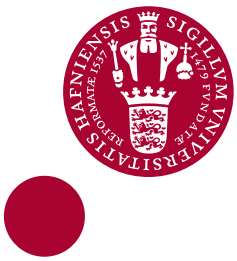

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the ICRAF/Danida Programme on Improved Seed Systems for Agroforestry in African Countries (ISSAAC)

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Forest & Landscape Working Papers no. 2-2004

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TRANSFORMING LIVES AND LANDSCAPES

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Terraced, heavily cultivated hills are the trademark of the district of Kabale

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Preface

This report has been prepared by Danida Forest Seed Centre (*Forest & Landscape, Denmark*) in co-operation with the World Agroforestry Centre (ICRAF) and Uganda Tree Seed Centre (UgTSC). The work was initiated by Danida Forest Seed Centre.

On the 1st January 2004, Danida Forest Seed Centre (DFSC) became part of *Forest & Landscape Denmark* (F&L) under the Royal Veterinary and Agricultural University of Denmark (KVL). The work program in relation to developing countries is mostly financed, as previously, through contributions from Danida. These activities are placed in the Departments for Management of Forest Genetic Resources, and Economics, Policy and Operational Planning.

Improved Tree Seed Production and Supply Systems for Agroforestry in African Countries (ISSAAC) is a Danida funded project hosted by ICRAF. It develops strategies and procedures to match agroforestry tree seed supply demands in Burkina Faso, Malawi and Uganda. The ISSAAC project runs from 2001-2010.

The present ISSAC-survey reported here is one of several national surveys designed to explore, benchmark and analyse the present tree seed supply situation in the three countries.

This **diagnostic survey on tree seed supply** from Kabale district in South West Uganda was carried out as the initial survey for ISSAAC in year 2002. The report entails methods, findings, discussions and recommendations from the survey. It aims at illustrating tree seed distribution and disbursement as it exists in this part of Uganda. Further, it identifies farmers' preferences and problems. Together with other regional surveys on basic tree seed information and flows the findings are eventually to be used to design test-projects for improved seed production and distribution systems.

ISSAAC

ISSAAC's objectives are to develop stronger and better seed systems that will enable small-scale land users to capture the benefits of utilising agroforestry systems for increased food security and increased income from sale of products produced on farm. Other organisations and institutions in Africa also develop technologies to improve the livelihoods of small-scale land users. A major bottleneck for dissemination and appliance of these technologies is lack of seed and other reproductive material. The traditional providers of reproductive material of trees and shrubs in Africa are not developed for decentralised production and supply that can meet the potential demand from millions of farmers. Many organisations and institutions are presently trying to fill this seed gap.

The situation for tree seed can be compared to the agricultural seed systems in Africa, where the seed demand-supply relationship in many smallholder-farming systems does not function well. However, while commericial crop seed systems are being tried out by a multitude of NGOs, donor projects and CGIAR centres, free tree seed and seedlings are still being handed out by numerous institutions, projects and NGOs in most of Africa.

Successful development of decentralised tree seed systems will depend on a thorough understanding not only of technical aspects of seed production and handling, but also institutional, organisational, social and economic dimensions of development of rural producer organisations and information networks.

ISSAAC is based at ICRAF, Kenya, and operates in Burkina Faso, Malawi and Uganda, the countries which have been chosen to represent the three regions of Sahel, Southern and Eastern Africa, respectively. ISSAAC has a secretariat with a seed supply specialist based in Nairobi and who works closely with a national counterpart in each country. The present project period ceases end of year 2005.

Acknowledgement

The authors of this report are grateful to the many organisations in Kabale district for their contributions. Special thanks go to Dr. Braimah and the entire Africare team for their support to the survey team. Many thanks to Dr. Jean-Mac Boffa of ICRAF-Uganda for his support in establishing contacts and advisory contributions to the survey.

Sincere thanks go to David Siriri, Levand Turyomurugyendo, Rhona Ayesiga, Beatrice Nabwire, Charles Byarugaba and the entire staff at the ICRAF/AFRENA office in Kabale for their help during the fieldwork. Special thanks to Mr. Kisu-Kisira, Seed Procurement Officer at Uganda National Tree Seed Centre for participating and contributing throughout the survey, and to Rebecca Ashley of the Yale School of Forestry and Environmental Studies for constructive contributions during fieldwork.

Lastly acknowledgements go to Lartey Lawson of the Danish Institute of Food Economics (KVL) and Anders Ræbild (F&L), for analysing field data and to Diane Russell and Jens-Peter Lillesoe, ICRAF, and Kirsten Thomsen, (DFSC), for their detailed comments on the report.

Acronyms

AFRENA	Agroforestry Research Networks for Africa
AHI	Africa Highlands Initiative
AICM	African International Christian Ministry
CBO	Community Based Organisations
DECP	Domestic Energy Conservation Project
DFSC	Danida Forest Seed Centre
DTC	Development through Conservation
FAO	Food and Agriculture Organisation
FIP	Farmer Initiative Project
F&L	Forest and Landscape Denmark
ICRAF	World Agroforestry Centre
ISSAAC	Improved Seeds Supply for Agroforestry in African Countries
KVL	Royal Veterinary- and Agricultural University of Denmark
NE	Northeastern
NGO	Non Governmental Organisation
M.a.s.l	Meters above see level
MBIFCT	Mgahinga Bwindi Impenetrable Forest Conservation Trust
NARO	National Agricultural Research Organisation
NEMA	National Environmental Management Authority
NRM	Natural Resource Management
PD	Planning and Development
TWAN	Two Wing Agroforestry Network
SW	Southwestern
UgTSC	Uganda Tree Seed Centre

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Executive summary

A survey was conducted as a means to provide information about tree seed pathways in Kabale, SW-Uganda. Steep slopes, a dense human population, and continuous intensive cropping have rendered the area vulnerable to soil degradation.

Kabale District was chosen due to the presence of numerous non-governmental organisations (NGOs), community-based organisations (CBOs), and other public and private institutions dealing and handling tree seed as part of their agroforestry activities.

16 *organisations*, 32 nurseries, and 121 farmers constitute the samples captured. The survey gathers information on tree seed supply as it happens in the area. Information on species, seed volume, suppliers, receivers at present is documented, as are bottlenecks, strengths and weaknesses in the present supply and demand chain. Ways to improve supply systems are suggested. The relevance of empowering farmers to initiate tree seed production in order to complement delivery services offered by *organisations* dealing with natural resource management in the area is also discussed.

Specific objectives

1. Identify organisations and institutions working with natural resource management and determine their role in tree seed distribution
2. Determine nurseries' seed/seedling distribution and priorities
3. Identify farmers' needs and priorities in terms of tree seeds/seedlings
4. Use information gathered to make recommendations

The method used was visits and interviews of *organisations*, governmental institutions, tree nurseries, and farmers.

Main findings

The main findings made during the survey include:

1. Tree seed is in general insufficient in supply because of the lack of tree seed sources to collect from.
2. *Organisations* (NGOs and CBOs) supply the greater share of tree seed to farmers and nurseries and it is free of charge.
3. Nurseries and farmers also collect their own seed or acquire from neighbours, governmental institutions, or local markets to supplement quantities received from *organisations.*
4. Poor seed market development due to free seed supplies from NGOs and CBOs.
5. Group nurseries rely mostly on seed from NGOs and CBOs.
6. Private and individual nurseries rely on NGOs and CBOs but also on own collections, sharing, and selling of seed.

7. *Organisations* do not provide enough technical information on seed collection and handling
8. Farmers who collect own seed also share with others.
9. Farmers who receive seed from NGOs and CBOs tend not to share with others.
10. Seedling disbursement by group nurseries cover only small areas compared to other types of nurseries.

Seed availability is impeded by lack of sources to collect from. O*rganisations* that are engaged in tree related activities deliver tree seeds freely to farmers and nurseries. The supply is limited and is dependent on life span of projects and the kind of agroforestry technology being promoted. The seed users, e.g. nurseries and farmers, depend on alternative supplies from neighbours and governmental institutions. Seed purchase is a rare option. Markets for tree seed have not developed as farmers and nurseries have the attitude that tree seed is a free or public good.

Effective, reliable and consistent tree seed supply eventually rely on the capacity of farmers. Strengthening these will ease production of tree seeds, and expedite and strengthen the whole tree seed supply. In other words, ensure total complimentarity between formal and local seed systems.

1. Introduction

Improved Seed Systems for Agroforestry in African Countries (ISSAAC) is a programme jointly supported by Danida and World Agroforestry Centre (ICRAF) and implemented by Forest and Landscape Denmark (formerly DFSC) and ICRAF. It is a programme that was initiated as a response to increasing demand for tree seed by low input farmers and other tree growers – despite the presence of national tree seed centres. DFSC became a natural strategic partner to ICRAF in this programme due to its established international track record in the design and management of integrated tree seed programmes and a strong commitment to conservation and greater diversity through use.

ISSAAC's objective is to improve tree seed supplies in three countries namely Uganda, Malawi and Burkina Faso. One of its challenges is how to create a sound institutional and organisational environment necessary for the production and distribution of tree seed for agroforestry on a large scale to satisfy the needs and priorities of small-scale farmers.

In order to realise the objective of this programme it was necessary to develop a good source of information in selected regions of the countries involved as a guiding tool for the overall implementation of the programme. In line with this a diagnostic survey[1] was proposed. This study was aimed at creating a holistic picture of seed distribution and disbursement in selected regions of the countries involved, through getting regional overviews of relevant information and utilise the findings to propose further projects for improved seed production and distribution systems.

The work presented here is solely on Uganda. It presents findings, discussions, and recommendations made during the survey. Kabale District was chosen to represent the south-western region of the country because of the presence of a relatively high number of non-governmental organisations (NGOs), community-based organisations (CBOs) and other public and private institutions. These organisations work with tree seed supply in an effort to promote agroforestry technologies in an area vulnerable to soil degradation due to steep slopes coupled with high rate of soil erosion, high population density and intensive cropping.

1.1 Work on seed

Seed availability remains a crucial factor in the effort to ensure food security in Africa. This statement covers both crop seed and tree seed. However, a great deal of work has been devoted to ensure agricultural seed supply to farmers in Africa. For instance, Soniia David (1996) reviews experiences in bean research on dissemination and adoption of new technology. In her study, local crop seed systems were investigated in Rwanda, Burundi, Zaire and in Uganda. She concluded that market demand and purchasing power are limiting factors for the adoption of new bean cultivars in eastern Africa and that most farmers want a variety that they can eat and sell.

[1] *Diagnostic survey in this context is a survey to describe tree seed supply systems and identify farmer preferences and problems.*

Robert Tripp (1997) in an attempt to review experiences gained in the organisation of small-scale seed provision, provides guidelines for analysing the potential of various seed supply options with emphasis on crop seed. He contends that the varied nature of seed demand has a strong bearing on the choice of seed provision strategy.

Elizabeth Cromwell (1996) analyses the seed sector in Africa and explains how relations between governments, farmers and seed affect agricultural performance and suggests how access to appropriate seed supply to farmers might be organised in the future. Almekinders and Louwaars (1999) also provide a range of issues in connection with local seed supply systems and technical information on seed production, storage and distribution useful to farmers, extension agents, *etc.* The research on seed supply systems for crops is expanding and much of this experience will be highly relevant to the development of new seed supply systems for agroforestry seed to farmers.

Recent trends indicate an increase in tree planting on farmland by smallholder farmers (Simmon, 1997). It is therefore not unexpected that in its strategic plan for 2001-2010, the World Agroforestry Centre (ICRAF) identified the importance of tree seed supply as one of the challenges to be addressed. That is, if the Centre's dual goal of reaching 80 million rural poor and improving the global environment is to be realised (ICRAF, 2000).

1.2 Objective

The overall objective of the survey is to gather information to improve tree seed supply.

In order to ensure efficient seed supply certain questions arise:

- are farmers getting adequate tree seed of their choice to satisfy demands?
- do farmers need or want better skills when dealing with tree planting?
- are farmers willing to procure tree seed the way they do with crop seed?
- are organisations dealing with tree seed providing sufficient seed for their target groups?
- are organisations dealing with tree seed providing information to encourage seed production?
- are there enough tree seed sources to meet the demand?

The objectives assume that sustainable tree seed procurement and distribution can be stimulated, improved and maintained only if fundamental activities of prime stakeholders (i.e., farmers, agricultural associations, NGOs, CBOs and seed dealers) are properly investigated and documented.

The specific objectives of the survey are to:

- identify and conduct surveys on organisations and institutions working with natural resource management and determine their role in tree seed distribution

- identify and interview staff of tree nurseries to determine their seed/seedling distribution and priorities
- identify and determine farmers' needs and priorities in terms of tree seed/seedlings, and
- use information gathered to make recommendation for ISSAAC pilot programmes

The aim of the study was to find the pathways of tree seed production and distribution both through formal and informal channels and to identify bottlenecks encountered in the process of establishing or facilitating reliable and effective seed supply systems.

2. Geographic description of survey area and land use

2.1 Survey area

Kabale district is in SW-Uganda. Its steep slopes coupled with dense human population and intensive farming render parts of the area vulnerable to soil degradation. It covers an area of approximately 2000 km^2 and is located about 400 km from the capital Kampala (see appendix 2). It lies approximately between latitudes *1°*S and *1°30'*S, and longitudes *29° 18'*E. It is mountainous with steep slopes (5° to 40°) and altitudes ranging from 1220 to 2500 m.a.s.l. (Rwabwoogo, 1997). The area is characterised by a temperate climate with mean minimum and maximum temperatures ranging between 10° and 23°C respectively. The original vegetation type is classified as *moist mountain forest* (Langdale and Brown, 1962).

The mean annual rainfall is 1000 mm and it is bimodal – first rains are from March to June and the second rains from September to December with gentle and evenly distributed precipitation (Carswell, 2002; Kabale district Department of Meteorology, 1997).

