

Characterisation of the forage situation on smallholder dairy farms was conducted in 2 farming systems (L. Victoria Crescent and Eastern Highlands). Results indicate that a wide range of forage species and feed types are being used by dairy farmers in Masaka (29) and Mbale (15). Prominent among these are Napier grass, *Calliandra calothyrsus, Sesbania sesban* and *Ficus natalensis*. Evidently, dairy farmers depend heavily on naturally existing forage through both wild browse and cut-and-carry systems. Dairy farmers are also more inclined to deliberately plant exotic forage species like *Calliandra calothyrsus* and *Sesbania sesban* while indigenous species are mainly retained on farms.

Table 1: Main characteristics of the forage situation on smallholder dairy farms

| Characteristics | Agro-ecological zone | | Overall |
|---|---|---|---|
| | L. Victoria Crescent | Eastern Highlands | |
| Number of farms sampled (N) | 100 | 108 | 208 |
| Forage growing as a tradition (%) | 47.9 | 45.3 | 46.8 |
| All year use of forage (%) | 85.0 | 94.4 | 89.4 |
| Main sources of forage (%) | | | |
| On farm | 74.0 | 60.0 | 67.2 |
| Off farm (Gathered) | 54.0 | 70.5 | 62.1 |
| Off farm (Purchased) | 14.0 | 18.9 | 16.4 |
| Feeding systems (%) | | | |
| Zero grazing | 77.1 | 49.0 | 63.0 |
| Tethering | 33.3 | 68.8 | 51.0 |
| Paddocking | 3.1 | 1.0 | 2.1 |

Although dairy farmers use forage throughout the year, there are variations in forage availability to farmers and levels of milk production at different periods. Apparently, milk production increases during months of forage abundance and vice versa, trends that may be comparable to the seasonal rainfall patterns in either region. But even with irregular forage supplies, preservation in form of hay and silage only occur in isolated instances. In fact, besides chopping before feeding to the animals, minimal processing is done to the forage if any.

An exhaustive description of the baseline scenario spans beyond the confines of this technical note. Nonetheless, data on existing forage types, their sources, seasonality and farmers perceptions on their contribution to milk production have been compiled in SPSS and AKT5 databases, providing a benchmark for tracking changes in the productivity of smallholder dairy systems. In the short term, this information is guiding selection of candidate forage species for further assessments of management techniques for optimal biomass build-up and laboratory analyses of vital nutritive ingredients for milk production.

b) Management practices for optimal forage production and utilization

A research protocol was developed and an RCBD on-station trial established at Kifu to assess biomass yield of 3 priority forage species i.e. *Calliandra calothyrsus, Morus alba* and *Vernonia amygdalina* under different management regimes. Propagation methods varied between species, with seedlings preferred for *C. calothyrsus*, while cuttings were used for *V. amygdalina* and *M. alba*. The first survival assessment conducted 1 month after planting showed low survival in the two species propagated by cuttings (Table 2).

Table 2: Survival assessment of forage shrubs planted in on-station trial at Kifu

| Species | Propagation method | Survival (%) | |
|---|---|---|---|
| | | 1st Assessment (1 month) | 2nd Assessment (3 months) |
| *Calliandra calothyrsus* | Seedlings | 86 | 96 |
| *Vernonia amygdalina* | Cuttings[1st]/Wildlings[2nd] | 66 | 92 |
| *Morus alba* | Cuttings | 63 | 80 |

A beating up exercise was done following the first survival assessment. Given apparent stress on the *V. amygdalina* cuttings, the propagation method was changed from cuttings to wildlings during the beating up. A second survival assessment conducted 3 month after the date of initial establishment showed relatively higher and uniform survival across the three species. The rationale for recurrent beating up is to enable standard representation of the different spacing regimes for each of the 3 species as per the experimental design to enable reliable comparison.

c) Farmers' capacity for forage production and utilization

As a strategy for guaranteeing sustainable forage seed supplies, this study set out to identify and map sources of seed (seeds and cuttings) for priority forage species. In Masaka district, L. Victoria Crescent AEZ, 12 sites have been identified and their GPS coordinates taken (Table 3). Their current status, production potential and terms of seed acquisition have also been discussed with the respective site host farmers.

Table 3: Locations of forage seed sources in Masaka district

| Site | Sub-county | GPS Coordinates | Forage species on site |
|---|---|---|---|
| 1 | Kkingo | 0347463E; 9962128N | *C. calothyrsus,* Napier, Lablab |
| 2 | Kkingo | 0347315E; 9962002N | *C. calothyrsus,* Napier, Kakilakambuzi, Mucuna |
| 3 | Kkingo | 0347419E; 9961058N | *C. calothyrsus*, Lablab, Mucuna |
| 4 | Mukungwe | 0371318E; 9966880N | *C. calothyrsus*, *S. Sesban, F. natalensis* |
| 5 | Buwunga | 0369180E; 9958842N | *C. calothyrsus*, *S. Sesban,* Mucuna |
| 6 | Katwe-Butego | 0359339E; 9964974N | *C. calothyrsus*, F. *natalensis, V. amygdalina; S. Ellipticum* |
| 7 | Buwunga | 0368802E; 9958666N | *C. calothyrsus, S. sesban*, Napier |
| 8 | Buwunga | 0369229E; 9958786N | *C. calothyrsus,* Mucuna, *S. sesban* |
| 9 | Buwunga | 0369154E; 9958754N | *C. calothyrsus* |
| 10 | Buwunga | 0368760E; 9959104N | *C. calothyrsus*, *F. Natalensis*, Napier |
| 11 | Katwe-Butego | 0360616E; 9964850N | *C. calothyrsus*, Kakirakambwa, Napier |
| 12 | Katwe-Butego | 0360532E; 9964952N | *C. calothyrsus* |

Inadequacy of forage planting material is recurrently cited as a major hindrance to farmers' growing of forage. Even where forage trees and shrubs exist on farms, farmers mainly grow them as a source of feed for their animals but not primarily for seed production. It is common practice for farmers to selectively leave a few trees to grow without cutting back for seed

production. Although cutting back is done purposely to enable more intense branching and hence more foliage as fodder for animals, in species like *C. calothyrsus*, the practice is reported to enhance seed productivity due to the numerous branches. Generally, farmers possess scanty knowledge on seeding behaviour of forage species, especially the indigenous types.

Towards enhancing availability of planting material, 0.25 acres of *Calliandra calothyrsus* and *Morus alba* seed stand has been established on station at Kifu, Mukono district. Besides such exotic species which farmers often plant deliberately, there are intentions to expand the species range to include indigenous forage species as well, following screening for their biomass stocking and nutritive attributes of relevance to milk production.

## 5.0 Gaps

a) Laboratory analyses

As part of the species screening of forage species for milk productivity, the study is yet to undertake laboratory analyses of the nutritive ingredients in candidate species. There is also need for analyzing milk samples following administration of different forage options to lactating cows. Ultimately, this will inform the choice of appropriate forage combinations for milk enhancement.

b) Soil analyses

The study omitted conducting of soil analyses prior to establishment of the biomass production experiment on station. There is a possibility that differences in the soil characteristics between trial plots could introduce variability in the quantity of biomass different treatments will exhibit. Therefore, there are plans to offset this limitation by undertaking these soil analyses.

c) Narrow species range

The study needs to expand on the species range in the various experiments (i.e. biomass production, nutritive content, farmers' capacity for growing forage species). Partnerships being established with livestock nutrition experts at the National Livestock Resources Research Institute (NaLIRRI) are purposely informing the screening exercise that is intended to strengthen this aspect of the study.

## 6.0 Planned activities/outputs for 2014-15

| Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 |
|---|---|---|---|
| 1. Quantities of vital nutrients (Fe, K, Ca, Multivitamins) in 10 potential forage species determined.<br>2. Survival and initial growth | 4. Quantities of vital nutrients (Fe, K, Ca, Multivitamins) in 10 potential forage species determined.<br>5. Leafy biomass stock of *M. alba, C. calothyrsus* and | 1. Forage combinations for milk enhancement in lactating cows determined on-station.<br>2. Leafy biomass stock of *M. alba, C. calothyrsus* and *V.* | 2. Leafy biomass stock of *M. alba, C. calothyrsus* and |

| | | | |
|---|---|---|---|
| performance of 3 forage species (*M. alba, C. calothyrsus* and *V. amygdalina*) determined in L. Victoria AEZ.<br>3. 2,000 seedlings each of 5 priority forage species raised ; 6 sites in L. Victoria and Eastern highlands AEZs identified and prepared for seed stand development. | *V. amygdalina* determined after 6 months, under different management regimes (spacing, cutting heights) in L. Victoria AEZ.<br>6. 5 Ha of forage seed stands established in L. Victoria and Eastern highlands AEZs. | *amygdalina* determined after 9 months, under different management regimes (spacing, cutting heights) in L. Victoria AEZ.<br>3. 5 Ha of forage seed stands maintained in L. Victoria and Eastern highlands AEZs. | *V. amygdalina* determined after 12 months, under different management regimes (spacing, cutting heights) in L. Victoria AEZ.<br>3. 5 Ha of forage seed stands maintained in L. Victoria and Eastern highlands AEZs. |
| *Activities:*<br>5. Prioritization of forage species for milk productivity.<br>6. Nutritive laboratory analysis of leaf samples (proximate analysis).<br>7. On-station forage management trial (spacing and cutting height).<br>8. Forage seed multiplication. | *Activities:*<br>1. Nutritive laboratory analysis of leaf samples (proximate analysis).<br>2. On-station forage management trial (spacing and cutting height).<br>3. Forage seed multiplication. | *Activities:*<br>5. Confirmatory on-station experiments of candidate forage species using lactating cows.<br>6. On-station forage management trial (spacing and cutting height).<br>7. Forage seed multiplication. | *Activities:*<br>1. On-station forage management trial (spacing and cutting height).<br>2. Forage seed multiplication and distribution. |

