REPORT ON A SURVEY TO IDENTIFY SUITABLE AGRICULTURAL AND NATURAL RESOURCES– BASED TECHNOLOGIES FOR INTENSIFICATION IN SOUTHWESTERN UGANDA

Thomas Raussen
Frank Place
Wilson Bamwerinde
Francis Alacho

A Contribution to the Strategic Criteria for Rural Investments
in Productivity (SCRIP) Progtam of the USAID Uganda Mission

The International Centre for Research in Agroforestry (ICRAF)
United Nations Avenue, P.O. Box 30677, Nairobi, Kenya

The International Food Policy Research Institute
2033 K Street, N.W. Washington, D.C. 20006

March 2002

Strategic Criteria for Rural Investments in Productivity (SCRIP) is a USAID-funded program in Uganda implemented by the International Food Policy Research Institute (IFPRI) in collaboration with Makerere University Faculty of Agriculture and Institute for Environment and Natural Resources. The key objective is to provide spatially-explicit strategic assessments of sustainable rural livelihood and land use options for Uganda, taking account of geographical and household factors such as asset endowments, human capacity, institutions, infrastructure, technology, markets & trade, and natural resources (ecosystem goods and services). It is the hope that this information will help improve the quality of policies and investment programs for the sustainable development of rural areas in Uganda. SCRIP builds in part on the IFPRI project *Policies for Improved Land Management in Uganda (1999-2002)*. SCRIP started in March 2001 and is scheduled to run until 2006.

The origin of SCRIP lies in a challenge that the USAID Uganda Mission set itself in designing a new strategic objective (SO) targeted at increasing rural incomes. The *Expanded Sustainable Economic Opportunities for Rural Sector Growth* strategic objective will be implemented over the period 2002-2007. This new SO is a combination of previously separate strategies and country programs on enhancing agricultural productivity, market and trade development, and improved environmental management.

Contact in Kampala
Simon Bolwig and Ephraim Nkonya
IFPRI, 18 K.A.R. Drive, Lower Kololo
P.O. Box 28565, Kampala
Phone: 041-234-613 or 077-591-508
Email: E.Nkonya@cgiar.org
S.Bolwig@cgiar.org

Contact in Washington, D.C.
Stanley Wood, Project Leader
IFPRI, 2033 K Street, NW,
Washington, D.C. 20006-1002, USA
Phone: 1-202-862-5600
Email: S.Wood@cgiar.org

TABLE OF CONTENTS

TABLE OF CONTENTS i
LIST OF FIGURES ii
LIST OF TABLES iii
ACRONYMS iv
1.1 Background 1
1.2 Objectives of this study 2
1.3 Implementation of the study 4
1.4 Outline of report 4
2. Agroecological Zones of Southwestern Uganda 6
2.1 Agroecological zones of southwestern Uganda 6
2.2 Crops, livestock, trees and main natural resources in the farming systems 9
2.3 Biophysical and socio-economic potentials and constraints of the farming systems 13
3. Assessment Framework 24
3.1 Proposed assessment method 24
3.2 Data needs and data availability 25
3.3 Gaps 27
4. Technology inventory 33
4.1 Crop options 33
4.2 Livestock options 43
4.3 Natural Resources Management options 46
4.4 Applying the assessment framework on the technologies 48
5. Recommendations and the way forward 56
5.1 Operationalizing the framework 56
5.2 Making options available to farmers 57
5.3 Soil management as a crosscutting issue 64
5.4 Trees and forest products 65
5.5 Markets, processing and prices 66
References: 72

LIST OF FIGURES

Figure 1.1 IFPRI recommendation domains for intensification in SW Uganda 3
Figure 2.1: Highland farming systems of southwestern Uganda suitable for intensification. 7
Figure 2.2: Land-use maps for Kasese and Bushenyi Districts 8
Figure 2.3: Percentage of subcounties identifying particular environmental constraints in Kasese District 14
Figure 2.4: Environmental concerns in Kasese District. 14
Figure 2.5: Time series price analysis for *matoke*..... …… ……17
Figure 2.6: Time series price analysis for maize……17
Figure 2.7: Weekly prices in Kasese……..18
Figure 2.8: Market Activity in Bushenyi District as Proxied by Government Revenue from Market Centres 20
Figure 3.1: Integrated Natural Resource Management Framework 29
Figure 4.1: Potential number of crop options vs those found in use 34

LIST OF TABLES

Table 2.1: Area and population data of southwestern 6
Table 2.2: Crop production area in 7 districts of southwestern Uganda. 9
Table 2.3: Food crops in Southwestern Uganda, annually cropped total area [ha] per farming system, % of cropped land (cL), % of area of the FS 11
Table 2.4: Livestock numbers in 7 districts of southwestern Uganda..... 12
Table 2.5: Frequency of Market Gluts and Shortages in Kasese District, 2000 (n=47 weekly observations) 19
Table 3.1: "Ideal" Technology Assessment Tool 30
Table 3.2: Pragmatic matrix for evaluating potential win-win technologies 32
Table 4.1: Crop options for SW Uganda……..33
Table 4.2: Annual crops in SW Uganda……...35
Table 4.3: Perennial crops in SW Uganda……40
Table 4.4: Livestock in SW Uganda……44
Table 4.5: Natural resources management in SW Uganda……...47
Table 4.6 Detailed scoring matrices for technologies in SW Uganda……. 50

ACRONYMS

AHI	African Highlands Initiative
ARDC	Agricultural Research and Development Center
ASARECA	Association for Strengthening Agricultural Research in East and Central Africa
CBO	Community Based Organization
CIAT	Centro International de Agricultura Tropical
COBS	Conserve Biodiversity for Sustainable Development Project
Ecotrust	The Environmental conservation Trust of Uganda
FORRI	Forestry Resources Research Institute
GDP	Gross Domestic Product
GOU	Government of Uganda
GIS	Geographic Information Services
HPI	Heifer Project International
ICRAF	International Center for Research in Agroforestry
IDEA	Investment in Development of Export Agriculture Project
IFPRI	International Food Policy Research Institute
KPSPC	Kabale Private Sector Promotion Center
KARI	Kawanda Agricultural Research Institute
M & E	Monitoring and Evaluation
MOU	Memorandum of Understanding
NAADS	National Agricultural Advisory Services
NARO	National Agricultural Research Organization
NGO	Non Governmental Organization
PMA	Plan for Modernization of Agriculture
SPEED	Support for Private Enterprise Expansion and Development Project
UFSI	Uganda Food Security Initiative
UGADEN	Uganda Agroforestry Development Network
USAID	United States Agency for International Development

1. Introduction

1.1 Background

USAID – Uganda has recently developed a six-year integrated strategic plan (ISP 2002-2007). A key ingredient of this plan (USAID, 2001) is the economic growth and environment-oriented strategic objective 7 (SO7): "Expanded sustainable economic opportunities for rural sector growth". It intends to support the people of Uganda to develop more effective and environmentally sound land use systems to reverse the country's long-term decline in environmental quality and agricultural productivity.

To help inform its strategy, USAID requested the International Food Policy Research Institute (IFPRI) to prepare a strategic framework for rural land-use in Uganda. IFPRI's approach to assessing strategic land use options for Uganda involves answering seven clusters of questions in sequence (Bolwig et al, 2001):

(1) What are the best land use options at different locations from the 'private' perspective of farmers and communities?
   - ⇒ *IFPRI characterized development pathways on the basis of combinations of population density, agroecological conditions and access to markets. Among others, results show that primary areas for agricultural intensification are located in southwestern Uganda and in a west to eastward widening band around Lake Victoria, while agricultural expansion is likely to occur in the north.*
   - ⇒ *This study attempts to analyze components of this strategy, such as suitable agricultural technologies and associated management options for agricultural intensification in various areas of southwestern Uganda.*

(2) What are the implications of these privately driven land uses for agricultural production and income within the adopting regions and for sector-wide production, trade and income, food prices and food consumption?
   - ⇒ *Using its DREAM model, IFPRI will estimate the sector-wide impact of alternative land use strategies. This will be useful for priority setting among investment options.*
   - ⇒ *This study evaluated various agricultural technologies and their impact on income / welfare, productivity and environment. This detailed information could further fine-tune information from the DREAM model.*

(3) How might the privately driven land uses conflict with broader environmental goals of the country and can "hot spot" areas with high potential for conflict between private and environmental goals be identified?
   - ⇒ *Overlaying maps of best private land-use options with maps of environmentally-desired ones, IFPRI identified potential "hot spots" as those with high potential of conflict between land-use and environmentally important areas.*
   - ⇒ *Information from this study provides a detailed analysis about technologies and their environmental impacts under various management options and in various agro-ecological zones.*

(4) What kinds of policies and interventions could avoid such potential conflicts?
   - ⇒ *In phase II of its work, IFPRI will analyze ways of changing incentive structures so as to promote sustainable development pathways without jeopardizing local livelihoods.*

⇒ *This study describes environmental policies and priorities by local councils in various districts of southwestern Uganda*

(5) Once best land uses have been identified for each area, what would be the implications for sector-wide production and income, national food prices and food consumption?
   ⇒ *Using its DREAM model, IFPRI will estimate wider market and trade impacts of various land-use options.*
   ⇒ *This study concentrated on individual agricultural technologies.*

(6) Where should USAID choose to focus its own land use development efforts?
   ⇒ *Using criteria such as: economic growth potential, environmental hot spots, incidence of poverty, population density, infrastructure and market potential, IFPRI developed a scoring matrix providing the basis for selecting specific geographic areas for development that best match USAID'S strategic priorities.*
   ⇒ *This study provides detailed information on some specific technological options for specific farming systems, altitudes etc. and attempts to rank the most promising ones.*

(7) How can progress be measured?
   ⇒ *In phase II IFPRI will identify community, market, sector, resource and ecosystem level indicators that could be monitored to assess changes in socio-economic and environmental conditions.*
   ⇒ *This study was confronted with variable data sets in the different districts and many data collection mechanisms by NGOs and others. Monitoring future work in southwestern Uganda would benefit from investment in more uniform data sets.*

Based on a consultative process that included the information generated by IFPRI, USAID SO7 defined four key results:

(1) Increased food security for the vulnerable;
(2) Increased productivity of agricultural commodity and natural resource systems;
(3) Greater competitiveness of enterprises; and
(4) A stronger enabling environment for broad-based growth.

1.2 Objectives of this study

The SO7 strategy emphasizes (p.38) that: "Farmers need concrete examples and incentives to increase their productivity. This will require viewing food, cash and export crops holistically, from production through value-adding processing to marketing. Further sustainable resource management must be integrated into production systems in order for change to occur."

In a nutshell, the objective of this study is to develop and test a methodology to identify potential win-win (income/food – environmental goods) technologies and to apply it to the southwest of Uganda, which has been identified as a priority area of SO7.

IFPRI's work had identified southwestern Uganda as one of the prime areas where agricultural intensification is the most promising development pathway. Using a few important commodities, IFPRI assessed their requirements depending on combinations of population density, agroecological conditions and access to markets. One of the outputs was a map highlighting areas for intensification. Figure 1.1 shows the southwestern part of this map, which shows that the most promising development pathway in all areas with a population density above 100 persons km^{-2} is

the intensification of agriculture. Such high population density is usually found in southwestern Uganda at altitudes above 1400 m.a.s.l.

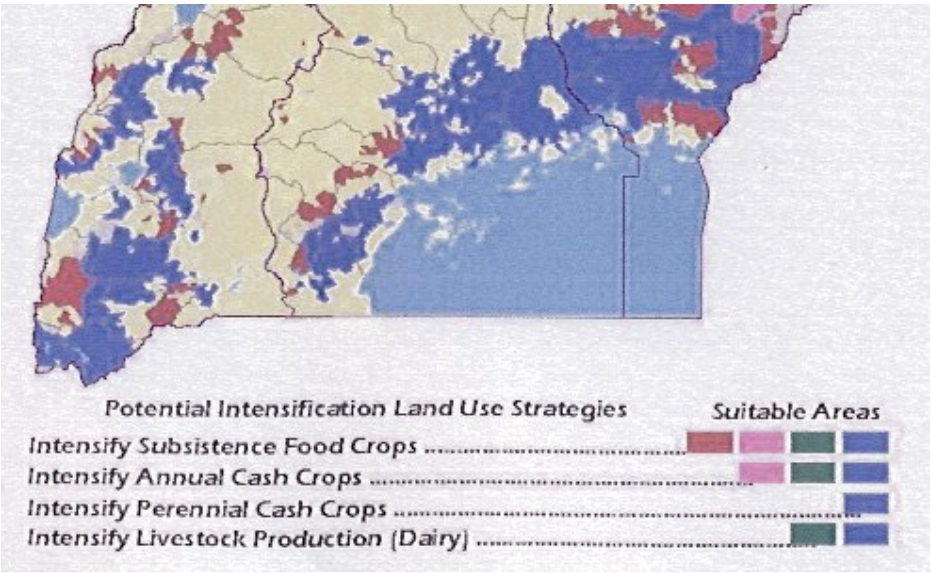


Figure 1.1 IFPRI recommendation domains for intensification in SW Uganda

For the development of a southwestern Uganda project, more information is required on the following questions:

- what are the commodities suitable for intensification in the southwest?
- where are they most suitable in the southwest?
- how can they be identified?

IFPRI requested ICRAF to provide support in answering these questions, given ICRAF's long history of working in southwestern Uganda.

In more detail, the expected outputs are as follows:

(1) A structure for compiling information about potential win-win technologies and practices, suitable for application in and beyond SW Uganda
(2) Inventory and characterization of technologies and practices judged to be successful in (some part or all of) SW Uganda, including:
   a) Nature of technology
   b) Assessment of scale of adoption
   c) Preconditions for likely success
   d) Type and scale of derived benefits
(3) A similar inventory of promising technologies or practices targeted for SW Uganda
(4) Exploring complementary practices in addition to individual ones. Often, success hinges upon the uptake of multiple techniques. In SW Uganda, for example, climbing beans require stakes.

To achieve the above, three prior outputs are needed:

a) An analysis/synthesis of the key environmental and socio-economic problems for the SW, both at household/farm scale and at village/catchment scale. This information is required in order to be able to identify "win-win" technologies – that is for what problems are we seeking "winners". For example, a practice might contribute to soil fertility improvement but not to soil erosion prevention.
b) Key conditioning factors for agriculture in the SW. For instance, most of the SW has similar small farm holdings. But in some places the extent and severity of land fragmentation is much greater than in others. Such types of differences will have a bearing on what technologies/practices are feasible or desirable for areas within the SW. The conditioning factors will also guide extrapolation from SW to other parts of Uganda.
c) Finally, it is important to characterize common farming enterprises and practices so that there is a baseline from which one may evaluate the potential success of new techniques and practices.

1.3 Implementation of the study

The leader of ICRAF's programme 1 'Natural Resource Problems, Priorities and Policies' assigned core responsibilities for this study to a survey team of 4 scientists:

Dr. F. Place	(Economist, ICRAF)
Mr. T. Raussen	(Agronomist, consultant, former ICRAF scientist in Uganda)
Mr. W. Bamwerinde	(Forester, Economist, NARO - FORRI)
Mr. F. Alacho	(Agronomist, NARO Secretariat [outreach])

Other ICRAF and NARO scientists assisted in various aspects of the study. The study was implemented between November 2001 and February 2002. Activities included:

- Review of relevant literature.
- Discussions with specialists for the various commodities to reveal recent developments in science and development work.
- Visits to the 7 districts of southwestern Uganda: Kasese, Bushenyi, Ntungamo, Rukungiri, Kanungu, Kabale and Kisoro. During these visits, discussions were held with district officials, NGO representatives and farmers. Relevant literature and statistics were collected and field visits conducted.
- Compilation of district profiles, covering aspects of demography, farming, technology, and natural resources, which formed the basis of the assessments.
- A midterm briefing / discussion at the USAID mission in Kampala that was attended by various stakeholders who contributed and commented on the preliminary results.
- Assessments of the technologies regarding their potential productivity gains, welfare implications, environmental impacts and recommendation domains.
- Compilation of the report.

1.4 Outline of report

Chapter 2 describes the farming systems of SW Uganda, including the biophysical and socioeconomic constraints and potentials. Appendix 1 contains the companion District Profiles. Chapter 3 introduces and discusses the assessment framework that is used in the study. Chapter 4 applies the assessment framework to major promising technologies in the SW. This provides detailed recommendations on the suitability of agricultural and natural resources-based

development options to support development towards rural sector growth. This is complemented by a more comprehensive and systematic treatment in Appendix 2. Finally, chapter 5 provides a summary of the usefulness of the framework and our technology assessments, which lead to detailed recommendations on potential win-win interventions..

2. Agroecological Zones of Southwestern Uganda

2.1 Agroecological zones of southwestern Uganda

Southwestern Uganda is home to over 3 million people living on about 14,500 km^2 of land, leading to an average population density of 287 people km^{-2} (see table 2.1). As mentioned in the first chapter, the densely populated area with bimodal rainfall, relatively fertile soil and in general moderate to good access to markets is well suited for intensification of all farming enterprises with only few potential conflict "hot spots" with protected areas.

Table 2.1: Area and population data of southwestern Uganda

Districts	total area [sqkm]	settled area * [sqkm]	total estim. population by 2001	population density
Kisoro	730	702	260,000	370
Kabale	1,827	1,779	642,000	361
Rukungiri / Kanungu	2,752	2,583	584,000	226
Ntungamo	2,055	2,012	417,000	207
Bushenyi	4,026	3,656	805,000	220
Kasese	3,206	1,207	409,500	339
Total	**14,596**	**11,939**	**3,117,500**	
Average				***287.3***

* = total area – National Parks - Lakes

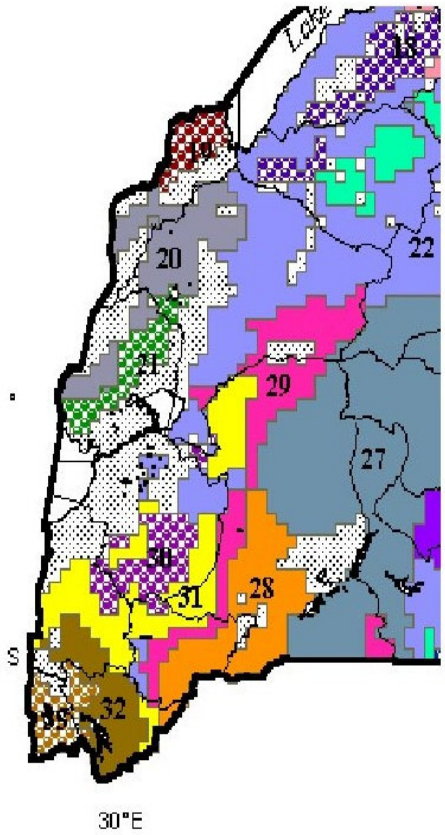
Uganda's southwest exhibits a good number of common features: bimodal rainfall, hilly terrain, relatively productive soils, moderate to high population density etc. However, local climate, soil and terrain interacted with farmers' traditions, preferences and markets, results in varied agricultural systems and land-use practices (Wortmann and Eledu 1999).

Aggregation of these farming systems can be conducted at various scales. At national level, NARO bases its agricultural research and development work on 12 zones for the whole country of which 3 are present in the southwest: the southern and western highlands and the southern lowlands. The areas suitable for intensification are however the highland areas.

For this study in the southwest of Uganda we found the farming systems delineation (33 for Uganda) described by Wortmann and Eledu (1999) particularly useful. A summarized description of the systems in the southwest is found in figure 2.1. Wortmann and Eledu considered three climatic variables, six soil variables, two population variables, four land-use types and ten food crops for the delineation. For planners with district-level responsibilities, this aggregation is still too coarse and various forms of district farming system maps were found or easily produced by the district extension staff. Two examples are presented in figure 2.2.

The southwest of Uganda is characterized by the Kigezi and Rwenzori mountain ranges separated by the Western Rift Valley. From the north to the south, average altitude increases from 1235 m.a.sl. to 2169 m.a.sl., which influences temperature and rainfall regimes.

Most land in southwestern Uganda is under household control (save for large portions of wetlands and some hilltops) and 80-90% is permanently held (the rest are seasonal rentals). Average farm sizes are from 1 to 2 hectares with half of the permanent plots being purchased and half being inherited (Bamwerinde and Place, 2000). A key feature is that households have many scattered plots throughout the landscape, averaging 8-10 in Kabale District. Rights are mainly with men, though some women buy land.



20: Rwenzori Footslopes and Fort Portal

2551 km^2; 1368 m.a.s.l.; >20° C; > 1200 mm year^{-1}; 214 persons km^2

Land-use: farmland 63%; woodland 29%;grassland: 7%; wetland; 1 %

Soils: The soils of volcanic origin are often sandy. Below the forest line of the mountains the footslopes have sandy clay and clay loam soils, developed from non-volcanic parent material which are of moderate fertility.

Soil erodibility is low and rainfall erosivity is moderate.

Main food crops:	***Main cash crops:***
Banana 79,644 ha, Maize 6,599 ha, Bean 14,529 ha	Coffee ; Tea

21: Kasese transition zone

1097 km^2; 1235 m.a.s.l.; >20° C; 1000-1200 mm year^{-1}; 260 persons km^2

Land-use: farmland:51%; woodland: 37%; grassland: 12 %

Soils: Soil characteristics vary a good deal.

Generally, soil erodibility is very low to low and rainfall erosivity is low.

Main food crops:	***Main cash crops:***
Banana 36,647 ha; Maize6,599 ha; Beans 5,404 ha	Cotton

30: Bushenyi – N.Rukungiri Farmlands

1505 km^2; 1593 m.a.s.l.; <20° C; 1000 - 1200 mm year^{-1}; 248 persons km^2

Land use: farmland: 79%; woodland: 14%; grassland: 6%

Soils: Soils are typically dark, deep and often acidic, but nutrient supply is generally good.

Soil erodibility is generally very low and rainfall erosivity is moderate

Main food crops:	*Main cash sources:*
Banana 90,123 ha	Tea; Coffee High numbers of cattle and goats

31:Southwestern medium high farmland

3546 km^2; 1428 m.a.s.l.; <20° C; 1000 - 1200 mm year^{-1}; 202 persons km^2

Land-use: farmland: 78%; grassland 15%; woodland 7%

Soils: Soils are commonly sandy loam in the southwest and loam in the northeast and are often acidic.