Topographically the area is characterised by undulating hills with steep slopes adjacent to valley bottoms, which were once papyrus swamps. Over the decades most swamps have been reclaimed for cultivation and pasture (Carswell, 2002). A greater proportion of the soils is acid loam with generally good nutrient supply, hence productivity is medium to high despite its high erosion potential due to the long slopes (Wortmann and Eledu, 1999 *cf.* Survey on technologies for intensification in SW Uganda, 2001).

According to Bamwerinde (1996) only a few moist mountain forests remain outside the gazetted reserves such as Echuya and Bwindi Forest Reserves due to intensive human activities. Dense forest occupies not more than 40,000 ha and open woodland is less than 10% of Kabale. The rest of the land is intensely cultivated with few scattered woodlots of planted *Eucalyptus saligna* and naturally regenerating *Acacia mearnsii* (black wattle). However, hillsides are mainly barren (Bamwerinde, 1996).

The population is projected to be 629,400 with a density of 246 persons per km^2. There is an annual population growth rate of over 2.2% (District population and housing census, 2000; Rwabwoogo, 1997; Ministry of Finance, Planning and Economic Development 1992). The population density is among the highest in Africa according to Lindblade *et al* (1998). The district is divided into four counties. Each county is divided into sub-counties, which are then divided into parishes. A parish may consist of several villages.

High population density, intensive cropping coupled with the steep terrain of the area result in excessive soil erosion even though the steep slopes were once intensively terraced due to the strict enforcement of colonial by-laws. Negative human

activities such as breaking up existing terraces to provide fertile soils for lands at the lower parts of the terraces, continuous cropping and poor soil management regimes have triggered a situation of land degradation and impoverished soil fertility (Turyomurugyendo, 2001).

2.2 Land use in the area

2.2.1 Farming system

Land holdings in the area are under household control and the average farm size is between 1-2 hectares with half of the permanent plots purchased and the other half inherited. Households have 8-10 scattered plots throughout the landscape. Men own rights to land, though there are cases of some women buying land (Survey on Technologies for Intensification in SW Uganda, 2001).

Land fragmentation is a characteristic feature in the area and as such, a feature that has been linked to abandonment of land. Most of the farm plots are small; this is a disincentive for mixed farming or integrated crop-organic input system since farmers prefer not to decrease land area under priority crops (Bamwerinde and Place, 2000 *cf.* Survey on Technologies for Intensification in SW Uganda, 2001).

The main farming system in the area involves planting annual food crops. Mixed cropping is practised to a large extent as a way of maximising the average cropping area. Inter-cropping with sorghum and climbing beans are common with anti erosion bounds along contour lines on steep slopes (Lillesø and Kaumi, 1993). Food crops grown include banana, beans and sorghum with banana as the main crop while Irish potato serves as the main cash crop. Table 1 below gives a representation of crops grown in the area.

Table 1: Composition of major food crops in Kabale-Rukungiri districts

Food crop	Area/ha	% of crop land	% of total area
Banana	31793	28.5	19,8
Beans	20231	18.1	12.6
Maize	19268	17.3	12.0
Sweet potatoes	13104	11.7	8.2
Finger millet	8080	7.2	5.0
Sorghum	10362	9.3	6.4
Irish potatoes	5933	5.3	3.7
Cassava	2328	2.1	1.4
Groundnuts	468	0.4	0.3
Crop land	111567	100	
Total area	**160700**	**69.4**	**69.4**

Adopted and modified from Wortmann and Eledu (1999) in: Survey on technologies for intensification in SW Uganda, 2001

2.2.2 Trees in the farming system

Trees are mostly found around homesteads and in small household woodlots and are not generally found in fields. A recent study by Turyomurugyendo (2001) shows that farmers prefer tree-growing on plots situated in the mid- and lower hills of slopes. These plots have low fertility levels due to their steep gradient and excessive rates of soil erosion and are used for trees that do not thrive well under continuous cropping.

Common tree species found in the landscape include *Markhamia platycalyx, Erythrina abyssinica, Ficus natalensis* and *Acanthus acanthae*. These are used as firewood, boundary markers and are commonly mixed with crops. *Cupressus* and *Pinus* spp in the farming system are used for shade in some compounds and eventually timber. *Calliandra calothyrsus, Grevillea robusta* and *Alnus acuminata* are becoming very popular species for soil erosion control, fodder, firewood, poles and stakes for climbing beans (Bamwerinde, 1996).

Some large but heavily degraded plantations of *Cupressus* and *Pinus* species exist in these highlands. These are Mafuga 27 km^2, Muko 1.7 km^2 and Kirima 10 km^2. The remaining natural forests are Echuya Bamboo Forest (34 km^2), Bwindi Forest (300 km^2) and Mgahinga Forest (24 km^2) ((Bamwerinde, 1996).

2.2.3 Agroforestry in Kabale

Agroforestry has been part of the farming system in Kabale for many decades. According to Carswell (2001), evidence from colonial archives indicate that woodlots of *Acacia mearnsii* (black wattle) were planted on hill-tops, along the roads and around homesteads and as a result formed a distinctive feature in the landscape in the 1930s and 1940s. These woodlots, which also included *Eucalyptus* plantations provided wood for poles, timber and firewood for family needs and cash earnings (AFRENA, 1988b).

Deliberate integration of trees with crop production was not common before the introduction of modern agroforestry technologies in 1988 by ICRAF/AFRENA. However, a later appraisal in Bubaale (a sub-county in Kabale) showed only modest use of trees in farming systems except for scattered woodlots on marginal lands and boundary plantings of *Eucalyptus spp* and black wattle (Miiro *et al*., 1998).

A relatively large number of development agencies including ICRAF/AFRENA are trying to promote agroforestry technologies. These technologies include: stakes for climbing beans, support for banana stems, trellis systems for passion fruits and vanilla, firewood for food and curing tea, fodder banks for livestock production and hedgerow planting of leguminous trees and shrubs for soil conservation and fertility. There is also promotion of fruit trees for nutrition and income generation and soft and hardwood timber for construction and income (ICRAF/AFRENA, 2002).

The main aim of most of these agencies has been to increase the tree cover in the area and help conserve soil to mitigate the threat of food insecurity in the area. The adoptions have been very encouraging and as a result many agencies have been stretched to their limits in terms of resources.

According to Lindblade *et al* (1998) tree cover has doubled from 1945 to 1996 (from 4.1% in 1945 to 9.2% in 1996) with a reversal in the relative abundance of species. *Acacia mearnsii*, which dominated the landscape in the 1940s, has now been overtaken by *Eucalyptus spp*.

3. Methodology

3.1 Introduction

The fieldwork was conducted in the dry season between June and July 2002. Work was carried out in three locations of the area in three of the four counties in the district. These were NE-parts of Rubanda County - including parishes around the Bwindi National Park, and the eastern and southern counties of Rukiga and Ndorwa, respectively.

The survey consisted of informal as well as formal surveys. Informal surveys included verbal discussions and interviews using interview guides and direct observations for findings on the tree seed supply systems (Franzel *et al.*, 1986). Formal surveys involved interviewing randomly chosen respondents using written questionnaire in order to generate quantitative information based on actual circumstances (Byerlee and Collinson, 1980).

The aim is to create a picture of tree seed/seedlings supply (and demand) in Kabale and not to survey technical seed aspects or socio-economics of seed. Only a description of the perceptions and insights into tree seeds/seedlings supply system is given.

Through conducted interviews the results present information on how many farmers access tree seed and how they obtain it. The report questions outsider and institutional approaches to seed dissemination. It highlights the need and importance of prioritising farmers' knowledge, skills, practices and perceptions in future studies.

3.2 Data collection

The target groups for the diagnostic survey were *organisations*, tree nurseries and farmers. Organisations identified for the survey comprised research institutions, public institutions, CBOs and NGOs working with tree seed and agroforestry in the Kabale District. These *organisations* were selected using a list from ICRAF-AFRENA's country office in Kabale.

3.2.1 Organisations and Institutions

Organisations here refer to the NGOs, CBOs, churches, and research centres not owned by the government, e.g., ICRAF/AFRENA. *Institutions* refer to governmental institutions like the Ministry of Agriculture and its various outlets in the sub-counties, Forestry Department, National Agricultural Research Organisation and National Farmers Association. The informal survey obtained information on this target group.

An inter-disciplinary team consisting of an agronomist, a tree seed specialist and a forester conducted a census of all organisations that distribute tree seeds for agroforestry and also work with natural resource management (NRM). The result is an overview of *organisations* and *institutions* involved in tree seed and seedlings (see table 2). The census consisted of two steps: (i) identifying and locating *organisations* and *institutions* and (ii) interviewing heads of the NRM units of these organisations using an interview guide (see appendix 4).

From the list given by ICRAF/AFRENA, 16 *organisations* and *institutions* were located and registered - all working with tree seeds, agroforestry and NRM. Information on operations, target groups, type of support to target groups, tree seed species supplied, problems and opportunities, and secondary information on physical, biological and socio-economic features of operational areas was obtained. Lastly, information was gathered leading to the identification of the second target group, the tree nurseries.

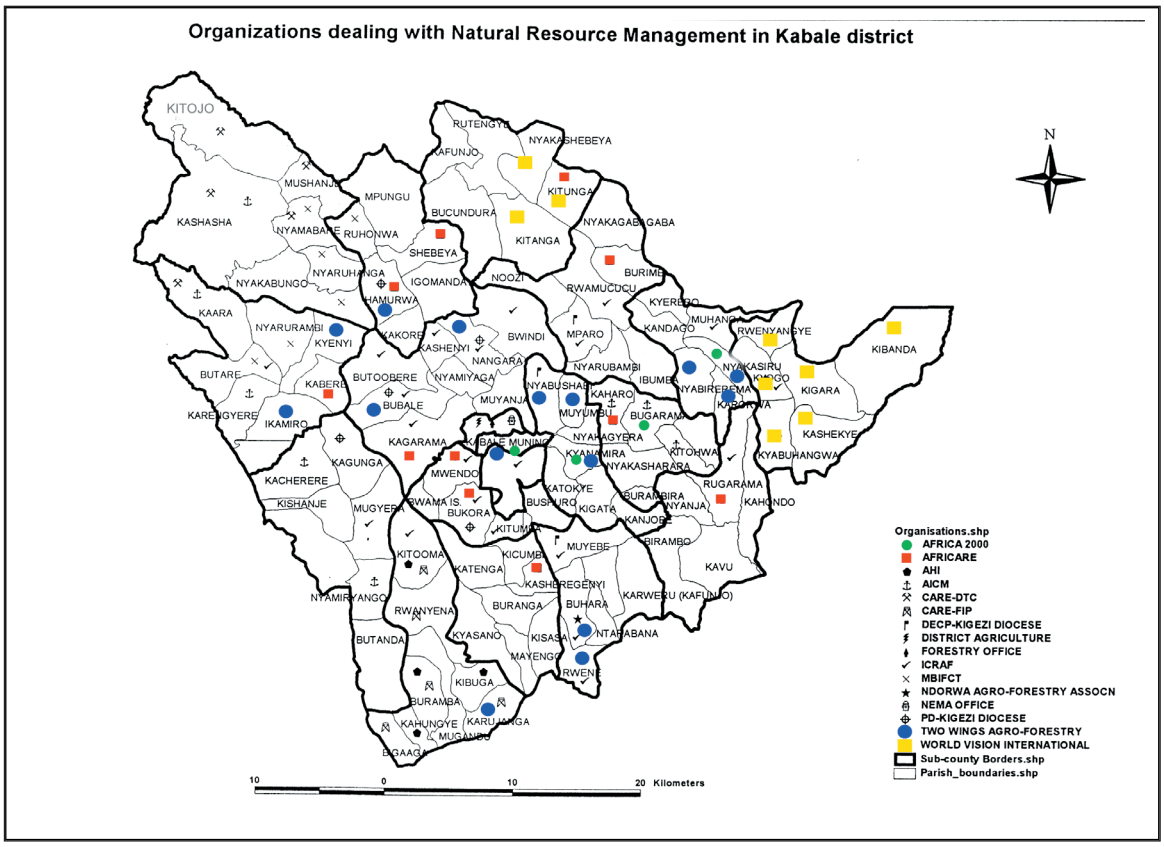


Table 2: organisations and institutions working with tree seed in Kabale

Organisations/ Institutions	Activities	Target group(s)	Number of nurseries supported	Number of parishes
Africa 2000 Network	• financial support to communities to protect environment • training and extension in agroforestry	• community groups • farmer groups	18 (1)	4
Africare	• soil fertility improvement • promote good nutrition • ensure sustainable use of natural resources	• farmer groups • individual farmers	119 (5)	11
Africa Highlands Initiative (AHI)	• crop production and protection • environmental management	• community groups • individual farmers	4 (non-functioning)	4
African International Christian Ministry (AICM)	• support for youth and vulnerable groups (pigmies) • promote tree planting	• community groups • women's groups	3 (non-functioning)	8
CARE-DTC (Development Through Conservation)	• protect biodiversity around national parks • increase production around the parks	• farmer groups	(12)	5
CARE-FIP (Farmer Initiative Project)	• improve farmer ability to innovate • facilitate linkage between farmers and service providers • facilitate farmer-to-farmer study • facilitate the development of local plans	• farmer groups	5 (just established)	6
DECP-Kigezi Diocese (Domestic Energy Conservation Project,)	• energy conservation • tree planting	• community groups	20	3
PD- Kigezi Diocese (Planning and Development)	• soil conservation and domestic fuel use	• community groups	not available	5
District Agriculture	• promotion of agroforestry	• community groups	non-functioning	-
District Forest Dept.	• oversee tree planting • sensitise and educate on tree planting on farm • technical advice on species selection, nursery establishment and management	• community groups	non-functioning	not available
ICRAF/AFRENA	• promotion of agroforestry	• farmer groups • individual farmers	not available (3)	not available
Mgahinga Bwindi Impenetrable Forest Conservation Trust (MBIFCT)	• conservation of national parks • provide development support for people residing close to the parks • promote community participation in forest conservation • promote agroforestry and other community projects	• individual farmers • farmer groups	20 (5)	6
Ndorwa Agroforestry Association	• promote soil conservation and agroforestry	• farmer groups	7 (1)	1
National Environmental Management Authority (NEMA)	• capacity building in environmental management	• community groups	8	-
Two Wing Agroforestry Network (TWAN)	• soil and water conservation • empowering women	• women's groups	17 (2)	15
World Vision International	• support nursery establishment • promote improved agricultural seeds • provide credit and training • promote environmental protection through tree planting	• community groups	15	9