## 7.0 Budget

The budget breakdown on quarterly basis:

| **Output target Qtr 1** | **Budget (000)** | **Output Target Qtr 2** | **Budget (000)** | **Output Target Qtr 3** | **Budget (000)** | **Output Target Qtr 4** | **Budget (000)** |
|---|---|---|---|---|---|---|---|
| Quantities of vital nutrients (Fe, K, Ca, Multivitamins) in 10 potential forage | 10,850 | Quantities of vital nutrients (Fe, K, Ca, Multivitamins) in 10 potential forage | 11,000 | Forage combinations for milk enhancement in lactating cows determin | 16,972 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| species determined. | | species determined. | | ed on-station. | | | |
| Survival and initial growth performance of 3 forage species (*M. alba, C. calothyrsus* and *V. amygdalina*) determined in L. Victoria AEZ. | 11,000 | Leafy biomass stock of *M. alba, C. calothyrsus* and *V. amygdalina* determined after 6 months, under different management regimes (spacing, cutting heights) in L. Victoria AEZ. | 10,500 | Leafy biomass stock of *M. alba, C. calothyrsus* and *V. amygdalina* determined after 9 months, under different management regimes (spacing, cutting heights) in L. Victoria AEZ. | 10,500 | Leafy biomass stock of *M. alba, C. calothyrsus* and *V. amygdalina* determined after 12 months, under different management regimes (spacing, cutting heights) in L. Victoria AEZ. | 10,500 |
| 2,000 seedlings each of 5 priority forage species raised ; 6 sites in L. Victoria and Eastern highlands AEZs identified and prepared for seed stand development. | 9,800 | 5 Ha of forage seed stands established in L. Victoria and Eastern highlands AEZs. | 14,000 | 5 Ha of forage seed stands maintained in L. Victoria and Eastern highlands AEZs. | 14,300 | 5 Ha of forage seed stands maintained in L. Victoria and Eastern highlands AEZs. | 13,740 |
| **Total** | **31,650** | | **35,500** | | **41,772** | | **24,240** |

## 8.0 References

DSIP (2010), "Agricultural Sector Development Strategy and Investment Plan: 2010/11 – 2014/15", Ministry of Agriculture, Animal Industry and Fisheries (MAAIF).
Kabirizi (2004), "Research and Development of Indigenous Fodder Trees and Shrubs in Uganda". Regional Land Management Unit (RELMA) / ICRAF Report.
Mugerwa S., Zziwa E., Kabirizi J and Ndikumana J (2013). Environmental Assessment of Climate Smart Agricultural Interventions in Smallholder Crop- Livestock Production Systems. Resources and Environment 3(4): 91-99.
NaFORRI (2013) "Assessment of Biomass Production Under Different Forage Management Practices". Agroforestry Program, National Forestry Resources Research Institute. Experiment Protocol.

## PRODUCTION AND PROMOTION OF QUALITY AGROFORESTRY TREE GERMPLASM FOR ENHANCED FARM PRODUCTIVITY

**Nansereko *et al* (2013/14)**

### 1.0 Introduction/Background

Trees are an important element of the landscape in Uganda and they provide social, economic, cultural and environmental benefits. For instance, trees on farm are exploited for wood and non-wood products but little attention has been paid to their sustainable regeneration. Little is known about agroforestry trees' reproductive biology particularly flowering, fruiting and seeding patterns in this country. This has led to shortage of such trees' planting materials limiting their wider use in agroforestry (Sacandé et al., 2004). In Uganda, the quality of tree seed is still generally poor and most of the tree seed is unselectively collected by the informal tree seed sector (SPGS, 2005). In particular, the lack of quality tree germplasm has hindered the scaling-out of agroforestry interventions and innovations thereby constraining adequate tree growing on farm (Kabeere and Wulff, 2008; SPGS, 2005). Lack of adequate trees on farm has implications to sustainable farm productivity and household food security. In Uganda, just like in many developing countries, the challenge of providing good agroforestry tree seed remains a problem, particularly for many smallholder tree growers (Gradual *et al*., 2009, Gradual *et al*., 2007, Kindt *et al*., 2006). There is therefore a need to develop strategies to produce and promote use of quality germplasm for on farm tree planting in Uganda.

1.1 This research project seeks specifically to:

i. Develop options for increased production, distribution and use of quality agroforestry tree-germplasm
ii. Build capacity of tree farmers in production and use of quality agroforestry tree-germplasm
iii. Establish a seed system for access, production and utilization of quality tree germplasm

### 2.0 Key activities undertaken during 2013-2014

To explore tree seed production and consumption of indigenous agroforestry tree species in Masaka, Lake Victoria Crescent Agro-ecological Zone (AEZ). This field activity was a springboard for the development of appropriate tree and germplasm management options consequently leading to

production of quality tree germplasm for on-farm planting. Data on source, maturity period, collection, handling, prices, propagation amongst others of tree seeds were collected from tree seed collectors, farmers, nursery operators , the District Forestry Officer as well as the VI Agroforestry Project tree seed officer

To select mother trees on farm to study seeding behaviour of common agroforestry tree species Masaka district in Lake Victoria crescent. Mother trees of *Markhamia lutea*; *Podocarpus usambarensis*; *Milicia excelsa*; *Albizia coriaria; Maesopsis eminii* and *Cordia* africana were identified on fields of willing farmers for a study on seeding behaviour. The selected mother trees were geo-referenced for precise data collection

## 3.0 Methodology

Purposive and snowball sampling methods were used in a study to explore tree seed production and marketing of indigenous agroforestry tree species in Masaka, Lake Victoria Crescent Agro-ecological Zone (AEZ). Such sampling methods were as tree seed value chain actors were not well distributed. Data on seed source, maturity period, collection, handling, prices and propagation of tree seeds were collected from tree seed collectors (13), farmers (7), nursery operators (27), the District Forestry Officer as well as the VI Agroforestry Project tree seed officer through face to face interview using a checklist of pre-determined questions and direct observation

Materials and tools used during data collection on selected seed mother trees on farm were GPS, caliper, measuring tape; Suunto clinometers; field data form, paint and brush. The study team used face to face interviews where the Masaka District Forestry Officer (DFO) and tree farmers responded to questions on seed mother tree management. Other methods used during this study were direct observation through farm visits, seed mother tree coding and painting; GPS mapping, pacing and pace factor.

Qualities considered when selecting seed mother trees on farmers' fields were health (free from disease); growth vigour; main end use/product of a tree (e.g. timber and poles): straight bole and few branches as well as absence of any damages on the tree.

Number codes were marked on the bark of selected seed mother trees using water resistant paint. The codes were derived from the tree's botanical name e.g. ML – *Markhamia lutea*; PU – *Podocarpus usambarensis*; ME – *Milicia excelsa*; AC – *Albizia coriaria;* M – *Maesopsis eminii* and CA – *Cordia* africana. The Luganda names for the above-listed trees; the code and number were recorded in the field form left with the tree farmers. For example two *Maesopsis eminii* trees marked on a farmer's field would appear like this on the data collection form: Musizi M01 for the first tree and Musizi M02 for the second tree. Two to three trees per species were selected per farm holding as data collection from many trees would be cumbersome for the farmer and this may compromise the quality of the data. The marked trees were assessed for height, diameter at breast height (dbh), age and placement on the farm. Since tree phenological data is recorded over a long period of time, farmers were trained how to record data in the data collection form left with them.

## 4.0 Outputs/Results

An inventory of key actors, commonly collected tree seed and market information in tree seed production to consumption chain in Masaka district. The five major actors in tree seed production – consumption chain in Masaka included tree seed collectors, farmers, tree nursery operators, District Forestry Services and the VI Agroforestry Project. Indigenous tree species whose seeds were dominantly collected in Masaka included: *Maesopsis eminii* (Musizi); *Makhamia lutea*(Lusambya); *Sesbania sesban* (Muzimbandegeya) and *Albizia coriaria* (Mugavu). The main source of tree seed in

Masaka was farmland. The collection method varied among tree species for instance *Maesopsis eminii* seeds were collected on ground after natural seed fall as such trees are large to climb without an appropriate climbing kit and its branches easily snap. The choice of tree seed to collect was almost exclusively based on market availability. Consequently, *M. eminii* seed was mostly collected as this tree is used for shade by coffee farmers in Masaka.

A total of 36 mother trees (i.e. 08 *Markhamia lutea, 11 Maesopsis eminii , 02 Milicia excelsa, 06 Albizia coriaria; 08 Podocarpus usambarensis and 01 Cordia Africana)* were selected and geo-referenced on farms in Masaka district for a study on flowering and fruit setting, maturation as well as ripening. Such phenology data will be used to develop seed collection calendars for the aforementioned tree species. The age and diameter ranges by tree species as well as their GPS points are given in Table 1. Trees of varying sizes and age were selected in this study because tree stands of same age were hard to find.

**Table 1: Overview of data on seed mother trees recoded in this study**

| Tree species | Age range (Year) | DBH (cm) | Tree location on farm | GPS points* |
|---|---|---|---|---|
| *M. excelsa* | 28-35 | 32-34.8 | Farm boundary and Tree nursery | 352870;9973726<br>361016;9965904 |
| *M. eminii* | 8-15 | 24-67 | Coffee/banana Intercrop and Tree nursery | 352782:9973711<br>360841;9965782 |
| *M. lutea* | 13- 25 | 16 - 38.9 | Farm boundary and Home garden | 352770; 9973707<br>361581;9965934 |
| *A. coriaria* | 12-36 | 27-69 | Coffee/banana intercrop and Compound | 364433;9989182<br>361596:9965924 |
| *C. africana* | 10 | 27 | Tree nursery | 360828;9965798 |
| *P. usambarensis* | 07-18 | 12-26 | Tree nursery and Farm boundary | 362221;995108<br>352811;9973685 |

* GPS points* for small and big trees in the sample

## Gaps

The following activities have not been conducted during this financial year:

- Determining appropriate propagation techniques for selected agroforestry trees in Masaka district. During the tree seed propagation experiment, we seek to develop a seed propagation protocol for each of the six agroforestry trees (*Makhamia lutea; Cordia africana; Podocarpus usambarensis; Milicia excelsa; Albizia coriaria* and *Maesopsis eminii*) in Lake Victoria Crescent (LVC) agro-ecological zone (AEZ). The seed propagation protocols developed will be compliant to local conditions making them relevant to tree seed propagation in this particular AEZ. Furthermore; such protocols will ensure reliable replication of propagation practices in nurseries in LVC thus improved supply of quality tree seedlings and maintenance of a quality tree estate especially on farms in this country.
- To explore tree seed collection, value addition, distribution and propagation of selected agroforestry species at National tree seed Centre. National tree seed Centre (http://www.nfa.org.ug/Tree%20Seed/tree%20seed.php) at Namanve is one of the key actors in the tree seed value chain in Uganda. This is because NTSC conducts seed source development and has standard infrastructure to collect, process, test, store, propagate and distribute tree seeds of over 100 indigenous and exotic species. So such an institution can provide insightful information for improved research outputs and impacts on tree seed research

Hopefully, during the next financial year, the above-mentioned gaps will be dealt with.