Soil erodibility is ry low and rainfall erosivity is low to moderate

Main food crops:	***Main cash sources:***
Banana 171,350 ha; Maize 13,688 ha; Beans 18,471 ha	Banana; cattle; goat

32: Kabale – Rukungiri highlands

1607 km^2; 2123 m.a.s.l.; <20° C; 1000 - 1200 mm year^{-1}; 244 persons km^2

Land-use: farmland: 83%; grassland 7%; woodland 10%

Soils: Much of the soil is acid loam but nutrient supply is generally good and productivity is medium to high.

Erodibility of the upland soils is very low, and while erosivity is moderate, erosion potential is high due to long slopes

Main food crops:	***Main cash crops:***
Banana 31,793 ha; Beans 20,231 ha; Sorghum 10,362 ha	Irish potato 5933 ha

33: Kisoro - Kabale highlands with acid soils

892 km^2; 2169 m.a.s.l.; <20° C; > 1200 mm year^{-1}; 309 persons km^2

Land-use: farmland: 82%; woodland 18%

Soils: Soils are dark brown, often acid and low in base, and are derived from basalt, lava, ash and in places, phyllite. In the south, the humose brown loam soils are typically of moderate to high productivity. In the north, soils are acidic with low base supply and low productivity.

Soil erodibility is low and while rainfall erositivity is moderate, the potential for erosion is high due to long, steep slopes.

Main food crops:	***Main cash crops:***
Finger millet: 9778 ha; Maize 6,656 ha; Beans 9,560 ha	Irish potato 9347 ha

Figure 2.1: *Highland farming systems of southwestern Uganda suitable for intensification.*
Source: Wortmann and Eledu 1999

All 6 farming systems were identified by the IFPRI study (Bolwig et al, 2001) as suitable for intensification of all agricultural enterprises: annual and perennial cash and subsistence crops as well as livestock production. Only for the western part of the southwestern medium-high farmland (31) did Bolwig et al (2001) propose intensifying mainly subsistence crops. Development of the lower lying areas, which are not covered in this report and by the above-mentioned 6 farming systems, will be mainly through expansion of agricultural enterprises (Bolwig et al, 2001). In chapter 4, this report proposes fine-tuned development domains within the 'intensification area' of southwestern Uganda by recommending the most suitable farming systems (or at times altitudes) for various technologies.

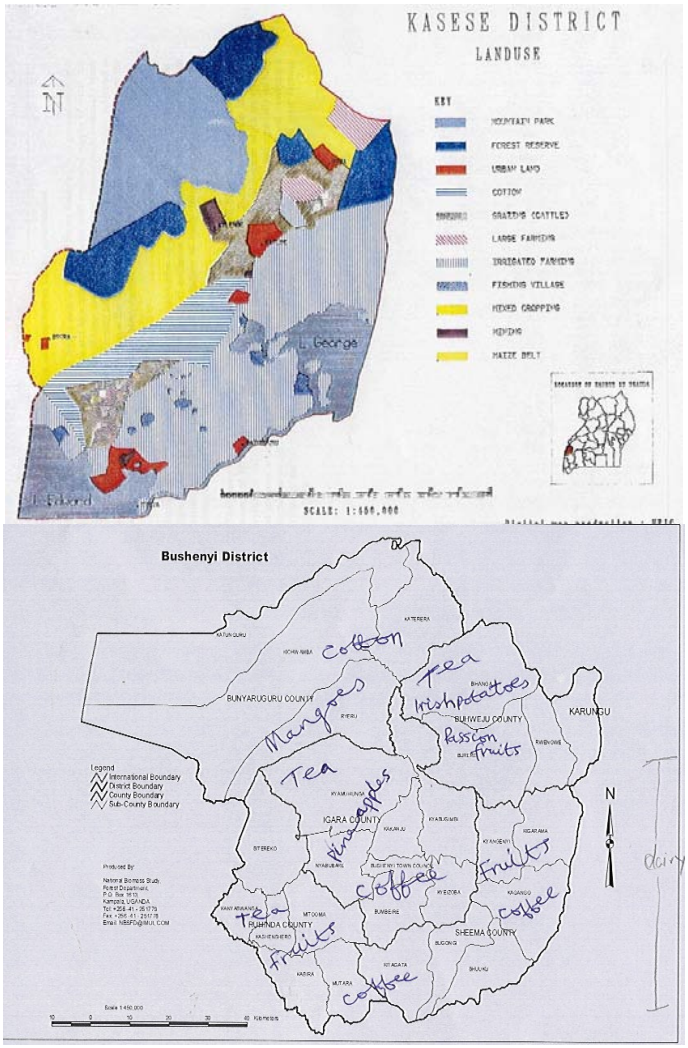


Figure 2.2: *Land-use maps for Kasese and Bushenyi Districts*

Banana production dominates the use of the cropped land (see tables 2.2 and 2.3), followed by bean, maize, sweet potato, finger millet and sorghum as the main food crops. Tea, coffee (both robusta and arabica) as well as cotton and Irish potato are the dominant cash crops.
More than half a million cattle and goats are kept in SW Uganda. Other livestock enterprises include sheep, pigs, fishponds, rabbits, silkworm and bee keeping (see table 2.4).

Wood products from forests, plantations, private woodlots and agroforestry form an integral part of the farming systems as e.g. stakes for climbing beans, support for banana stems, trelling systems for passion fruits and vanilla, and firewood for curing tea. Furthermore, preparation of food still depends to over 95% on fuelwood and construction of traditional houses depends to a large extent on poles. In all areas, farmers and local leaders express concern about the dwindling wood resources and / or their high prices. Information about the non-wood products from forests remains scarce. However, a study commissioned by the Forest Secretariat will generate more information on the use and value of forest products.

Table 2.2: Crop production area in 7 districts of southwestern Uganda. Source: district profiles (6.1)

Crops	**Area [ha] by District**						**Total Area [ha]**
	Kisoro	Kabale	Rukungiri / Kanungu	Ntungamo	Bushenyi	Kasese	
Banana	1,924	40,616	17,169	29,699	170,000	1,000	**260,408**
Beans	4,881	27,538	3,132	1,473	15,000	8,000	**60,024**
Finger millet	7,380	11,873	2,235	373	10,000		**31,861**
Sweet potatoes	2,248	18,500	5,876	1,539	9,000	400	**37,562**
Maize	5,399	19,714	2,386	735	5,500	6,000	**39,734**
Coffee (robusta)	Lw	Lw		10,000	5,000		**15,000**
Cassava	Lw	4,887	445	573	3,500	3,200	**12,605**
Field peas	7,914	14,374	1,225	135	2,800		**26,313**
Ground Nuts	87	311	809	514	2,000	140	**3,347**
Tea	Nn	Nn	1,132	Nn	1,800		**2,932**
Coffee (arabica)	Lw	Lw		Ms	2,000	2,500	**4,500**
Sorghum	5,931	20,580		224	1,000		**27,511**
Cotton	Nn	Nn		Nn	1,000	4,800	**5,800**
Irish Potatoes	7,975	23,328	676	34	800	500	**33,279**
Soya bean	Lw	Lw	Lw	Lw	Lw	160	**160**
Tobacco	Lw	Lw	908	Lw	Lw	Lw	**908**
Rice	Lw	Lw	250	Lw	Lw	Lw	**250**

Lw = low; Nn= none / negliable, Ms = missing; Sources: District Development Plans, MAAIF production data 1992-99, MAAIF data on areas planted 19992-96; personal comm.. with District Technical staff.

2.2 *Crops, livestock, trees and main natural resources in the farming systems*

Official agricultural data collection is usually aggregated to the district level and does not usually reflect the boundaries of farming systems. While all districts had data on cropped areas, the levels

and accuracy of record keeping differed between the districts. Some districts had information on annual yields and average yields while some even had information on gross agricultural product per capita.

Table 2.2. summarizes the data on cropped areas provided by the districts while table 2.3 summarizes information from the Wortmann and Eledu (1999) study on annual growth of food crops. The two data sources do not match exactly since the areas covered by the 6 farming systems is slightly different from the area covered by the 7 districts studied. For example, district data covers all district area, including low-lying areas not covered by the 6 farming systems. Table 2.4 provides some information on livestock kept.

The data confirms the great importance of ***bananas*** (matoke) in areas below 1800 m.a.s.l. Matoke is both a key staple food and major cash crop. Particularly Bushenyi District produces a considerable surplus of matoke, mainly for the urban markets of Kampala.

Beans also play a significant role in all districts and farming systems. Except for Kisoro and to some extentd Kabale, climbing beans are not common. However in these two districts they are much appreciated because of their tolerance to pests and diseases and their higher yields. ***Maize*** is important as a food and cash crop. Kasese District produces a large amount of maize which at the time of the survey was selling at a very low price (~ 100 U Shs[1] kg^{-1}). In previous years prices had been higher since food shortages in Kenya led to good export markets.

[1] At the time of the survey 1 US $ was equivalent to 1700 U Shs

Table 2.3: Food crops in Southwestern Uganda, annually cropped total area [ha] per farming system, % of cropped land (cL), % of area of the FS and % of total area of this crop in southwestern Uganda. Source: Wortmann and Eledu 1999

Food crop	Area [ha] per Farming system; % area of the farming system and % of respective crop cropped in the SW																								**Total Areas [ha]**	
	20: Rwenzori Footslopes				21: Kasese transition				30: Bushenyi-N.Rukungiri				31: SW medium high farm.				32: Kablae Rukungiri HL				33: Kisoro Kabale HL					
	ha	% of cL	% of FS	% of crop	ha	% of cL	% of FS	% of crop	ha	% of cL	% of FS	% of crop	ha	% of cL	% of FS	% of crop	ha	% of cL	% of FS	% of crop	ha	% of cL	% of FS	% of crop		% of crop
Banana	79644	66,0	31,2	19,3	36647	68,0	33,4	8,9	90123	81,4	59,9	21,9	171350	69,5	48,3	41,6	31793	28,5	19,8	7,7	2696	5,2	3,0	0,7	412319	59,3
Beans	14529	12,0	5,7	20,0	5404	10,0	4,9	7,4	4513	4,1	3,0	6,2	18471	7,5	5,2	25,4	20231	18,1	12,6	27,8	9560	18,6	10,7	13,1	72720	10,5
Maize	8904	7,4	3,5	14,4	6599	12,2	6,0	10,7	3720	3,4	2,5	6,0	13688	5,6	3,9	22,1	19268	17,3	12,0	31,2	9656	18,8	10,8	15,6	61842	8,90
Sweet potatoes	6178	5,1	2,4	15,0	1913	3,6	1,7	4,6	4073	3,7	2,7	9,9	12624	5,1	3,6	30,6	13104	11,7	8,2	31,8	3353	6,5	3,8	8,1	41250	5,94
Finger millet	1243	1,0	0,5	3,9	131	0,2	0,1	0,4	3411	3,1	2,3	10,7	9196	3,7	2,6	28,9	8080	7,2	5,0	25,4	9778	19,0	11,0	30,7	31840	4,58
Sorghum	1560	1,3	0,6	4,9	334	0,6	0,3	1,1	1744	1,6	1,2	5,5	10811	4,4	3,0	34,2	10362	9,3	6,4	32,7	6841	13,3	7,7	21,6	31653	4,55
Irish Potatoes	1125	0,9	0,4	5,6	723	1,3	0,7	3,6	64	0,1	0,0	0,3	2720	1,1	0,8	13,7	5933	5,3	3,7	29,8	9347	18,2	10,5	46,9	19913	2,87
Cassava	5245	4,3	2,1	38,4	1857	3,4	1,7	13,6	1100	1,0	0,7	8,1	2996	1,2	0,8	22,0	2328	2,1	1,4	17,1	115	0,2	0,1	0,8	13645	1,96
Ground Nuts	1202	1,0	0,5	13,8	202	0,4	0,2	2,3	1988	1,8	1,3	22,8	4725	1,9	1,3	54,1	468	0,4	0,3	5,4	146	0,3	0,2	1,7	8732	1,26
Rice	1040	0,9	0,4	93,5	72	0,1	0,1	6,5	0	0,0	0,0	0,0	0	0,0	0,0	0,0	0	0,0	0,0	0,0	0	0,0	0,0	0,0	1113	0,16
Cropped land	120670	100,0			53882	100,0			110736	100,0			246581	100,0			111567	100,0			51492	100,0			695028	100
Total area	255100		47,3		109700		49,1		150500		73,6		354600		69,5		160700		69,4		89200		57,7			

Cotton (in Kasese) and ***coffee*** (except in Kabale and Kisoro) are important cash crops. ***Tea*** is of significant importance in Bushenyi and Rukungiri. Where tea is grown on smallholder farms, it offers a regular (monthly) income while tea plantations also provide employment. In addition, tea factories buy firewood and offer markets for woodlot owners.

Livestock plays an integral part in all farming systems. Most households own some small ruminants and poultry. Rabbit keeping is common in some areas and seen as an activity for the youth. Cattle keeping varies greatly between areas, where the largest numbers are found in the drier areas of Bushenyi and Ntungamo Districts. Dairy farming is an important feature although the recently low farmgate prices of well below 200 U Shs per liter have frustrated farmers. Still, dairy and tea growing appear to be the only enterprises with a relatively regular, monthly income. In all districts, milk collection points were available, although the number and availability of coolers varied, i.e. moderately high in Bushenyi but low in Kisoro. Bee keeping is an increasingly important activity and there are encouraging initiatives of local processing and joint marketing. Remnants of silk production initiatives are found at a number of sites, but interest in this enterprise is rather low and successes are rare.

While fish catch in the natural lakes is reported to have decreased dramatically (i.e. in Kasese District from 13,000 t [1978] to 2,200 t year^{-1} [1994]), fishponds have gained importance. However, (re)stocking is a major concern as fingerlings are not readily available. Informal exchange or sale of fingerlings between farmers is functional in some areas and is an attractive income source (100 U Shs per fingerling).

Table 2.4: Livestock numbers in 7 districts of southwestern Uganda. Source: district profiles (6.1)

	Livestock production by District						
	Kisoro	Kabale	Rukungiri / Kanungu	Ntungamo	Bushenyi	Kasese	**Total numbers**
Cattle	27193	69000	73000	183791	173756	49580	**576.320**
Goats	45210	194688	112000	20660	64227	10500	**447.285**
Sheep	25100	51610	28000	5460	22495	600	**133.265**
Pigs	7100	6000	4500	350	6306	1500	**25.756**
Poultry	510000	500000	290000	30890 (exotic)	15088 (exotic)	62000	**1.407.978**
Fishponds	102	236	211	68	544 (351 farmers)	436	**1.597**
Rabbits	3000	Ms	Ms	MS	*Ms*	MS	**3.000**
Bee keeping	2500 hives 145 beekeepers	Ms	6494 hives	1465 hives	On 850 farms	Ms	
Silk farming	Ms	Ms	MS	12 units	On 80 farms	Ms	

Lw = low; Ms = missing; Nn= none / negliable; Sources: District Development Plans; personal comm.. with District Technical staff.

Farmers depend mainly on rainfed agriculture. However, there are two alternative options in the region. The first is the relatively abundant wetland resources that dissect the many mountain and hill ridges. Before the 1960's, very few wetlands were used for cultivation. Since then a large proportion of wetland area has been converted to agriculture. Among the earlier conversions, were several wealthy farmers who established medium to large scale dairy enterprises. Now, many smallholders also have claimed, appropriated, or have purchased wetland plots for intensive cultivation. In most of the cultivated wetland areas, some investment in irrigation can also be found – mainly in form of canals. Outside of the wetlands, there is hardly any other investment in irrigation, but a major scheme in the lower elevation of Kasese District is an exception. There, horticultural crops and dairy farming are the key enterprises, with some commodities being exported to Europe (chillies).

The intensity of agricultural extension activities varies between the various zones. While Kabale and Kisoro districts have large numbers of NGOs supporting extension, in other districts such support hardly exists. All district directorates of production and marketing were hampered by staffing levels of below 70% of approved posts and reported lack of operational funds and transport facilities. There were apparent mismatches between staffing levels and outputs between different specializations and districts, suggesting an unevenness in resource allocation or performance. The newly introduced NAADS approach is not yet operational. One of the aims is that this new approach will be more demand driven and therefore able to perform more effectively and efficiently.

The extent and quality of agricultural data recording and management differed between districts. The same applies for the records of the other organizations. Some of the traders and processors freely shared their information with the survey team while others didn't.

2.3 Biophysical and socio-economic potentials and constraints of the farming systems

This survey confirmed the finding of the earlier IFPRI work (Bolwig et al 2001) regarding feasible development pathways for the southwest:

- Cultivated land has not increased in recent past and there is no scope for further expansion;
- The most promising development pathway lies in the intensification of agricultural production that should increase food production and income generation while at the same time reducing the pressure on, and inappropriate use of, very vulnerable land, particularly steep slopes.
- Encroachment into protected areas seems to be a minor problem, but conflicts between farmers in the buffer areas and protected area authorities are common. However, overall conflict potential between intensified agriculture and protected areas appears to be low.
- Fallow and grazing land is declining, while abandonment of cropping on degraded sites is found in many areas.
- The decline in natural forest areas is not a recent development while the planting of woodlots is becoming common. This confirms the common finding that tree planting on-farms occurs when population pressure reaches a certain threshold level (Holmgren et al., 1994; Shepherd and Brown 1997).

Two sets of constraints are found to be limiting intensification in southwestern Uganda: low productivity and issues related to markets and prices.

2.3.1 Low productivity and environmental degradation

A main concern of farmers and leaders is the decrease in soil fertility and high rates of runoff and erosion. The latter also leads to serious flooding at the valley bottoms. Various mitigation measures are implemented by farmers' own initiative or stimulated by formal extension services and NGOs. In most cases these initiatives are based on individual farmers' efforts without community planning at e.g. watershed level. Given the high fragmentation of land, the length, and the slope of the land, these individual efforts only have limited success. Except for the bench terraces in Kabale (which were established more than 60 years ago) and some few watersheds with coordinated initiatives, no interventions at landscape level were observed.

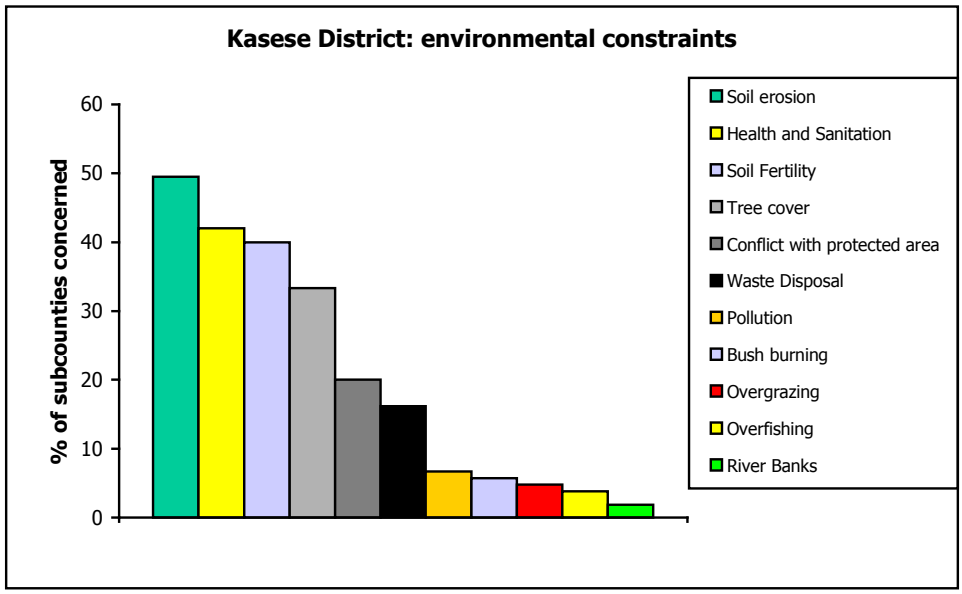


Figure 2.3: Percentage of subcounties in Kasese District identifying particular environmental constraints among the three most important for their areas. Source: NEMA (1996)

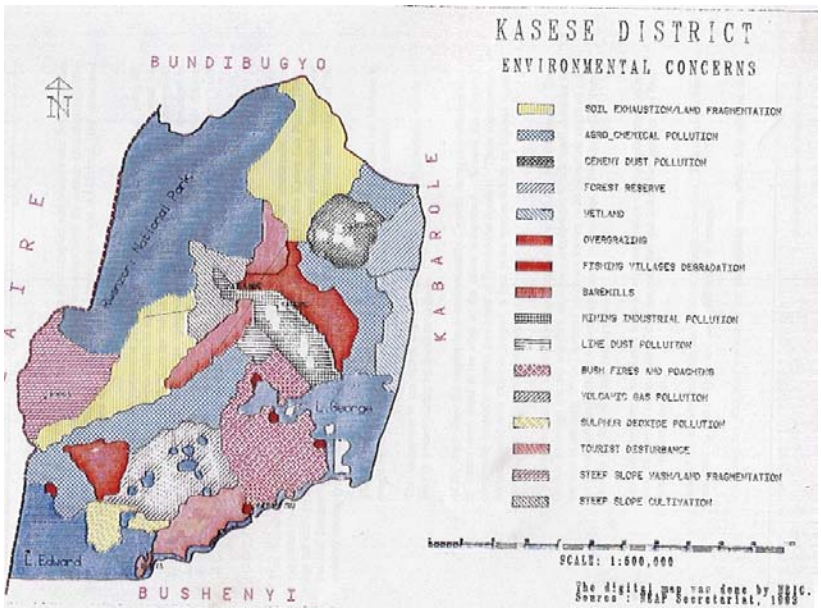


Figure 2.4: Environmental concerns in Kasese District. Source: NEMA, 1996

All 7 district had documents related to the environmental status and / or environmental plans for the districts. Figure 2.3 shows a good example of a prioritized list of environmental concerns in Kasese district while figure 2.4 shows their spatial distribution (NEMA, 1996).

All reports show that productivity in farmers' fields is less than a third of what is achieved with improved technologies. Even when considering that yields reported by research tend to be higher than what is economically achieved in the field, there is still a tremendous gap between potential and actual yields. This is also evidenced by nearly stagnant average crop yields over the last 40

years, reported by Bolwig et. al (2001). Also, there were only very limited signs of adoption of improved technologies. Below we discuss some of the elements leading to low productivity:

- ***Low levels of use of improved production technology***

Very few examples of successful adoption of improved technologies were found in the 7 districts studied. Much of the farming practice is based on technologies that have been available for more than 30 years. The few successful adoptions relate to:

- Contract farming, e.g. cotton or tea, where the contracting enterprise determines and often provides (on credit) all the inputs;
- Where inputs are given out free, e.g. seedlings of clonal coffee, and farmers clearly see the superior attributes after intensive extension efforts;
- Response to disasters, i.e. where local governments have initiated soil conservation initiatives after land slides; or replacing bush beans which are severely affected by root rot with climbing beans tolerant to that disease. Still these efforts require intensive support by extension;
- Replacing a variety with a clearly superior one without having to make major changes in the overall farming practice.