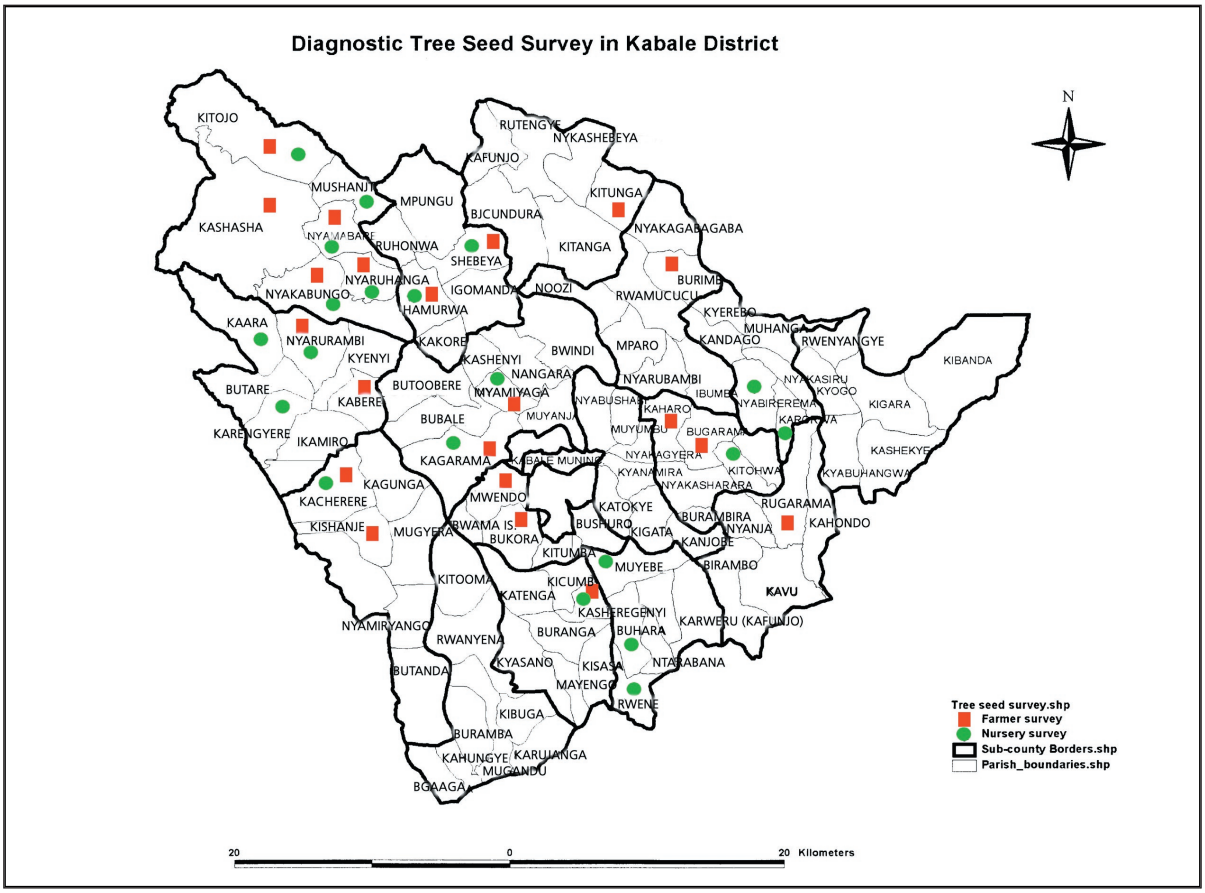
Numbers in parenthesis indicate number of nurseries found during field survey.

3.2.2 Tree nurseries

The nursery survey follows the *organisational* survey. It determines major limitations that they encounter in terms of capacity, operations, and seed and seedling flow. The survey builds on a previous nursery survey made in 2001 by Jaenicke, H. *et al.* (ICRAF, unpublished) in the Kabale and Mukono districts on small-scale tree nurseries. Questionnaires from this survey were modified and used for new interviews.

The nursery survey gathered information on seed sources and suppliers. Next, seed acquisition, seedling delivery, and disbursement was explored. Seed flow to nurseries, species used, nursery types and sizes, modes of information exchange, the potential for improving profitability, networking and marketing of seedlings were determined.

Maps of Kabale were provided to *organisations* and *institutions* to mark their areas of operations and the number of tree nurseries that they support (table 2). Through this exercise some 248 nurseries across the area were found from desk work and/or registered. These nurseries are basically the sample frame. A list was then compiled with names of the *organisation* or *institution*, number of nurseries supported and the corresponding parishes in which the nurseries were situated.



In order to locate the nurseries, facilitators from the corresponding *organisations* were consulted. Six out of the sixteen *organisations* and *institutions* were able to provide facilitators to locate nurseries. These were Africare, CARE-DTC, Africa 2000, MBIFCT, TWAN, and Ndorwa Agroforestry Association. The remaining eight *organisations* and *institutions* did not have any functioning nurseries or any facilitators available. Thus, they were not pursued further.

During the early stages of the fieldwork it was realised that most of the nurseries did not exist or were not functioning. The time gained hereby was converted into direct sampling in the parishes to spot any *operational* nurseries which could be included in order to get better coverage of the area. Parishes in four directions from Kabale Municipalities were visited for possible nurseries. In all, 32 nurseries were identified and visited. That represents 13% of the figure obtained from the organisational census.

In the process other nurseries were located but most of them were not used for tree seedlings but for agricultural crops.

Questions involving nursery size, species on nursery beds, source of seed, mode of acquisition of seed, distribution channels for seedlings, potential species, problems associated with tree seed/seedlings, type of nursery training acquired and training needs of nursery operators or representatives were posed (see appendix 5). Intensive field observations were conducted before and after the interviews. Interviews lasted between 1hr –1½hrs.

The nursery survey was carried out in 9 sub-counties, 21 parishes and 31 villages. On the average 3.5 nurseries were interviewed in a sub-county, 1.5 in a parish and 1 in a village. Out of the 32 nurseries, 29 had direct support from *organisations* and 3 survived on their own. Out of the 32 nurseries, 25 were actively operating and 7 were abandoned or not functioning. Managers of some abandoned nurseries were available for interview. These interviews were made in order to establish the main course for abandonment. In all 1 central, 12 private and 19 group nurseries were interviewed in the survey.

3.2.3 Farmer survey

An additional survey was developed to provide clues on farmers' interest in trees, species on fields, their introduction, origin of planting material, knowledge on tree seeds, etc. In 2000, ICRAF/ AFRENA conducted a randomised study of on-farm tree diversity in Kabale. Therefore, in parishes where no nurseries existed, a sub-set of the randomised list of farmers within those parishes was used to conduct interviews. Selection of farmers were based on:

- their access to land
- their right to land
- trees were present on their fields
- they plant trees.

Only farmers present at homesteads were interviewed.

In order to increase the sample size and therefore the reliability, another technique for selecting farmers was employed. A non-random technique similar to the so-called 'quota sampling' method (SSC, 2000) was used. During the interviews it was ensured that there were not too many tightly defined categories. Interviews were cross-sectional, meaning that no factors used for the analysis were predetermined.

Two techniques were used for contacting farmers. In the first instance the research team spent the morning locating and interviewing nursery operators in a particular parish, and then used the afternoons for contacting farmers. As one interviewer made contact with a farmer, a second interviewer hiked up the mountain to contact other farmers and the third interviewer hiked down the mountain or in the opposite direction to contact farmers either at homesteads or in fields.

When all three had returned to the original site the team moved on by car or foot to a new point (at least 2 kilometres away) and then repeated the process. Farmers selected during contacts were those who are involved in planting trees, have trees on farm plots, or were willing to be interviewed.

This procedure was found to be effective though biased towards sampling farmers close to the road. However due to the general fragmented farms across the landscape farmers tend to move well beyond the limits of the homestead[2], thus mixing the population and reducing the problem of 'clusters'.

Factors like the uneven and fragmented farming landscape, limited time, the method of moving across the landscape, and sampling from more than 102 different parishes at varying distances from Kabale municipality made a perfect sampling procedure virtually impossible. However, within the time frame given, it was necessary to adopt sampling strategies that satisfy the prevailing conditions by omitting a few remote farms and those farms where the farmer was not at home at the time of the visit. Hence, the sampling adopted is partly biased and does not likely represent the entire population of Kabale. However, it reveals existing trends on how farmers access seed in their daily farming activities.

121 individual farmers were identified and interviewed in 47 villages, 22 parishes and 11 sub-counties across the Kabale district using a semi-structured questionnaire. On average, 2.6 farmers were interviewed in every village, 5.5 farmers in every parish and 11 farmers in every sub-county. Out of the 121 respondents 60% were males and 40% female.

The sample frame is 629,400 people living in Kabale (cf. page 4) - 95% are farm families, of which 30% plant, or have, trees on farm (Bamwerindi 2004). That reduces the effective frame to some 179,000. If such a family consists of 6 members we have a frame of 30,000 families. The interviewed 121 farmers are thus 0.4% of the frame, i.e. approximately 1 out of 250 families fulfilling the tree planting criteria was interviewed.

A homestead is a farmhouse plus its surrounding land.

Questions posed involved farm size and number of plots, source of tree seeds, tree species on fields, problems associated with tree seed/seedlings, potential species, and training needs of farmers (see appendix 6). Interviews lasted between

30-45 minutes and farmers were allowed to pose questions during interviews to generate instant feedback from respondents. Direct field observations were not carried out effectively due to the scattered nature of the household plots.

Apart from the structured interviews, focus group discussions were also held in remote areas to disclose common problems in tree seed supply. In some of the group discussions causal diagrams were made to highlight problems associated with tree seed.

3.3 Analysis

Simple percentages are used in quantifying seed supplies, problems, training needs, composition, ratios etc. for organisational census and tree nurseries.

For the farmer survey simple percentages illustrate seed supplies and problems. Existing trends on how farmers normally access seed is shown. Further, simple statistics analyse the association between sources of tree seed and constraints/ limitations ('bottlenecks') involved in seed acquisition and dissemination. Unfortunately, quantities of seed supplied were not available from organisations or farmers. Hence, the analysis only examines associations between farmers' perception of tree seed sources and major bottlenecks encountered. Later, tree seed availability, its acquisition and dissemination is examined.

Associations between sources/suppliers of seed and bottlenecks are determined using the Pearson's chi-square (χ^2) test of homogeneity or independence for each stratum (Schlotzhauer and Littell, 1997). The *odds ratio*, OR, a probability concept, (see also 4.7), determines links and magnitude of association. The Statistical Analysing Systems (SAS) Programme was used for this, particularly the procedure called '*proc freq*'.

4. Results

4.1 Organisational Census

All the *organisations* hand out seed free of charge to different target groups in the area. Activities of these *organisations* overlap (see next chapter for discussion).

In order to promote agroforestry innovations, these *organisations* and *institutions* encourage establishment of nurseries. Nurseries are supported in different ways and used to produce and store seedlings for members. In all, 10 *organisations* and *institutions* work with farmer groups. These farmer groups are used as entry points to reach a large number of farmers in the communities. The groups therefore become beneficiaries of free tree seeds, which are sown in group nurseries and the resulting seedlings shared amongst members. Figure 1 below shows the distribution of *organisations* and *institutions* and their target groups.

Most *organisations* and *institutions* see establishment of community group nurseries as an effective way of reaching many farmers. It is seen as a way to get farmers to establish a network through which vital information could be shared. However, it was observed that these assumptions are only true as long as organisations continue to provide support.

Apart from those *organisations* and *institutions* that work with farmer groups, nine work directly with individual farmers. These farmers serve as contact persons and their nurseries are used as demonstration plots for the village community or for cross-visit purposes. This target group was observed to be very self-sustaining since upon establishing their nurseries they tend to be more self-dependent and resourceful despite the termination of project support.

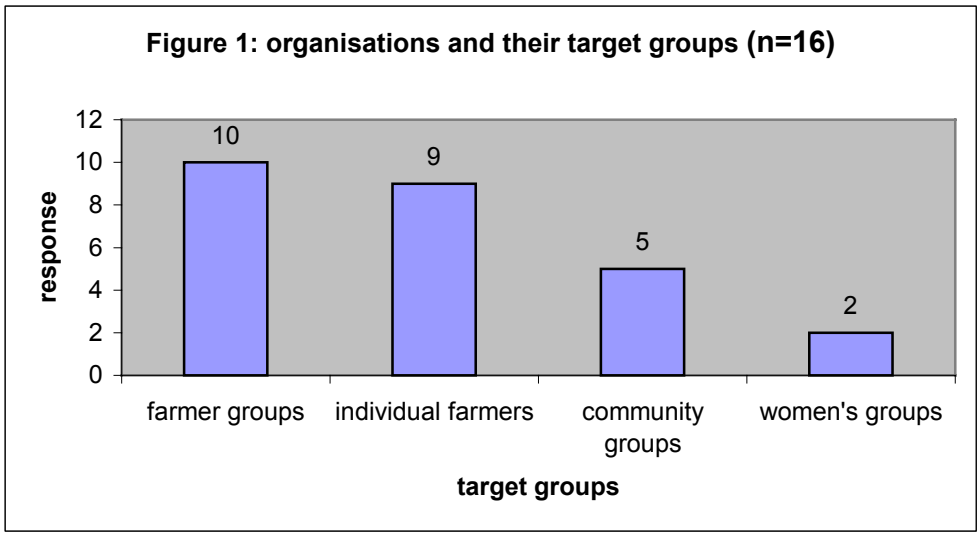


Figure 1. Organisations and their target groups (n=16)

Five *organisations* and *institutions* supported community-based groups targeting the most vulnerable such as, youth, widows and disabled. Only two *organisations* work with women's groups.