**Planned activities/outputs for 2014-15**

| Quarter 1 output | Quarter 2 output | Quarter 3 output | Quarter 4 output |
|---|---|---|---|
| 1. One calendar for each of 4 priority tree species from Masaka district developed<br>**2.** One propagation protocol for 4 priority tree species in Masaka district | 1. One calendar for each of 4 priority tree species from Pallisa district developed<br>**2.** One propagation protocol for 4 priority tree species in Pallisa district | 1. One calendar for each of 4 priority tree species from Otuke district developed<br>**2.** One propagation protocol for 4 priority tree species in district Otuke district | 1. One calendar for each of 4 priority tree species from Kasese district developed<br>**2.** One propagation protocol for 4 priority tree species in Kasese district |
| **Key activities**<br>1. Collect and validate indigenous knowledge on phenology of priority tree species<br>2. Collect tree germplasm, nursery work<br>3. Prepare reports | **Key activities**<br>1. Collect and validate indigenous knowledge on phenology of priority tree species<br>2. Collect tree germplasm, nursery work<br>3. Prepare reports | **Key activities**<br>1. Collect and validate indigenous knowledge on phenology of priority tree species<br>2. Collect tree germplasm, nursery work<br>3. Prepare reports | **Key activities**<br>1. Collect and validate indigenous knowledge on phenology of priority tree species<br>2. Collect tree germplasm, nursery work<br>3. Prepare reports |

**Budget: 2014/15**

The total budget breakdown on a quarterly basis is shown below

| Output target Qtr 1 | Budget (000) | Output Target Qtr 2 | Budget (000) | Output Target Qtr 3 | Budget (000) | Output Target Qtr 4 | Budget (000) |
|---|---|---|---|---|---|---|---|
| One calendar for each of 4 priority tree species from Masaka district developed | 10,168 | One calendar for each of 4 priority tree species from Pallisa district developed | 6,138 | One calendar for each of 4 priority tree species from Otuke district developed | 13,508 | One calendar for each of 4 priority tree species from Kasese district developed | 3,344 |
| One propagation protocal for 4 priority tree species in Masaka district | 3,320 | One propagation protocal for 4 priority tree species in Pallisa district | 5,518 | One propagation protocal for 4 priority tree species in district Otuke district | 3,418 | One propagation protocal for 4 priority tree species in Kasese district | 1,218 |
| **Total** | **13,488** | | **11,656** | | **16,926** | | **4,562** |

## References

Gradual L., Lillesø J.P.B. (2007). Experiences and future prospects for tree seed supply in agricultural development support: based on lessons learnt in Danida supported programmes 1965-2005. Ministry of Foreign Affairs, Danida, Copenhagen. Denmark.

Gradual L., Lillesø J.P.B., Moestrup S., Kjaer E.D. and Kindt R. (2009). Better trees on-farm in Africa: The contribution of National Tree Seed Centres to development of small-scale tree planting. Denmark: Forest and Landscape; Faculty of Life Sciences, University of Copenhagen

Kabeere F. and Wulff E. (2008). Seed Sector Country Profile: Uganda: Overview of seed supply systems and seed health issues. Kampala, Uganda.

Kindt R., Lillesø J.P.B., Mbora A., Muriuki J., Wambugu C., Frost W., Beniest J., Aithal A., Awimbo J., Rao S., Holding-Anyonge C. (2006). Tree Seeds for Farmers: A Toolkit and Reference Source. Nairobi: World Agroforestry Centre

Leach G. and R. Mearns. (1988). Beyond the Wood fuel Crisis. Earthscan Publications, London.

Sacandé, M.; Jøker, D.; Dulloo, M.E.; Thomsen, K.A. (eds.) 2004 Comparative storage biology of tropical tree seeds..Bioversity International: research for development in agricultural and forest biodiversity

SPGS (2005). Tree Planting Guidelines for Uganda. Sawlog Production Grant Scheme, Kampala, Uganda.


# UTILIZATION OF INDIGENOUS TREE SPECIES FOR IMPROVED LIVELIHOODS AND ECONOMIC DEVELOPMENT


**Ongodia *et al* (2013/14)**


## 1.0 Background/Background

Most agroforestry interventions have relied on exotic species to demonstrate effect on crop yield and land productivity enhancement, with little attention given to indigenous tree/shrub species. However, rural farmers have for long relied on indigenous trees for food, medicine and income (Roothaert and Franzel, 2001). These species also contribute to a cleaner environment as they sequester more carbon dioxide from the atmosphere compared to exotics (Plan Vivo, 2008). Wise use of indigenous tree species is crucial for restoration of ecosystems and provision of livelihood support functions (Byabashija *et al.*, 2004). Scientific studies on indigenous tree - crop interaction to assess effect on land productivity improvement and increased crop yields have not been comprehensively conducted in Uganda. Similarly, harvesting of products from indigenous trees is often destructive, calling for a need to develop sustainable ones. In most cases the injury caused to trees during bark harvesting leads to wood deterioration as a result of insect damage and fungal infection (Chungu *et al.*, 2007). There is need to conduct science based research to quantify the contribution of indigenous tree species to livelihoods improvement and conservation of the natural resource base.

### 1.1 Project objectives

i). Determine socioeconomic attributes of indigenous tree species and their contribution to livelihood improvement.
ii). Develop sustainable harvesting and processing methods for products from indigenous tree species.
iii). Assess the effect of indigenous trees on land productivity and crop yield improvement under tree-crop-soil interaction trials both on station and on-farm trials.

## 2.0 Key activities undertaken during 2013-2014

i). Prioritization of indigenous tree species for on-farm integration with crops in Kyoga plains (Tororo and Lira districts) and the eastern highland ranges AEZs
ii). Preliminary assessment of maize crop performance and determination of baseline soil status from on-farm tree-crop interaction trial sites identified in Tororo district.
iii). Assessment of Indigenous Technical Knowledge (ITK) used by farmer for on-farm propagation of *Markhamia lutea,* a priority indigenous tree species integrated with crops in Tororo district.
iv). Assessment of on-farm tree management options used by farmers to achieve optimal crop performance under integration with *Markhamia lutea* trees in Tororo district.
v). Assessment of farmers' preferred pattern and planting niche for on-farm integration of *Markhamia lutea* trees with crops in Tororo district

## 3.0 Methodology

*i). Socioeconomic attributes of indigenous tree species and their contribution to livelihood improvement.*

To assess the socio economic characteristics of indigenous tree species and their role in contributing to improving livelihoods of the households, formal surveys using a questionnaire were conducted in two agro ecological zones of Uganda namely Kyoga plains (Lira and Tororo districts) and the eastern highland ranges (Manafwa and Sironko districts). The surveys sought to provide insight into household characteristics in the study zones, prioritise indigenous tree species according to the attached use value and species spatial availability in the study zones. The study covered a total of 422 households both in Kyoga plains and highland ranges AEZs

*ii). Sustainable harvesting and processing methods for products from indigenous tree species.*

An inventory of the existing harvesting methods among the communities was conducted. This was by use of questionnaire interviews among selected households in the study zones covering two districts in each of Kyoga plains (Lira and Tororo districts) and the highland ranges (Manafwa and Sironko districts) AEZs. The study

covered a total of 422 households (120 in Sironko, 117 in Manafwa, 60 in Tororo and 125 in Lira)

*iii). Effect of indigenous trees on land productivity and crop yield improvement under tree-crop-soil interaction trials both on station and on-farm trials.*

31 household interviews were conducted in Tororo district in the sub counties of Kisoko and Osukuru. The interviews focused on *Markhamia lutea*, one of the two priority indigenous tree species identified in Tororo district for integration within cropping land for soil fertility enhancement. A total of 12 farm sites with adequate populations of *Markhamia lutea* trees were selected for establishment of on-farm tree-crop interaction trials. Soil samples were collected from the identified trial sites for determination of the baseline soil status prior to trial establishment.

## 4.0 Outputs/Results

### *Prioritization of indigenous tree species for on-farm integration*

The surveys carried out indicate priority indigenous tree species as *Markhamia lutea, Ficus natalensis, Mangifera indica, Albizia coriaria, Ficus mucuso, Melicia excels, Vernonia amygdalina, Cordia africana, Artocarpus heterophylus, Syzygium cumnii* and *Senna spectabilis.* These trees are commonly found in farmers' crop lands, internal and external boundaries, homesteads and fallows (Table 1). Indigenous trees are mainly valued for their timber, household food in form of fruits, firewood, medicine, soil fertility, animal fodder and household income from sale of products such as charcoal, furniture and construction and fencing poles.

### *On-farm tree management options*

Majority of the indigenous tree species (57.9%) existing on- farm were planted by the farmers, with exception of Tororo and Lira districts (Kyoga plains agro ecological zone) where over 50% of the respondents acknowledged that the indigenous trees on their farms were retained (Table 1). Apart from pruning, there is hardly any tree management option applied to indigenous trees by the farmers across the two agro ecological zones. Adequate management of trees on-farm can lead to restoration of lost productive capacity in farm land and promotion of local enterprises, reduction of poverty, malnutrition, hunger and land degradation (Leakey, 2010).