Until recently most of the technology development work in Uganda has been conducted at research institutes which are centered near Kampala. Farmers from the various agroecological zones with their varied demands and preferences were hardly involved in the research processes. Consequently, many technologies have attributes unacceptable to the farmers, i.e. unacceptable food characteristics, high labour demands, low adaptability to highland conditions etc. There is need to intensify recent decentralization efforts by the National Agricultural Research Organization to test and adapt technologies with farmers under local conditions. This may also help to overcome two other critical concerns:

a) the absence of information on the new technologies (i.e. it is common to find a new variety in farmers' fields without the farmer or extension staff having any information about its agronomic characteristics); and
b) the low local availability of seed and planting materials for the improved technologies.

- ***Soil degradation, erosion and flooding***

Farmers, professionals and local leaders in all districts are concerned about soil degradation. Wherever environmental concerns were ranked, declining soil fertility and erosion ranked among the top three. Often this was coupled with problems of flooding further downstream. This finding is not surprising in an area where steep and long slopes foster erosion despite relatively low erodibility of the soil and the low to moderate erosivity of the rains. Much of the fertile top soil has been lost and replenishment of soil nutrients leaving the fields through the harvested products, is only taking place through limited organic inputs in some fields of the farms. Only a handful of farmers use fertilizer in southwest Uganda, but this is characteristic of the whole of Uganda.

Initiatives to conserve soil and water are usually limited to 'pilot areas' and often fragmented efforts based on actions by individual farmers. Given the non-consolidated structure of most farms, coupled with long slopes, these efforts are not likely to be very successful. However, a positive example of local government – driven watershed management was observed in Kabale District (Raussen et. al, 2001).

- ***Land fragmentation***

Fragmentation, or the scattering of plots within a household, is a common feature of land holdings in Kisoro, Kabale and Rukungiri Districts. It also occurs to a much lesser degree in the highlands of Kasese where households may farm one plot near their home, one in the higher elevations (e.g. for passion fruit) and one in the lowland (e.g. rented for cotton or maize). In Kabale, Kisoro, and Rukungiri, farmers may operate an average of 8-10 distinct plots of land, depending on the area. While farmers do seek plots in different topographical locations, the degree to which fragmentation appears on the landscape is deemed excessive by most of them (Place, 1995). These plots are scattered in many directions and the majority are not usually visible from the homestead (Place, 1995). A good portion of the plots is located over an hour's walk from the home and incentives to manage such plots are low. Fragmentation has been found to be an important factor in observed abandonment of land areas in Kabale District (Bamwerinde and Place, 2000). This highly disjunctive pattern of land ownership makes concerted soil conservation and management efforts exceedingly difficult. In addition to fragmentation, the small size of plots tends to reduce incentives for mixed farming or integrated crop-organic input systems, as farmers prefer not to reduce land area under priority crops. Household rights over land are very strong with almost all plots being inherited or purchased. A minority of the plots is rented out seasonally. Women's land rights are inferior to those of men, and this does have an impact on women's participation in longer-term decision making such as tree planting (Place, 1995).

2.3.2 Markets and prices

With very few exceptions all farmers sell some of their products and are linked to markets. Particularly in Bushenyi District, a common statement was that farmers are able to produce a wide range of commodities but are limited by market access. Below are some of the main observations:

- Low and fluctuating prices

We were not able to visit large parts of the districts to examine how farmgate prices varied across the southwest. Instead, we relied on prices collected at selected markets by Foodnet, other secondary sources, and a few validation exercises with key informants. Prices for most major commodities vary both spatially and temporally. This is demonstrated in Figures 2.5 thru 2.7. Figure 2.5 shows a typical pattern of price seasonality, using Kasese as an example. For nearly all major commodities, prices have a single peak period, around January to February and then begin a slow but eventually profound fall in price. Because many prices move together, this implies that Kasese markets are poorly integrated into regional or national markets in general. It also suggests that there are few gains to be made by farmers through selection of alternative crop mixes. It is likely that seasonality of price changes is less severe in other places better connected to markets, but we did not have comprehensive data on this.

Instead, we were able to find (again through Foodnet) price data for selected commodities in 3 market centres, Mbarara, Kasese, and Kabale. Mbarara, like Bushenyi, is a major producer of matoke. As can be seen, matoke prices are generally much lower and less variable in Mbarara than in the other two district sites, which are net importers of matoke. In contrast, maize prices move in the same manner, with some seasonal variation, in all 3 locations. It is interesting that a maize producing area (the lower elevation areas in Kasese District) faces similar price levels and

movements as other areas. This may be because in fact there is relatively little local demand for maize in the southwest.

Figure 2.5: Time Series Analysis - (Interpolated) for MATOKE

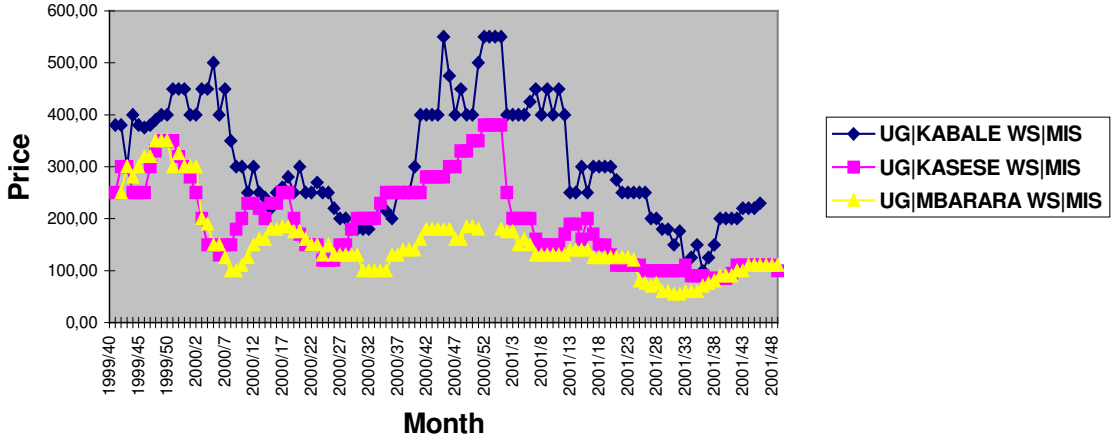


Figure 2.6: Time Series Analysis - (Interpolated) for MAIZE

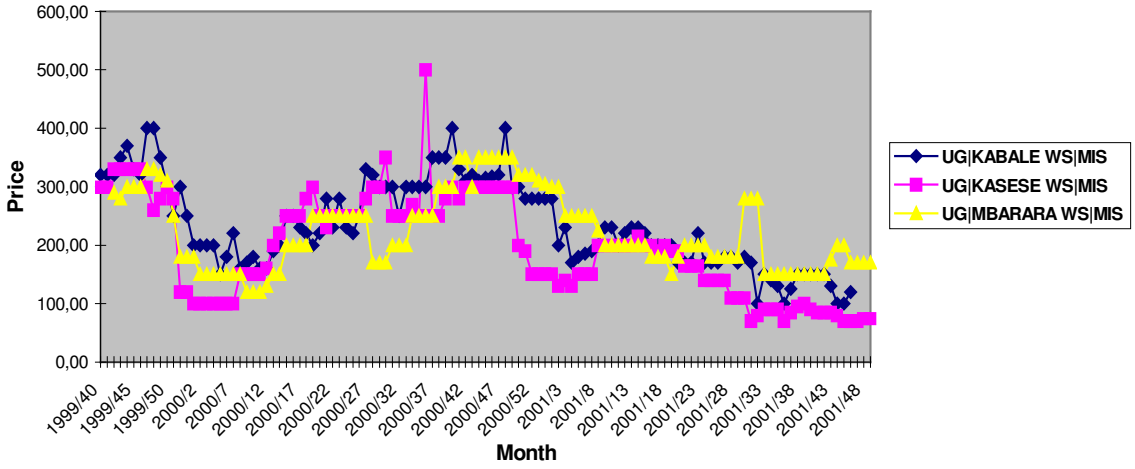
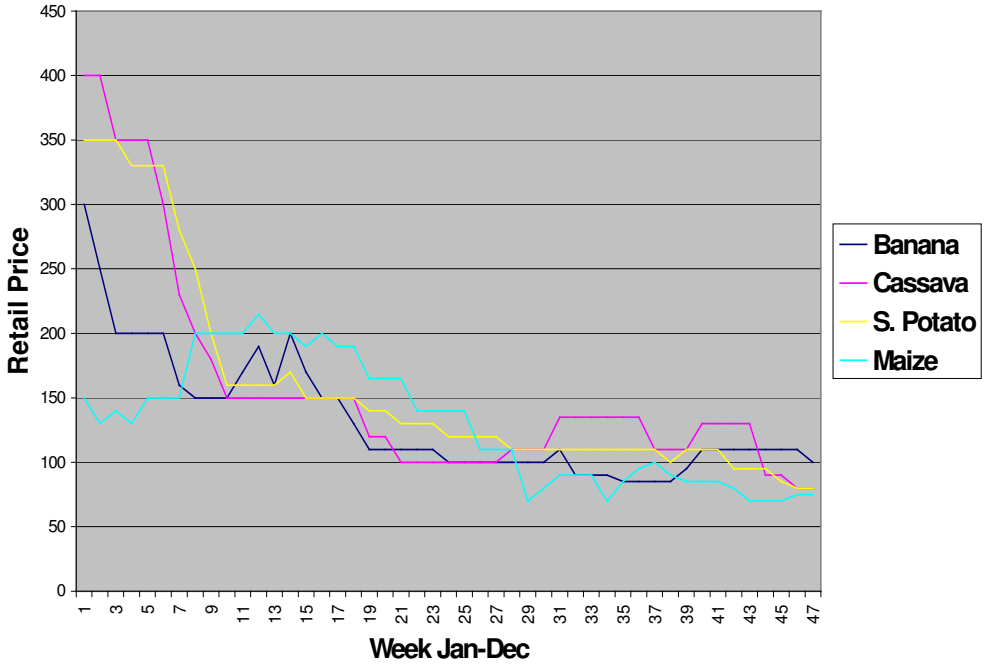


Figure 2.7: Weekly Prices in Kasese



o Market access

Prices are very important, but farmers main concern is whether they can sell at all. Southwest Uganda is no exception to most other places in Africa in that market integration is weak. Weak integration means that when production increases in one area and is above the level that is locally demanded, there is no guarantee that the surplus can find outside markets. We encountered such a situation in Kasese District where maize production was very high. Farmers and district officers both lamented that there were no buyers for this excess. Kasese is a good example of how market integration is also not uniform across the southwest. Kasese key informants complained that it was caught between two major market routes, one that reaches Fort Portal to the north, but does not extend southward to Kasese. Similarly, another major market route passes up to Bushenyi District but does not extend northward to Kasese. This pattern points to another factor in market integration. It appears that the private sector responds very well to supply opportunities for matoke, the major staple food of the urban centres. These transporters then of course take advantage to deal in other valued commodities along these routes. Attracting this level of attention in the other areas appears to be a major unresolved issue.

As for the strength of local markets, we were not able to get solid quantitative evidence on this. However, it is obvious that farmers do have differential access to markets, as measured by proximity to major market centres. Some interesting data being collected by some districts is the amount of revenue generated from market trading centres. From this, it is possible to assess the relative size of markets within a district. It is not be possible to compare across district without more knowledge on tax rules and rates. Figure 2.8 indicates the location, by sub-county, of the largest markets in Bushenyi District. Some of these locations are well known for production of

matoke, for instance. Aside from such obvious cases, the team did not have sufficient time to determine reasons for variation in market activity in other locations.

We were able to assess the shortage and glut situation of major commodities for the Kasese town market, using data collected by Foodnet. Table 2.3 shows this for some commodities. It can be seen that different commodities follow different patterns. Some products are often in glut (e.g. matoke and maize), others often in deficit (milk and soybean), while for others there is high seasonal variation (e.g. beans). Gluts and shortages corroborate the earlier statements of poor market integration, particularly in Kasese District. The relatively high number of shortages also suggests that timing of marketing is critical and thus the scope for gains from storage or irrigation could be significant.

Commodity	Number of Balanced Markets	Number of Market Gluts	Number of Market Shortages
Matoke (cooking banana)	11	23	13
Beans	13	18	16
Maize	17	27	3
Soybean	5	11	31
Milk	11	0	36

Table 2.5: Frequency of Market Gluts and Shortages in Kasese District, 2000 (n=47 weekly observations)

- Quality of the products

Traders on the other hand experience problems, such as high transport costs, low international prices etc., the low and varying quality of the products affecting the marketability of the commodities. A case at hand is an area in Bushenyi District, Burere subcounty, where farmers reported no markets for their passion fruits. When traders and horticulturalists were contacted it became obvious that it was the low quality of the fruits that hampered traders' interest in them. There is a clear need to shift emphasis of farmers' towards quality and to support their work through technologies that guarantee uniform and high quality of the products. Another example is tea. One tea factory manager in Bushenyi noted that increasing the average quality of tea was a major concern. Farmers suffer for this too – it appeared that farmer prices for tea were 40% of those received by farmers in Kenya.

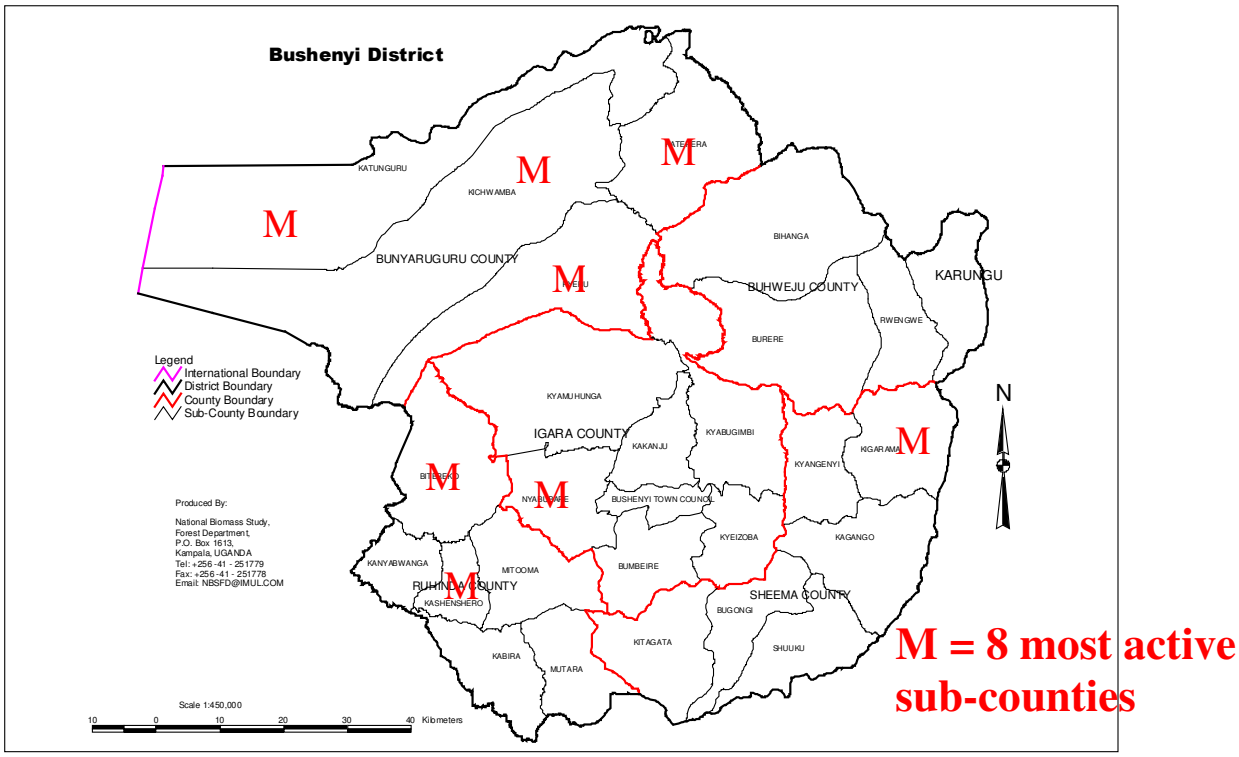


Figure 2.8: Market Activity in Bushenyi District as Proxied by Government Revenue from Market Centres

- Lack of processing and value adding

There is a strong interestfor more investment in processing and value adding by farmers and local leaders, particularly for perishable commodities, such as milk, fruits and vegetables. Various milk cooling plants, cheese and yogurt producers and a fruit processing enterprise in Kasese are examples of industries that are already functioning in the southwest. Equally cotton ginneries, tea and coffee factories and grain milling facilities, honey marketing associations added value to less perishable products. Data from Bushenyi District shows that there are large numbers of coffee and tea factories as well as milk cooling plants. This is facilitating farmer expansion in these key cash crops. However, the number of other processors in the district (e.g. bakeries, animal feeds) is very low. This is characteristic of the other districts as well. Of course, catalyzing or strengthening rural non-farm development is an age-old problem that is not easily solved.

- Input availability, costs and knowledge

With the few exceptions of contract farming, all smallholder farming in southwestern Uganda can be described as low external input farming. Basic supplies of pesticides and veterinary drugs are available in the main towns and trading centers. Uganda is well known for its very low use of fertilizer. As a cause or consequence, or both, it is not surprising that fertilizer availability is poor in the southwest, even in many of the trading centers.

Asked why they wouldn't use inputs farmers cited both high costs and lack of knowledge as reasons. Indeed, use of a good number of inputs do not appear to be profitable under current economic conditions, i.e. fertilizer for low value crops such as sorghum. However, on the other hand farmers reported total losses of crops that could have been prevented with relatively cheap inputs. Equally, overcoming the above-mentioned issues on product quality will require improved management including increased input use.

Evaluating economic returns to inputs under on-farm conditions use should form the basis for appropriate recommendations. Knowledge of extension workers and farmers on appropriate and economic input use levels needs to be strengthened. Also, working with input dealers to review the units for sale may enhance the use of inputs as farmers often prefer to purchase smaller quantities.

- High poverty rates and low capitalization for investments

We were not able to obtain precise measures of poverty nor how poverty relates to farm investments. However, much is known about the nature of the relationship from studies in other countries. There are efforts underway to develop highly disaggregated poverty maps for all of Uganda (with the World Bank and AERC). When these are completed, these additional data will be important to better understand the nature of constraints to intensification as well as opportunities for targeting interventions.

2.3.3 Particular intensification potential

Intensification of agricultural production in southwestern Uganda could be based on some niches and comparative advantages of the region. Among the key elements of the comparative advantage are:

- Farmers' and leaders' willingness to intensify given the high population density and the vulnerable environment (many farmers and leaders said that intensive agriculture would allow them to concentrate on better land, leaving the vulnerable ones for other land-use, i.e. perennials);
- Reasonable market access in most areas;
- Dense coverage by development organizations in some areas;
- Cool climate as a niche;
- Relatively plentiful labour
- Cash enterprises are already integrated in parts of the farming systems

These findings match well with the criteria used by IFPRI for the delineation of development domains (Bolwig et al, 2001): agricultural potential, market access and population density.

Principle pathways for intensification in the southwest can build upon the following natural capital assets or promising enterprises:

(1) Favorable environmental conditions – good agricultural potential

Soils without major inherent limitations, favorable climate and a highly diverse environment related to the various altitudes, offer basic biophysical conditions to produce a wide range of agricultural and forest commodities. Key factors are:

- Inherently fertile soils
  As shown in figure 2.1 soils in the southwestern farming systems do not inherently limit production potential. With appropriate management, most soils are suitable for producing a wide variety of commodities.

- Climate
  Except for the rift valley areas, the southwest of Uganda receives medium to high levels of bimodal rainfall, sufficient to cover the needs of most crops. Mid May to early September is a dry period where annual crops cannot grow without irrigation. The exception is the highland valley areas that are currently being used for pasture and cultivation by farmers. These lands can be farmed during off-seasons and farmers have invested in irrigation channels. The cool climate is a niche for temperate crops, as evidenced by Irish potatoes being a cash crop that can only thrive in cool environments but has a good market in the urban centers where it is too warm to produce them. Similarly, it is expected that temperate fruits can only grow in the highlands and can substitute for imported products in the urban centers.

- Highland diversity
  Highlands offer a wide variety of local growing conditions. Different temperature and rainfall regimes based on altitude as well as soil diversity along the catena offer a wide

range of niches for production of commodities. Specialization into commodities most suited for the local environment is a promising strategy.

- Low disease pressure for Livestock

(2) Market driven opportunities

- Given the generally favorable and diverse climate in the southwest, farmers have the potential to produce a large number of crop, livestock, and tree outputs. Aside from the local demand for wood inputs into agricultural production and processes discussed below, national market demand will to a large part shape the pattern of production in the southwest. It is evident that once markets are integrated with Kampala (e.g. through matoke), a range of other opportunities opens up. Areas along major commercial routes should be able to seize this opportunity and to respond to price and quantity signals. Other areas that may not be as well linked to national marketing routes, may nonetheless enjoy access to local collection centers as often the case for coffee, tea, and milk. Evidence from around Africa suggests that cash crops are an essential element to increased farm investment and improved land management.

(3) Demand for wood products

Trees were cleared from the highlands of southwestern Uganda more than half a century ago (see e.g.: Lindblade et al, 1999). With increasing population density and absence of available forest resources, farmers have seen a strong need to produce wood and other tree products on their farms. As mentioned earlier, various wood products are inputs into agricultural production and processing, including the main income earning enterprises. A tree - growing culture, emerging in some areas, could form the basis of production that is based on woody perennials that could be particularly useful for vulnerable land.

Continuous economic growth coupled with the currently unsustainable management of the timber plantations, will result in significantly increased prices for timber. Farmers willing to invest in woodlots for 10 to 20 years are very optimistic to achieve good returns to their investment by the time their timber will be on the market.

Also, the abandonment of land reaching over 10% of the area (Bamwerinde, personal communication) of the highlands offers an interesting niche for tree-based production on the degraded land. This is an area that should be considered in IFPRI's analysis (Bolwig et. al, 2001) of forestry options in Uganda where preliminary conclusions suggest that forestry is likely to be suited to low population density areas only.