4.1.1 Organisational support to target groups

There are three main forms of support offered to the nurseries by these *organisations* and *institutions*; these include provision of seed, nursery equipment and technical advice on nursery management.

As a response to land degradation, agroforestry has become heavily promoted. Agroforestry technologies promote trees providing shade, shelter, erosion control and soil nutrient enrichment. Similarly, trees which provide products like timber, building materials, fuelwood, food, medicine and fodder are also being introduced and encouraged in the farming system.

15 out of the 16 *organisations* / *institutions* (table 2) provide training in nursery establishment, tree seed, and information on agroforestry technology. Seven provide nursery equipment in the form of watering cans, wheelbarrows and potting materials.

It was observed that the District Department of Forestry and Agriculture had no established nurseries or for that matter supported any with seed.

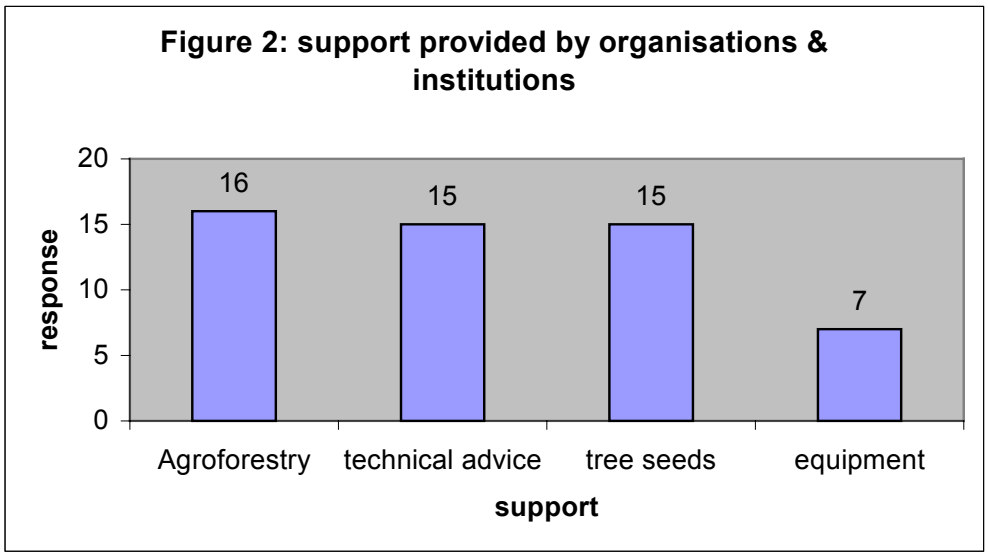


Figure 2. Support provided by organisations and institutions

Table 3 shows the 23 major tree species being promoted in the area by *organisations* and the main sources of seed acquisition. The species are ranked after popularity in terms of frequency of supply.

Table 3: Organisations supply of seed of various tree species

Species	Local name	Origin	Number of organisations	Main supplier
Grevillea robusta	-	exotic	11	ICRAF, Farmers
Calliandra calothyrsus	-	exotic	11	ICRAF
Alnus acuminata	-	exotic	10	ICRAF
Eucalyptus spp	karitusi	exotic	4	Farmers
Persea americana (grafted)	ovacado	exotic	4	ICRAF
Sesbania sesban	omunyegany-egy	local	4	Farmers
Tephrosia vogelii	-	exotic	3	Farmers
Apples (grafted)	-	exotic	2	ICRAF
Pinus patula	-	exotic	2	Farmers
Cupressus lusitanica	karwenda	exotic	2	Farmers
Tree tomatoes	omutunda	exotic	2	ICRAF
Markhamia lutea	omusavu	local	2	ICRAF
Maesopsis eminii	-	exotic	2	Farmers
Pears	-	exotic	2	ICRAF
Leucaena spp		exotic	1	ICRAF
Passion fruits	-	exotic	1	Farmers
Moringa oleifera	-	-	1	Farmers
Croton macrostachyus	omurangara	Local	1	ICRAF
Dovyalis caffra	amayonza	exotic	1	ICRAF
Albizia spp	omushebeya	Local	1	West Kenya
Erythrina abyssinica	ekikoo	Local	1	Farmers
Cedrela odorata	-	exotic	1	ICRAF
Casuarina equisetifolia	-	exotic	1	ICRAF

ICRAF/AFRENA serves as the main tree seed supplier in the area supplying about 13 of the 23 species that were registered and promoted by the *organisations*. Individual farmers also play an important role in the supply of seed to *organisations*. They supply nine species while the remaining species, specifically the *Albizia* group, are obtained from Western Kenya by Africa 2000 Network. The species that farmers supply are mostly local to which they have acquired some knowledge in their collection and handling over the years. These farmers are mainly contact farmers who receive additional information and training on how to collect and handle these seeds.

The volume and dynamics in tree seed acquisition and dissemination in Kabale depends on how much the supplying farmers can produce. However, it also strongly depends on how long ICRAF/AFRENA continues to serve as the main supplier of tree seed.

Tree seed in Kabale comes through two channels. The main pathway has ICRAF/AFRENA as its main supplier (see figure 3). The second pathway depends on farmers' supply. These farmers collect seed themselves and sell to *organisations* and commercial or private nurseries. The seed is collected from local tree stands.

Organisations supply seed giving priority to various target groups, mainly community-based group nurseries and individual farmers. Community supported group nurseries share the resulting seedlings amongst members, while individual farmers sell or use own seedlings on fields. It must be mentioned that ICRAF/AFRENA also supply some free seed to community-based group nurseries and individuals.

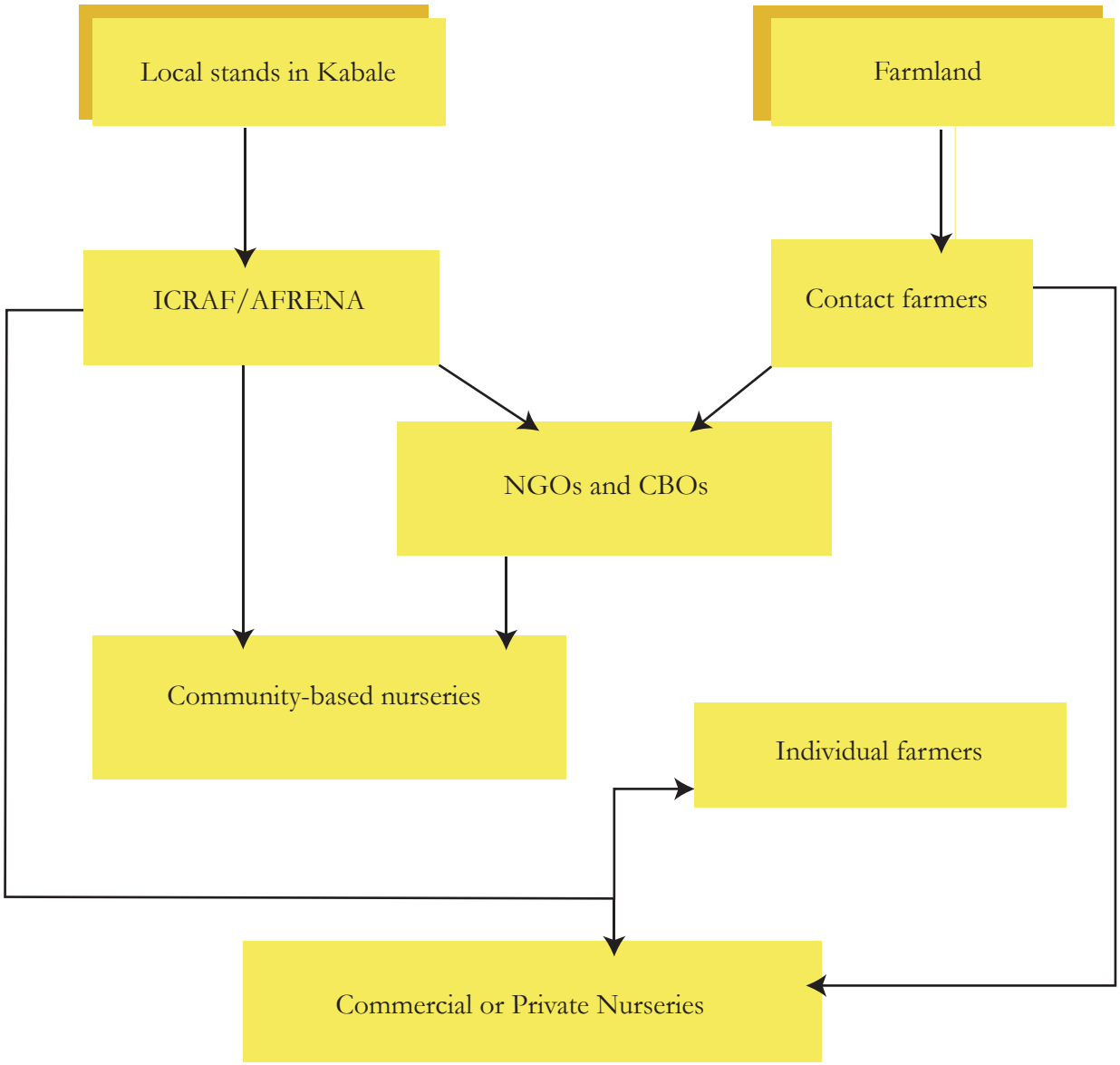


Figure 3. Tree seed main flow in Kabale district, Uganda June 2002

14 *organisations* support nurseries with seed (all, exc. Ministry of Agriculture, and Dept. of Forestry). The supply is, however, insufficient to meet the need. They find this to be a major setback fulfilling the agroforestry mission. As a result eight *organisations,* i.e., MBIFCT, AHI, AFRCARE, AFRICA 2000 Network, World Vision, Two Wings Agroforestry, CARE-FIP, aim to alleviate the seed shortage by establishing tree seed orchards together with farmers to increase the seed sources in the area (the investigation did not follow-up on this).

Another observation made was that ICRAF/AFRENA serves as both the main seed supplier as well as the main provider of technical information to these *organisations*. Most *organisations* (12) consult the office for technical advice on agroforestry techniques and also use their facilities, such as the nursery for agroforestry demonstrations, for visiting farmers.

To obtain information from farmers, *organisations* use different approaches like participatory rural appraisal, field days and enquiries at the National Agricultural Research Organisation and ICRAF/AFRENA offices. All the *organisations* and *institutions* unite to serve as a forum for exchange of information. For this forum ICRAF/AFRENA serves as the secretariat. The forum meets quarterly every year. The *organisations* indicated some main constraints regarding seed supply. These constraints include:

- inadequate sources of tree seed
- duplication of activities by *organisations*
- inadequate human resources for field operations
- lack of funds
- lack of enforcement of by-laws by local government

4.2 Nursery survey

The nurseries surveyed are grouped into four categories. These are central, group, small and large-scale private nurseries (table 4).

The central nursery, which in this case is ICRAF/AFRENA, sells seedlings to farmers, *organisations*, *institutions* etc. It also serves as a demonstration nursery for individuals or groups of individuals interested in tree nurseries.

Table 4: categories of 25 operational nurseries and their average sizes and coverage area

Nursery categories	Number	Nur. avg. size* m^2	Average distance covered km
Group	12	28	5
Small-scale private	9	36	8
Large-scale private	3	4036	125
Central	1	450	180

** Size of nursery is measured according to the size and number of beds*

Group nurseries are those established with support from *organisations* and owned by group of farmers who share the responsibilities of managing the nurs-

ery. Seedlings are distributed free of charge to these members in amounts according to the quantity produced.

Individual farmers own the **small-scale private nurseries**. They may also be established with support from *organisations*. Seedlings are planted on farms or sold to farmers, schools, churches, institutions etc.

Farmers and other individuals, who are not necessarily farmers, own **large-scale private nurseries**. These are people who operate these nurseries as full time businesses. They sell seedlings to the same type of clients as the small-scale nurseries.

Of the 32 nurseries interviewed 19 are group, 12 private, and one central. Among the 32 nurseries are 7 group nurseries, which were out of operation. People who had been involved were found and interviewed to determine cause of abandonment. These nurseries were all situated in parishes very close to the Bwindi Forest.

The explanation for abandonment of nurseries was given as follows: the abandoned nurseries were supported by CARE-DTC, which was one of the projects by CARE-Uganda involved in community development. The project provided among other things tree seeds to these nurseries. When it was phased out the members could not sustain the nurseries. Members mentioned the lack of seeds, technical advice and nursery equipment as the main bottlenecks for abandoning the nurseries.

4.2.1 Seed sources to Nurseries

Four main sources of tree seed to nurseries were identified. These comprised:

- Supply from *Organisations*
- Farmlands (own collections)
- Markets
- Neighbours

Organisations provide the majority of nurseries with seed. Of the 32 nurseries interviewed, 20 received seed from *organisations* as free handouts. Out of this, only 9 receive seed solely from this source. These nurseries also receive nursery equipment like watering cans, potting materials, and technical advice on nursery management to facilitate their operations. Local farmland serves as seed source for 12 nurseries out of which one obtains seed exclusively from this source.