**Table 1**: On-farm tree distribution, establishment and management options used by farmers

| Variable | Highland ranges AEZ | | Kyoga plains AEZ | | Total |
|---|---|---|---|---|---|
| | Sironko | Manafwa | Tororo | Lira | |
| N | 120 | 117 | 60 | 125 | 422 |
| **Distribution of indigenous trees on-farm (%)** | | | | | |
| Croplands | 48.0 | 55.1 | 24.9 | 40.6 | 43.9 |
| Homesteads | 31.9 | 27.4 | 68.3 | 45.2 | 40.7 |
| Boundaries | 18.9 | 10.1 | 6.2 | 3.8 | 8.4 |
| Fallows | 1.3 | 5.8 | 0.5 | 8.4 | 5.6 |
| Roadsides | 0.0 | 1.6 | 0.0 | 1.9 | 1.3 |

| | | | | | |
|---|---|---|---|---|---|
| **Mode of establishment (%)** | | | | | |
| Planted | 80.1 | 70.1 | 43.1 | 44.6 | 57.9 |
| Retained | 19.8 | 29.9 | 56.9 | 55.4 | 42.1 |
| **Indigenous tree management** | | | | | |
| No management | 13.5 | 48.2 | 42.1 | 51.4 | 41.6 |
| Pruning | 73.3 | 32.7 | 52.7 | 37.9 | 45.8 |
| Coppicing | 12.7 | 1.8 | 4.7 | 10.0 | 8.1 |
| Weeding | 0.0 | 17.3 | 0.0 | 0.0 | 4.0 |

Indigenous tree species are usually propagated using seedlings, wildings, direct sowing of seed and stem cuttings (Figure 1).

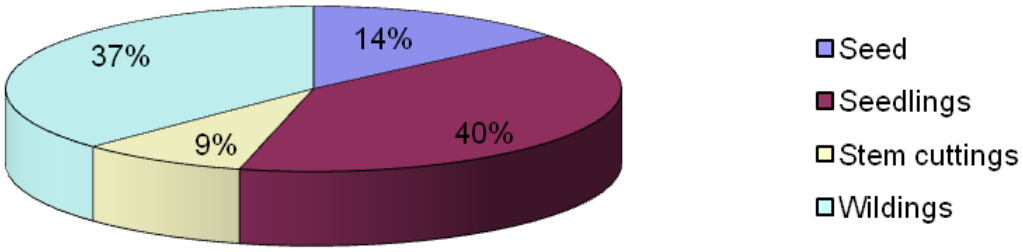



**Figure 1:** Method of indigenous tree propagation

***Effect of indigenous trees on land productivity and crop yield***

The effect of *Markhamia lutea* trees on maize crop yield, assessed for farms in Tororo, indicated varying distances of planting maize from the *M. lutea* trees on farm (Table 2). Over 50% of the respondents in Tororo district plant their maize at 0.5-1 meter from the *M. lutea* trees in their gardens.

**Table 2**: Distance of planting maize form *Markhamia lutea* and observed changes

| **Minimum distance of maize from tree** | **% of responses** |
|---|---|
| <0.5 Meter | 38.7 |
| 0.5-1 Meter | 54.8 |
| > 1 Meter | 6.5 |
| **Changes observed in maize performance when integrated with *M. lutea*** | |
| Bigger maize cobs | 54.2 |
| Taller maize stems | 37.5 |
| Greener maize leaves | 16.7 |
| Bigger maize grains | 8.3 |
| More maize cobs | 8.3 |
| Higher grain yield | 4.2 |

The major changes observed in maize performance when integrated with *M. lutea* were bigger maize cobs, taller maize stems, green maize leaves and bigger maize

grains (Table 2). This implies that *Markhamia lutea* could influence soil fertility and thus contribute to the changes in maize performance observed by the farmers.

## 5.0 Gaps

Soil laboratory analysis to determine baseline status of farm soils in Tororo district (i.e. pH, O.M, Ca, Mg, N, P and K)

## 6.0 Planned activities/outputs for 2014-15

| Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 |
|---|---|---|---|
| 1. 15 farms with adequate population of *Markhamia lutea* selected for trial establishment in Tororo district<br>2. Baseline soil chemical and physical properties of 45 target trial sites determined | 1. 15 farms with adequate population of *Albizia coriaria* selected in Lira district for trial establishment<br>2. Baseline soil chemical and physical properties of 45 target trial sites determined | 1. 45 Trials in Tororo district (Osukuru and Kisoko sub counties) planted with maize and beans<br>2. Growth performance of the companion crops determined | 1. 45 Trials in Lira district (Adekokwok & Ngetta subcounties) planted with millet and beans<br>2. Growth performance of the companion crops determined |
| *Activities:*<br>• Selection of on-farm trial sites in Tororo<br>• Quantification of leaf litter biomass fall from *Markhamia lutea* trees<br>• Soil sampling and lab analysis for physical and chemical properties | *Activities:*<br>• Selection of on-farm trial sites in Lira<br>• Quantification of leaf litter biomass fall from *Albizia coriaria* trees<br>• Soil sampling and lab analysis for physical and chemical properties | *Activities:*<br>• Establishment of on-farm test-crops trials<br>• Assessment of test crops performance<br>• Determination of nutrient return from *Markhamia lutea* leaf biomass<br>• Determination of crop yield under *Markhamia lutea*<br>• Development of the training manuals and *Markhamia lutea* tree-crop management protocols<br>• Training of farmers and partners in tree management options | *Activities:*<br>• Establishment of on-farm tree-crop interaction trials<br>• Determination of nutrient return from *Albizia coriaria* leaf biomass<br>• Determination of crop yield under *Albizia coriaria*<br>• Development of the training manuals and *Albizia coriaria* tree-crop management protocols<br>• Training of farmers and partners in tree management options |

## 7.0 Budget: 2014/15

| Output target Qtr 1 | Budget ('000) | Output target Qtr 2 | Budget ('000) | Output target Qtr 3 | Budget ('000) | Output target Qtr 4 | Budget ('000) |
|---|---|---|---|---|---|---|---|
| 1. 15 farms with adequate population of *Markhamia lutea* selected for trial establishment in Tororo district | 15,645 | 1. 15 farms with adequate population of *Albizia coriaria* selected in Lira district for trial establishment | 14,550 | 1. 45 Trials in Tororo district (Osukuru and Kisoko sub counties) planted with maize and beans | 12,400 | 1. 45 Trials in Lira district (Adekokwok & Ngetta subcounties) planted with millet and beans | 11,945 |
| 2. Baseline soil chemical and physical properties of 45 target trial sites determined | 13,053 | 2. Baseline soil chemical and physical properties of 45 target trial sites determined | 15,278 | 2. Growth performance of the companion crops determined | 8,425 | 2. Growth performance of the companion crops determined | 8,526 |
| **Total** | **28,698** | | **29,828** | | **20,825** | | **20,471** |

## References


Byabashija, M., Esegu, J., Kidiya, J., Basoga, M. &Ondia, R. (2004). Traditional uses of indigenous tree species. *Uganda journal of agricultural sciences* 9: 367-371.

Chungu, D., Muimba-Kankolongo, A., Roux, J. &Malambo, F. (2007). Bark removal for medicinal use predisposes indigenous forest trees to wood degradation in Zambia. *Southern Hemisphere Forestry Journal* 69(3): 157-163.

Leakey, R. R. (2010).Should we be growing more trees on farms to enhance the sustainability of agriculture and increase resilience to climate change. In *ISTF News, Bethesda*.

Roothaert, R. &Franzel, S. (2001). Farmers' preferences and use of local fodder trees and shrubs in Kenya. *Agroforestry Systems* 52(3): 239-252.

## FOREST PRODUCTS AND SERVICES RESEARCH PROGRAMME

### UTILISATION OF EFFICIENT BIOMASS ENERGY TECHNOLOGIES AND BIOFUELS FOR DOMESTIC AND INDUSTRIAL USE IN UGANDA

**Turinayo *et al*** (2013-2014)

### 1.0 Background

Uganda features a high deforestation rate of about 2.2% (Nampewo, 2013) and heavily depends on biomass (over 90%) as energy source (MEMD, 2009). Petroleum which is currently imported accounts for 6% of Uganda's energy consumption (REA, 2011) and the recent discovered oil is expected to last less than 30years (Okupa, 2012). Urban and rural dwellers use predominantly metal charcoal stoves and traditional three-stone stoves, respectively, at efficiency less than 10% (Okello et al., 2013). This puts Uganda's forests and its growing population (3.32%/year) under tremendous pressure. Therefore adoption of improved biomass cook stoves and use of bio-fuels such as *Jatropha oil (Jatropha curcas)* and castor oil *(Ricinus communis)* could conserve energy and reduce environmental degradation.

*Jatropha curcas* and *Ricinus communis* as energy crops have been found to have the potential for biodiesel production elsewhere (Bonjean & Le-Recin, 2002; Okullo et al., 2012). These two energy crops have however not been evaluated in Uganda. *Jatropha curcas* has rapidly established a niche for itself within the agriculture and energy industry in Uganda, though the current production is not well understood. The private sector entrepreneurs are establishing *Jatropha* plantations in Karamoja and Masindi sub-regions but with no scientific production information in support of the business enterprise. *Ricinus comminis* is also increasingly being promoted for biodiesel due to its high oil yield and relatively low water requirements like *Jatopha*. Castor has many industrial, medicinal, and automotive uses, including: aircraft lubricants, hydraulic fluids, explosives, dyes nylon and many others (Bonjean & Le-Recin, 2002). Castor and *Jatropha* biofuel crops are perceived as not competing with food production because they are inedible (which makes them suitable for pesticides) and can be grown on marginal lands and thrives in waste lands as a potential contribution to the rehabilitation of degraded land (Fitzgerald, 2007). It is therefore, important to understand yield seed provenances, their general agronomic performance, oil quality and quantity and product usage from the bio-materials and plan for their detoxification.

The aim of the study therefore, is to evaluate the utilization potential of efficient biomass energy technologies and biofuels for domestic and industrial use in Uganda. The project specific objectives are to:

i). Determine efficiency and acceptability of improved biomass energy technologies
ii). Determine the physico-chemical properties and energy potential of J. curcas and R. Communis for biodiesel production in Uganda.

### 2.0 Key activities for FY 2013/2014

i) Strategic random home visits, administering of questionnaires and Key Informant Interviews
ii) Kitchen Performance Test (KPT)
iii) *Efficiency testing: Water Boiling Test (WBT)*
iv) *J. curcas* and *R. Communis* seed collection from Nebbi District.

## 3.0 Methodology

### 3.1 *Performance testing of coking stoves: The Kitchen Performance Test (KPT) and Water Boiling Test (WBT)*

The KPT is used to demonstrate the effect of stove interventions on household fuel consumption, whereas WBT provides a range of stove performance indicators: thermal efficiency; fuel consumption, and time to boil a fixed quantity of water. Daily measurements of fuel consumption were made in a representative sample of households using traditional stoves and Improved Cooking Stoves (ICSs) over an extended period of time (3-7 days). Because fuel consumption is weighed directly, the KPT was the preferred method of quantifying the ICS's impact on household fuel use.