3. Assessment Framework

3.1 Proposed assessment method

In this section, we describe the framework that was developed to evaluate technologies. The framework needed to encompass the following:

1. Criteria pertaining to the technology's effects on key objectives of farmers and society
2. Assessment of the current and potential status of the technology in the southwest
3. Favorable and unfavorable factors in scaling up the adoption of the technology

As a first step in identifying criteria to be used in assessing "win-win" technologies, the ICRAF Integrated Natural Resource Management (INRM) research framework was consulted. The framework emphasizes the importance of assessing potential or actual interventions (of which technologies are one) in terms of their effect on productivity, income/poverty reduction, and environmental resilience (see Figure 3.1).

The team assumed that "win-win" technologies must provide beneficial impacts on the environment as one "win" and then on either productivity or income/poverty reduction to produce the other "win". Within each of the three broad categories of impacts, the team then identified a relatively large number of criteria. These can be shown in Table 3.1. This served as the initial guide to collecting information pertaining to the impacts of technologies.

However, after two days in the field it became clear that the indicators in the table were much too ambitious for the breadth and rigor of the data available. Quantitative data were simply not available except in rare occasions, such as the case where international research centers worked with local authorities and had well-established research programmes in the region (CIP's research on potatoes). This is not to say that such data is not important – on the contrary, we believe that collecting data on these variables and indicators is very important. Such monitoring/impact assessment should be given some priority for research centers and as well any new development projects for the region. But such an undertaking was not feasible for this rapid assessment.

The team maintained that the broad areas of productivity, income/poverty reduction, and environmental sustainability were still valid, but that ways of integrating various forms of evidence, mostly qualitative types, would need to be found. For example, it was necessary to broaden the scope of certain indicators so that widely varying types of information on related themes could be compared across different types of technologies.

The assessment of "win-win" technologies further requires evidence as to the current or future potential of widespread adoption. The current status was easy to judge given that the team toured the southwest and was able to meet with numerous key informants, including the agricultural extension teams at the district level. The future potential was not easy to assess. This depends on the feasibility of the technology at the farm or community level (e.g. labor requirements), on larger institutional requirements to disseminate information, materials, or seed, as well as on available markets and prices that would generate large-scale demand for adoption.

The result of these deliberations was the technology evaluation matrix presented in Table 3.2. The columns are: description, status, soil impact, bio-diversity, productivity, income, feasibility, concerns, and requirements.

Description is a brief description of the technology. This is underpinned by a very detailed technology profile (see Appendix 2), that provides a definition, discusses major species or cultivars used (where appropriate), productivity impacts, areas in the southwest where it is found, environmental impacts, required resources, commonality in southwest landscapes and overall scores.

Status is a description of the use of the technology in the southwest, ranging from "on-station" to a "common farmer option".

Soil impact is a specific environmental indicator selected. It is selected because soil fertility and soil erosion have been identified as high priority environmental problems in the southwest (see chapter 2 above). The indicator is qualitative, but the assessment uses a variety of sources ranging from quantitative measurements to expert opinion.

Diversity reflects the impact of the technology on biodiversity and hence resilience and risk reduction. Other environmental indicators could not be selected due to poor information as well as the inability to apply them to a wide range of technologies.

Productivity mainly assesses the impact on agricultural yields, either directly in the case of improved seed technology or indirectly in the case of soil fertility or conservation measures. In some cases, productivity may pertain to other components such as wood production.

Income encompasses underlying components such as prices received, revenue generated per hectare, and the availability and extent of the market for the ultimate product stemming from the use of the technology.

Feasibility includes aspects of labor, cash, and land requirements for the technology. It also includes social/cultural concepts of acceptability and informational requirements at farm level.

Equity concerns reflect possible negative effects or outcomes related to the technology, which may be related to gender or wealth equity concerns.

Requirements relate to the extent of public or private institutional action or intervention that would be needed to scale up the technology to wide areas of the southwest.

3.2 Data needs and data availability

As indicated above, our assessment framework had evolved in response to preliminary investigations into the availability of data. In particular, the "ideal" framework has been replaced by a more "pragmatic" framework. Despite this, the data requirements are still rather demanding. There is still need to identify useful indicators, whether qualitative or quantitative; to be able to compare indicators across diverse sets of technologies; and simply to locate evidence on the numerous types of agricultural technologies that are potentially attractive in the highland systems.

In this section, we briefly describe the types of information used to provide evidence for each of the criteria used in the evaluation matrix and listed at the end of section 3.1.

Description: Much of this has come from first hand knowledge given that the team has a long experience in technology development in the southwest. We also used a document titled "Synthesis of agricultural technologies disseminated among communities in Kabale " published

by the African Highlands Initiative. In the more detailed technology tables, we again used first hand knowledge, but also read documents of NARO (South western highland farming systems improvement programme, workplan 2001-2003, Technology Development and Transfer Nation-Wide Survey, and NARO Annual Reports) and held discussions with extension and NGOs to provide more details on the technologies (e.g. which varieties or species are being tested; which management options are being developed in tandem.)

Status: This is a subjective measure of the stage of dissemination of a technology in the southwest. This subjective measure substitutes for a more rigorous (but unattainable) count of households or mapping of areas using the technology. For the evaluation matrix, this assessment is generalized for the southwest – a more rigorous but costly method would have been to assess the spread of technology district by district. There are six possible cases: 1) on station only, 2) on-farm testing, 3) pilot location, 4) initial dissemination, 5) wide dissemination, and 6) common option for farmers. The knowledge of the team was the main source of information for this. The technology tables (Appendix 2) do provide a bit more information about the status.

Soil impact: This captures the impact of the technology on soil fertility and conservation. In some cases, experimental data could be found to compare across a certain number of treatments. Where absent, expert opinion was sought. This criterion is most useful when comparing types of technologies within the same general category, such as alternative technologies for soil conservation. Comparisons between a soil conservation practice and a soil fertility practice are not warranted. Moreover, while it is possible to assess crops and varieties on their ability to provide ground cover or to efficiently use available nutrients, there was insufficient information on which to do this systematically. So for such types of technologies, we have only noted the cases where clear evidence suggests a significant impact. For indicator values, we have reduced this to 5 outcomes: excellent/very good, good, fair, poor/neutral, and negative.

Diversity: This variable examines the impact of the technology on biodiversity at the landscape level. This mainly involves an assessment of the range of species/varieties/provenances suitable for the use of the technology in the southwest. Where indirect effects on biodiversity are clear, these are also considered.

Productivity: An attempt was made to find data on yield effects of technologies. For instance, these could be the yield-enhancing effects on crops of soil fertility practices, new varieties, pest management strategies, or even soil conservation methods. We also looked at the livestock sector and the productivity enhancing capacity of new feed strategies. For wood or fruit production systems, productivity would be the yield of the tree products. Data were often available from on-station trials, but little information is available from farmers' experiences. Using this information, we were able to assign qualitative rankings (the technology tables retain the quantitative measures where available). When quantitative data were unavailable, we often were able to assign relative value based on expert opinion of performance relative to other known technologies (e.g. a new variety compared against a well known variety). In the evaluation matrix, we use the same 5 impact outcomes: excellent/very good, good, fair, poor/neutral, and negative.

Income: Income depends on a number of factors, the quantity produced, the amount of production that can be sold and the price received for the quantity sold. Production has been well covered by the previous criterion so this variable reflected principally the output price (less any input costs) and the ability of producers to sell their output. Data on prices were easy to establish as were average yields per crop. These served to provide an indicator of potential gross revenue. This indeed was the principal driver of the "income" evaluation. But this was conditioned by the extent of the market, which was assessed through consultations with local traders, extension

personnel, and farmers. Data on market shortages and gluts from selected markets were also available. Where markets were very thin, this would cause a drop in the income indicator. This variable is easy to measure when a technology pertains to a particular crop, livestock type, or tree species. For soil conservation and soil fertility technologies, this assessment becomes more difficult and we have to rely on our knowledge of which crops such technologies are most likely to be associated with. As with the other variables, we used 5 measures, excellent/very good, good, fair, poor/neutral, and negative to assess the income impact of the technology.

Feasibility: This is intended to capture factors that may be thought of as forming a recommendation domain both at household and higher scales. That is, are there some types of households or regions for which a technology may not be feasible? Household factors such as labor time or effort, land requirements, cash outlays, and knowledge/skills were considered. At higher scales, we focused on the necessity to have good access to markets and to be in specific agro-climatic zones as principal underlying factors for the assessment of feasibility at a landscape scale. For some of this information, data were available (e.g. cash required for fertilizer, yield performance according to altitude), but for others, the assessment was based on expert opinion. For this variable, we used 4 outcomes, feasible throughout the southwest, feasible for large areas of the southwest, feasible, for selected areas of the southwest, and not feasible for most of the southwest. The technology tables specify the exact limitations, where applicable.

Equity Concerns: This indicator was put in place to raise the importance of the ability of technologies to meet the demands of women and to be used by them. This variable was highly subjective in that almost no data at all exists on utilization and benefits of technologies across gender. Thus, rather than providing a ranking for all technologies, we have identified those technologies that particularly stand out as being attractive for women as well as those that appear to be beyond the reach of women or that clearly favor men.

Institutional Requirements: This indicator addresses the ability of the private, government and NGO sector to meet the information, seed, and material needs of farmers should demand for the technology expand. For example, if there is a newly introduced tree species whose seed is difficult to multiply, institutional requirements would be high. The same would hold true for a technology that required a significant amount of training or continued technical support. For this indicator, we have assigned 3 possible outcomes: high, moderate, or low institutional requirements. Specific institutional concerns are identified in the technology tables.

3.3 Gaps

The gaps that pertain to the individual criteria have already been highlighted in section 3.2. This sub-section will therefore focus on a more general summary of key gaps and the implications of these gaps for the power of our analysis and conclusions.

1. Data from farmer experiences generally not available

There has been no comprehensive assessment of technologies on farmers' field in the southwest. There are only isolated studies that are generally focused on specific technologies or farming enterprises (e.g. potatoes, beans, agroforestry).

2. Much of the data on productivity therefore comes from on-station research and the relevance of this for the southwest is not necessarily high.

Much of the yield data for new crop varieties has been generated from on-station experiments established at Kawanda or Namulonge Research Stations. When applied at the field level, results are hardly ever quantified, and sometimes there is no follow up by researchers.

3. There is uneven availability of data for different technologies and this affects the precision of assessment.

Because of the first two points, there is a significant unevenness in the data according to technology. Thus, it is possible to be quite specific in relative rankings of some related sets of technologies (e.g. Irish potato varieties) but not in others (e.g. banana varieties).

4. The assessment is more of a current period evaluation as important information that may shed light on future opportunities and comparative advantage for the southwest is unavailable.

Our evaluation of market and income potential is based on current price and market conditions. These will undoubtedly change but it was not possible to predict the implications of national and regional forces on the ability of the southwest to compete. This will be critical to do for the long-term development project, but there was no easy source of data for the team to gauge this. Other changes to account for include extension services, infrastructure development, and new technologies in enhancing production or reducing disease in crops and livestock.

The implication of these gaps is that our assessment has several limitations. We are limited in terms of the breadth of rigor that could be used to assess technologies. We are further limited in terms of the consistency with which the assessment framework is applied across technologies. There will no doubt be some subjectivity introduced into the final assessments. This will emerge from the research team's own experiences, the mix of key informants visited, and the biases that may be present in affecting what types of information have been published or remains unavailable. With this caveat in mind, we believe that framework does allow for likely winners and losers to be identified. We also hope that the framework itself will prove to be useful in the future so that the assessments can be revised as new information becomes available.

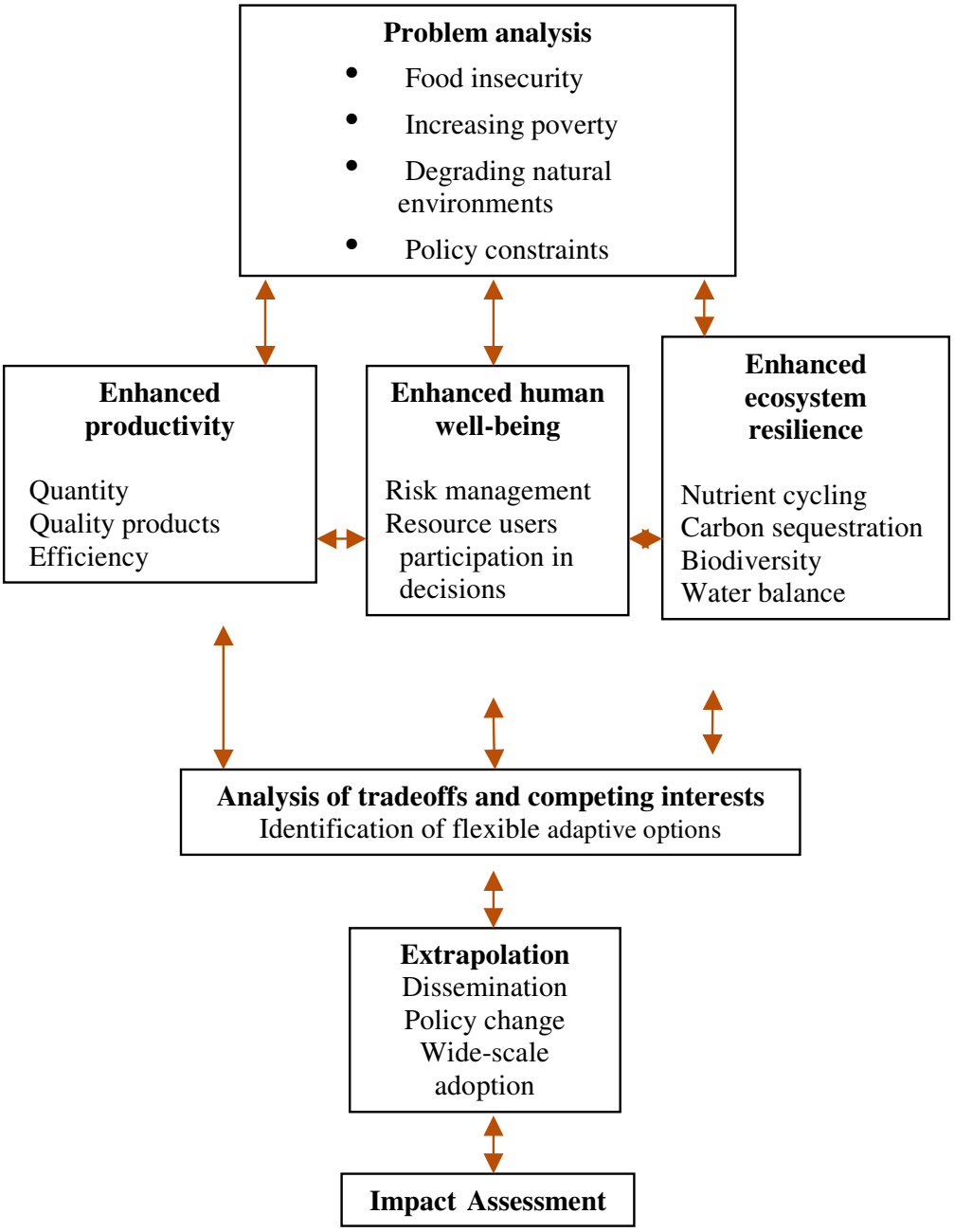


Figure 3.1 *Integrated Natural Resource Management Framework*

Table 3.1: "Ideal" Technology Assessment Tool

Evidence by Source (or Stage)					
Indicator	**Characterization**	**On-station**	**On-farm**	**Pilot project**	**Wide dissemination**
IMPACTS					
Productivity					
Yields per hectare					
Yields per labour					
Yields of complementary products					
Variation in yields					
Trends in yields over time					
Environment					
Soil fertility					
Soil conservation					
Pest prevalence					
Disease prevalence					
Water efficiency					
Water runoff/infiltration					
Biodiversity					
Pressure on wetlands/ forests					
Human Welfare					
Profitability per land					
Profitability per labour					
Variation in profits due to price/market risk					
Labour time required					
Physical labour effort					

Cash inputs required					
Land inputs required					
Time period before benefits received					
Limitations for impact on the poor					
Limitations for impact on women					

Table 3.2: Pragmatic matrix for evaluating potential "win – win" technologies for southwestern Uganda

Technology		Environmental concerns		Livelihood impact			Equity	Institutional
Description	**Status ***	**Soil impact**	**Diversity**	**Productivity**	**Income**	**Feasibility**	**Concerns**	**Requirements**
1. contour hedgerows	4	Conservation **Very efficient**		Moderate impact	Moderate	Requires community action	Men as decision makers	high
2.								
3.								
4.								
5.								
6.								

* Score
1: on-station
2: on-farm testing
3: pilot location
4: initial dissemination
5: widely disseminated
6: common option for farmers

4. Technology inventory

To generate an inventory of agricultural technologies suitable for southwestern Uganda, the team used:

- Available literature and reports, particularly from NARO;
- Discussions with specialists on various commodities;
- Own knowledge and experience from work in SW Uganda and on various commodities;
- Farmers and extension workers views; as well as
- Discussions with local leaders and departmental heads.

The aim was to establish the actual or potential effect of various technologies on improved livelihoods of people living in SW Uganda while conserving or enhancing the environment.

Technology profiles presented in Appendix 2 provide detailed information on some key technologies, while the following sections provide an aggregated overview. In the final part of this chapter, (4.4) the assessment framework presented in the previous chapter (3) is applied to the technologies.

It should be noted that the team looked mainly at improved technology options available from research. The team nonetheless went further and considered the indigenous / farmers / local technologies utilized. However, in the short period of the study these were too numerous to document. Since the majority of the farmers use these technologies this would be an important gap to fill through a systematic documentation process. Such an insight as to the preferences, tastes, attributes and the decision-making criteria of farmers to adapt and adopt a particular technology would be very helpful.

4.1 Crop options

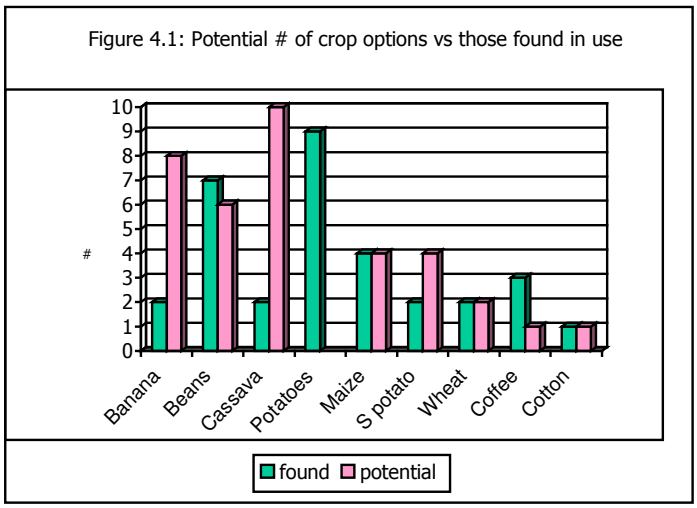
The team observed a striking difference between the options that exist for crop production in southwestern Uganda and the narrow range of options, which are actually used. Not only are most improved varieties and cultivars not usually found in farmers fields (see figure 4.1), but also management in farmers' fields differs widely from recommended practices. This is explained by:

- Economic constraints: higher labour or cash demands of the recommended practices.
- Non-adaptation of the recommended practices. Examples at hand are crop varieties that are superior in terms of yields or pest tolerance but that do not meet the quality criteria of farmers and consumers in the southwest. There were many examples for this, such as the new improved banana Varieties 'Kabana 1-5' which have not been readily adopted due to their inferior tastes after cooking and banana juice despite their higher productivity and resistance to diseases.

Table 4.1: Crop options for SW Uganda

Annual		Perennial	
Subsistence	**Cash**	**Subsistence**	**Cash**
	Cotton	Yams	Coffee
Millet	Wheat		Tea
	Vegetables		Pineapple
	Pyrethrum		Avocado
	Tobacco		Desert banana
	Sunflower		Beer banana
	Chilies		Passion Fruits
			Citrus
Sweet potato			Guava
Beans			Vanilla
Sorghum			Apple
Irish potato			Pear
Maize			Plum
Peas		Matooke	
Groundnut		Cassava	

- Seed and planting material for the new varieties are often only available at the research institutes near Kampala, which are usually beyond the reach of local farmers. With the exception of potato and climbing beans where attempts have been made to support informal farmer based seed multiplication and distribution systems in Kabale and Kisoro. The seed companies are reluctant to engage in highland varieties because of the limited land and demand that constrain markets for highland varieties. In Kasese farmers multiply improved seed for the Uganda Seeds Project but this is for the warm mid altitude areas.



- Where materials are made available it is often not accompanied by information on their agronomic and other characteristics. This prevents farmers from using them successfully.
- The potential for improvement however is great, as most farmers seem to be interested to experiment with new technologies.

Table 4.1 shows the main crops grown in southwestern Uganda. Obviously, most subsistence or food crops are also marketed by most farms in times of surplus production or to satisfy urgent cash needs, but their primary aim is to meet the family's food demands. While the table shows a wide range of options, discussion in section 2 revealed that banana, beans and maize cover close to $^3/_4$ of the cropped land. This limits diversity and probably contributes to overproduction and flooded markets during parts of the year. Few crops can be considered as solely for subsistence. The dominant crops of southwestern Uganda: banana, bean, maize, potatoes and sorghum serve dual purpose: food and cash.

Among the cash crops, official markets and support services are reasonably well developed for tea, cotton and to some extent coffee. Farmers in Kasese are served by a permanent buyer for their vanilla, while farmers in Kabale do contract farming for a pyrethrum processing company which is now also extending its work to Kasese. Sorghum and beer banana are used for brewing and the products find ready markets. Irish potato is an interesting example of a cash crop for the national and regional markets that benefits from a particular niche, the cool climate of the highlands. They have good markets in the major urban centers lying at lower elevation where potatoes cannot be grown economically. Temperate fruits, which are currently being researched at Kabale, could take advantage of this same comparative advantage of the highlands. Markets for most other cash crops, fruits and vegetables as perishable commodities in particular, are fragile. For example, a vegetable (mainly tomato) and fruit (passion fruit) processing facility was only found in Kasese.

Table 4.2 and 4.3 provide a brief and broad overview on the technologies and a first assessment of their potential to improve livelihoods and the environmental situation. Investment decisions will require much more detailed analysis.