Eight nurseries, predominantly private, purchase seed from local markets. Seed purchases from local markets are mainly of fruit trees. Group nurseries depend on free seed rather than purchases. No nurseries depended solely on seed from either markets or neighbours. Only five nurseries obtained seeds from neighbours.

Organisations are obliged to establish group nurseries. Consequently, these nurseries depend on them for seed and less on other seed supplies that require labour, time or money. However, to supplement *organisations*' supplies some members of the groups contribute with own seed collected from farms to keep up the nursery.

Even though some private small-scale nurseries seemingly are dependent on *organisations* for free seed, most seed is collected on farms. For private large-scale nurseries, most of the seed is bought and some collected. The only central nursery surveyed, i.e. ICRAF/AFRENA nursery, uses seed collected locally from its established tree stands or purchased outside Kabale.

4.2.2 Problems facing nurseries

Nursery managers identified and ranked the following bottlenecks:

1. Inadequate supply of seeds
2. Inadequate supply of nursery equipment
3. Lack of technical know-how in nursery management
4. Lack of information on market opportunities for seed/seedlings
5. Lack of water sources

In general, 25 of the 32 nurseries indicated that seed obtained is insufficient. One reason given is lack of reliable depots where they can purchase, bargain or barter for vigorous tree seed just like they do for crop grains/seed.

25 nurseries indicated lack of nursery equipment as a problem. Examples given were wheelbarrows, watering cans and potting materials.

Lack of skills in nursery management was another constraint, identified by 22 nurseries. Management practices such as pest and disease control, soil mixing, nursery hygiene, pricking out, sowing and transplanting of seedlings were some of the practices named. It was observed during nursery visits that most of the beds, especially those belonging to group nurseries, were not cleaned. Debris of all kinds was found lying over the beds and large swarms of insects were seen all over these nurseries.

Lack of market information on sales of seedlings was another problem indicated by 16 nurseries. According to these nurseries, this is a problem hindering the commercialisation of tree nursery activities in the area since the majority of particularly group nurseries have no idea of where and how to sell excess seedlings.

Water shortages for nursery beds was reported as a limiting factor by 12 nurseries. These nurseries are located at higher altitudes between 1858 to 2264 m.a.s.l. and frequently face water shortages. This problem appears to be due to untimely sowing and transplanting:

It was generally observed that the majority of nurseries, especially group nurseries, sow towards the end of the rainy season as the members give priority to work on their main fields in the beginning of the season rather than in the nurseries. Hence, the transplanting stage of seedlings coincides with the dry season, resulting in failures in seedling establishment.

4.2.3 Networking among nurseries

Communication or networking[3] among nurseries was limited, especially among group nurseries. In all seventeen nurseries reported being involved with other nurseries, out of which ten are private owned. Out of the fifteen, which do not have network with others, twelve are group nurseries.

It was observed that most group nurseries had excessive numbers of over-grown seedlings as a result of members not utilising their share. When asked why excess seedlings are not sold the reason given was lack of information on demand for seedlings.

This problem of excess seedlings in some places and high demand in other places was linked not only with poor networking but also physical location of the nurseries. It was observed that nurseries in the eastern dry areas had relatively better market information and for that matter better market potential than for those in the north-east.

4.2.4 Nurseries' seedling disbursement

The four categories of nurseries have two ways of disbursing seedlings beyond their own consumption on farms. These include selling and sharing. These disbursing patterns are regardless of species. Figure 4 lists proportions of nurseries, which use, sell or share part of their seedlings,

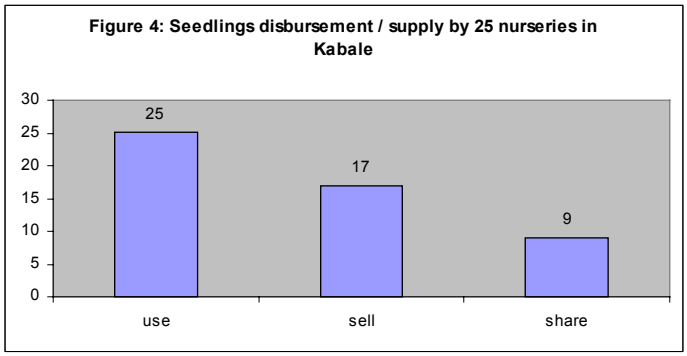


Figure 4. Seedling disbursement/supply by 25 nurseries in Kabale.

All the twenty-five functioning nurseries use part of seedlings for planting on fields. For instance, group nurseries distribute seedlings to members when due for transplanting. Small and large-scale private nurseries and central nurseries plant some of their seedlings on farms and also for tree stand establishment respectively.

Seventeen nurseries sell seedlings. These are mostly private and central nurseries. Nine nurseries share seedlings for example between members for group nurseries and between neighbours for both group and private nurseries. The large-scale private and central nurseries do not share seedlings with others, they produce for themselves and sell.

[3] *Communication here is used interchangeably with networking which refers to exchange of ideas and information*

4.2.5 Nursery Species

Twenty-two different tree species were identified in nurseries out of which only four are local. *Eucalyptus* was found to be the most popular. Table 5 below gives a representation of species identified at nurseries.

Table 5: Seedling and species counts in 25 nurseries in Kabale district Uganda. June 2002

Species	Local name	Origin	Nurseries	Avg. count pcs./nursery
Grevillea robusta		Exotic	15	5601
Calliandra calothyrsus	-	Exotic	15	4568
Eucalyptus spp	karitusi	Exotic	12	7625
Alnus acuminata	-	Exotic	10	3887
Pinus patula	-	Exotic	9	7004
Persea americana	ovacado	Exotic	5	182
Cupressus lusitanica	karwenda	Exotic	5	7754
Sesbania sesban	omunyeganyegy	Local	3	60
Tree tomatoes	omutunda	Exotic	3	1800
Markhamia lutea	omusavu	Local	1	2500
Passion fruit	-	Exotic	3	1102
Dovyalis caffra	amayonza	Exotic	3	4000
Apples	-	Exotic	1	22
Podocarpus milanjianus	omusenene	Local	1	3
Pears	-	Exotic	1	30
Tephrosia vogelii	-	Exotic	1	205
Maesopsis eminii	-	Exotic	1	1000
Erythrina abyssinica	ekikoo	Local	1	5
Cedrela odorata	-	Exotic	1	120
Casuarina equisetifolia	-	Exotic	1	620
Acacia mearnsii	burikoti	Exotic	1	100
Callistemon citrinus	bottle brush	Exotic	1	4

Grevellia robusta and *Calliandra calothyrsus* were most commonly recorded (15 nurseries). Even though this represents a considerable number of active nurseries, the quantities recorded do not reflect the popularity of these two species in the area in terms of agroforestry species. This is because almost all the agroforestry technologies being introduced involve these two species. It was thus expected during the survey that the production of these species would be high enough to meet the demand. This was not the case since there were no established stands identified in the area where seed collection was done. Hence, nurseries have to depend on *organisations* for free supplies.

4.2.6 Seedlings in nurseries

The highest number of seedlings was recorded on the large-scale private nursery with some 176,000 seedlings. The fewest were recorded in a group nursery with only 60 seedlings at the time of the survey. 413,000 seedlings were recorded in 25 nurseries situated on an average area of 1.3 ha. Out of the overall total number of seedlings recorded 250,000 were produced by large-scale private nurseries, 75,000 by small-scale private nurseries, 51,000 by group nurseries, and 38,000 by the central nursery as indicated in table 6 and Figure 5, below.

Table 6: Tree seedling production in nurseries between June/July 2002

Nursery category	Seedlings in nurseries	Average area of nurseries (m^2)	Operational Distance (radius) (km)
Group	51,167	336	5
Private-small scale	74,825	324	8
Private-large scale	249,272	12,108	125
Central	38,000	450	180

Private small-scale nurseries have the highest production per area compared to the other categories (i.e., ca. 231 seedlings/m^2) followed by the group nurseries with ca. 152 seedlings/m^2. This could be due to the fact that private small-scale nurseries are more committed and have relatively less internal constraints compared to the rest.

Group nurseries have small coverage area (5km) compared to the rest. The values shown in figure 5 represent individual counts of seedlings recorded on beds in various categories of nurseries.

Figure 5: standing seedlings on nurseries based on individual counting between June/July 2002

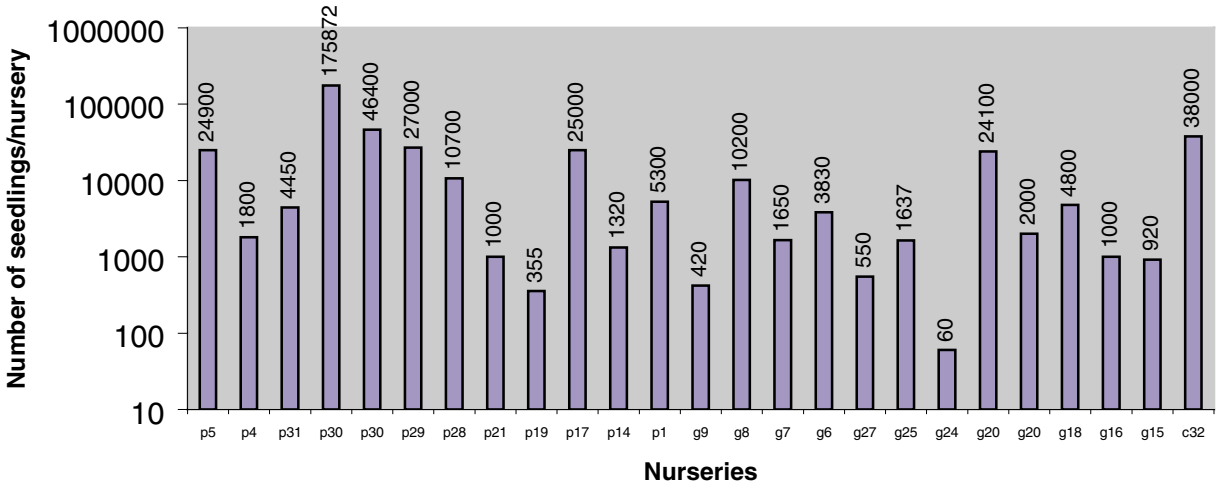


Figure 5. Standing seedlings on nurseries based on individual counting between June/July 2002

4.2.7 Nursery price of seedlings

There were no fixed prices for any seedlings, nursery operators determined prices. Nursery prices for some of the species given above are shown in table 7

Table 7. Seedling prices as informed by private large-scale nurseries

Species	Price/potted seedling Uganda Sh (1 USH~0.00xx$)
Grevillea robusta	200
Calliandra calothyrsus	100
Alnus acuminata	100
Markhamia lutea	100
Cupressus lusitanica	100
Pinus patula	200
Passion fruit	400
Persea americana (grafted)	2500
Dovyalis caffra	50
Eucalyptus spp	50
Tree tomato	100

4.2.8 Nursery training needs

Organisations and *institutions* dealing with tree planting activities have trained 26 out of 32 nursery foremen/operators. This occurred in the form of workshops, seminars and cross-visits. Topics covered included bed preparation, sowing and watering regimes, potting, and other basics in nursery management and practices.

Four nurseries had operators who got their skills through a long period of experience with tree planting. They used the term 'acquired skills from local knowledge'. Similarly, the remaining 2 had skills from working in plantations.

Despite the level of training possessed by the operators, they still indicated that the operational levels of their activities could reach an optimal level if more information on tree nurseries is availed to them.

The operators are interested in further training in specific areas to enable them work efficiently. Topics noted: twenty-eight nurseries wanted to acquire more skills in general nursery management; eighteen want skills in seed collection and handling; sixteen want to learn about tree seed orchards, and fourteen want to improve business skills.

4.3 Farmer survey

4.3.1 Farmer plot size

There were 121 respondents, 60% men and 40% women. 89% of all respondents, both men and women, own their farmland compared to the rest who rent theirs on various terms. Table 8 gives an indication of farmers and number of plots or parcels/ fields of land owned by a household for agricultural purposes.

The range of plots owned by farmers varies from 1 to over 30. The majority of respondents (60%) have between 1-10 plots. These plots are scattered in the landscape and not all of them are under cultivation.

Table 8: Number of plots owned by 121 farmers interviewed

Number of plots	Number of farmers
1-5	34
6-10	39
11-15	16
16-20	11
21-25	2
26-30	2
>30	2
Do not know	15
Total	121

Table 9: Farming plot size

Average size of plots in ha	Number of respondents
0.25-2.4	23
2.5-4.4	13
4.5-6.9	11
7.0-9.9	3
>9.9	12
Do not know	59
Total	121

Table 10: Average number of plots under cultivation and fallow

Number of plots	Average number of plots under cultivation	Average number of plots under fallow	Percent respondents
1-5	2.9	0.5	32
6-10	5.9	2.0	37
11-15	10.1	3.0	15
16-20	13.3	5.3	10
21-25	15.0	6.5	2
26-30	20.5	9.5	2
>30	30.5	10	2
Do not know	-	-	15
total	98.2	36.8	100

More than 50% of respondents who could estimate their plot sizes have plots ranging from 0.25 to 2.4 ha (table 9). Despite the small sizes of farm plots, farmers apply various agroforestry technologies to combat soil erosion and ensure soil fertility regeneration.

The number of plots left under fallow depends on plots available to the farmer in question. A high number of plots favour a higher number of plots left under fallow (table 10).

Farmers with many plots can afford to allow the process of natural regeneration for their exhausted land to recover. Those with fewer plots have no other option than to use their plots throughout the year.

4.3.2 Tree seed supply sources available to farmers

68% of respondents indicated that they have their own small private nurseries for seedlings. Five sources of tree seed available to farmers were identified. Table 11 lists responses obtained from respondents on the issue of where they access tree seeds.