3.2 *Study design and sample size*

The study was conducted in Mbale District located in Eastern Uganda, Nebbi and Adjumani Districts located in West Nile. Nearly the entire population in the Districts relies on biomass fuels for cooking, which is typical of rural Uganda. Cross-sectional design was employed in data collection (Figure 1). This design compared fuel use between households with ICSs (n = 25 for Mbale District, n = 20 for Nebbi District and n = 20 for Adjumani District) and households with traditional three-stone stoves (n = 11 for each of Mbale, Nebbi and Adjumani Districts). The sample of households that participate in the test was selected randomly from among the target population in order to obtain unbiased results. Participants in the cross-sectional study had self-purchased the improved cooking stove

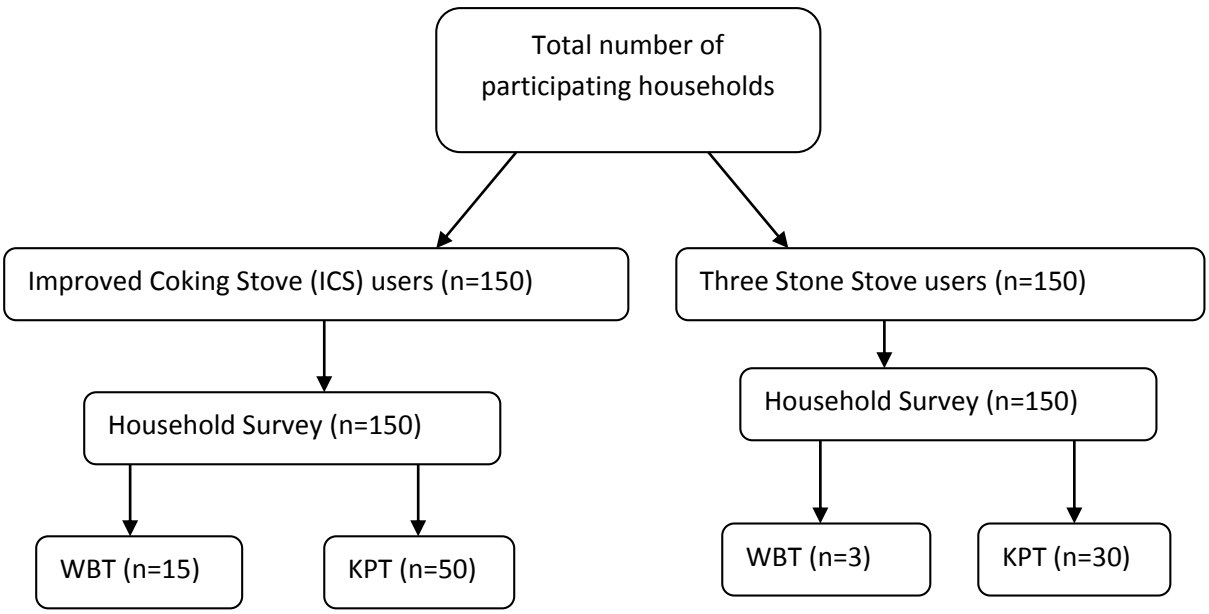



**Figure 1:** Sampling approach employed in the study.

The KPTs and WBTs were conducted for 6 days in Mbale District, from 3rd to 9th March 2014 and 12 days in Nebbi and Adjumani Districts, from 17th to 29th June 2014. During this period, we also collected baseline information of the study households including demographic, socio-economic, fuel and stove usage patterns using interviewer administered semi-structured questionnaires.

*3.3 Fuel use measurements*

Our KPTs were based on two days of repeat fuel use measurements in a relatively large sample size, thereby limiting the influence of inter-household variability. As part of the experimental protocol, participants prepared three batches of fuel enough for 3 days of cooking, based on their typical fuel requirements. On the first day of the tests, the three batches of fuel were weighed on a spring balance. The weight of each batch was recorded, with the third batch serving as a spare batch. We also estimated the fuel moisture content, i.e. the amount of water contained in wood as a percentage of the mass of the oven dry wood. The moisture level was obtained using pin-type electrophysics moisture meter (protimeter Mini BLD2000) with an electronic sensor for wood moisture level, displayed on the instrument's screen upon contact of the pin points with wood. Because wood pieces in the batches were not similar, we obtained an average reading of 3 pieces of wood in each fuel batch. On the second day of the tests, the fuel that remained from the first day was weighed and the difference recorded as the day's fuel consumption. The same procedure was repeated on the second day.

All our analyses were based on fuel consumption in kg per day, obtained by averaging fuel consumption for the 2 days of measurement.

*3.4 Efficiency testing: Water Boiling Test (WBT).*

We also conducted the WBT on three stone stove and improved cooking stoves, where the test was repeated three times for each stove using a low power test. In this study, we report two performance indicators that are of particular importance to end-users and stove designers: fuel consumption per unit of water boiled, and thermal efficiency. Specific consumption (SC) is defined as the ratio of the mass of fuel consumed to the volume of water heated for each cooking task (after 45 minutes at, or just below, the boiling point) and is measured in grams (g) of fuel per liter (l) of water; whereas thermal efficiency is the ratio of the work done by heating and evaporating water (at a constant temperature) to the energy embodied in the fuel.

3.4 *J. curcas seed collection from Nebbi, for oil quantity and quality analysis*

Both grown-up yellow and dried fruits of *J.curcas* were collected from 12 accessions from Nebbi district. Fruits/seeds were collected from at least 30 trees in the same population spaced at least 10 to 15 m and randomly selected to ensure unbiased genetic variability. In this study, the accession represented fruits/seeds collected from trees in the same life area or from isolated trees in the same garden or village. Trees were at least 3-6 years old. Accessions were distant each other at least 20-30 km in different sub-counties. Fruits/seeds were labeled to keep identity of each accession. The collection sites coordinates were recorded using the Global Positioning System for point mapping.

Fruits/seeds were air dried at Research Laboratory in Kifu until constant weight under similar conditions of temperature and humidity were realized and kept for Laboratory analysis.

**4.0 Outputs/Results**

Thermal efficiency and energy consumption of 5 commonly used domestic biomass energy technologies (Lorena stove, Molded 1-pot mud stove, trench fire, brick stove, three stone stove) from Eastern Uganda and west Nile were determined using WBT and KPT (Table 1).

**Table 1:** Performance of Improved cooking wood stoves Vs traditional three stone stove (n = 3)

| **stove** | **performance indicators** | **WBT** | | **KPT** | |
|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD |
| Lorena stove | Specific fuel Consumption (g/l) | 195 | 25 | | |
| | Thermal efficiency (%) | 14% | 2 | | |
| | Fuel Consumption (MJ/cap) | | | 33 | 5 |
| Molded 1-pot mud | Specific fuel Consumption (g/l) | 155 | 21 | | |
| | Thermal efficiency (%) | 16% | 3 | | |
| | Fuel Consumption (MJ/cap) | | | 28 | 15 |
| trench fire | Specific fuel Consumption (g/l) | 227 | 20 | | |
| | Thermal efficiency (%) | 13% | 5 | | |
| | Fuel Consumption (MJ/cap) | | | 37 | 9 |
| brick stove | Specific fuel Consumption (g/l) | 128 | 19 | | |
| | Thermal efficiency (%) | 17% | 3 | | |
| | Fuel Consumption (MJ/cap) | | | 24 | 14 |
| three stone stove | Specific fuel Consumption (g/l) | 310 | 35 | | |
| | Thermal efficiency (%) | 9% | 1 | | |
| | Fuel Consumption (MJ/cap) | | | 53 | 9 |

Results show that average performance (thermal efficiency and energy consumption) of brick stove (17%; 24MJ/cap) is better than Molded 1-pot mud stove (16%; 28MJ/cap), 2-pot Lorena stove (14%; 33MJ/cap), trench fire stove (13%; 37MJ/cap) and three stone stove (9%; 53MJ/cap) (Figure 2).

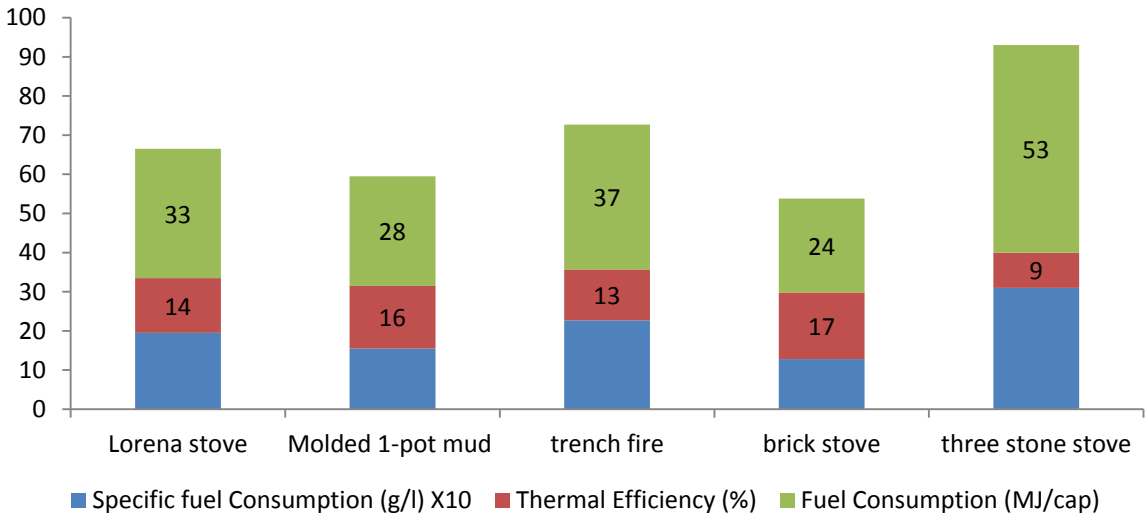



**Figure 2:** Performance comparison of Improved wood stoves and traditional three stone stoves (n = 3 for each stove)

The level of adoption of improved biomass energy technologies (other than traditional three stone stoves) is 45% in rural households of West Nile and 32% in Eastern Uganda. The study revealed that adoption of improved technologies reduces with proximity to protected areas.