Table 4.2: Annual crops in SW Uganda

Crops	Suitable technologies	Status* in SW	Impact ** on Productivity	Impact ** on Environment	Impact ** on Welfare	Recommendation domain Geographic***	Recommendation domain Socio-econ.
Bush beans	7 local varieties 9 improved var.	6 4	4	3	4	20, 21, 31,32,33	Subs. & comm. farmers
	Management recommendations	4	5	4	4		
Climbing beans	4 varieties	4	6	5	5	20, 31,**32,33**	Subs. & comm. farmers
	Management recommendations	4	5	4	5		
Maize	5 open pollinated 4 hybrid varieties	3	4	4	4	**20**, 21, 31,32,33	Subs. & comm. farmers
	Management recommendations	3	6	3	4		Comm.. farmers
Sweet potato	12 imp. Varieties	4	4	4	4	20, 21, 31,32,33	Subs. farmers
	Management recommendations	4	4	4	4		
Finger Millet	4 imp. varieties	1	3	3	3	20, 21, 31,32,33	Subs. farmers
	Management Recommendations	1	3	3	3		
Sorghum						21, 31,**32,33**	
	Management recommendations						
Irish potato	Local varieties 10 imp. varieties	5 4	6	5	5	21, 31,**32,33** > 1500 m.a.s.l.	Subs. & comm. farmers
	Management recommendations	4	6	4	5		
Groundnuts	3 imp. varieties	3	3	3	3	20,30,31 < 1500 m.a.s.l	Subs. & comm. farmers
	Management recommendations						
Rice	3 upland, 1 lowland imp. Var	2	5	4	4	20	Subs. Farmers
	Management recommendations	2	5	4	4		
Field Peas	Local	6	2	4	4	21,32,33 > 1500 m.a.s.l	Subs. & comm. farmers
	Management recommendations						
Wheat	3 imp. Varieties	3	5	4	4	21,32,33 > 1500 m.a.s.l.	Subs. & comm. farmers
	Management recommendations	2	3	3	2		
Cotton	2 imp. varieties	6	6	4	5	20,30,31 < 1500 m.a.s.l	Subs. & comm. Farmers
	Management recommendations	5	6	4	5		
Tobacco	-	-	-	-	-	21,32,33 > 1500 m.a.s.l	Subs. & comm. Farmers
	Management recommendations	6	5	2	5		
Pyrethrum	An assortment raised thru seed	-	-	-	-	20, 30, 32, 33 > 1800 m.a.s.l.	Subs. & comm. farmers
	Management recommendations	4	4	4	5		
Vegetables	Indigenous & temperate	6	6	4	5	all	Subs. & comm. farmers
	Management recommendations	6	5	4	6		

* Score: 1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
** Score: 1: very negative; 2: negative, 3: neutral; 4: moderately positive, 5: positive; 6: very positive
*** Farming Systems (see: 2), areas printed in bold are particularly suitable

Additional information on some of the crops, particularly as related to the highlands, is provided here:

❖ Bush beans

These are in most areas affected by root rot and stem maggot (bean fly). Both pests are difficult to control and are worse under low soil fertility when plant vigour is particularly affected. Crop rotation, removal of crop residues and soil fertility management are some of the best management options to control them. Where there is no threat of bean root rot and stem maggots farmers tend to readily adopt the bush beans and prefer them to climbing beans because of lower labor and input demand.

Although bush beans are nitrogen fixing, the nitrogen in the crop residues at best matches the nitrogen lost through the crop. During the early stages of growth, soil cover is low and erosion risk high. Consequently, bush beans do not improve the soil.

Despite the availability of 8 improved bush bean varieties, their wide adoption has not been achieved due to little dissemination effort. Most farmers in the region still grow local varieties / landraces of beans. There is little documentation about these varieties although there have been attempts to use them for breeding purposes. This is because farmers and consumers like them for a variety of reasons such as good taste, long shelf life after cooking, storage quality, thick sauce and high marketability. Their yield potential is however low because of their high susceptibility to disease. For example, at the height of the bean root rot outbreak in 1996-2000, most of the landraces in Kabale and Kisoro were virtually wiped out. Some of the popular bush varieties include Rushare, Kanyebwa, Kaki, Mutikke, Kahura. Kahura is a very popular variety with a premium market in the whole country.

❖ Climbing beans

These are more tolerant to diseases and low soil fertility than bush beans. Farmers in Kisoro and Kabale districts are substituting them for bush beans. Informal seed exchange mechanisms are very successful. Farmer exchange visits have been very successful in introducing climbing beans in areas where they were not common before.

Climbing beans show a much more vigorous growth than bush beans and leave much more biomass in the field (the stakes are often taken to the homes with some crop residues on them, but roots and litter remain behind). They are therefore expected to have positive impacts on soil fertility. Climbing beans require at least 4 stakes per square meter, or 40,000 stakes per hectare. These stakes can be used for 2 to 4 seasons and are then being used as firewood. Integrating contour hedgerows of various shrub/tree species is found to be useful as they produce about 4 stakes per meter of hedge per year. Climbing beans have been used as an entry point to promote contour hedgerows and vice versa.

❖ Maize

This is a highly respondent crop to soil fertility and good production depends much on soil fertility. Use of inorganic fertilizer is not common with smallholder farmers who use organic inputs –although often in sub optimal quantities. Combined use of organic inputs with strategic supplementation of crucial mineral nutrients is seen as the way forward. Improved fallows and rotational woodlots are agroforestry technologies currently under pilot area dissemination for soil fertility improvement.

Improved maize varieties are available as open-pollinated material (Longe 1 to Longe 5) for which seed can be recycled and as hybrids (SC 627 and PAN 67). In lower lying areas of Kasese, Rukungiri, Bushenyi and Ntungamo 2 hybrids 'Longe 2H' and '3H' can potentially be grown. in some areas of the region. Their adaptability and acceptability of these improved maize varieties to southwestern Uganda has only been assessed in a few locations. Farmers' investments in maize production will depend much on the output (and input) prices.

❖ Sweet Potato

Sweet potato is an important food and cash crop while the potato vines serve as high quality livestock fodder. Sweet potatoes are grown all year round, with dry season production concentrated in the wetlands. Sweet potato covers the soil rapidly and thus reduces soil erosion. The planting method of ridges along the contours also minimizes soil movement. Sweet potato is a major source of cash for women.

The region mainly depends on local landraces such as Nakamanzi, Mushemeza, Mbale, etc. Through the East and Central Africa Potato and Sweet Potato Research and Development Network (PRAPACE), an improved variety 'Nsovu' which is adapted to the high altitudes has been disseminated and is highly promising in Kabale District. There are also orange-fleshed varieties like 'Naspot 5', which are rich in carotenoids which are precursors of vitamin A. It is therefore potentially very useful in the nutrition of children in the region. Their leaves are edible and rich in vitamins.

❖ Finger Millet

This is a traditional staple food crop whose cultivation and consumption is reducing especially in the densely populated highlands above 1800 m.a.s.l. Despite this it is eaten as a special food in the region. It has potential to have a niche of consumers who make porridge (Bushera) and bread (kalo) from it. Some of the factors responsible for reduction in acreage include high labour demand both at production, processing and food preparation. It also yields low especially in exhausted soils. It is however a crop that can be stored for more than 5 years and is affected by few diseases.

❖ Sorghum

Sorghum is an important crop in the region especially in Kisoro, Kanungu and Kabale where it is used to brew a local beverage (Bushera) and alcoholic drink (Muramba). In the other districts, it is used to brew wine from the banana juice. The varieties commonly used are local, which possess the desired qualities for brewing. Brewing is a cash generating enterprise that makes sorghum production relatively attractive.

Most of the improved varieties are for baking bread and are not suitable for the purposes in the SW. Hence sorghum represents a crop in SW which is grown typically using farmers' practices without any input of improved technologies. Some of the new varieties are from Rwanda and it is not known whether these are landraces or improved types. Sorghum is also a crop which has generated a lot of debate because whereas the technocrats and local leaders think that it is not profitable to grow, there is a lot of sentimental attachment to it for socializing and providing food during times of food scarcity. This is an area that research needs to understand better in order to identify acceptable changes to sorghum production and even farming systems.

❖ Wheat

Wheat is a crop with mixed fortunes. In the last 5-15 years it had gained a lot of prominence to the extent that there was a wheat improvement program and a wheat mill built at Kabale. Resulting from the wheat improvement program, two soft wheat varieties were released namely Kenya Kiriku and Pasa as well as Nkungu which is a medium hard variety. However, these succumbed to the yellow rust diseases. There are now 2 promising elite lines namely UW 309 and UW400. Both are resistant to loose smut, and are high yielding (2.5 to 3.0 MT/ha) varieties compared with the farmers' varieties (500 kg/ha under farmer conditions).

However, the crop faces an uphill task because the farm gate price is low. Hence most of the soft wheat is imported. The farmers in the whole country produce only 5 % of the requirement and feel that the price offered is too low. Indications are pointing to a poor marketing strategy which makes the local mill dependent on imported wheat. Hence there is need to develop market strategies, provide market information and the need for stakeholders to come together and work out strategies to realize benefits from improved wheat production.

❖ Irish Potato

Irish potatoes thrive best under cooler climate and are a typical highland crop that cannot be produced well under lowland conditions. It is a major cash crop in Kisoro and Kabale Districts. There is potential to expand its production in the region especially in Kanungu, and the higher altitude areas of Rukungiri, Ntungamo, Bushenyi and Kasese. The current concentration of production seen in Kabale and Kisoro is mainly due to the proximity of the Potato Research Station at Kalengyere. Seed multiplication schemes initiated by NGOs and government departments have significantly enhanced the availability of clean and improved planting materials in kabala district. If efforts are intensified it could equally become important in the rest of the SW highlands. Government is supporting increased potato production as one of the seven priority investment areas of the PMA.

Local varieties not in the potato production improvement activities include Sutama, Rwamakonde, Kataikome, Mbumbamagara, Matare, Kabera and Viri. There are others with local names which are grown by farmers. These are grown mainly for subsistence because of good local taste, high tolerance to late blight & bacterial wilt.

❖ Cotton

Cotton in the SW is mainly grown in the Cotton belt lowland of Kasese (Kasese transition zone (31) and covers close to 5000 ha). In Uganda's cotton production strategy, this area is very important because represents the first site of multiplication in the cotton seed wave after the nuclear seed from research at Serere Agricultural and Animal Production Research Institute (SAARI). Hence it always has the latest variety. For example, at the time of the study (December 2001) it was growing BAP 2000 cotton variety. It is also where farmers in the whole country are realizing the highest yields of 2500 to 3000 kg per ha compared to the 300 to 500 kg per ha in other regions. Some of the reasons for this, is that they receive the purest high quality seed cotton from research. They also have adopted improved technologies like spraying and optimum spacing. There are however, some technologies like inter-cropping and controlling plant height using chemicals that they are not using.

In the southwest cotton it is also grown in Bushenyi at Bunyaruguru. The yields are equally high as in Kasese. The southwestern region provides a high potential for increased cotton production especially in areas within the Western Rift Valley. Government has also selected cotton as one of the seven investment areas to increase its production. This is aimed at taking advantage of the

African Growth and Opportunities Act (AGOA). This zone is therefore critical in achieving targets set by the Government of Uganda.

Two local ginneries in Kasese provide market and to some extent credit for inputs.

❖ Pyrethrum

Pyrethrum was first tried in the then Kigezi district (now Kabale, Kisoro, Kanungu and Rukungiri) in the 1930's to 1950's and was abandoned. Its production was revived in 1992 and efforts have been concentrated in Kabale and Kasese. A processing factory has been built in Kabale but production has not picked up very well. According to Agro-Management some of the problems have been lack of elite planting materials, low soil fertility, pests and diseases and a weak extension system. Also, prices appear to be persistently low. There could a number of other factors responsible for its low uptake but there is clearly need to understand further the prospects of this crop in the region.

❖ Vegetables

These include: tomatoes, onions, green pepper, peas, pumpkin, chilies, cabbage, carrots, spinach, cauliflower, amaranthus, egg plant, garlic, cucumbers, French beans and many others. They are usually grown in smallholder gardens, often in drained wetlands. In Kasese a gravity irrigation scheme, the Mubuku irrigation scheme is partly used for vegetable production. This scheme comprises about 150 families who work individually but management is monitored by the agricultural officer. The marketing system is well organized as the scheme is able to export high-grade vegetables to European markets. Investments in structures to store the plants under cool conditions before they are exported or sold out have been made.

High-input contract vegetable growing has been introduced in some areas, i.e. the production of runner beans on a farm near Kabale. The crop is produced under high input, floodlights etc. and marketed overseas. The enterprise has been supported by the Idea project and the developments should be observed to establish the prospect of such enterprises. Processing was only found in Kasese where a factory produces tomato ketchup using tomatoes, chilies. More processing options would be very beneficial.

❖ Banana

Currently most of the banana grown and marketed is of the local East African highland type. They are typically for cooking, have big bunches, are resistant to fusarium wilt and have good cooking qualities. However, they are tall, susceptible to wind and are threatened by a wilt which has not been well identified (it is suspected to be bacterial wilt). The most common varieties are Kisansa, Kibuzi and Mbwazirume.

The improved varieties are very impressive in terms of the big bunch size and large fingers. However, they lack the conventional cooking qualities and desert taste. Since the local varieties are preferred in the markets and the banana is a major staple and cash crop, these varieties will need sometime to find their niche. The breeders are nonetheless continuing to generate improved varieties with more desirable qualities like the four new matooke hybrids. The characteristics of the 4 matooke hybrids have not yet been described but they are potential technology options in the pipeline.

Table 4.3: Perennial crops in SW Uganda

Crops	Suitable technologies	Status* in SW	Impact ** on Produc-tivity	Environ-ment	Wel-fare	Recommendation domain Geographic***	Socio-econ.
Banana	Many local var. 9 improv. varieties	6 2	5	4	2	20,21,**30,31,**32 < 1700 m.a.s.l.	Subs. & comm. farmers
	Management recommendations	5	6	5	5		
Coffee (arabica)	3 imp. Cultivars	4	4	4	4	20, 30, 32, 33 > 1500 m.a.s.l.	Subs. & comm. Farmers
	Management Recommendations	5	4	4	4		
Coffee (robusta)	6 clones	6	5	5	5	21, 30,31 < 1800 m.a.s.l.	Subs. & comm. Farmers
	Management Recommendations	5	5	5	5		
Tea	?					20, 30, 32, 33 > 1500 m.a.s.l.	Subs. & comm. Farmers
	Management Recommendations	6	6	6	6		
Pineapple	Local Varieties	6	4	5	5	20, 30, 31, 32, 33 < 1800 m.a.s.l	Subs. & comm. Farmers
	Management Recommendations	4	5	5	4		
Cassava	12 imp. Cultivars	4	6	5	4	20,21,30,31,32	Subs.
	Management recommendations	2	5	5	4		
Yams	Local	6	4	5	4	20, 30, 31, 32, 33	Subs. farmers
	Management Recommendations	1	3	3	3		
Citrus	Local & 3 imp. Vari.	2	3	3	4	21, 30,31 < 1500 m.a.s.l.	Subs. & comm. farmers
	Management recommendations	1	3	3	3		Subs. & comm. farmers
Avocado	> 15 cultivars tested	4	4	5	5	20, 21, 31,32,33	Subs, farmers
	Management recommendations	3	4	3	5		Subs, farmers
Apples	13 cultivars tested	3	5	5	5	20, 30, 32, 33 > 1500 m.a.s.l.	Subs. & comm. farmers
	Management recommendations	3	6	3	6		Subs. & comm. farmers
Pears	7 cultivars tested	3	5	5	5	20, 30, 32, 33 > 2000 m.a.s.l.	Subs. & comm. farmers
	Management recommendations	3	6	3	6		Subs. & comm. farmers
Plums	8 cultivars tested	2	5	5	5	20, 30, 32, 33 > 1800 m.a.s.l.	Subs. & comm. farmers
	Management recommendations	2	6	3	6		Subs. & comm. Farmers
Peaches	4 cultivars tested	2	5	5	5	20, 30, 32, 33 > 1500 m.a.s.l.	Subs. & comm. farmers
	Management recommendations	2	6	3	6		Subs. & comm. Farmers

* Score: 1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
** Score: 1: very negative; 2: negative, 3: neutral; 4: moderately positive, 5: positive; 6: very positive
*** Farming Systems (see: 2)

❖ Coffee (arabica)

This crop thrives well under the highland climate. Current low prices, negative experiences of the past with collapsing market structures and non-availability of seedlings delay progress in re-establishing arabica coffee production in southwestern Uganda. Arabica coffee is one of the priority investment areas of the PMA and the strategy is to avail seedlings to farmers for planting. There will however be need to understand better the dynamics of the coffee industry and devise appropriate strategies to boost production and add value to benefit the poor farmers.

❖ Coffee (robusta)

Robusta is a major cash crop in the lower altitude ranges, below 1800 m.a.s.l. of southwestern Uganda where it is often integrated in the banana gardens. Robusta coffee is also a priority investment area for the PMA. Coffee wilt and low prices are major constraints for the crop. This leads some farmers to leave the robusta coffee trees unmanaged for a long time which appears to be a major source of plant health problems. Well-managed improved 'clonal' coffee varieties however are very productive. The high yields have however to be supported be good soil fertility- and crop - management.

The prices tend to fluctuate a lot. The main challenge is to add value and improve quality at farm level. The threat by the coffee wilt is a top research priority and integrated diseases management practices to minimize coffee wilt have been generated and need to be tested, modified and verified under the agro-ecological and socio-economic circumstances in the region.

❖ Tea

The tea produced by outgrowers is seen as an attractive enterprise particularly since it provides a relatively regular, monthly income. Contract farming, including credit facilities is attractive. A major constraint to the further development of smallholder tea farming is the need to transport the bulky tealeaves within a few hours to the factory. There have also been questions raised about the quality of smallholder tea. This concern is seen as becoming increasingly important as world production increases mean that competition will heat up.

Government is importing elite planting materials from Kenya. These, together with selected local ones are intended for expansion of the area under the crop as part of the priority investments of the PMA. This may inevitably involve expanding the current processing facilities in the medium term and if the project takes off well possibly building new factories in the long run. The expansion will however be mainly around the current processing plants.

❖ Cassava

Cassava has for the last decade been severely affected by the introduced mosaic virus. Joint research and development efforts of national and international research institutes as well as development organizations have led to the development and popularization of resistant materials. New varieties also increasingly meet farmers' quality demands but are not yet common on farms in SW Uganda. There is still need for local multiplication of the improved materials.

❖ Yams

Indigenous species of yams are traditional food of forest people (Batwa) and farmers surrounding forest areas. This may be an interesting entry point to provide a forest product from agriculture.

Improved varieties are being tested at Namulonge Research Institute and Kachwekano ARDC. Yams are usually staked which offers a similar link to agroforestry as the case of climbing beans.

❖ Fruits

A range of fruits is being grown in SW Uganda. Generally, management levels are low. Improving these and providing quality planting material (that is usually vegetatively propagated: grafted) are key strategies to enhance productivity. Most important for temperate fruits but also to a lesser extent for tropical fruits are appropriate pruning / trelling systems. Fertilization and plant protection further enhance production and quality, the latter being most important for the marketability of the fruits. Plant protection needs to be based on recommended management practices, biological control, pesticides and appropriate application technology to avoid negative impacts on the environment and the population

❖ Avocado

Avocado has been grown in many areas of southwestern Uganda. Markets for the fruit seem to be limited since the trees also produce well in lowlands. Extraction of avocado oil for international markets may be an option that should be explored further. Improved varieties (grafted: early maturing, dwarf, and with recognized cultivars) are available at Kawanda and at AFRENA site in Kabale. On-farm trials are ongoing. Also, varieties with high oil content (for extraction) are available, i.e. 'Hass'.

❖ Apple

Have not been grown successfully in Ugandan highlands but perform well in similar environments in Kenya and Tanzania. Suitable varieties and management practices have been developed especially in Kenya. There, they have become an important enterprise for farmers in the highlands as apples can usually not produce below 1500 m.a.s.l. Urban markets seem to absorb significant numbers of imported apples. In addition to direct consumption, apples form the basis for many types of juice.

Currently 13 cultivars of apples and their appropriate management are being tested at the AFRENA site and in some on-farm trials in Kabale. Management practices, currently unfamiliar to farmers, and use of grafted planting material will be key to success. Promotion is likely to succeed when rootstock material is raised in local nurseries, planted in farmers' fields and grafted in-situ (Raussen, 2001).

❖ Pear

Growing conditions for pear and their introduction to East Africa are similar to those descried above for apples. However, pears should be grown at higher altitude > 2000 m.a.s.l. Currently 7 cultivars and their appropriate management are being tested at the AFRENA site and in some on-farm trials in Kabale. A strategy for dissemination of pears would be similar to that for apples, but targeting farms on higher ground.

❖ Plum

Growing conditions for plums (the Asian plum *Prunus salicina*) and their introduction to East Africa are similar to those described above for apples. However, plums should be grown at higher altitude > 1800 m.a.s.l. Currently 8 cultivars and their appropriate management are being tested at the AFRENA site and in some on-farm trials in Kabale. A strategy for dissemination of plums would be similar to that for apples, but targeting farms on higher ground.

❖ Other fruits

- Citrus: can best be grown at altitudes < 1500 m.a.s.l. Only grafted material should be used. Greening disease is a major production constraint and is difficult to control.
- Mango: can be grown at altitudes < 1500 m.a.s.l. There is urgent need to introduce better (grafted) planting material. Occasional fungicide application may be required.
- Passion fruits are widely produced. Viral diseases are a major production constraint for local and improved material. Trelling systems are important and provide an interesting link to agroforestry.
- Figs: have shown an excellent growth potential and are easy to propagate (cuttings) and to process (drying). Early trials with 3 cultivars in Kabale and Mukono indicate good growth at altitudes between 1200 and 2500 m.a.s.l. Figs are expected to grow well also in hot and dry environments (northern Uganda).
- Guava: is widely grown for home consumption. Better planting material (seedless fruits) should be introduced, management improved and processing be explored. The `strawberry guava´ produces large number of small fruits and is ideal for children.
- Peaches and Nectarines are high priced, imported commodities in Kampala. Early trials in Kabale show good growth potential above 1500 m.a.s.l. Grafted material and biannual heavy pruning will be key to success.
- Early observations with almonds in Kabale are promising for this non-perishable cash crop.
- Grapes produce under highland conditions but like figs, can be produced at lower elevations as well. Grapes probably produce better and with less disease problems in warmer and drier environments.
- Loquats are widely grown in district centers and schools, often as ornamentals since fruit production and quality of the material is low. Improved planting material will improve this.
- Oyster nut, a climber, is grown in some places of southwestern Uganda (Rukungiri). The nutritious nut is an important commodity on markets in Tanzania.
- Tree tomato is commonly grown on farms. Production and quality is often low because of poor planting materials and high pest and disease pressure which is usually not controlled.