Table 11: Sources of seed to 121 farmers in Kabale, Uganda 2002

Seed sources	Number of farmers	%
Organisations	107	88
Farmlands	66	55
Neighbours	33	27
Institutions	13	11
Markets	8	7

Farmers often have more than one major source/supplier of seed. Supplies from *organisations* provide tree seed mainly free as handouts to farmers. 88% of respondents reported that they receive tree seed from local *organisations* dealing with agroforestry. A quarter of these farmers depend solely on *organisations* for seed supply.

From the farmland/farms 55% of farmers collect seeds for planting. 6% of these obtain seed solely from farms.

Neighbours (inc. friends and relatives) serve as the third largest supplier of tree seeds. 27% of respondents indicated that they procure tree seed from neighbours, but only 2% solely procure all their seed from this source. This seed supply is in the form of gifts or exchange in a barter system.

11% obtain seed from *institutions*. This source is less used due to the bureaucracy involved in accessing seed. Local markets serve as a fifth source for tree seed. Only 7% of respondents purchase seed from markets. Seed obtained here is mainly for fruit trees. No private persons were identified for selling other species on the market. The ICRAF/AFRENA office sells tree seed and prices are out of the reach of ordinary farmers.

4.3.3 Tree species found on farms

Farmers have diverse ranges of trees on their farms and homesteads as shown on table 12. Fifty-one species or species groups were recorded on the farms.

Table 12: Tree species on farms as stated by 121 farmers. Kabale, June 2002.

Species	Local name	Origin	No. of resp.	Main source(s)
Eucalyptus spp	karutusi	exotic	111	Farmland
Grevillea robusta	-	exotic	98	Africare
Calliandra calothyrsus	-	exotic	89	Africare
Persea americana	ovacado	exotic	56	Market
Acacia mearnsii	burikoti	exotic	53	Farmland
Sesbania sesban	omunyeganyegy	local	42	Farmland, CARE
Alnus acuminata	-	exotic	39	Africare
Markhamia lutea	omusavu	local	35	Farmland
Cupressus lusitanica	karwenda	exotic	29	farmland, forest
Ficus natalensis	ekitooma	local	17	Farmland
Erythrina abyssinica	ekikoo	local	16	Farmland
Passion fruits	-	exotic	15	Market
Pinus patula	-	exotic	13	Forest
Casuarina equisetifolia	-	exotic	13	CARE, MOA
Acacia spp	omunyinya	local	11	Africare
Prunus africana	omumba	local	8	Forest
Tree tomatoes	omutunda	exotic	7	Market
Albizia spp	omushebeya	local	7	farmland, forest
Mangifera indica	omuyembe	exotic	6	Farmland
Apples	-	exotic	5	ICRAF
Polyscias fulva	omungo	local	5	Forest
Mimosa scabrella	-		5	Africare
Podocarpus milanjianus	omusenene	local	5	Africare
Vernonia amygdalina	omubirizi	local	5	Forest
Bersama abyssinica	omukaka	local	4	Farmland
Maesa lanceolata	omuhanga	local	4	Forest
Ricinus communis	ekishogashoga	local	3	Africare
Vernonia auriculifera	ekinyaminyami	local	3	Forest
Leucaena spp	-	exotic	3	Africare
Citrus sinensis	omucungwa	exotic	3	Forest
Dodonaea angustifolia	omushambya	local	3	Farmland, forest
Tephrosia vogelii	-	exotic	2	Africare
Solanecio mannii	entagara	local	2	Farmland
Mitragyna stipulosa	engomera	local	2	Farmland
Ficalhoa laurifolia	omuvumaga	local	1	Ruhiji Forest
-	omutagara	local	1	Farmland
Hagenia abyssinica	omugyesi	local	1	CARE
Faurea saligna	omurengyere	local	1	Forest
Cedrela odorata	-	exotic	1	CARE
Entandophragma excelsum	omuyovi	local	1	Bwindi Forest
Dovyalis caffra	amayonza	exotic	1	SWWA
Ritchea albernsii	omuhenvu	local	1	Mafuga Forest
Crassocephalum mannii	omukoona	local	1	Forest
Solanum aculeastrum	emitugunda	local	1	CARE
Syzigium cordatum	omukondokondo	local	1	Farmland
Azadirachta indica	neem	exotic	1	Africare
Acanthus arboreus	amatojo	local	1	Farmland
-	*emizuma*		*1*	*Farmland*
-	*ekyoganyanja*		*1*	*Farmland*
-	*ekiterankuba*		*1*	*Farmland*
-	*omukunyu*		*1*	*Forest Department*

4.3.4 Bottlenecks in tree seed/seedlings acquisition

Four main bottlenecks in connection with tree seed/seedling acquisition were identified. Table 13 gives a representation of these bottlenecks

Table 13: Major problems in seed acquisition as stated by 121 farmers, June 2002 Kabale Uganda

Bottlenecks	Yes response	
	Number	%
Inadequate seed supply	117	97
Inadequate technical information	94	78
Inadequate seed sources	90	74
High cost of seed	59	49

Almost all respondents indicated that insufficient tree seed was a major bottleneck confronting them in their agroforestry and tree planting activities. Farmers reiterated that the lack of seed is mainly a hindrance when it comes to the exotic species, which they believe will improve soil fertility. However, there is inadequate seed for many of the useful local species like *Prunus africana*, *Podocarpus milanjianus*, *Entandophragma excelsum*.

Out of the 121 respondents interviewed 78% stated having insufficient technical information on seed collection and handling, which prevents them from harvesting and storing seed. Most information given relates to species use and not how to obtain propagating materials.

74% indicated that there were not enough avenues to access tree seed. They reiterated that despite the presence of a relatively large number of *organisations* handing out tree seed in conjunction with promoting agroforestry technologies, the seed supply was not reliable.

49% of respondents reported that tree seed was too costly. Popular species, like *Calliandra calothyrsus* and *Grevillia robusta,* are sold by ICRAF/AFRENA at 2250 shillings and 1750 shillings *per* 1000 seeds, respectively. No other suppliers or sources are available for these species. This causes dependency on ICRAF/AFRENA.

4.4 Farmers' perception on seed acquisition and dissemination

This part of the survey tries to determine farmers' perception in relation to procuring tree seed and the bottlenecks involved in seed acquisition and dissemination. In order to achieve this, the concept of *odds ratio* (OR) is used in a *case-control study* to express the level of farmers' perception.

OR is a tool for testing and quantifying associations between two independent samples (Uebersax, 2002). It is used to estimate the relative risk when the probability of a positive response is small. It is also interpreted as a measure of the magnitude of association between two independent variables.

*Case-control studies are retrospective designs in which odds ratio are used to estimate relative risks when the probability of positive response is small (Agresti, 1990). In this case, two independent samples, thus (1) sources of tree seed and (2) bottlenecks in seed acquisition are identified based on a binary (***yes – no)** *response variable. The conditional distribution of the dual explanatory variable is examined within fixed levels of response variable. Under this circumstances, sources of seed are used as explanatory or fixed variables since they do not change, while bottlenecks in seed acquisition are used as response variables.*

Table 14 is a modified version of tables 11 and 13. It lists the variables, which basically comprise sources of seeds, bottlenecks, responses and their sampling frequencies.

Table 14: Quantifying variables for odds ratio calculations

Variables	Yes response (one)	
	Number	%
Sources of seed		
Organisations	107	88
Farmland	66	55
Neighbours	33	27
Bottlenecks		
Lack of technical information	94	78
Lack of seed sources	90	74
High cost of seeds	59	49

Cross-classification frequencies for the dual ratings of two raters (i.e., sources of seed and bottlenecks) are given by the following assuming a *yes* response is represented by one and a *no* by zero:

	Rater 2 (Bottlenecks)	
Rater 1 (Sources of seed)	**1 (yes)**	**0 (no)**
1 (yes)	**a**	**b**
0 (no)	**c**	**d**

OR = ad/bc, which is a simple cross product ratio of a 2x2 table.

An OR value above 1 indicates that the odds of a positive response are higher in the first row than the second. Values less than one indicates that the odds of posi-

tive response are higher in the second row. For example the OR for farmers who received seed from *organisations* but stated that they lack technical information is:

	Lack of technical knowledge	
Seed from Organisations	**1(yes)**	**0 (no)**
1 (yes)	**84**	**23**
0 (no)	**10**	**4**

OR = 84 * 4 / 23 * 10 = 1.5

This indicates that the magnitude of perception that technical information was lacking was higher with farmers accessing seed from *organisations* compared to seed from other sources. In other words those who receive seed from *organisations* lack technical information on seed collection and handling. Table 15 below gives the various ORs for matching cross variables.

Table 15: Odds Ratios

Cross variables	Frequencies	odds ratio (OR)	p-value	95% cl
Seeds from organisations but lack technical knowledge	84	1.461	0.55	0.419-5.088
Seeds from farmland but lack technical knowledge	49	0.641	0.32	0.266-1.544
Seeds from neighbours but lack technical knowledge	24	0.686	0.42	0.272-1.729
Seeds from farmlands but lack seed source	46	0.19	0.575	0.247-1.337
Seeds from neighbours but lack seed source	26	1.393	0.49	0.535-3.628
Seeds from organisations but costly	51	0.683	0.50	0.222-2.103
Seeds from farmland but costly	37	1.914	0.08	0.926-3.956
Seeds from neighbours but costly	11	0.417	0.04*	0.181-0.962

** = Significance*

There is a significant association between getting tree seed from neighbours and responding that seed is costly (*p*-value=0.04). The perception that seed is costly is lower (OR=0.4) for farmers who accessed seed from neighbours compared to those who accessed seed elsewhere.

This is obviously due to the fact that in village communities, receiving seed from neighbours is inexpensive due to societal obligations people have towards each other. Especially when the commodity involved is tree seed. This is valid since trees are perceived as common property.

4.5 Farmers use of seed

4.5.1 Seed use

Figure 6 shows how farmers use tree seed. Irrespective of how farmers acquire seeds, they use part for own plantings on fields.

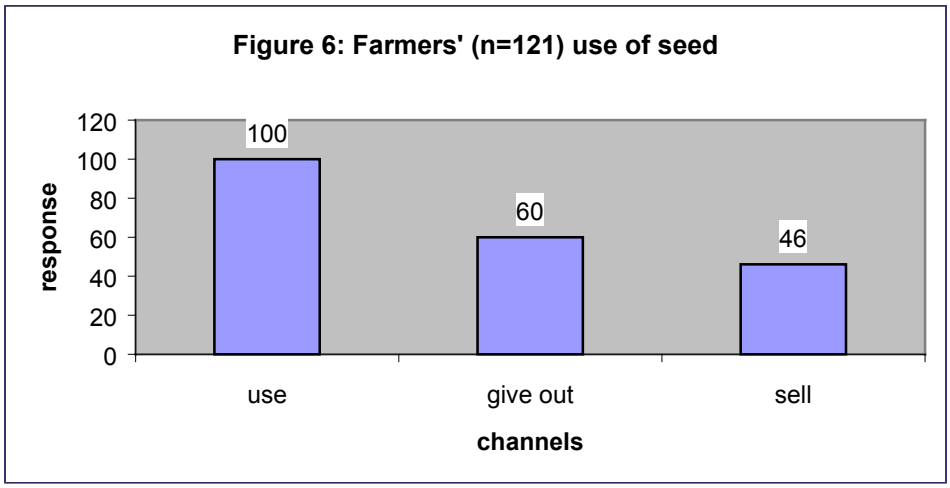


Figure 6. Farmers (n=121) use of seed

60% share or give seed/seedlings to neighbours. Some reasons stated by farmers are exchange (barter) for new species and security to avoid thefts and animosity.

To examine if there exist associations between farmers' source of seed and use the same procedure as in section 4.4 is used. The outcome is presented on table 16.

Table 16: Odds ratio determining farmers seed use

cross variables	frequencies	%	odds ratio	p-value	95% cl
Seed from organisations and sharing	63	59	0.6	0.367	0.169-1.943
Seed from farmlands and sharing	47	71	2.8	0.007**	1.302-5.847
Seed from neighbours and sharing	14	42	0.4	0.014*	0.159-0.823
Seed from organisations and selling	45	42	0.3	0.038*	0.086-0.985
Seed from farmlands and selling	31	47	1.1	0.714	0.557-2.349
Seed from neighbours and selling	13	39	0.7	0.412	0.315-1.607

Conclusions on the significant *p*-values lead to the following interpretation: farmers who collect seed from 'farmlands' have a higher tendency to share with others. However, if seed is received from neighbours the opposite tendency is valid - they tend not to share it further.

There is also significant association in getting seed from *organisations* and selling. Farmers who receive seed from *organisations* have less tendency of selling seedlings (OR=0.3) compared to those who receive seed elsewhere. This may be due to small seed quantities received from *organisations* as well as from neighbours.

4.5.2 Farmers price of seed and seedlings

Local prices of seed/seedlings by farmers in the study area depend on the demand and the nature of clientele. High demand for a particular species implies a relatively high price for that species assuming a functioning market. Furthermore, the price of a given species depends on whether the clientele is a neighbour or an outsider. The table below gives farm prices of some of the species in the area.

Table 17. Average farm prices of seeds/seedlings

Species	Average price/ seedling/ Ugandan Shillings	Average price/kg seed Ugandan Shillings
Persea Americana	50	
Tree tomatoes	70	800
Passion fruits	100	-
Alnus acuminata	50	-
Eucalyptus spp	10	-
Pinus patula	50	-
Acacia mearnsii	10	1500
Cupressus lusitanica	50	-
Casuarina equisetifolia	25	-
Citrus sinensis	25	-
Calliandra calothyrsus	50	-
Grevillea robusta	100	-
Callistemon citrinus	200	-
Acacia spp	10	-
Podocarpus milanjianus	150	-
Sesbania sesban	50	-
Markhamia lutea	10	-

4.5.3 Training needs of farmers

Farmers expressed opinion on how to tackle bottlenecks in tree seed collection and seedling production. They suggested training, which they think can help them solve the problems identified in section 4.7. 56% of respondents indicated that it is not enough only to know the benefits of trees in the farming system but also to be informed in basic knowledge about how to propagate trees and manage the seed.