During the FY 2013/2014, about 55kg of J. curcas germplasm from Identified and marked mother trees in Nebbi District was collected for oil quantity and quality analysis. It was observed that J. curcas seed traits depicted a High variability among the accessions. 100 seed weight ranged from 60.44 to 79.43 g (dry weight).

**5.0 Gaps**

i. The results presented are based on preliminary data analysis. Comprehensive data analysis is still ongoing which will unveil more findings of the study.
ii. Energy saving technologies were not Identifeid and their performance indices not determined in L. victoria crescent and Southwestern AEZ.
iii. *R. Communis* seed collection was not done due to mismatch of harvesting seasons and release of funds vis-a-vis annual work plan.
iv. Oil quality and quantity of *Jatropha curcas* was not analysed for biodiesel production
v. J. curcas and R. communis Seeds were not collected from Western and Southwestern AEZ; Oil quality and quantity not yet determined

**5.1 Planned activities/outputs for 2014-15**

| Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 |
|---|---|---|---|
| 3. Efficiency performance indices of biomass energy technologies determined in institutions in Mukono district.<br><br>4. Atleast 50 kg of J. curcas seed collected from eastern AEZ, Oil extracted | 4. Efficiency performance indices of biomass energy technologies determined in agro-based industries in Lake Victoria crescent<br><br>5. Atleast 50 kg of R. communis collected from L. Victoria AEZ, Oil extracted | 1. Efficiency performance indices of biomass energy technologies determined in chemical processing industries in Eastern AEZ<br>2. J. curcas and R. communis Seeds collected from Western and Southwestern AEZ, their oil quality and quantity determined | 4. Efficiency performance indices of biomass energy technologies determined for domestic use acquired for demonstrations.<br><br>5. J. curcas and R. communis Seeds collected from West Nile, their oil quality and quantity determined |
| **Activities** | **Activities** | | **Activities** |
| Surveys in industries and institutions; Water Boiling Test (WBT) and Kitchen performance tests; Collect seed, oil extraction (Automatic Solvent Extraction) | Surveys in industries and institutions; Water Boiling Test (WBT) and Kitchen performance tests; Collect seed, oil extraction (Automatic Solvent Extraction) | Surveys in industries and institutions; Water Boiling Test (WBT) and Kitchen performance tests; Collect seed, oil extraction (Automatic Solvent Extraction) | Surveys in industries and institutions; Water Boiling Test (WBT) and Kitchen performance tests; Collect seed, oil extraction (Automatic Solvent Extraction) |

## 5.2 Budget 2014/15

| Output Target Qtr 1 | Budget Qtr 1 '000 | Output Target Qtr 2 | Budget Qtr 2 '000 | Output Target Qtr 3 | Budget Qtr 3 '000 | Output Target Qtr 4 | Budget Qtr 4 '000 | Source |
|---|---|---|---|---|---|---|---|---|
| Efficiency performance indices of biomass energy technologies determined in institutions in Mukono district. | 8,500 | Efficiency performance indices of biomass energy technologies determined in agro-based industries in Lake Victoria crescent | 11,727 | Efficiency performance indices of biomass energy technologies determined in chemical processing industries in Eastern AEZ | 10,700 | Efficiency performance indices of biomass energy technologies determined for domestic use acquired for demonstrations. | 12,300 | ATAAS |
| Atleast 50 kg of *J. curcas* seed collected from eastern AEZ, Oil extracted | 7,700 | Atleast 50 kg of *R. communis* collected from L. Victoria AEZ, Oil extracted | 8,800 | J. curcas and R. communis Seeds collected from Western and South-western AEZ, their oil quality and quantity determined | 7,700 | J. curcas and R. communis Seeds collected from West Nile, their oil quality and quantity determined | 8,800 | ATAAS |
| | 16,200 | | 20,527 | | 18,400 | | 21,100 | |

## Reference


Bonjean, A., & Le-Ricin. (2002, October 3). CASTOR. Retrieved September 25, 2013, from http://ienica.fera.defra.gov.uk/crops/castor.htm

MEMD. (2009). Ministry of Energy and Mineral Development Annual Report 2008.

Okello, C., Pindozzi, S., Faugno, S. & Boccia, L. (2013). Development of bioenergy technologies in Uganda: A review of progress. Renewable and Sustainable Energy Reviews, 18, 55 – 63.

Okullo, A., Temu, A. K., Ogwok, P., &Ntalikwa, J. W. (2012).Physico-Chemical Properties of Biodiesel from Jatropha and Castor Oils.International Journal of Renewable Energy Research, 2 (1), 49-52.

Okupa, E. (2012). Development in the oil and gas sector in Uganda. The Parliamentarian (1), pp. 32-35.

REA. (2011). Value for money audit report on implementation of rural electrification

Nampewo, N. (2013). Saving Mabira Rainforest: Using Public Interest Litigation in Uganda to Save Mabira and Other Rainforests. *Boston College Environmental Affairs Law Review , 40* (2), 523-553.

## DETERMINATION OF OPTIMUM CARBON SEQUESTRATION CAPACITIES FOR PINES AND EUCALYPTS

**Balitta *et al* (2013-2014)**

### 1.0. Introduction/Background

Global warming is posing increasing threat to mankind, a trend for which solutions remain elusive. Most attempts at addressing this problem seek to mitigate causes of global warming and enable adaptation to climatic changes. Carbon dioxide (CO2), the dominant GHG, represents the standard yardstick for monitoring implementation of CDM and other Kyoto Protocol mechanisms. Sale of CO2 removed or prevented from entering the atmosphere constitutes the emission reduction credits traded in carbon markets. Without new energy sources or technological breakthroughs, prices of carbon are expected to increase over time. Nevertheless, Ugandan small scale farmers will not benefit from this due to excessive financial and technical requirements involved in carbon transactions. Absence of carbon sequestration data for both indigenous and exotic trees of Africa contributes enormously to this problem as it hinders production of mandatory Project Development Documents (PDDs). This study addresses this by providing relative carbon sequestration capacities of major plantation tree species in Uganda.

**1.1 The objectives of this project are**:

1. To document carbon sequestration capacities of the selected plantation tree species at different ages
2. To develop local methodology for estimating baseline and monitoring carbon sequestration
3. To develop local models of PDD for advising farmers to engage in carbon trade

**2.0 Key activities undertaken during 2013-2014**

- Maintained established carbon sequestration trails in Kamuli, Kyamulibwa and Alebtong.
- Carried out survival assessment of pine seedlings planted in Kamuli and Kyamulibwa.
- Measured dbh of pine trees planted at Alebtong and calculated amount of carbon sequestered per hectare.

### 3.0 Methodology

Farmers who were willing to host carbon sequestration trials were selected in two farming systems (coffee- banana, cotton- millet).Farms were selected from different parishes from the study sub-counties. On each farm, one acre was marked out for assessment for above and below ground carbon. For above ground carbon, all trees with Diameter at Breast Height (DBH) more than 5cm were measured and DBH and heights recorded. These measurements were used to determine the amount of carbon dioxide sequestered by the pine trees. The biomass wasfor each of the sampled trees was calculated using the power-law allometric

relationship between biomass and dbh, of the form M = aDbwhere M is the oven-dry weight of the biomass component of a tree (kg), D is the diameter in cm at breast height (dbh, cm) and a and b are parameters (Ter-Mikaelian and Korzukhin 1997 and Chave et al. 2001).

In this study we chose to use Chave's et al. (2001) transformed equation of lnM = α+b ln(D) where α is the natural log of parameter a, which is equal to -2 and b = 2.42 as representatives of the species-specific variants given by Ter-Mikaelian and Korzukhin (1997) and other workers.

Diameters of the trees from each species were entered on a spread sheet and their respective biomasses were calculated. From the biomass data, both solid and gaseous forms of the carbon cycle: the sugars and CO2 respectively for the trees were also calculated at a default value of 45% and 1.65 kg of CO2 per unit of dried tree biomass as used anonymously in the undated document of Environmental Science Activities for 21st Century (ESA21).For converting tree carbons, the atomic mass unit (AMU or amu) value which is 1/12 of the mass of an atom of carbon-12 (C12) was used. Specifically, the calculation ofCO2 was based on the chemical composition of this gas, namely that it has one atom of carbon combining with 2 atoms of oxygen giving a total atomic mass of 12+2(16) = 44. That is each kilogram of dried tree biomass therefore corresponds to [(1 kg of dried tree biomass) x (0.45 kg of carbon per 1 kg of dried tree biomass) x (44 amu of CO2 / 12 amu of C12)] = 1.65 kg of CO2.

**4.0 Outputs/Results**

- The survival percentage for pine seedlings was 58.4% and 3% for Kamuli and Kyamulibwa respectively.
- Beating up was carried out to replace dead seedlings in the respective carbon sequestration trial sites.
- In Alebtong, the amount of carbon sequestered was calculated to be 39,300 kg of carbon dioxide per hectare of pine trees planted at a spacing of 3 m by 3 m. This value will be used in selling carbon in the project design document (PDD).

**5.0 Gaps**

- It has not been possible to determine the additional carbon at Kamuli, Kyamulibwa because the seedlings are young and have not attained dbh of 5 cm and above.
- Pine plantations of ages 5, 10 and 15 years have not been identified in Kamuli, Kyamulibwa and Alebtong for determining carbon sequestration potential of pines.