❖ Nuts

Macadamia nuts are a very promising cash crop. It grows well in similar highland environments in Rwanda, Kenya and Tanzania. Few unimproved trees exist in Kabale District and produce nuts. Only in Kenya a significant commercial Macadamia production and processing system exists. A 2-ways approach is proposed for the SW highlands: planting of rootstock from seed, that could be imported from Butare (Rwanda) while elite materials are multiplied in mother gardens. Grafting of macadamia is not easy and staff needs to be trained. Initial marketing and processing would have to be done via Kenya until significant quantities exist in Uganda. However, local consumption of unprocessed nuts is also common.

4.2 Livestock options

Some form of livestock is integrated in almost every farm in SW Uganda. They are kept for their products but not as working animals. Manure from livestock forms an important part of farmers' soil management strategies.

❖ Dual purpose cattle

This is mainly based on the Ankole long horned cattle and Kigezi short horn. They are used for several purposes like supply of milk, beef and cultural practices like the dowry. They are well adapted to local conditions and have developed endemic stability to East Coast Fever. The pockets of tsetse fly infestation have been mapped out by research. This information has been

used to develop disease and parasite control strategies that minimize and rationalize the use of chemicals. The beef of the Ankole cattle is reputed to have less cholesterol and hence could get a premium export market. This has not been achieved due to failure to overcome quarantine restrictions. Under the priority investment areas, the aim is to control diseases to overcome the trade barriers and to supply water. There are some traditional breeders who have developed the local breeds with superior characteristics who may need support. Support may be required to strengthen systematic local selections. Use of these cattle for animal traction has not been successful, partly due to the terrain, limited land and the culture which adores cattle.

Table 4.4: ***Livestock in SW Uganda***

Suitable technologies	Status* in SW	Impact ** on			Recommendation domain	
		Produc-tivity	Environ-ment	Wel-fare	Geographic***	Socio-econ.
Dairy cattle	5	6	4	5	20,21,30,31,32,33	Subs. & comm.. farmers
Dual purpose cattle	6	4	2	5	20,21,30,31,32,33	Subs. & comm.. farmers
Goats	6	5	2	5	20,21,30,31,32,33	Subs. & comm.. farmers
Sheep	5	4	3	4	20,21,30,31,32,33	Subs. & comm.. farmers
Chicken	6	4	3	4	20,21,30,31,32,33	Subs. & comm.. farmers
Fish farming	5	4	4	5	20,21,30,31,32,33	Subs. & comm.. farmers
Bee keeping	5	5	6	4	20,21,30,31,32,33	Subs. & comm.. farmers
Silk worms	2	3	3	2	20,21,30,31,32,33	Subs. & comm.. farmers
Genetic improvement	4	6	5	6	20,21,30,31,32,33	Subs. & comm. farmers
Tick control	5	6	2	5	20,21,30,31,32,33	Subs. & comm. farmers
IDM against Nagana, ECF, FMD, CBPP	1	6	4	5	20,21,30,31,32,33	Subs. & comm. farmers
Tsetsefly control	2	6	2	6	20,21,30,31,32,33	Subs. & comm. farmers
Worm control	4	6	4	5	20,21,30,31,32,33	Subs. & comm. farmers
Feed resources improvement	4	6	5	4	20,21,30,31,32,33	Subs. & comm. farmers
Pasture seed production	1	5	5	4	20,21,30,31,32,33	Subs. & comm. farmers

❖ Dairy cattle

The southwestern region has the greatest concentration of dairy cattle in the country. Commercial dairy farming is mainly based on the exotic breeds of the Friesians and a few Guernseys. There is also a large stock of crosses which are better adapted to the local conditions. Breeding is by both artificial insemination and natural, using bulls. A significant quantity of milk is also produced by the indigenous breeds.

A major problem is lack of continuous improvement through availability of quality semen and insemination services. Further, advanced management and veterinary services are not established in many areas, particularly away from the centers. However, zero grazing dairy cows are now much more common especially in Kabale , Rukungiri and Bushenyi Districts. This has greatly improved the nutritional status of some households, added a (moderate) source of cash and led to better manure management for soil improvement. The price for milk has dropped significantly over the last 3 years and farmgate prices are now often below 200 U Shs / l liter. This has made dairy farming much less profitable than previously and rendered it a less promising strategy to reduce poverty. The extent to which the southwest enjoys a competitive advantage in national milk production requires more investigation.

There are a number of cooling plants scattered all over the region and some processing plants in Mbarara. The plants in Mbarara have not been very successful in penetrating the market. There is however a potential of exporting processed milk and milk products to neighboring Rwanda, Burundi, Democratic Republic of Congo and Northern Tanzania. This huge regional market has not been exploited. The local consumption of milk is still very low and there is need to develop strategies to increase milk consumption like the school milk scheme undertaken by processing plants with primary schools in Entebbe. Parents pay on either a weekly, monthly or termly basis for supply of a quarter a liter of milk three times a week to schoolchildren.

- Goats

Goat production is based on the local breeds which are hardy and tolerant to local diseases but with slow growth rates and small body weight. They are for meat production. There have been attempts to introduce dairy goats using the 'Toggenburg' breed but there is no documented success of this. There is also a possibility of crossing with exotics or improving the locals with selections to meet the requirements of the export market especially in the Arab world. There is no concerted strategy to benefit from goat production.

Goats are common in most households as a source of cash and food. Particularly in the land-constrained highland farming systems, goats can be integrated without allocating extra land for their pasture. They are kept in free range or tethered by the roadside. Free grazing goats are a major constraint for the establishment of trees.

- Sheep

These are not as popular as goats but are also kept on a good number of farms . Little has been done to improve them. Current production is based on local breeds for the production of mutton. It would need to be promoted to serve a niche market locally and for export.

- Chicken

Most of the chicken produced in the region are indigenous. The indigenous chicken kept under free range have a higher premium price and fetch a higher market price which is about double that of the exotics. The local eggs are preferred and fetch a higher price as well. It is however difficult to produce large quantities because they are kept under a free range system. On the other hand intensive production of eggs and broilers based on exotic breeds, feeds and other inputs such as veterinary drugs is increasing in the region. Strategies are required to exploit opportunities both in the production of indigenous chicken with a ready market and the exotics which can be used to take advantage of economies of scale. There could be a hybrid system. There is however a challenge in farmers benefiting from the current marketing system of chicken and their products.

There is the added challenge of chicken destroying crop fields as well as the diseases in the free range system.

❖ Fish production

There are two systems of fish production namely open water fishing and fish farming (aquaculture). Open water fishing is based on lakes George, Edward, and small lakes like Nyabihoko in Ntungamo. The fish stocks have greatly dwindled in these lakes due to poor fishing methods and wrong fishing gears. In some lakes in Kisoro like Mulehe, Kyahafi and Mutanda the fish stocks were exhausted and NARO with the district authorities have just restocked the two lakes with Nile Tilapia. There is need for more technical backstopping of these initiatives. There are still challenges of farmers cultivating up to the lake shores which continue silting and polluting them. These are experiments that need to be nurtured to provide lessons learnt for other lakes. The other lakes will require a similar strategy which should actively involve the communities surrounding the lakes.

Aquaculture: This is an area that is very much talked about but with little to show. The current strategy of working with farmers who need and demand fish farming might be the way forward. There are a good number of fishponds in the region. There is need to support fish fry production by farmers and the actual production of fish for consumption. The other challenge is how to integrate aquaculture into the production system of a farm household as well more capacity building. Aquaculture could provide a major source of proteins in this region especially areas with no access to big lakes. However, many farmers practice it as a low input system and expect the fish to grow naturally without being fed.

❖ Bee keeping

Bee keeping is fairly common in all areas visited. Most hives are of the traditional types that significantly disturb or even destroy the bee colony had honey harvesting. Improved systems with top-bar hives should be promoted and also help to overcome the second obstacle, the need to improve the quality of the product. Most honey appears to be marketed in the informal sector but some is processed, packed and sold in Kampala's supermarkets. There was little evidence of the marketing of bee wax – an area that could be substantially expanded.

❖ Silk worms

Silk worms have been tried at a number of sites in southwestern Uganda. Although the concept sounds very convincing, i.e. low demand for land and capital, the high labour demand, special management skills and lack of reliable local markets seem to have affected most projects.

4.3 Natural Resources Management options

As indicated in previous chapters the need to improve management of the natural resources base is widely acknowledged. Similar to what was discussed under the crop options, a wide range of constraints hamper the adoption of the promising innovations, such as:

- Insufficient information on the implementation details of the various options;
- Non-availability of required inputs, planting materials, seed and fertilizer;
- Economic constraints and unfavorable market conditions do not only affect the use of purchased commodities, like fertilizer, but low product prices also often render investments in natural resources unprofitable.

- Many interventions in natural resources management require community action and agreements, which need time and local support to be accepted (i.e. high transactions costs).

Based on the technology profiles in appendix 2, table 4.5 provides an overview on available technologies and their current and potential use in southwestern Uganda.

Table 4.5: Natural resources management in SW Uganda

Natural Resource Option	Suitable technologies	Status* in SW	Impact ** on			Recommendation domain	
			Produc-tivity	Environ-ment	Wel-fare	Geographic***	Socio-econ.
Contour hedgerow	> 5 species	4	5	5	4	33,32,(31,30),20	communities and smallholder farmers
Physical soil conservation	6 technologies	4	4	4	4	33,32,(31,30),20	communities and smallholder farmers
Grass strips	> 4 grass species	5[2]	4	4	4	33,32,(31,30),20	communities and smallholder farmers
Mulch	> 6 various materials	5	5	5	5	33,32,31,30,21,20	smallholder farmers
Soil fertility management	inorganic fertilizer	3	6	4	5	33,32,31,30,21,20	semi commercial f.
	manure / compost	5	4	5	4	33,32,31,30,21,20	all farmers
	natural fallow	6	3	4	3	33,32,31,30,21,20	smallholder farmers
	improved fallow	3	6	5	4	33,32,31,30,21,20	all farmers
	rotat. woodlots	3	5	6	5	33,32,31,30,21,20	all farmers
	biomass transfer	2	a	a	a	33,32,31,30,21,20	all farmers
	intercropping	5	4	4	4	33,32,31,30,21,20	all farmers
Water / irrigation	water harvesting	4	4	4	4	33,32,31,30,21,20	all farmers
	pumps	3	4	4	4	33,32,31,30,21,20	all farmers
	gravity schemes	3	6	4	5	33,32,31,30,21,20	all farmers
	wetland farming	6	6	3	5	33,32,31,30,21,20	all farmers
Farm woodlots	> 7 species	4 – 5	5	5	5	33,32,31,30,21,20	all farmers
Boundary planting	> 4 species	4	5	5	4	33,32,31,30,21,20	all farmers

a – there is no evidence from Uganda, but evidence from western Kenya would suggest scores of around 4.
* Score: 1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
** Score: 1: very negative; 2: negative, 3: neutral; 4: moderately positive, 5: positive; 6: very positive
*** Farming Systems (see: 2)

❖ Soil and water conservation

In most areas, natural resource management requires soil and water conservation as the base for further investments. Physical soil conservation measures and contour hedgerows are sufficiently tested, accepted and developed to be implemented on a wide scale. Acceptance of contour hedges is usually higher when their productive functions rather then their services are used to motivate farmers. Examples for community organization on watershed scale exist (Raussen et al, 2001) and could be considered in other areas.

❖ Soil fertility management

Low soil fertility is an issue for most farmers and leaders. It is best addressed by a combination of organic inputs with the strategic application of inorganic inputs where required and economical. It is often feasible to provide sufficient amounts of nitrogen through biological nitrogen fixation,

[2] Natural grass strips

e.g. through improved fallows and to supplement this by addition of e.g. mineral phosphorous where required. Compacted soil structure is an issue in some areas and requires either alternative land uses, i.e. woodlots, or correction through e.g. improved fallows or rotational woodlots. Many leaders were concerned about the non-availability of soil laboratories in their areas. Such laboratories are expensive to establish and difficult to manage in rural areas. Alternatively, soil productivity could be evaluated through defined application of plant nutrients and their combinations on small areas to investigate crop response. Such a system ("SPEAK") has been successfully explored by ICRAF / AFRENA.

❖ Irrigation and water

Use of wetlands for cultivation of mainly tubers and vegetables during dry seasons is the most common form of irrigated farming. Views on the environmental impacts of such horticultural practices in wetlands differ to a great extent. Environmentally acceptable practices should be determined and promoted.

Experiences with gravity water schemes such as the Mubuku scheme in Kasese District are positive as they increase productivity and 'insure' other investments such as fertilizer use against the vagaries of the weather. Information from district leaders indicates that there are more suitable sites for gravity irrigation schemes that could be developed. Simple manual pumps, i.e. treadle pumps should be tested in areas where farmers cultivate vegetables along perennial streams during dry periods.

❖ Farm woodlots and boundary planting

Forestry per se is not likely to be an option in the densely populated highlands of SW Uganda. However, many niches where trees can be profitably integrated with low opportunity costs have been highlighted earlier (abandoned fields, degraded upper terraces etc.). Up to one third of the cropped land is suitable for such interventions. Further, boundaries of fields and terraces can be planted with lines of trees. If well managed (pruned) certain trees integrate well with crops and provide additional income and service functions. However, bird damage on crops may increase.

4.4 Applying the assessment framework on the technologies

In an effort to further synthesize the above information and to compare the potential impacts of different technologies, we assess a range of promising and/or common technologies according the assessment matrix presented in Chapter 3 (a full list of technologies can be found in Appendix 2). We have partitioned the analysis into four separate groupings: annual crops, perennial crops (including trees), livestock , and natural resource management practices. The score from the status columns is not included in the sum of scores as it would tend to bias against emerging technologies that are not yet widely disseminated.

- Annual crops

We have lumped together all annual crops whether food commodities or not, because as noted earlier, almost all crops are marketed to some extent by farmers. The highest overall scores are for sweet potato, Irish potato, climbing beans, and bush beans. They rate highly from a combination of good soil protection and high incomes. Most are also grown by men and women and have well developed mechanisms for germplasm multiplication and distribution. Other crops are promising, but raise concerns in certain aspects such as soil impact (maize) and gender equity (cotton). At the low end are sorghum and pyrethrum. Pyrethrum scores low because while it is aimed as an income-generating crop, it has been beset by poor prices. Sorghum is a major cereal

in the southwest, but it is used primarily to produce a low value alcoholic beer. There are no new improved varieties for the SW so it remains limited by low yields.

- Perennial crops

Cooking bananas (matooke) rate highest among all perennials owing to its contribution to income, its importance to women as a major food crop. The improved matooke varieties need to be further adapted to farmers' and consumers' quality demands. Their germplasm need to be made available locally to make full use of the research investments made. Most other perennials also rate highly in terms of income impact. At the same time, the perennial nature of the crops promotes soil conservation. The traditional export crops of coffee and tea are thus also attractive in the proper altitude bands in the southwest. Other promising crops include a variety of newly tested temperate fruit trees and even cassava, a staple food crop with several different processing opportunities.

- Livestock

The highest rated livestock enterprises are poultry followed by goats, dairy cattle, and dual-purpose cattle. Bee-keeping is also promising. Many of these enterprises generate relatively high levels of income, which are more regular than the income from crops. Most also help to manage soil fertility through the use of manure. Farmers seem to be aware of this and livestock raising in intensive systems is growing in the region. There are still significant obstacles to overcome before silkworm and fish farming enterprises can be considered to be promising for the region.

- Natural resource management

Among the natural resource practices assessed are those related to soil fertility, soil conservation, pest management, and water harvesting (with some practices impacting on more than one of these simultaneously). The techniques scoring the highest are mulching (soil conservation and fertility), manuring/composting (mainly soil fertility), improved fallows (mainly soil fertility), rotational woodlots (soil conservation & soil fertility), and intercropping (soil erosion and pest and disease control). Mulching is already common in the more intensive management of bananas, with clear impacts. All such techniques are so far limited by the amount of land area, biomass available and dissemination related issues such as limited knowledge and low levels of germplasm availability. They will thus need to be focused on certain priority land areas or crops.

The soil conservation structures, particularly with physical means did not score very highly because of poor ratings for feasibility (e.g. labour and concerted action) and equity (such investments decisions are male dominated). They would thus be attractive where strong local structures to overcome these obstacles exist. Soil conservation with contour hedgerows were slightly more attractive due to the multiple products produced.

Irrigation facilities would have high impact on farmers' livelihoods but have high institutional and financial requirements. A more rational approach to the demarcation of wetlands suitable for irrigated farming is required.

Table 4.6: Detailed scoring matrices for technologies in SW Uganda

Technology		Environmental concerns		Livelihood impact			Equity	Institutional	Recommendation	Sum
Description [(1)]	**Status *** (not part of sum scores)	**Soil impact ****	**Diversity ****	**Yield increase ****	**Income ****	**Feasibility *****	**Concerns ******	**Requirements**	**Domain**	**of Scores**
1. Bush beans		Neutral	Wide range of varieties				Balanced	Very low	> 1000 m.a.s.l. – 2500 m.a.s.l.	
Score	4	3	5	4	4	5	5	5		**31**
2. Climbing beans		m. positive	Fair range of varieties	50 % increase	50%	High adoption potential	Balanced	Low	> 1400 m.a.s.l. – 2500 m.a.s.l.	
Score	4	4	4	6	5	5	5	4		**33**
3. Maize		Negative if inputs not provided	Few suitable OP varieties	Moderate	Low prices frequent	OP var. simple to handle & multiply	Balanced	Very low	< 2200 m.a.s.l.	
Score	3	2	4	4	3	5	5	5		**28**
4. Sweet potato		Good soil cover	Many cultivars	Moderate		Good cv. spread easily	Preferred by women	Very low	All areas	
Score	4	5	6	4	5	6	6	5		**37**
5. Sorghum		Negative if inputs not provided	No suitable impr. var.	High but var. not accepted	Good if brewed	Little interest in the crop	Brews preferred by men	Moderate	> 1500 m.a.s.l.	
Score	3	2	1	3	4	2	2	3		**17**
7. Irish potato		Moderately positive	Wide range of varieties	High	High	High adoption potential	Balanced	Moderate	> 1500 m.a.s.l.	
Score	4	4	5	6	6	5	5	3		**34**
8. Wheat		Neutral	Few suitable varieties	Moderate	Low farm-gate price	Moderate	Men control income	High	> 1500 m.a.s.l.	
Score	3	3	3	4	2	3	2	2		**19**
9. Cotton		Moderately positive	New varieties provided	High	High	High	Men control income	High		
Score	5	4	4	5	5	5	2	2	< 1800 m.a.s.l.	**27**
10. Pyrethrum		Neutral	Few varieties	Low	Moderate price	Moderate	Men control income ?	High	> 2000 m.a.s.l.	
Score	4	3	2	2	3	3	2	2		**17**
11. Vegetables		neutral	Wide range of types & var.	Moderate	Perishable crops	Moderate (marketing)	Balanced	High	All areas	
Score	4	3	5	4	3	4	5	2		**26**

[(1)] refers to improved varieties

Technology		Environmental concerns		Livelihood impact			Equity	Institutional	Recommendation	Sum
Description	**Status *** (not part of sum scores)	**Soil impact ****	**Diversity ****	**Yield increase ****	**Income ****	**Feasibility *****	**Concerns ******	**Requirements**	**Domain**	**of Scores**
1. Matooke		Positive with good managem.	Few suitable imp. Varieties	Very high	Low (not marketable)	Moderate (more particip. R&D)	Balanced	High	> 1700 m.a.s.l.	
Score impr. cv.	2	5	2	6	2	3	5	2		**25**
Score local cv.	6	5	6	3	5	6	5	4		**34**
2. Coffee (arabica)		Positive with good managem.	Few varieties	High	High	High	Income often controlled by men	Moderate	> 1500 m.a.s.l.	
Score	4	5	2	5	5	5	2	3		**27**
3. Coffee (robusta)		Positive with good managem.	Few varieties	High	High	High	Income often controlled by men	Moderate	< 1500 m.a.s.l.	
Score	6	5	2	5	5	5	2	3		**27**
4. Tea		Very positive with good managem.	Moderate	High	High & regular	Moderate	Income often controlled by men	High	> 1500 m.a.s.l	
Score	5	6	3	5	6	4	2	2		**28**
5. Cassava		Negative (without inputs)	Many new varieties	Very high	Moderate unless processed	High	Mainly a food crop	Moderate	< 1800 m.a.s.l.	
Score	4	2	6	6	3	5	4	3		**29**
6. Citrus		Positive with good managem.	Few suitable cultivars	Particularly quality improv.	High	Moderate due to disease issue	Income often controlled by men	Very high	< 1600 m.a.s.l.	
Score	3	5	2	4	5	4	2	1		**23**
7. Avocado		Positive with good managem.	Many new varieties	Very high	Moderate	High	Income often controlled by men	Moderate	All	
Score	5	5	6	6	3	5	2	3		**30**
8. Apples		Positive with good managem.	Many new varieties	New crop High yields	High	Moderate	Income often controlled by men	High	> 1500 m.a.s.l	
Score	3	5	6	5	5	4	2	2		**29**
9. Pears		Positive with good managem.	Many new varieties	New crop High yields	High but less certain	Moderate	Income often controlled by men	High	> 2000 m.a.s.l.	
Score	3	5	6	5	4	4	2	2		**28**
10. Plums		Positive with good managem.	Many new varieties	New crop High yields	High	Moderate	Income often controlled by men	High	> 2000 m.a.s.l.	
Score	2	5	6	5	5	4	2	2		**29**

Technology		Environmental concerns		Livelihood impact			Equity	Institutional	Recommendation	Sum
Description	**Status *** (not part of sum scores)	**Soil impact ****	**Diversity ****	**Yield increase ****	**Income ****	**Feasibility *****	**Concerns ******	**Requirements**	**Domain**	**of Scores**
1. Dairy cattle		Good manure	Narrow breeding stock	With good management very high	Currently low prices	Well established	Zero grazing benefits whole family	High	All	
Score	5	5	2	6	5	5	4	2		**29**
2. Dual purpose cattle		Some manure	Wide range of breeds	With some selection		Very well established	Beef income mainly for men	Low	All	
Score	6	4	5	4	5	6	2	4		**30**
3. Goats		Some manure, negative on vegetation	Wide range of breeds	With some selection	Good local market	Very well established	Meat income mainly for men, some home cons.	Low	All	
Score	6	3	5	4	5	6	3	4		**30**
4. Sheep		Some manure	Wide range of breeds	With some selection	Moderate local market	Requires some market research first	Mutton income mainly for men	Moderate	All	
Score	5	4	5	3	4	4	2	3		**25**
5 Poultry		Little manure	Wide range of breeds	With some selection	Good local market	Very well established	Income and food for the family	Low	All	
Score	6	4	5	5	5	6	5	4		**34**
6 Beekeeping		Neutral – may promote tree planting	Pollinators	Quality management required	Development of markets	Well established, requires better management	Mainly a men's business	High, as there is need to improve management and marketing	All	
Score	4	4	5	4	4	5	2	2		**26**
7. Silk worms		Neutral – needs mulberry planting	Dependent on import	Many management problems	Poorly developed markets	Low	Income mainly for men	Eggs imported, High marketing requirements	None	
Score	3	4	2	3	2	2	3	1		**17**
8. Fish production		Neutral but may stimulate soil conserv.	Moderate range of options	Very variable	Good local market	Fish fry production has to be establish.	Income mainly for men, some home cons.	Moderate	All	
Score	3	4	3	3	4	4	3	3		**24**