They contended that through local knowledge and adoption of modern tree planting technologies, they have incorporated a lot of trees both local and exotic with their crops. However, the knowledge they posses on retention or multiplication of seed from most of these tree species is less compared to that of crop seed. Therefore, it would be fruitful to promote tree-planting technologies that will move beyond just handing out seeds. Providing information on how to collect and handle tree seed will not only be an advantage, but will be much more sustainable.

41% of respondents pointed out that they obtain very low seed germination rates with seeds they have collected compared to those received from organisations. They assumed the cause to be lack of knowledge in storing seed. They stated that much seed is wasted during collection due to premature seed or overdue collections (lack of timing).

Better skills in tree seed source management could ensure more and better seed. 27% of respondents indicated that since most of the trees they need are present on fields it might be appropriate to acquire knowledge on how to use and maintain these trees in order to harvest seed from them.

5. Discussions

5.1 Organisations as tree seed suppliers

Many *organisations* provide tree seed free of charge to motivate farmers to promote agroforestry and to improve farm forestry practices. The system works well, quality seed is distributed and comprehensive planting efforts have taken place in the area over the past two decades. However, inasmuch as seed is made available to nurseries and farmers during various projects, efforts should be made to ensure the security or self-reliance of the farmers to sustain the seed access beyond a project's life span.

All the *organisations* dealing with farmer and community groups indicated in the survey that dealing with farmer groups is a cost-effective way of reaching more farmers/planters within a short time. This assertion is true considering the number of nurseries and individual farmers these *organisations* claim to support and work with. However, the fact that most of these nurseries were not found or functioning suggests that support given to farmer-groups is not enough to keep nurseries running.

Most of the group nurseries previously supported by phased out projects were out of operation. Typical instances are the nurseries formally supported by CARE-DTC. These nurseries are not operating because the members claim they do not have enough resources and skills to collect and handle seed and also maintain nursery beds. There could be other factors, which have lead to the collapse of these nurseries such as lack of economic incentives, personal priorities, internal squabbles between members etc. However, the fact remains that there is a lack of follow-up mechanisms by *organisations* to verify possible lapses in mode of services to their different target groups.

5.2 Problems expressed by organisations supplying tree seed

The major challenge faced by *organisations* is the inability to reach their seed supply targets. This is not only a threat to promoting agroforesty but also a disincentive to farmers who subscribe to these technologies.

These circumstances may not have arisen if *organisations* were vigilant and collaborative and thus avoiding duplication of activities. This situation has arisen as a result of *organisations* showing very little consideration for the work of others in the same area. More often, they initiate and implement the same agroforestry technologies, which implies competing for the same scarce species from the same seed sources at the same time.

One side effect of duplication observed was the 'sit-down-and-wait' attitude of farmers towards procuring seed from elsewhere other than from *organisations*. Thus some farmers have developed the attitude that if *organisation* A does not deliver seed, then B will. This phenomenon was widespread during the survey. Respondents were

typically blaming *organisations* for not supplying enough seeds the previous season, hence their inability to expand planting to more plots.

Almost all the *organisations* complained about being under-staffed. This impedes extension since the nature of the work demands a lot of man-hours to disseminate information and equipment to target groups in the area. It was therefore not uncommon during the nursery and farmer surveys to hear respondents complaining about the long waiting time in information flow.

Insufficient donor funding was mentioned as the main factor contributing to constraints such as under-staffing or low human resources and inadequate seed supply. *Organisations* contended that budgets cut by donors has lead to their inability to employ more staff to execute extension activities in the villages and also import seeds from distant areas to supplement what is obtained in the area.

Lack of enforcement of by-laws by local government to curb uncontrolled grazing is another major challenge to effective establishment of tree nurseries and tree stands for that matter. Most of the species introduced by the organisations are possible fodder for livestock. The fact that most nurseries are not fenced means unwanted visits of livestock from the neighbourhood. The ruminants destroy most of the seedlings and also the seed. They sometimes go to the extent of browsing on the hedges and the small trees. This is a problem for nurseries, farmers and *organisations* since with each seedling that is destroyed there is an additional demand for seed to compensate the loss.

This situation is unfortunate because it is the responsibility of local government to create an environment for proper implementation of farming activities, even though farmers also have a responsibility to protect their investment. According to the NEMA officer there are no established procedures at the moment to enforce the existing by-laws.

5.3 Nurseries as seedling suppliers

Nurseries supply a substantial amount of seedlings. However, relying on group nurseries alone is not effective in terms of covering a wider area since they tend to cover a small area compared to private and central nurseries. However, they are cheaper to establish than bigger nurseries.

Apart from its small coverage area, the complications involved in the social dynamics within these groups cannot be ignored. Group members expect more from the group and the leaders in terms of proper information flow, monitoring and evaluation of beds and proper distribution of seedlings. Failure may lead to collapse. It was therefore not unexpected that all the nurseries recorded to be out of operation were group nurseries. This suggests that using groups as entry points into areas for seedling distribution is not enough to ensure continuity and wide coverage of seedling supply.

Individual farmers could provide a better alternative by producing seedlings and collecting, trading and/or swapping seed. They have less internal problems and

the most innovative are highly motivated to raise own seedlings. Hence, focusing mainly on individual farmers will ensure a higher rate of production and a high margin of sustainability.

5.4 Motivation to acquire and disseminate seed

Farmers motivations for planting trees can be classified into three forms, (1) the ability and capability to have easy access to the propagating material, (2) access to sufficient technical skills to retain and reproduce them and (3) the ability to sell the ensuing product. From the nursery and farmer surveys, it was clear that farmers and nurseries surveyed were not having adequate access to these basic motivating factors.

In Kabale a lot of effort is being put into tree related activities by both government and NGOs. Yet none of these efforts are actually geared towards putting in place permanent structures and institutions to deal with regular tree seed supply to farmers as it is done with agricultural crops. Instead these governmental agencies, CBOs and NGOs focus on handing out very limited quantities of tree seeds to farmers without either fulfilling the immediate demand or envisaging the future demand for species as a response to adoption.

Lack of tree seed was always linked to the lack of established tree stands of the species being promoted. Farmers contend that tree stands of species like *Eucalyptus*, *Acacia mearnsii* are abundant in the landscape, hence it makes it easier for them to collect seeds as well as wildings for propagation. However, the situation becomes difficult when one tries to go beyond these species and find newly introduced and heavily promoted species like *Grevillea robusta* and *Calliandra calothyrsus*. This is because there are few stands and also there is no local knowledge for collection.

For instance, farmers claim that they cannot determine how to collect seeds of Calliandra calothyrsus, considering its usefulness. It has been introduced as a fodder species and also for soil fertility replenishment. Being a fodder tree, branches are often cut to feed animals thereby reducing its ability to produce enough seeds. Meanwhile, the few stands, which are sometimes left, serve very little purpose for seed production since farmers do not know when to collect mature seeds before the pods open and the seeds dispersed.

A lot of seeds are therefore lost every season due to the inability of farmers to collect them. This situation is unfortunate since farmers have always demonstrated the ability to collect and reproduce seeds they cultivate when they are given the necessary information needed for the procedure.

Farmers complained about low viability of most of the local species, which they collect from farmlands and forest areas. This situation may be linked to the fact that farmers lack the skills of timing and storage, i.e., when to collect and how to handle them. Therefore, most seeds collected are unproductive or lose their vigour during storage. A typical example given was *Markhamia lutea*, which farmers reported that they tend to get no germination upon sowing.

Aside from the lack of seeds and technical problems, the lack of market and market information on tree seeds/seedlings has relegated the market potential of this venture to only a few private nurseries and individual farmers. The idea of making profits from the sale of tree seeds and seedlings is virtually non-existing for farmers who receive them free of charge. To these farmers there is an attitude that tree seed are goods that should be handed or collected free of charge and no effort put into marketing.

However, farmers who make the effort of collecting their own seeds from their farmlands have a higher perception of selling tree seeds or seedlings compared to those who receive them for free. The major obstacle faced by these farmers is the lack of market especially for smaller quantities of seed of less than 1kg. This is because this kind of business has not been developed by the farmers or between farmers and any established agency in the area.

Nurseries and farmers alike do not have strong networks to facilitate the flow of market information, hence there is little motivation for farmers to produce tree seed or seedlings. This has been due to the absence of an initiative, which encourages production and sale of tree seed or seedlings. Another reason is the rugged terrain found in the area which hampers road transport, especially in the western and north-eastern areas.

5.5 Farmer perception of seed availability, acquisition and dissemination

Organisations promoting agroforestry tend to make farmers rely on them. In a bid to promote their technologies in a very short period they tend to make farmers rely on them to ensure increase in the adoption rate of their technology without ensuring long-term sustainability. This problem was manifested by farmers during the direct field observation where several farmers reported that they could not collect seed from mainly the exotic species due to their inability to time seed maturity and the opening and dispersal of seeds for species like *Callindra calythyrsus*.

Even when they are able to collect a few, they have no knowledge of how to store them to maintain viability. This is an unfortunate predicament since most *organisations* dealing with tree seed have expertise that is capable of alleviating this problem.

Farmers who locally collect seed however, provide a positive contrast. They also possess better skills. The perception of farmers in this category that technical information was inadequate was much lower (OR=0.6) as compared to the rest. This implies that this category of farmers has fewer problems with seed collection and handling. The interpretation is that farmers collect species in which they have acquired some knowledge over the years. Any species which appear difficult to deal with will be left out in order to minimise risk.

Given the opportunity and experience, farmers have the ability to learn and develop the technical skills needed to produce tree seeds. Farmers have demon-

strated this feature in relation to agricultural crops by retaining grain/seed for multiplication season after season. This ability of farmers has to a large extent led to the establishment and spread of various varieties of agricultural crops.

Farmers' ability to produce their own seed also provides them with the confidence to share part of these seeds with their neighbours. This assertion is supported by the finding that farmers who collect their own seed from farmlands share more often and willingly and rely on themselves for seed production.

This observation does not imply that *organisations* should be discouraged from supplying seed. On the contrary, they should be encouraged since they are dealing with a range of crucial and difficult species. They should also play an enabling role by enlightening farmers on species identification and collection in the farming system.

6. Conclusion

Agroforestry is still controlled by projects and *organisations* working with tree planting since they supply a substantial amount of free tree seed to nurseries and farmers. However seed supply is not enough to satisfy demand.

In order to supplement seed some farmers and nurseries make their own local collections and also exchange seed with neighbours. In addition, some farmers receive seeds from governmental institutions and some buy from local markets. The latter two sources of seed have little impact as compared to the supplies obtained from *organisations*, own collections from farmlands and seed exchange with neighbours.

Despite the efforts of farmers and nurseries to find alternative sources of seed they reported that it is difficult to meet demand. The crucial bottlenecks observed were the lack of established tree seed sources coupled with the inability of farmers and nursery operators to collect their own seed.

With regard to seedling supplies, it is mostly done by four categories of nurseries among which are group nurseries, private small and large-scale nurseries, and ICRAF/AFRENA nursery. Seedling supply by group nurseries is in the form of seedling disbursement to members over a small coverage area at no cost. Comparatively, private small and large-scale and ICRAF/AFRENA nurseries cover relatively wide areas. Group nurseries were found to be very dependent on *organisations* for free seed supply as compared to the other categories.

Organisations hand out free tree seeds to target groups but the sustainability of these supplies is questionable. Farmers and nurseries are motivated to adopt agroforestry technologies, which go with the provision of seed. However, technical skills given in addition to seed are not sufficient to cover eventual seed production of the species supplied.

Hence, the majority of target groups who depend on free seed are incapable of providing their own seed. Instead, they become dependent on free seed from *organisations* whose activities are driven by project budgets that are short lived.

Another drawback of long term free seed distribution is that seed markets have not been able to emerge fully due to the farmers' and nurseries' expectations of having seed at no cost.

This is not incentive to a reliable seed supply system and adoption of agroforestry technologies since research in other areas of seed dissemination has established that farmers are more motivated to adopt varieties that they can consume and sell. Hence, initiatives are destroyed when marketability of seed/seedlings is limited.

None the less, some farmers and nurseries demonstrated the feasibility of a self-sustained seed supply system through collecting, sharing and selling tree seed and seedlings. There is a high tendency among self-collecting farmers and nurser-

ies, to share and/or sell seed and seedlings, as compared to those who receive seed free of charge.

Therefore there is the need to encourage and strengthen this attitude so that sufficient skills are developed to change attitudes to enable farmers and nurseries to be independent in own seed production.

This does not imply that *organisations* with capabilities should be excluded in the process. Those with knowledge in species which are difficult to produce by farmers can play a role in supplying farmers at a cost. By so doing seed supply from farmers and organisations will compliment each other and ensure sustainability.

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Appendix 1 - Way forward

To develop a reliable and sustainable tree seed system there is the need to ensure complimentary relationship between local and formal sources of supply. However, the question still remains that how does one share responsibilities or create an enabling environment in order to put this system to work.

Developing a tree seed system, which is cost-effective and relatively self-sustaining to encourage farmers' willingness to adopt and maintain, involves a collaborative effort of donors, governments, the private sector, NGOs, CBOs, seed producers (farmers and nurseries), and consumers. All these stakeholders need to be linked in a reliable network that will draw on each other's strengths to establish such a system.