### 5.1 Quarterly budget breakdown is follows:

| Output target Qtr 1 | Budget (000) | Output Target Qtr 2 | Budget (000) | Output Target Qtr 3 | Budget (000) | Output Target Qtr 4 | Budget (000) |
|---|---|---|---|---|---|---|---|
| Measure above and below ground carbon from pine and eucalypts | 11,000 | Measure above and below ground carbon for at least 1,000 pine trees of 5, | 20,400 | Measure above and below ground carbon for at least 1,000 pine trees of 5, | 23,527 | Measure above and below ground carbon for at least | 21,300 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1,000 trees (1 hectare) of Eucalypts at Kifu assessed for carbon | | 10 and 15 years inAlebtong | | 10 and 15 years in Kamuli | | 1,000 pine trees of 5, 10 and 15 years in Masaka | |

**TREE IMPROVEMENT AND GERMPLASM RESEARCH PROGRAMME**

# DEVELOPMENT OF TOOLS AND OPTIONS FOR PRE-BREEDING OF SHEA NUT TREE (*VITELLARIA PARADOXA*) FOR IMPROVED LIVELIHOODS IN EASTERN AND NORTHERN UGANDA

**Gwali *et al*. (2013-2014)**

## 1.0 Introduction/Background

The shea tree (*Vitellaria paradoxa* subspecies *nilotica*) grows in the savanna parklands of northern and north-eastern Uganda. Subspecies *paradoxa* grows exclusively in West and Central Africa. The nuts of the shea fruit contain abundant oil which is used in cooking (Lamien et al. 1996), for cosmetic and medicinal ointments, as a hair cream, for soap, as an illuminant and even for waterproofing (Abbiw 1990). Uganda's shea oil is the most liquid on the African continent on account of its high oleic acid content (Maranz et al. 2004), an important attribute for the international shea market for the production of cosmetics. Uganda's current production is estimated at only 38,571 metric tons (equivalent to US$ 15 million) and hence it cannot compete on the international market due to insufficient and intermittent supplies caused by poor regeneration.

Propagation by seed is the most commonly used method of producing new plants. However, the seed of *Vitellaria* are very recalcitrant and viability is usually lost within two to three weeks after harvesting (Hall et al., 1996; Maranz & Wiesman, 2003). Seed propagation is also hampered by collection of nuts for human consumption and sale. Moreover, the characteristic long tap root that grows from seedlings makes transplanting difficult. In addition, shea trees raised from seed mature very slowly, bearing their first fruits after 12-25 years and taking 30-50 years to achieve full productivity. Various studies (Hall, et al. 1996; Lovett & Haq, 2000) have recommended continued research on the propagation of shea trees for early fruit production. This project therefore aims at enhancing shea production in Uganda by identification of appropriate propagation techniques that can enhance fruit production and shorter rotation ages.

The objectives of this project are:

4. To identify shea plus trees with high fruit and oil production as sources of planting material.
5. To determine the most suitable shea tree propagation and multiplication techniques.
6. To establish a shea tree seed production and distribution system

## 2.0 Key activities undertaken during 2013-2014

Todetermine the best grafting method for shea butter trees so as to provide germplasm with short rotation to fruiting. This was planned to be done using farmer participatory approaches. A set of farmers who are willing to offer some of their shea butter trees for grafting experiments were therefore identified in Katakwi and Amuria district. In addition, stakeholders in shea nut production, distribution and dissemination were identified using

formal and non-formal methods. Shea nuts were also collected from Amuria and Katakwi district for multiplication and dissemination to farmers in the region.

## 3.0 Methodology

### 3.1 Participatory farmer and farm identification

Farmers who are willing to accept grafting experiments were identified in a participatory manner together with local community leaders. On each farm, wild and naturally growing seedlings were identified for use as rootstocks during grafting. The wildlings were selected on the basis of vigorous growth (ranging between 50 and 150 cm in height with a collar diameter of between 1.5 and 3 cm) and absence of parasites.

### 3.2 Formal surveys

A formal survey was utilized to (i) establish a shea tree seed production and distribution system, (ii) determine the shea nut dissemination pathways for planting materials.For this purpose, a structured questionnaire was administered in sampled households. Data collection for the household survey was done by a team of enumerators, closely supervised by the research team. Local enumerators were preferred for their ability to dialogue with respondents in the local language and likelihood to gain rapport faster. The enumerators were identified with consultation of district natural resource departments. They were then trained, tested and assigned specific study sites. The questionnaires were collected and checked before leaving the field. Data collected included:

(i) Socio-demographics (e.g. household size, sex ratio, age-sex distribution, education, marital status, settlement type etc.);
(ii) Land ownership;
(iii) Shea tree availability and population dynamics;
(iv) Shea nut harvest, storage and distribution

### 3.3 Non-Formal surveys

Non-formal survey techniques included focus group discussions (FGDs) and key informant interviews (KIIs) so as to obtain specialist information on distinguishing characteristics of different local varieties of shea tree in the shea butter tree zones of Uganda. Non-formal survey approaches were preferred in this instance due to the need for explanatory depth and focused analysis.

## 4.0 Outputs/Results

A total of 384 wildlings were identified on 6 farms in Katakwi (Omodoi and Angerepo villages) and Amuria (Akamurei village) districts of Teso farming system. In addition, seven (7) farmers (key informants) from the two aforementioned districts were consulted on shea tree dissemination. 100 farmers were interviewed in Katakwi and Amuria while 6 stakeholder groups (farmers, traders, laborers, formally employed, transporters and students) were identified to be involved in the production and dissemination system of shea tree seed system. Two (2) field trials have so been established in Bukedea and Mukongoro in eastern Uganda. However, one site has been destroyed by grazers and work is under way to rehabilitate and fence off the trial. 3862 shea seeds (approx. 200kg of fresh shea fruits) were collected from Teso farming system and have been germinated under nursery conditions at Kifu for rehabilitation of the ravaged trials.

## 5.0 Gaps

It has not yet been possible to conduct grafting experiments. This will be possible after signing memoranda of understanding between NaFORRI and the farmers on whose land the experiments will be established. During the next year, grafting experiments will be established and the multiplication and dissemination of shea nuts will be undertaken.

## 6.0 Planned activities/outputs for 2014-15

| Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 |
|---|---|---|---|
| 5. 50 shea trees from Teso farming system assessed for morphological traits.<br>6. 10 grafted shea plants from Teso developed for each method (side cleft, top cleft, tongue, chip budding and side veneer grafting); Survival and growth rates for grafted plantlets determined<br>7. Shea tree seed production and distribution system determined for Teso farming system | 6. 50 shea trees from Lango farming system assessed for morphological traits.<br>7. 10 grafted shea plants from Teso developed for each method (side cleft, top cleft, tongue, chip budding and side veneer grafting); Survival and growth rates for grafted plantlets determined<br>8. Shea tree seed production and distribution system determined for Lango farming system | 3. 10 grafted plants from Lango developed for each method (side cleft, top cleft, tongue, chip budding and side veneer grafting); Survival and growth rates for grafted plantlets determined<br>4. Shea tree seed (dissemination) system determined for Teso farming system | 6. 10 grafted plants from Lango developed for each method (side cleft, top cleft, tongue, chip budding and side veneer grafting); Survival and growth rates for grafted plantlets determined<br>7. Shea tree seed (dissemination) system determined for Lango farming system |
| Activities.<br>9. Field sampling and measurement of shea trees for biophysical characteristics<br>10. Grafting<br>11. Survival and growth measurements<br>12. Maintenance of grafted plants<br>13. Prepare reports. | Activities.<br>6. Field sampling and measurement of shea trees for biophysical characteristics<br>7. Grafting<br>8. Survival and growth measurements<br>9. Maintenance of grafted plants<br>10. Focus group discussions<br>11. Key Informant Interviews<br>12. Household Interviews<br>13. Prepare reports. | Activities.<br>8. Grafting<br>9. Survival and growth measurements<br>10. Maintenance of grafted plants<br>11. Prepare reports. | Activities.<br>3. Grafting<br>4. Survival and growth measurements<br>5. Maintenance of grafted plants<br>6. Prepare reports. |

## 7.0 Budget: 2014/15

The total budget breakdown on a quarterly basis is shown below:

| Output target Qtr 1 | Budget (000) | Output Target Qtr 2 | Budget (000) | Output Target Qtr 3 | Budget (000) | Output Target Qtr 4 | Budget (000) |
|---|---|---|---|---|---|---|---|
| 50 shea trees from Teso farming system assessed for morphological traits. | 4,433 | 50 shea trees from Lango farming system assessed for morphological traits. | 5,707 | | | | |
| 10 grafted shea plants from Teso developed for each method (side cleft, top cleft, tongue, chip budding and side veneer grafting); Survival and growth rates for grafted plantlets determined | 10,586 | 10 grafted shea plants from Teso developed for each method (side cleft, top cleft, tongue, chip budding and side veneer grafting); Survival and growth rates for grafted plantlets determined | 10,340 | 10 grafted plants from Lango developed for each method (side cleft, top cleft, tongue, chip budding and side veneer grafting); Survival and growth rates for grafted plantlets determined | 10,433 | 10 grafted plants from Lango developed for each method (side cleft, top cleft, tongue, chip budding and side veneer grafting); Survival and growth rates for grafted plantlets determined | 10,856 |
| Shea tree seed production and distribution system determined for Teso farming system | 5,828 | Shea tree seed production and distribution system determined for Lango farming system | 5,700 | Shea tree seed (dissemination) system determined for Teso farming system | 5,895 | Shea tree seed (dissemination) system determined for Lango farming system | 5,687 |
| ***Total*** | ***20,847*** | | ***21,747*** | | ***16,328*** | | ***16,543*** |

## 8.0 References

Abbiw DK (1990) Useful plants of Ghana: West African uses of wild and cultivated plants. Intermediate Technology Publications Ltd, London, UK

Hall J.B., Aebischer D.P., Tomlinson H.F., Osei – Amaning E. & Hindle J.R. (1996). Vitellaria paradoxa: A monograph. School of Agricultural and Forest Sciences, University of Wales, Bangor.

Lamien N, Sidibé A, Bayala J (1996) Use and commercialization of non-timber forest products in western Burkina Faso. In. Non-wood Forest Products. FAO, Rome, Italy, pp 51-64

Lovett, P.N. and Haq, N. (2000) Diversity of the Sheanut tree (Vitellaria paradoxa C.F. Gaertn.) in Ghana. Genetic Resources and Crop Evolution, 47, (3), 293-304.

Maranz S., Wiesman Z. (2003). Evidence for indigenous selection and distribution of the shea tree (Vitellaria paradoxa), and its potential significance to prevailing parkland savanna tree patterns in sub-Saharan Africa north of the equator. Journal of Biogeography 30 (10): 1505-1516.

Maranz S, Wiesman Z, Bisgaard J, Bianchi G. (2004). Germplasm resources of Vitellaria based on variation in fat composition across the species distribution range. Agroforestry Systems 60: 71-76.