Technology		Environmental concerns		Livelihood impact			Equity	Institutional	Recommendation	Sum
Description	**Status *** (not part of sum scores)	**Soil impact ****	**Diversity ****	**Yield increase ****	**Income ****	**Feasibility *****	**Concerns ******	**Requirements**	**Domain**	**of Scores**
1. Contour hedgerows		Conservation ***Very positive***	Few species options	Moderate positive impact	Positive through products	Requires community action	Men as decision makers	Training and germplasm supply	Slopes of highlands All farmers	
Score	4	6	4	4	5	3	2	2		**26**
2. Physical soil conservation		Mixed (i.e. soil scouring)	Neutral	Moderate impact	Moderate	Requires community action	Men as decision makers	Moderate	Slopes of highlands All farmers	
Score	4	4	3	4	4	3	2	3		**23**
Grass strips		Depending on width and vegetation	Wide range of grasses & nat. vegetation	Positive but competition	Moderate	Requires community action	Men as decision makers	Moderate	Slopes of highlands All farmers	
Score	5	5	5	3	4	3	2	3		**25**
Mulch		very positive	Enhances soil fauna	High, particularly for perennials	Low cost but high effect	Limited by availability of materials	Benefits food and cash crops	done by individ. farmers without external support	All farmers Banana plantations in particular	
Score	5	6	5	5	5	3	5	5		**34**
Inorganic fertilizer		Very positive if used correctly	Little effect	Very high	Moderate due to high costs	Requires training and infrastructure	Rather for wealthier farmers	High (credit, infrastructure)	Cash crops with high nutrient demand	
Score	3	5	3	6	4	4	4	2		**28**
Manure / compost		Very positive , particularly for soil structure	Enhances soil fauna	High impact but only with high quantities	Moderate	Common practice, but insufficient quantities	Benefits food and cash crops	Training	All farmers	
Score	5	6	5	4	4	4	5	5		**34**
Natural fallow		Often positive on soil but increased weed pressure	Wide range of species establish	Often no significant increase	Negative due to high opportunity costs	Common practice but land pressure is high	Men as decision makers	Substitute with better alternatives	All farmers	
Score	6	3	6	3	2	5	2	4		**25**
Improved fallow		Very positive on soil nutrients and structure	Few shrub species, enhances soil fauna	Significant increase over 3-4 seasons	Up to 100% increase to land&labor	High demand on training and germplasm supply	Suitable for most farmers, relatively independent of sex or wealth	High, research, training and germplasm supply systems	All farmers	
Score	3	6	5	5	6	5	4	4		**35**

Technology		Environmental concerns		Livelihood impact			Equity	Institutional	Recommendation	Sum
Description	**Status *** (not part of sum scores)	**Soil impact ****	**Diversity ****	**Yield increase ****	**Income ****	**Feasibility *****	**Concerns ******	**Requirements**	**Domain**	**of Scores**
Rotational woodlots		Very positive on soil nutrients and structure	Few shrub species, enhances fauna	Rehabilitates degraded land, tree-crop competition	Yield on degraded land plus wood products	High demand on training and germplasm supply	Suitable for most farmers, relatively independent of sex or wealth	High, research, training and germplasm supply systems	Farmers with degraded land	
Score	3	6	5	4	6	5	4	4		**34**
Biomass transfer		Data from East Africa indicates high effect but on small area only	Few species but enhances soil fauna	High but limited to small areas	Yield increase but high labor demand	Likely to be accepted by farmers on horticultural crops	Suitable for most farmers, relatively independent of sex or wealth	Research, Training	Horticulturalists	
Score	2	4	5	4	4	4	4	4		**29**
Intercropping		Better soil cover, less erosion	Direct and indirect positive effects on diversity	Land Equivalent Ratios typically at 120%	Increases overall yields	Common practice of farmers that could be improved upon	Suitable for most farmers, relatively independent of sex or wealth	Research, Training	Smallholder and semi-commercial farmers	
Score	5	4	5	4	4	5	4	4		**30**
Water harvesting		Often reduces erosion	Neutral	Significant but on small areas	Low costs high yield increase	High demand	Particularly useful for homegardens → women	Training, credit (?)	Smallholder farmers	
Score	4	4	3	5	4	4	6	4		**30**
Pumps		Neutral	Neutral	Increased yields and security	Relatively low costs	High demand, require maintenance	Often benefits mainly wealthier farmers	Training, credit (?) maintenance		
Score	3	3	3	6	5	5	3	3		**28**
Gravity schemes		Conserving soil	Clearing land	Increased yields, security and more harvests	high cost	High public investments required, Land acquisition?	Often benefits mainly wealthier farmers	Investment, land acquisition, community action, marketing support		
Score	3	5	2	6	4	4	3	2		**26**

Technology		Environmental concerns		Livelihood impact			Equity	Institutional	Recommendation	Sum
Description	**Status *** (not part of sum scores)	**Soil impact ****	**Diversity ****	**Yield increase ****	**Income ****	**Feasibility *****	**Concerns ******	**Requirements**	**Domain**	**of scores**
Wetland farming		Acidification risk	May affect natural diversity	Increased yields, security and more harvests	Only labor costs to achieve high yields	Common practice; need to define suitable sites and protection areas	Often benefits mainly wealthier farmers	Characterization and definition of suitable wetlands; marketing support	Smallholder farmer	
Score	6	2	2	6	6	5	3	4		**29**
Farm woodlots		Positive if suitable species and management are used	Few species options; provide habitat	May regenerate soil fertility; wood products	High demand for wood products	Common practice, requires enhancing species options	Mainly done and owned by men and more wealthy farmers	Improved germplasm supply, training, research and processing	All farmers	
Score	4-5	4	4	4	5	5	2	4		**28**
Boundary planting		Reduced erosion; mulch material	Few species options; provide habitat	Wood products; but may affect adjacent crops	High demand for wood products	May lead to conflict between neighbors	Mainly done and owned by men, firewood for the family	Improved germplasm supply, training, research and processing	All farmers	
Score	4	4	4	3	5	4	3	4		**27**

5. Recommendations and the way forward

In this chapter we first discuss the assessment methodology and follow up with some summary comments regarding the main empirical findings.

5.1 Operationalizing the framework

In this section we try to answer the following questions:

- How useful is the assessment methodology?
- What would be steps to refine it?
- Would that be worth the effort?

The assessment framework has definitely provided a means for collating and synthesizing information known about agriculture and new innovations in the southwest of Uganda. It attempted to identify impact oriented criteria around which the data could be analyzed, thus making it compatible with the goals of research, development, and donor organizations. As such, it may also prove to be a starting point for a monitoring or impact assessment framework for new projects. The implementation of the framework was facilitated by the use of criteria that could be amenable to inputs from a range of data, including quantitative and qualitative types. Thus, we found that the framework could provide a valuable tool for identifying win-win technologies. Also, by creating structure for assembling information, it was relatively easy to identify critical information gaps, which we observed to be numerous (e.g. note the variation in available data in the District Profiles of Appendix 1).

There are still some difficulties in using the matrix. For instance, some important criteria were omitted because they were not uniformly applicable to a wide range of technologies. Other important criteria were left out because they were conceptually difficult or required data that were too costly to obtain (e.g. impacts on nutritional status). It is difficult to arrive at objective rankings for some individual criterion and especially for overall scores. We did not weight the criteria and therefore assumed that each one was equally important. Finally, the shear number of included technologies proves to be a challenge in ensuring that relative rankings are consistent with the supporting data. It also makes the contemplation of assessing integrated technological packages quite daunting.

Though the framework has many desirable attributes, it's utility is limited by the quantity and quality of available data. Limited data, especially from farmer experiences with technologies, is a critical constraint that would limit any type of analysis. This is a critical shortcoming to be rectified. Among the problems with the data include: lack of information altogether for key variables, lack of locally relevant data (e.g. yield data for crops from Kampala based research stations), non-systematic collection of data across districts, sub-counties, projects, commodities, etc., and conflicting data originating from different sources.

Despite some of the limitations, especially concerning available data, additional insights could gained through modest efforts (which were beyond the scope of this rapid assessment). Three examples are provided. The team was unable to integrate GIS tools with our analysis. One important use of GIS tools/data would be the delineation of recommendation domains. With the knowledge of altitude and population, our qualitative recommendation domains could be converted into mapped areas and numbers of potential users. Second, we lacked time to be able to

delineate areas where new technologies have been disseminated, tested, and adopted. Again, we gained insights into the types of technologies tried and approximate numbers of farmers using them, but much more effort would be required to obtain more precise information on how many and where. Third, we lacked information about how socio-economic variables (e.g. household resources, ethnicity) may impinge on interest and adoption of new technology. This information would be vitally important for designing development programmes, but precious little information exists.

These information gaps could be relatively easily rectified and indeed a new USAID project on GIS in the southwest will attempt to address them in 2002. But many of the gaps may not be worth the trouble to rectify. For instance, if existing development projects are consistently failing to value the collection of a certain types of data, sustaining new information collection systems may prove to be unattainable. It will be important to build up an appreciation for the value of data analyses among local government and non-governmental organizations.

5.2 Making options available to farmers

A key finding from the survey is that most farmers have only access to a fraction of the potential agricultural and natural resources – based technologies available in Uganda. Most of the new innovations are only available in pilot areas or with so-called "contact farmers" of research institutes or development projects. The areas and contact farmers are in most cases too fragmented to have significant impact on the spread of improved technologies. Also, the conditions under which organizations work with farmers vary to a great extent and often contain 'hidden subsidies' such as attendance at workshops including payment of allowances, sets of free tools etc.
There is need to further spread positive examples of research & development networks such as the one on cassava or the newly founded UGADEN agroforestry network.

5.2.1 What hampers adoption of improved technologies?

Prior to such recommendations it is worthwhile to look at what is usually called "improved" technologies. In this study, improved technologies refer to materials, methods and knowledge produced through a process of formal and informal research to improve the production system. The survey team came across a range of constraints that prevent farmers from adopting them. Among the most important are:

- Technologies not tested and adapted to the local conditions
  Often the survey team came across technologies that were tested and developed at national centers or even outside Uganda and that were disseminated without serious efforts to adapt them to local conditions and without an established system to solicit for farmers' feed back. While in many other East and Central African countries similar findings led to the establishment of 'Farming Systems Research and Extension Teams in the late 1970s and early 1980s, on-farm and participatory research had not been institutionalized in Uganda until recently.

  Decentralized, locally-adapted technology development is even more important in highland areas, where the biophysical environment changes rapidly with altitude. The various conditions offer attractive niches for agriculture but also pose a major challenge for adaptive research and dissemination. Obviously environmental conditions around Kampala as well as farmers' preferences and needs differ greatly from the highland conditions prevailing in southwestern Uganda. It is hoped that the more decentralized Ugandan agricultural research structure through its Agricultural Research and Development Centers (ARDC) will improve

this situation. Unfortunately only one ARDC (Kachwekano) is located in the southwestern highlands and e.g. more than 200 km away from the Rwenzori footslopes where farmers could benefit from highland technologies developed and tested at Kachwekano.

- Insufficient involvement of farmers in the development process
  Similar to what is said above, it appears that farmers are often insufficiently involved in the development process for improved technologies. Rather they are confronted with a final product and requested to evaluate or, even more often, to adopt it. There were obvious examples where farmers had received new crop varieties that were clearly superior in some agronomic characteristics but for example failed to meet farmers' quality requirements of the product. Examples are: Kabana 1-5 banana varieties with unacceptable taste, white skinned Kisoro potato variety where the market demands red-skinned potatoes, small seeded K131 bean variety where farmers prefer large seeded, sorghum varieties not suitable for brewing and many others.

- Low availability of germplasm
  The second major constraint for the adoption of new technologies is the very low availability of seed and planting materials. While small amounts are often available at research centers, the availability of germplasm is very restricted in rural areas. Some NGOs and local governments have initiated seed multiplication and storage schemes that work successfully. Depending on the biology of the crop, seed multiplication is more or less complicated. But for most of farmers current seed demands the multiplication can be organized locally. Strengthening seed multiplication and distribution schemes and introducing a quality control mechanism are of high priority.

- Unavailability of accompanying information
  In other cases, farmers had somehow gained access to improved planting material (some farmers reported trips to research institutes near Kampala) but did not receive sufficient information on the agronomic characteristics and the management of these new materials. Hence, they did not cultivate the crops appropriately or were disappointed with the products that didn't meet their requirements. With few exceptions information that exists is in very technical form or so general (i.e. "use appropriate spacing") that it is not helpful for farmers and extension workers.

- Labor intensive
  Most of the improved technologies, i.e. for many new varieties, demand higher levels of management. Other technologies, such as most agroforestry innovations are based on extra labour demanding initiatives for the farmers, although they may in the long run lead to reduced workload in some areas, such as reduced weed pressure or higher yields from small areas. The additional labour requirements may in the long run result in additional employment opportunities in the rural areas. Initially, the investment in extra work or expenses to employ labour restrain farmers from adopting innovations, particularly those that do not payback within one season. Mixes of new technologies, those with short-term and others with medium term benefits may help to overcome these problems.

- Long period to generate benefits
  As indicated above, the economy of many rural households is based on meeting their urgent needs, with little or no resources for investments. For example: the 'Kabale' potato variety with good quality and good yields requires use of relatively expensive seed and frequent sprays. Even though the output of the crop usually warrants the investment, most farmers are not in a position to pre-finance the crop.

Overall, there is little scope for long-term investment. Mixes of new technologies, those with short-term and others with medium-term benefits may help to overcome these problems.

- High investment costs / low incentives
  Cash is a precious resource for most smallholder farmers and has many competing uses, including purchase of food, healthcare, and education. Poor households simply do not have sufficient cash or access to credit to be able to invest substantially in their farms. Generating technologies that are first and foremost inexpensive is of utmost importance for impacting on poor households.

5.2.2. What characterizes cases of adopting new technologies?

There is an encouraging number of cases where adoption of new technologies appears to generate momentum. Factors that contribute to the success are:

- Partnership with local organizations / institutions
  Local availability of information and germplasm is a key ingredient to a successful dissemination strategy that reaches out to rural, resource poor farmers. A few examples:
  a) NARO's and CIP's collaboration with Africare and other organizations has greatly increased the number of Irish potato seed producers and the numbers of farmers using improved varieties of Irish potatoes in Kabale District.
  b) Similarly a local network of various organizations in Kabale, such as FORRI/ICRAF, local government and NGOs has advanced agroforestry and soil conservation in Kabale District.
  c) The presence of a vanilla purchasing and processing facility at Kasese is important for the promotion of the crop in the district.

- Clearly superior attributes of the new technologies
  Visible improvements in terms of yield, product quality, natural resource - base or income motivate farmers to take up new technologies. Minute yield improvements (< 10 to 20%) or increased yields at the expense of product quality are rarely acceptable for farmers. "Seeing is believing" to most farmers which means that the improvements have to be significant to be visible, such as:
  a) Doubled yields of climbing beans over bush beans coupled with significantly lower disease problems of the climbing beans
  b) Clearly visible soil build-up behind contour hedges
  c) Obvious yield increases following the use of inorganic fertilizer or improved fallows
  d) Reliable and attractive income from vanilla or tealeave production as a new enterprise

- Multiple products
  Technologies with a range of products, such as agroforestry shrubs producing stakes, firewood and fodder are appealing to farmers. Services, such as soil conservation through shrubs planted in contour hedgerows are considered an 'added advantage'.

- Attention to gender
  Experience shows the importance of targeting the technologies to the right user group, i.e. sweet potato research and dissemination should concentrate on women while work on woodlots has to consider that it is usually men who will make the decisions and manage

these woodlots. However, in most cases a balanced approach is most successful. For instance, an early attempt to work exclusively with a women's group on agroforestry in Kabale was not successful until the group was reformulated as the 2-Wings group which included men.

- No major changes in farmers' practices
  Replacing a variety with a new one that does not require any other changes in the farming practice makes adopting relatively easy. There are a number of examples where new varieties spread from farmers to farmers without significant external effort when varieties are easy to multiply and clearly superior to the traditional varieties.
  On the other hand, new enterprises that require a major change in farming practices must be accompanied by training and technical support. Ideally, new technologies should be build upon existing farming practices (supporting or complementing them).

- Intensive extension effort
  More intensive extension efforts are usually required to introduce new innovations that need significant new areas of knowledge and changes in farming practices. Most innovations in Natural Resources Management as well as changes in land-use systems fall under this category. To overcome initial resilience and to build knowledge and confidence intensive and longer-term efforts are required.
  Demand driven technologies sometimes may make extension service self supporting in sense that farmers are willing to pay for services.

- Contract farming
  Contract farming, providing inputs on credit and a guaranteed market are very attractive to smallholder farmers. Success cases at hand are: smallholder tea producers in Bushenyi or cotton farmers in Kasese. The pyrethrum contract farming in Kabale is less successful, probably because the income from the labour - intensive work is not very attractive.

- Subsidy
  Clonal robusta coffee seedlings and arabica coffee seedlings are currently distributed in many areas free of costs. Some other agricultural inputs are distributed free of charge by departments and NGOs. This is highly appreciated by farmers and leads to rapid adoption. It entices farmers to invest in areas they previously may not have liked to invest in. Although most subsidies are on non - edible cash crops, they may have an impact on food security as well, since farmers may use the income to buy inputs for food crops or buy food directly.
  An important question however is whether subsidies do not in the medium - term discourage farmers own initiatives and the development of undisturbed markets for agricultural products or inputs.

5.2.3 Opportunities for providing appropriate intensification options to farmers in SW Uganda

The survey found a number of opportunities in SW Uganda that support the intensification of farming in the area, such as:

- Priority areas under the PMA
  The southwestern highlands are a priority area in the PMA for cotton, coffee, tea, horticulture, potato, livestock and fish. These commodities have improved funding to support research and dissemination efforts. The marketing issues are also being handled and hence these commodities have better opportunities.

- Local leaders and farmers are aware of their problems. Discussions with farmers and local leaders as well as key documents at the districts (District Environmental Action Plans, District Development Plans) had clear evidence that key problems in the areas have been identified. Clusters of problems were:
  a) Lack of markets, low prices;
  b) Environmental degradation, declining soil fertility
  c) Few improved agricultural production technologies being adopted

  Farmers are open to new approaches and technologies. Local leaders are ready to invest time and local resources to improve farming and natural resources in their areas.

- Improved technologies available
  At research stations in Uganda and in East Africa a range of technologies are available to improve highland farming. The urgent need in Uganda is for multilocational, adaptive and participatory on-farm research to test and adapt the innovations with full farmers involvement. Without this component, only a fraction of the potential benefit from agricultural research is achieved.

- Suitable approaches available
  After nearly two decades of development, a wide range of participatory research and development tools are available and well tested. While all organizations in SW Uganda would claim to conduct their work in a participatory manner, there appears to be a strong need to go beyond the semantics. As indicated earlier, Uganda didn't play a significant role in the development and institutionalization of these methods in the late 70s and early 80s.
  Not more workshops on participatory methods but practical field training and experimentation with participatory planning, research and extension methods are required. Experienced practitioners of truly participatory methods work in Uganda and in the region and could lead a practical training and field experimentation programme in participatory methods.

- Institutions available
  Uganda has in place a good set of development policies and corresponding institutions that are well placed to support intensification of agriculture in SW Uganda.

  a) ARDC, NAADS, NGOs
  NARO's new strategy acknowledges the need for decentralized research services and for a research – development continuum. To support the strategy, 12 Agricultural Research and Development Centres (ARDC) have been established. Their mandate is to prioritize agricultural research and development needs, conduct adaptive research, multiply seed and provide demonstration and extension support. The ARDCs work in close partnership with other institutions supporting agriculture in the region. Unfortunately only Kachwekano ARDC (in Kabale district) covers the highland areas of the southwest.

  The National Agricultural Advisory Services (NAADS) are also based on a decentralized approach within which subcounties play the important role of identifying needs and requesting for advisory services. The level of NGO support to rural development varies widely within SW Uganda with Kabale and Kisoro Districts having a high coverage with NGO programmes while Bushenyi District has hardly any NGO support for its rural development programme.

  Coordination of the activities of the players and a broad sense of common goals and approaches are important but often not easy to achieve. Local government and the ARDC are well placed to support the coordination of the activities in their areas.

Once common goals and approaches are identified, training in participatory methods and empowering local structures to take responsibilities for the activities are key areas that should be addressed to scale up the impact of the above institutions.

b) Decentralization

Decentralized government structures are a powerful tool to provide more development options to farmers. Many local government organs have identified the main constraints to agricultural intensification in their areas and chosen priority interventions for their areas. Given technical and methodological support the local governments will be in a position to implement many of their development programs. They have clear comparative advantages in: prioritizing development needs; motivating farmers to join development programs; providing information and to address a range of social factors such as conflict resolution or enacting appropriate bye-laws that support development initiatives.

Funds are channeled to decentralized government to support some of the priority intervention areas. This ensures that the beneficiaries participate and own the activities aimed at improving their livelihoods. Funds to assist these are the Poverty Alleviation Funds (PAF), PMA funds, NAADS, non-conditional and conditional funds.

c) Farmers associations

The survey team came across a wide range of formal and informal farmer groups and associations that provide appropriate structures for development initiatives. They provide nucleus to:

- Demand for advisory services;
- Provide seed multiplication opportunities;
- Help organize joint marketing;
- Generating experiments and adaptations of technologies
- Facilitate farmer exchange visits
- Organize on-farm experiments and demonstrations
- Stocking inputs

- Agro-processing potential

Highlands provide a range of niches for the production of specialized agricultural commodities. On the other hand, the main markets for these products are usually the urban centers. Processing can often

  - Increase the shelf-life of the product;
  - Add value;
  - Reduce volume and weight of the products that need to be transported, and
  - Create incentives for increased production

The potential is high especially in fruits, food crops, vegetables and livestock products.