Donors dealing with sustainable agriculture and forest management can contribute to a reliable tree seed supply system by supporting projects that will provide long term and effective training programme for producers. These programmes may include training designed to provide adequate technical skills to prospective tree seed producers in seed collection and handling, formation of tree seed network to promote demand and sales.

Governments on their parts have a bigger role to play by providing an environment that makes tree seed attractive to producers and consumers. Thereby classifying tree seeds as a public good and providing incentives for individuals and organisations dealing with production. These may include:

- equipping district forestry offices with the expertise and means to transfer technical skills to tree seed producers
- create tree seed depots in districts to serve as sources of seed supply and also to buy from producers
- provide forum for tree seed production, marketing and networking

The private sector can contribute by providing a market for sales both locally and nationally as a way of motivating production. This may be done through the creation of tree seed buying outlets in producing areas. These outlets will serve as cells where producers can deliver their produce for sale. If this system is well organised, prices of seeds can then be regulated through proper monitoring of demand and supply.

NGOs and CBOs may also contribute to the delivery system by providing the following services in their activities:

- providing expertise to mobilise and train producers in tree seed production
- promoting seed/seedling markets for local producers
- creating network between seed collectors and potential buyers

The collective activities of all possible stakeholders in a tree seed supply system may be put in three broad approaches for a sustainable system. These include:

- Organisational approach

- Community-based approach
- Farmer based approach

In the **organisational approach** donors and governments are required to provide the environment for building strong capacities in the private sector and organisations (NGOs and CBOs) dealing with natural resource management. This should include providing them with adequate funding to enable them achieve their targets. Funds for the private sector could be used to provide small loans for seed producers and also create markets for them.

Funding for organisations could be used to establish own seed sources and create networks between target groups to facilitate information dissemination. It could also be used to improve technical expertise in order to provide services in skill improvement in tree seed source establishment and management, tree seed collection and handling for seed producers.

This approach functions on two preconditions (1) there is a donor willing to invest in tree seed system and (2) a private sector and an organisation dedicated to tree seed supply. The aim of this approach is to ensure that seeds delivered to farmers include sufficient information that will enable farmers to make own production to consume and sell after a certain period of time.

The advantage of this approach is that:

- it provides quality information in addition to seeds being given
- farmers can learn from each other through networks
- it provides a source of market for seeds produced

The disadvantages are that:

- tree seed dissemination will still be dictated by project objectives
- farmers will only get access to technical information on species being introduced by organisations
- only few farmers will get the opportunity to receive seeds and information since organisations always have a limited target of participants

The community-based approach entails developing tree seed systems through self-help projects by building capacity at community level to facilitate an effective and reliable seed distribution. It involves setting up community interest groups in tree seed source establishment, identification of species appropriate in the landscape that are preferred and can be used by members, nursery and seedling management, etc. Information on seed collection and handling could be sought from district forestry department or other organisation engaged in tree planting.

A strong network could be established between the various interest groups in the communities to ensure information exchange. Members could share seeds obtained through the activities of the group and they could also establish their own nursery beds. This approach is appropriate in areas where there are few organisations working with natural resource management.

The approach is based on three preconditions: (1) there should be an available funding in the communities that could be used to mobilise and facilitate group activities (2) there should be already existing tree stands (3) there should be a source where information on the various activities could be accessed.

The advantages of this approach is that it:

- ensures a readily available supply of seeds due to established sources
- exposes members of different interest groups to information from other groups through the network
- utilises local stands which means the use of species which are familiar to members
- depends on local knowledge of members as the background for further improvement

The disadvantage of this approach is:

- high initial funding is needed to start interest groups
- difficulties in mobilising members
- internal conflicts of interest between members

The farmer-based approach involves building individual capacities for self-mobilisation and self-reliance in tree seed supply. This approach is based on the demonstration by farmers that given adequate knowledge about the species in question they have the ability to produce and share information with others (farmer-to-farmer extension).

It entails embarking on a mission to train farmers in where they can obtain species of their choice, after which efforts could be made to encourage on-farm tree stands for seed production. These farmers can then be used in later stages to educate others through farmer-to-farmer information exchange.

This approach has two preconditions: (1) there is a source of technical expertise readily available for farmers to improve local knowledge in identifying, collecting and handling of tree seeds and (2) there are willing farmers ready to learn and improve upon their local knowledge base

The advantages of this approach are that it:

- thrives on existing motivation and reduces the chances of failure
- provides dynamic farmers with the opportunity to access and transact in tree seed
- provides alternative income to farmers when excess seeds are sold
- provides a broad base of seed sources for tree related technologies
- demystifies the idea that tree seeds are difficult to handle, since farmers will be exposed to all the necessary techniques involved in collecting and handling their preferred seeds

Its main disadvantages are that:

- it needs external funding for farmer training
- it requires free supply of initial seed
- it requires a good system of monitoring

The success of each of the approaches depends on the availability of external donors, be it governmental or non-governmental, with the capacity to provide funding for proper implementation. In each of the approaches the major focus is on strengthening a particular target group by providing the required input for capacity building. However, there is also inter-dependency between the various approaches.

Organisations require willing farmers in order to proceed with capacity building. Communities need willing members in order to function as groups while individual farmers need capable organisations and enabling communities to promote their activities. Therefore, in choosing an approach one needs to decide on which of the three will be direct and suitable to the prevailing circumstance in the area in question.

This implies that an approach that provides a wider range of possibilities for seed availability through self-initiation and reliance will be appropriate. Farmer-based approach even though it involves a higher initial cost it also promises a future of easy accessibility of tree seeds and an assurance that technologies related to trees will be without seed problems.

How realistically this can be done depends on how extensively farmers are informed of the technicalities involved in seed stand establishment, seed collection and handling. This will then go a long way to improve the message carried across during farmer-to-farmer information exchange, i.e., if reliable links are created between farmers in the process.

Appendix 2 - Species wanted by farmers and nurseries but not available

Species	Local name	Farmers	Nurseries
Acacia spp.		X	
Albizia			X
Araucaria spp.		X	
Azadirachta indica			X
Dracaena reflexa			X
Ehretia cymosa	enkoba	X	
	empwewere	X	
Euclea divinorum	omusikizi	X	
Ficalhoa laurifolia			X
	fortunel	X	
Fruit trees		X	
	hubere	X	
Khaya sp.p		X	X
Lovoa spp.			X
Macaranga kilimandscharica	omushasha	X	
Mitragyna stipulosa	engomera		X
	myrica	X	
Noxia congesta	omubuzigye	X	
Polycias fulva	omungo		X
Prunus africana	omumba		X
Ricinus communis	ekishogashoga		X
Terminalia			X
	omuhika	X	
	omuvure	X	
	omunyama	X	
Croton macrostchyus	omurangara	X	X
	omulama	X	
	omitimi	X	
	omushayu	X	
	omukusu	X	
	omujugangoma	X	
	omusoroza	X	
Entandophragma excelsum	omuyovi		X
Faurea saligna	omurengyere		X
Podocarpus milanjianus	omusenene		X
Dodonaea angustifolia	omushambya		X

Appendix 3 - Uganda map showing location of Kabale district

Appendix 4 - Checklist for organisational interviews

Date and location of interview:				
Name of institution and position of interviewee:				
Introduction: Introduce the purpose of the survey				
Basic knowledge:				
1. Main objectives and main activities of the organisation				
2. Target groups and beneficiaries				
3. Source of funding (government? Customers? Other?)….				
4. Structure of organisation and number of staff				
5. Main areas of work: Put on map!! *Parish* ☐ *Sub county* ☐ *County* ☐				
Seed and seedlings: Supply and demand				
6. Main activities related to trees, seed and seedlings				
7. Types of agroforestry/tree planting and species they are promoting				
8. How do you make decisions on what species and technologies to promote				
9. How do you determine the suitability of species for different areas (planning, sources of information, implementation				

10. How do you promote seed/seedling production and distribution							
11.a Seed species	**Purchase from**	**Local source**	**Who collects**	**Type of source (farmland, forest, etc.)**	**Time of collection**	**Quantity seeds (kg) per season/year**	**Quantity seedlings per year/season**

11.b. How do you estimate demand and plan for collection/purchase of seed.

11. c. How do you ensure quality of seed (drying/storage) *Drying* *Storage*
12. How do you organise distribution/marketing of seed *Distribution* *Marketing*
13. Who are the main customers or recipients for seeds/seedlings *Seeds* *community groups* *individual farmers* *nurseries* *other projects* *Seedlings* *community groups* *individual farmers* *nurseries* *other projects*
14. Does supply cover demand (timeliness, quality, quantity) – **by species**
15. Are there species that you would like to promote but cannot get the seeds/seedlings Species

16. Do you support nursery activities

a. If yes, ownership forms (community, individual, etc.)

b. In which ways do you encourage nurseries?

- information support,
- inputs

c. How many nurseries do you support in your areas of work?

d. What are the seedling production numbers in the supported nurseries

- How much seeds/seedlings do you give to the nurseries
- How many seedlings are produced by the nurseries

e. Are there other nurseries in your areas of work (not directly supported by you)?

f. Others...

Sustainability aspects
17. How do you link up with extension services and other public agencies within the area

18. Do you support farmers in seed production (Seed source management, processing, and storage)

19. Has your organisation identified existing community organisations involved in developing local seed supply systems

19.a Are you involved in any networks of these organisations

19.b Do you train tarmers/farmers' organisations in business skills

20. Additional flows of information

- *How do you get the information you need to carry out your tasks?*

Research
Farmers needs and priorities
If not: what kind of information do you need?

21. What are the Government rules/regulations/policies/incentives that are beneficial/ detrimental to your work with seeds and seedlings to farmers

22. General situation related to trees, seed, and seedlings (Organisation's own view)

a. Main constraints for carrying out activities

c. Main strengths of this institution

d. Main weaknesses of this institution

e. Main opportunities

Appendix 5 - Diagnostic nursery survey questionnaire Kabale - Uganda

Introduction: the objectives of this survey are to understand the operations of tree nurseries in the area, determine their operational activities, determine the market potential in tree seedlings, build a nursery operators network in the area to facilitate information exchange.

1. Date _____ **2002**

2. Nursery _____

3. Nursery category: private ❑, group ❑, central ❑

4. District _____

5. Subcounty _____

6. Parish _____**6a. Village** _____

7. Land title holder _____

8. Caretaker/representative _____**Position:**_____

9. Number of group members _____

10. Size of nursery _____

GPS coordinates
Latitude_____ S
Longitude_____ E
Altitude _____ m.a.s.l.

11. Species currently in nursery, their origin and general condition

Species	Do you use seeds, cuttings or wildlings?	Where did you get the seed?	If collected: From where	Why do you collect these species?	How many seedlings are in nursery?	What are seedlings for and who gets them?		
						own use	give away free	sell

12a. Which constraints and problems do you face in your nursery?

seed availability ❑, not enough water ❑, lack of technical knowledge ❑, lack of marketing knowledge ❑, lack of technical/financial inputs ❑, theft of seedlings ❑, other_____

12b. Which is the most important of these? _____

13. How far do the farthest clients encountered come from?

Place and estimate distance in Km/hours walking _____

14. Which species would you like to produce but not available: - List in order of priority?

Species	why are not available	why do you want to produce them

15. Are you in contact with other nursery operators in this area?

Yes ❑, No ❑. If yes, please how is it helping you?_____

16. How did you learn to operate a nursery?

17. Are there any specific nursery operations you will like to learn? Yes ❑, No ❑. If yes, please state them?_____
_____

18. Have you had any contact with relevant organizations in the past year?

NGOs ❑ Forest Department ❑ Ministry of Agriculture ❑ ICRAF ❑ ❑ others_____

19. Have you got any questions or comments?

20. Other general relevant observations by the enumerator:

THANK THE FARMER FOR HER/HIS TIME !!

Appendix 6 - Diagnostic farmer survey questionnaire Kabale

Introduction: This questionnaire is designed to determine farmers needs and priorities with respect to tree seeds and seedlings and their distribution channels. All categories of farmer, i.e., small-, medium-, and large-holder farmers will be interviewed to find out which of these categories contain farmers involved in seed supply.

1. Date _____ **2002**

2. Farmer _____

3. Farmer category: smallholder ❑, medium ❑, large ❑

4. District _____

5. Subcounty _____

6. Parish _____ **6a. Village** _____

7. Land title holder _____

8. Size of farmer plot: cultivated_____, **fallow-land**_____, **untouched**_____

GPS coordinates
Latitude_____ S
Longitude_____ E
Altitude _____ m.a.s.l.

Farming practices

9. How do you obtain seeds and other planting materials for sowing? _____
_____
_____

10. Which kinds of seeds and other planting materials (agriculture, horticulture and tree) do you produce by yourself?

_____

_____

11. Species currently on farmers plot, their origin and general condition

Species	Do you use seeds, cuttings or wildlings?	Where did you get the seed?	If collected: From where	Why do you collect these species?	Do you produce your own seeds/seedlings?	What happens to seeds/seedlings produced?		
						own use	give away free/who	sell

12a. Which constraints and problems do you face in getting tree seeds/seedlings ?

seed availability ❑, lack of seed source ❑, high cost ❑, lack of technical information on tree seeds/seedlings ❑, other_____

12b. Which is the most important of these? _____

13. Which species would you like to have on your field but not available: - List in order of priority?

Species	why are they not available?	why do you want to have them?

14. Are you in contact with other farmers in this area?

Yes ❑, No ❑. If yes, please how is it helping you?

_____

15. Have you had any contact with relevant organizations in the past year in connection with tree seeds/seedlings?

NGOs ❑, Forest Department ❑, Ministry of Agriculture ❑, ICRAF ❑, others ❑

_____

16. Have you got any questions or comments?

17. Other general relevant observations by the enumerator:

THANK THE FARMER FOR HER/HIS TIME !!

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