## DOMESTICATION AND PROPAGATION OF PRIORITY PLANT SPECIES FOR IMPROVED HEALTH, NUTRITION AND INCOMES

**Abigaba *et al* (2013-2014)**

### 1.0 Introduction/Background

Although Uganda is richly endowed with biodiversity, this has not been fully harnessed for poverty alleviation. A number of these resources are being lost due to overexploitation, habitat loss and climate change among others. Uganda has lost approximately 50% of its original forests vegetation cover including virtually all its primary forests and the loss continues at an alarming rate of 2.0% per annum (FAO, 2003). The loss of natural vegetation inevitably leads to loss of their component species, some being lost completely, and corresponding loss of their potential benefits. The total conservation of all species is an impossible task, given the ever-increasing need for food and space necessitated by human population explosion.

Whereas a number of wild food, medicinal and high value plants are known in Uganda, their promotion and marketing have been hampered by inadequate knowledge of their precise chemical composition (for food plants), active ingredients (for medicinal) and physical and chemical properties (for high value plants). These plant species are limited and scattered in their distribution, and are therefore not suitable for commercial exploitation and market sustenance (all wild plants). Measures need to be taken to domesticate them and promote their planting, utilization and marketing to ensure they contribute towards poverty reduction and improved livelihoods.

This project therefore seeks to prioritize, in collaboration with the users, the key species for food (including food additives), medicine and high value commercial products such as essential oils, natural dyes, quality wood etc that can make a difference towards improved health, food security and livelihoods for Ugandans. The priority species will then be improved

(through propagation) for domestication and promotion. The overall project aim is to promote conservation and use of priority plant species for health, nutrition and income.

The specific objectives of this project are:

1). To document the priority wild plants for food, medicine and high value products found in Uganda
2). To document their ecology and distribution in the country
3). To determine the chemical composition of the harvested plant parts
4). To design strategies for their conservation and sustainable use
5). To determine their appropriate harvesting and processing methods

**2.0 Key activities undertaken during 2013-2014**

3 types of cuttings (soft, semi-hardwood and hardwood) of *Xanthoxylum* and *Carissa* were obtained from Budongo Forest Reseve and Nakasongola savanna ecosystem respectively and propagated under non-misting conditions in a 45x3x4 expt design at Kifu. The rooting hormone (IBA) of 0.2, 0.6. 0.8 was applied to the cuttings before placing them in the propagation tunnels. 8kg of *Prunus africana* seed was collected and 50000 seedlings of Prunus raised in the Nursery at Kifu of which an on-station trial of 1hactare was planted with 11100 seedlings at Kifu and 7000 seedlings of *Prunus africana* were given to farners in Nakisunga and Nagojje sub-counties in Mukono district for ex- situ conservation. Consultative Workshop on harvesting methods of 10 medicinal plants in Central region of Uganda was held at Kifu. 1000 copies of Prunus, Warbugia and Melia bochures produced for dissemination to stakeholders at various foras. A presentation of the project's progress for two years was made during the NARO' bi-annual review and planning workshop at Collin Hotel, Mukono.

**3.0 Outputs**

i). 2 Experimental trials of 540 cuttings of *Xanthoxylum* and *Carissa* each set up at Kifu
ii). 15000 seedlings of Prunus raised in the Nursery at Kifu for ex-situ conservation
iii). I Ex-situ conservation trial equivalent to 1 hactare of Prunus africana established at Kifu
iv). 7000 seedlings of Prunus africana given to farmers in Nakisunga and Nagojje sub-counties in Mukono district for ex- situ conservation
v). Appropriate harvesting methods for 10 medicinal species (***Warburgia ugandensis, Zanthoxylum chalybeum, Prunus africana, Spathodea campanulata, Erythrina abyssinica, Securinega virosa, Kigelia africana, Albizia coriaria*** **and** ***Mimusops bagshawei*****)** recommended during a consultative Workshop on harvesting methods of medicinal plants in Central region of Uganda held at Kifu
vi). 1000 copies of Prunus, Warbugia and Melia bochures produced for dissemination

**4.0 Gaps**

Cutting propagation of *Xanthoxylum chalybeum* and *Carissa edulis*; Identification of harvesting and processing techniques of the 10 priority plants of Eastern, Western and Northern AEZs; Sensitiing and training farmers on appropriate harvesting methods of medicinal plants in lake Victoria AEZ, Management protocols for 7 on-station demo plots (*Psidium guajava, Mangifera indica, Malus domestica, Persea americana, Markhamia lutea,*

*Melia volkensii, Warburgia ugandensis* and *Prunus africana*). Training farmers and students on on-farm techniques of growing high value plants.

**5.0 Planned activities/outputs for 2013-14**

| Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 |
|---|---|---|---|
| A randomised complete block experiment for propagation of *Xanthoxylum chalybeum* on-station (Kifu); Harvesting and processing techniques of 10 priority plants of the L Victoria crescent AEZ determined; Management protocols for 7 on-station demo plots (*Psidium guajava, Mangifera indica, Malus domestica, Persea americana, Markhamia lutea, Melia volkensii, Warburgia ugandensis* and *Prunus africana*) identified; 25 farmers and 100 students trained in on-farm techniques of growing high value plants | Appropriate propagation techniques for *Xanthoxylum chalybeum* identified; Harvesting and processing techniques of 10 priority plants of the Eastern AEZ determined; Management protocols for 7 on-station demo plots (*Psidium guajava, Mangifera indica, Malus domestica, Persea americana, Markhamia lutea, Melia volkensii, Warburgia ugandensis* and *Prunus africana*) identified; 25 farmers and 100 students trained in on-farm techniques of growing high value plants | A randomised complete block experiment for propagation of *Carissa edulis* established on-station (Kifu); Harvesting and processing techniques of 10 priority plants of the Western AEZ determined; Management protocols for 7 on-station demo plots (*Psidium guajava, Mangifera indica, Malus domestica, Persea americana, Markhamia lutea, Melia volkensii, Warburgia ugandensis* and *Prunus africana*) identified; 25 farmers and 100 students trained in on-farm techniques of growing high value plants | Appropriate propagation techniques for *Carissa edulis* identified; Harvesting and processing techniques of 10 priority plants of the Northern AEZ determined; Management protocols for 7 on-station demo plots (*Psidium guajava, Mangifera indica, Malus domestica, Persea americana, Markhamia lutea, Melia volkensii, Warburgia ugandensis* and *Prunus africana*) identified; 25 farmers and 100 students trained in on-farm techniques of growing high value plants |
| Activities.<br>1. Procurement of materials, tools and equipment<br>2. Collection of stem/root cuttings; Propagation experiments for *Xanthoxylum chalybeu;*<br>3. Focus group discussions; Key Informant Interviews; Silvicultural treatments;<br>4. Training and demonstrations to farmers, school children, students and other stakeholders | Activities.<br>1. Procurement of materials, tools and equipment<br>2. Propagation experiment of *Xanthoxylum chalybeu* investigated and monitored<br>3. Investigation of harvesting and processing of medicinal species techniques eastern AEZ<br>4. Training and demonstrations to farmers, school children, students and other stakeholders<br>5. Prepare reports. | Activities.<br>1. Procurement of materials, tools and equipment<br>2. Collection of stem/root cuttings; Propagation experiments for *Carissa edulis*<br>3. Investigation of harvesting and processing of medicinal species techniques western<br>4. Training and demonstrations to farmers, school children, students and other stakeholders<br>5. Prepare reports. | Activities.<br>1. Procurement of materials, tools and equipment<br>2. Propagation experiment of *Carissa edulis* investigated and monitored<br>3. Investigation of harvesting of medicinal species techniques in the Northern<br>4. Training and demonstrations to farmers, school children, students and other stakeholders<br>5. Prepare reports. |

**5.0 Budget: 2014/15**

The total budget breakdown for the next year on a quarterly basis is shown below:

| Output target Qtr 1 | Budget (000) | Output Target Qtr 2 | Budget (000) | Output Target Qtr 3 | Budget (000) | Output Target Qtr 4 | Budget (000) |
|---|---|---|---|---|---|---|---|
| Randomised complete block experiment for propagation of *Xanthoxylum chalybeum* established on-station (Kifu) | 6,270 | Appropriate propagation techniques for *Xanthoxylum chalybeum* identified | 6,242 | Randomised complete block experiment for propagation of *Carissa edulis* established on-station (Kifu) | 6,919 | Appropriate propagation techniques for *Carissa edulis* identified | 6,592 |
| Harvesting and processing techniques of 10 priority plants of the L Victoria crescent AEZ determined | 11,916 | Harvesting and processing techniques of 10 priority plants of the eastern AEZ determined | 12,150 | Harvesting and processing techniques of 10 priority plants of the western AEZ determined | 13,262 | Harvesting and processing techniques of 10 priority plants of the northern AEZ determined | 13,638 |
| 7 on-station demonstration plots (*Psidium guajava, Mangifera indica, Malus domestica, Persea americana, Markhamia lutea, Melia volkensii, Warburgia ugandensis* and *Prunus africana*) managed and maintained | 4,126 | 7 on-station expt. plots (*Psidium guajava, Mangifera indica, Malus domestica, Persea americana, Markhamia lutea, Melia volkensii, Warburgia ugandensis* and *Prunus africana*) managed and maintained | 4,126 | 7 on-station expt. plots (*Psidium guajava, Mangifera indica, Malus domestica, Persea americana, Markhamia lutea, Melia volkensii, Warburgia ugandensis* and *Prunus africana*) managed and maintained | 4,126 | 7 on-station expt. plots (*Psidium guajava, Mangifera indica, Malus domestica, Persea americana, Markhamia lutea, Melia volkensii, Warburgia ugandensis* and *Prunus africana*) managed and maintained | 4,126 |
| 25 farmers and 100 students taught in on-farm | 4,584 | 25 farmers and 100 students taught in on-farm | 4,584 | 25 farmers and 100 students taught in on-farm techniques of | 4,584 | 25 farmers and 100 students taught in on-farm | 4,584 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| techniques of growing high value plants | | techniques of growing medicinal plants | | growing medicinal plants | | techniques of growing medicinal plants | |
| **Total** | **26,896** | | **27,102** | | **28,891** | | **28,940** |

## 6.0 References

FAO (2003). Global Forest Resources Assessment and the State of the World's Forests. UN FAO, Rome, Italy