5.2.4 What next ?

To make options for agricultural intensification available to farmers in SW Uganda, a range of support measures could be considered:

(1) Support decentralized seed and planting material multiplication

- Formal initiatives
- Informal initiatives
- Quality control systems

(2) Support adaptive research and development activities

- Practical training and experience sharing in participatory planning, research and development approaches / methodologies for research and development organizations as well as for appropriate sections of local government.
- Support to ARDC and NAADS in SW Uganda
- Support to other research and development institutions conducting adaptive research and development
- Support to local government

(3) Support information delivery

- Ensure good documentation of the initiatives supported under (1) and (2).
- Make available the technical information in appropriate form for farmers, local leaders, CBOs and NGOs.

(4) Bottom up approach

- decentralization has empowered local leaders at various administrative units to address the highly recognized (see District Development Plans) issues of agriculture and environment. However, local government has to deal with a range of conflicting demands for their resources and often agricultural production and environment do not score high in resource allocation.
- many local government officers in the southwest are very capable, hardworking, and have some resources at their discretion.
- Policies for community driven processes have been initiated and projects need to pay attention to these priorities (e.g. in District Environmental Action Plans)
- Local ownership of projects from the outset is a key component for the success of projects.
- Support to the policy formulation for land management at both local and central levels is crucial for successes in land management.

(5) Build up databases to be able to assess progress and adjust where necessary

- The are major gaps in the systematic collection and documentation of data on environment, agriculture and agricultural practices.
- There is however an increased interest in data collection and processing by local government which requires more local data for efficient decentralized administration.
- Many NGOs and extension (e.g. in Kasese District) are active in data collection efforts to increase knowledge bases and they can become partners in the process

(6) Market development may assume equal or greater emphasis than production enhancement

- Farmers and extension throughout the southwest mention market issues as a high priority
- Evidence suggests that integration with wider markets for some commodities is poor and over production becomes a concern

- Research or information provision on enhancing market options would be welcomed and supported by local leaders

(7) Need to consider or identify alternative off-farm sources of livelihood

- The land area per farm household is generally small in the region and there is need to assist farmers to identify priority enterprises to improve their livelihoods without subjecting to risks and uncertainities.

5.3 Soil management as a crosscutting issue

The survey report, and chapters 2 and 4 in particular, highlight the concern of farmers and local leaders that the quality of their basic resource, soil, is rapidly declining. Together with marketing issues, soil erosion and soil fertility decline ranked top of the agenda in all areas. In some areas a link between run-off in the hills and flooding of valley bottoms and lowlands was clearly expressed. Similarly, a clear link exists between low soil fertility, less vigorous plants and increased effects of pests and diseases.

While it is true that concerns about the state of the soil are not new (reports on this date back to the early parts of the 20th century), it is also evident that soil degradation has reached a state that limits the scope of agricultural options for farmers and leads to low outputs from nearly all farm enterprises.

It is therefore proposed that soil management be an integral part of all efforts for agricultural intensification in SW Uganda.

To achieve this, a rationale for soil management, based on scientific findings should be developed. This could be based on the following proposed principles:

(1) Soil conservation is the basis of all soil improvement methods;
(2) Organic inputs are at the core of soil fertility management
(3) Supplementation by strategic use of inorganic inputs where required and economical

Currently most of the soil management initiatives are conducted in 'pilot' areas or with 'contact farmers'. A key challenge is to scale up these activities to larger areas and to make them operational. Individual efforts on soil conservation are not efficient in highland areas with fragmented farms. Such coordinated, locally driven efforts cannot be initiated by sporadic, short-lived initiatives but requires long-term commitment.

Apart from the use of (capital intensive) inorganic fertilizer, soil management innovations are labour and/or land intensive. This means that farmers will have to adopt a stepwise approach to the management of their soils. In the longer term when these efforts are rewarded by better yields, intensive soil management is expected to lead to increased rural employment.

- Conservation as first step
  Soil and water conservation are the base for further investments in highland agriculture. Without conservation, all other investments in soil fertility are at risk to be 'washed away' with the next storm. Farmers seem to prefer biological methods for soil conservation that also provide products useful to their farms, such as:
    - Grass strips providing fodder
    - Contour hedges, providing firewood, stakes and fodder

These biological conservation measures may have to be supplemented by engineering approaches where necessary, such as:

- Storm drains
- Channels

While the technical aspects of soil conservation are well studied and options have been developed and documented, the scale of the work and its social organization are at the core of the problem. Protecting hundreds of thousands of hectares of steep farmland and to organize coordinated efforts by thousands of farmers is a real challenge. Recently, watershed approaches that have been relatively successful in East Africa have been combined with opportunities resulting from decentralized government structures and led to promising results in a few cases that need to be replicated and further developed (Raussen et al, 2001).

- Soil fertility management

It is beyond the scope of this report to discuss soil fertility management options in detail. However, the team observed a striking need for a rational approach to soil management as described above. Currently at the extremes, some organizations advocate for organic inputs only and condemn inorganic inputs as responsible for 'spoiling the soil' while at the other extreme only inorganic inputs are seen as a meaningful input into soil management.

Publishing in appropriate form the many available results from research institutes, universities and other organisations on the issue soil management in the SW highlands would be an important step towards a more rational and coordinated approach to soil management.

In practice it is appropriate to promote concepts which include:

- Improved management and use of manure and compost
- In-situ production of organic inputs, such as improved fallows (and cover crops)
- Good agronomic practices such as appropriate tillage, crop rotation, intercropping etc.
- Strategic use of inorganic inputs where required and economical.

5.4 Trees and forest products

There are few places in East Africa where the role of trees in generating income is so clear than in southwest Uganda. Trees are already used in many ways by farmers, but the use will need to be intensified if key income generating opportunities are to be seized. Most of the best-bet crop and livestock technologies require some form of input from trees. Examples of these are:

- Trelling systems for passion fruit and vanilla
- Stakes for climbing beans
- Support for banana branches
- Hedges for soil conservation
- Tree fallows for soil fertility management
- Fodder for livestock
- Construction for zero grazing
- Firewood for tea

Simply put, there will be limitations as to the development of these best-bet options in the absence of improved management of trees in farming systems. This will involve making management information and germplasm for a wider variety of species and technologies more available.

Details for information management and germplasm production and delivery have been made in 5.2.

Trees also generate direct benefits and some of the important products that provide income or livelihood are:

- Wood
- Fruit
- Medicine
- Poles

One of the most promising options seems to be with temperate fruits. Already, Uganda imports much fruit from South Africa and elsewhere both as fresh fruit and in processed form (e.g. juice). Uganda has never grown productive cultivars of temperate fruits and these are just now being tested. The southwest has a definite comparative advantage in their production because there are relatively few places where temperate fruits can flourish.
The other products are also important, but perhaps to fill more so the local demand. Similar products can be grown in other parts of the country and transportation costs can restrict the geographical market boundaries for such products.

Lastly, it is important to recognize that tree growing can be an environmentally friendly land-use on degraded land. Thus, for most of the benefits above, niches can be found on the landscape where trees can be grown without much opportunity cost in terms of lost crops and at the same time can help to reduce soil and water erosion.

While the local importance of forest products is well known (i.e. Cunningham, 1996), relatively little information exists on the value and marketing of forest products. A study has been commissioned by Forest Sector Secretariat and will provide more information on this important area.

5.5 Markets, processing and prices

Though much of the above recommendations would suggest that the major problem of agricultural intensification lies on the production or supply side, efforts aimed at developing markets are of equal or perhaps greater importance. We observed cases where farmers were able to increase production (e.g. maize, pyrethrum, milk) only to fail to be rewarded with buyers or favorable prices. There are many different reasons for poor producer prices, among them:

- lack of market access based on geography (e.g. for many crops in Kasese)
- poor product quality (e.g. tea, passion fruits)
- few buyers of products (e.g. pyrethrum)
- lack of local processors or cottage industries
- lack of storage to avoid price seasonality
- lack of organization among producers to enhance market power and bulk products to achieve sufficient quantities
- lack of market information
- competition in supply from other areas of Uganda

We did observe examples of these during our field visits. However, we were not able to analyze marketing constraints in any detail. This should be a priority area for collaboration between research, development, and local government. It will be important to take a long-term perspective in helping to guide market development in the region. Every region in East Africa is faced with a similar problem of trying to best position itself in order to provide good income opportunities for farmers. Thus, it is not only a question of identifying markets that offer growth, but to understand the strengths of the southwest in competing for these markets. Because of the continued conflict in Eastern Congo, nearby markets in Rwanda and Eastern Congo have been intermittent. For instance, raw milk imports into Rwanda are now stopped. Can the southwest compete for the Kampala market in areas besides matooke? Is there potential to export products to Kenya or outside of the region?

A further area for investigation concerns the development of local processing capacity. There are numerous processors operating in the region, but most are tea or coffee factories. It would be valuable to understand the potential for additional value added industry to locate in the southwest. Reviewing the experiences of some of the local processors could provide valuable insight. Honey processing and marketing could be an interesting case to study since the team observed a range of processing and marketing strategies for various consumer groups.

Further, farmers will have to appreciate that for many of their products higher quality is the key to marketing. This is particularly important for fresh fruits and vegetables. Current agricultural extension is not well equipped to advice on enhancing quality of products. Also packaging and presentation of most products require enhancement if they are to succeed on national and regional markets.

5.6 Win-win technologies and their niches

At the end of this survey report we present some technologies that seem to stand out as having good chances to improve the livelihood of the people in the southwest and also have positive effects on the environmental status of the region. We have no intention to single out the 'best' technologies. But we wish to propose them as components in packages intended to improve the farming systems in the southwest in terms of economic output and ecosystem functions.
We have made a strong point on the importance of local ownership of development initiatives and the potential of local organizations, local government in particular, to steer development. Adaptive research and participatory development planning and implementation have come out as strong requirements to achieve agricultural intensification which is compliant with environmental demands. Senior managers would be well advised to verify the quality of what is generally termed 'participatory' in development initiatives. Where deficits are found, practical field training of extension workers on participatory approaches may be a basic need.

5.6.1 Crops with particular potential in southwestern Uganda

The basic assumption here is that the southwestern region should make use of its particular environment, that is its highland climate and that the fragile nature of the sloppy terrain requires investments in soil productivity. Besides special conservation structures (5.6.3) perennial crops and crops with good ground cover provide good conservation services.
Also, it is important to consider the various climatic zones in highlands which change with altitude. The tables in chapter 4 and the technology profiles in appendix 2 indicate suitable altitude ranges for various crops. Some farmers are well aware of this. We found the most striking example at the Rwenzori footslopes where farmers live at 2000 m.a.s.l. and have their main fields,

but cultivate cotton at ~1000 m.a.s.l. and have plantations for passion fruit and vanilla at ~2500 m.a.s.l.

Among the perennial crops

- Banana is the most important crop at lower elevations up to 1700 m.a.s.l. Adaptive research on varietal improvement and management improvement are key areas.
- There are high expectations in temperate fruit trees, that are successfully grown in similar environments in East Africa above 1500 m.a.s.l. Adaptive research, a quality-controlled multiplication system, training in tree management and market research (cottage industry) are high priorities.
- Vanilla and passion fruits are tropical fruits which are grown in the area. Improving fruit quality and local processing are high priorities.
- Other tropical fruits, grow well in the area, but are also grown in the warmer areas of the country. There is some scope to improve their cultivation for local markets and home consumption.
- Expansion of tea production is a high priority for many local governments since it is a cash crop with good export potential. Expansion of current tea growing areas is ongoing and feasibility of establishing further tea factories should be determined.
- Strengthening and reintroducing and arabica coffee cultivation in the highland areas has to overcome market constraints and reservations by farmers. Farmers still remember the previous marketing problems.

Among the annual crops

- Irish potatoes thrive well under highland climate and have interesting national markets. Establishment of quality-controlled seed multiplication systems and promotion of integrated management of Irish potatoes are high priorities. Processing of potatoes is already done at small scale in the southwest but could probably be expanded.
- Production of bush beans for which the area is well known is hampered by a number of constraints. Climbing beans provide a viable alternative which integrates well with agroforestry initiatives.
- Sweet potato is a very important food crop and the main source of cash for women. Its good ground cover conserves the soil. Improvement of planting material through adaptive research and quality-controlled multiplication schemes are priorities.
- Horticultural production has a long tradition in SW Uganda and farmers are able to produce significant quantities of quality vegetables. Marketing and processing are key areas for the revival of the industry.

5.6.2 Livestock

In the highland areas integration of livestock into the smallholder farming systems on small and often fragmented farms is a key concern. Livestock is an important 'saving scheme' for farmers and manure is a common and important input into soil management. Commercialization of the dairy sector is well advanced in most areas but recent marketing problems have affected its growth.

- Dairy cattle (milk, manure, meat, hides, cash from bull calves, in-calf heifers, heifers, culled cows, breeding bulls) continue to be highly demanded and are promoted by a range of organizations. Exploring new markets for milk and by-products such as hides are high priority.

- Dual-purpose goats (produce milk, meat, manure, cash, skins) have been introduced with some success in SW Uganda. Further promotion of dairy goats and exploring processing (goat cheese) and markets are high priorities.
- Chicken, are kept on most farms and provide manure, eggs and meat. They are an important source of cash for women. Improving local breeds and their management should be stimulated through adaptive research and extension work.
- Beekeeping is well established in the region but production systems, processing and marketing could be significantly improved.

5.6.3 Natural resources management

While the scale of degradation in southwestern Uganda may be subject to debate, there is no doubt that the hilly terrain of SW Uganda requires increased efforts to maintain and improve its productivity. Farmers readily accept a focus on increasing productivity while conservation is considered a 'by product'. This has some important implications on extension approaches.

The key questions in the management of natural resources are less technical but rather organizational and social. We wish to underling the particular importance that local ownership of natural resource management initiatives has for their success. Most of the 'success stories' on natural resource management show that only when the initiatives become a farmer-driven movement supported by local government and with some knowledge inputs from suitable organizations, they are likely to be successful and sustainable. This may be an area where adaptive social research would be of high priority to document the lessons learnt and analyze key factors for success. One such factor is integrating more profitable enterprises (as mentioned above) into the farming systems, which provide much needed incentives for improved management of agricultural land.

Despite the above emphasis on socio-economic issues, there exists a clear need for adaptive technical research and sound technical advice on both methodologies as well as technical implementation details. Practical field training of extension agents should be a high priority.

While we consider soil fertility management an integrated activity which should make use of all suitable resources on farms, some key technologies can be identified:

- Contour hedgerows with diverse, durable shrubs producing products which are in high demand on farms, such as firewood, stakes, fodder and mulch. Seed multiplication, farmer-driven and watershed based conservation initiatives are key areas that require well-designed support.
  Contour hedgerows as biological means of soil conservation should be supplemented where necessary with physical soil conservation structures, i.e. storm drains.

Although these conservation efforts only have moderate effect on the productivity, they are a pre-requisite for all other soil management aspects and long-run systems health of the agricultural environment.

- Improved use and management of manure and compost are at the disposal of most farms and require mainly training. Equally the use of mulch has many positive effects on soil productivity. For all these technologies the quantities of the organic inputs are usually rather low and insufficient to cover all fields. Transporting the bulky material is laborious particularly in highlands. Strategic use of these inputs in the productive fields near the

homestead are feasible and these technologies can be well integrated with the ones mentioned below.

- Improved fallows with suitable shrubs are being researched on-farms and preliminary results show attractive technical and economic response. This technology fits well on exhausted land, such as the upper parts of bench terraces. Continued adaptive research, particularly on the labour aspect and gradual promotion of this technology is warranted.

- On more degraded sites, rotational woodlots with suitable trees are an option under on-farm research. On degraded sites, the opportunity costs are low. About 10% of the cropped land is considered by farmer to be degraded to an extent that cropping is no longer an option. These degraded hilltops and slopes are suitable for the rotational woodlots.

- Instead of attempting to rehabilitate the degraded land, alternative land-uses such as woodlots for timber, medicine and others could be considered. Even fruit trees seem to produce on degraded land as long as a large planting hole is dug and filled with a good soil mixture (manure).

- Inorganic inputs (fertilizer) are important inputs to supplement the above organic measures. Phosphorus and potassium can often not be supplied in sufficient quantities through organic inputs. With high input costs and low farmgate prices for most commodities the use of fertilizer is only economical on higher-value crops.

- Although rainfall is fairly high and evaporation relatively low, irrigation is considered important by farmers and local leaders to 'insure' other inputs against the vagaries of weather. Manual pumps and water harvesting are proposed as smaller scale interventions. Feasibility of additional gravity irrigation schemes requires further investigations. Wetlands have been used for considerable time for horticulture based on (residual) soil moisture. Not all wetlands are suitable, because of flooding, low pH and others while others have a high conservation potential or provide highly important hydrological services. There is need for rational evaluation and demarcation of wetlands suitable for horticulture and those that should be under conservation.

Overall, there are some key areas requiring consideration and support to improve the management of agricultural resources:

- Landscape level interventions, such as watershed management should support and make use of decentralization. Information exchange through exchange tours, introducing simple, participatory planning tools are key activities.
- Nurseries are required for most tree-based innovations. A key concern here is that the ideal management of these nurseries depends on the trees to be produced. While some, like many of the shrubs used for contour hedgerows, fodder and improved fallows can be raised in a similar manner as vegetables in small beds on the farms; others such as fruit trees or difficult to propagate high-value tree species may need specialized nurseries including some quality-control mechanisms.

Further, none of these nurseries require free handouts, despite seed. The average farm has all inputs and tools for a small, simple shrub / tree nursery and a commercial nursery may require credit but no handouts. Diversity of the trees raised based on the seed available, as well as the quality of the seed and planting materials are key concerns.

- Seed multiplication is therefore an issue that –like nurseries- requires diverse approaches. Again, some seed is simple to multiply and emphasis should be on training,

bulking and distribution while with more delicate seed and planting materials initial emphasis is on adaptive research, training and quality control.

References:

Bamwerinde, W. and F. Place. 2000. Factors Explaining Land Use and Abandonment in Kabale District, International Centre for Research in Agroforestry (mimeo).

Bolwig S.; P. Hazell and S. Wood 2001. Assessment of strategic land use options for Uganda. Phase I draft completion report. IFPRI, Washington

Braun, A.R.; E. Smaling , E. Muchugu, K.D. Shepherd and J.D. Corbett (eds.) 1997. Maintenance and improvement of soil productivity in the highlands of Ethiopia, Kenya, Madagascar and Uganda. AHI Technical Report Series 6, AHI, ICRAF, Nairobi

Bushenyi Local Government 1998. Three Year District Development Plan (1998-2001). Bushenyi, Uganda

Bushenyi Local Government 2001. Three Year Rolling District Development Plan 2001 - 200). Bushenyi, Uganda

Chemonics International INC (eds.) 2001. USAID SO 7 Assessment of strategic Agriculture & Environment Options. Report submitted to USAID / Uganda, Chemonics, Washington, D.C.

Chemonics International INC. and Makerere University Institute of Environmental and Natural Resources (eds.) 2001. Environmental Threats and Opportunities Assessment for Uganda – Biodiversity Assessment. Report submitted to USAID / Uganda, Chemonics, Washington, D.C.

Cunningham, A.B. 1996:People, park and plant use. Recommendations for multiple-use zones and development alternatives around Bwindi Impenetrable National Park, Uganda. People and Plants working paper 4. UNESCO, Paris.

Holmgren, P., E.J. Mashakha and H. Sjöholm 1994. Not all African land is being degraded: a recent survey of trees on farms in Kenya reveals increasing forest resources. *Ambio,* **23**, 390-395

Kabale Local Government 2000. Three year development plan 2000/2001 to 2002/2003. Kabale, Uganda

Kabale Local Government 2001.Kabale District Environemental Profile. Uunpublished draft report, Dept. of Environment, kabala, Uganda

Kasese District Local Government 2000. 3-year Rolling District Development Plan 2000/1 – 2002/3. Kasese, Uganda

Kisoro District Local Government 1999. Three year district development plan (1999, 2000-2001 / 2002), Kisoro, Uganda

Lindblade K.A, Carswell G., and Tumuhairwe J.K., 1998. Mitigating the relationship between population growth and land degradation: Land-use change and farm management in Southwestern Uganda. *Ambio 27: 565-571*

NARO 2001. South Western highland Farming Systems Improvement Programme. NARO Secretariat, Entebbe, Uganda

NARO 2001: Scientific Conference "NARO and Poverty Reduction in Uganda" Programme and Abstracts. NARO Secretariat, Entebbe, Uganda

NEMA - National Environment Management Authority, undated but probably 1996: Kasese District Environment Profile. NEMA, Kampala

Ntungamo Local Government 1999. Ntungamo District Local Government three year development plan 1998-2001. Ntungamo, Uganda

Place, F., J. Ssenteza and K. Otsuka 2001. Customary and private land management in Uganda. In: Otsuka, K. and F. Place (Ed) Land Tenure and Natural Resource Management, 195-233, IFPRI, Washington

Raussen, T., G. Ebong and J. Mussime (2001): Natural resource management made effective through democratically elected and decentralized government structures in Uganda? *Development in Practice* 11(4) 460-470, Hants, UK

Raussen, T. (ed.) (2001):Useful trees for farming: Temperate fruit trees for Uganda's highlands. Technical Bulletin 2, ICRAF, Uganda 24 pp

Raussen, T. (ed.) (2001a): Useful trees for farming: Calliandra calothyrsus. Technical Bulletin 1, ICRAF, Uganda 20 pp

Rukungiri Local Government 1999. Rukungiri District Local Government three year development plan. Rukungiri, Uganda

Shepherd, G. and D. Brown 1998. Linking international priority-setting to local institutional management. In: S. Doolan (Ed) African Rainforests and the Conservation of Biodiversity, 77-87, Earthwatch, Europe, Oxford, UK.

Tukahirwa, J. and K. Kabananukye 1995. Diagnosis characterization activities in African Highland Initiative (AHI) Benchmark locations in South West Uganda; Synthesis Study. AHI Task Force, ICRAF, Nairobi

USAID 2001: Integrated Strategic Plan for USAID's program in Uganda, volume 1: assisting Uganda to reduce mass poverty. USAID, Kampala, Uganda.

Vosti, S.A. (ed.) 2000. Alternatives to Slash-and-Burn Working Groups on Economic and Social Indicators: Report on Methods for the ASB Matrix. ASB Coordination Office, ICRAF, Nairobi

Wortmann C. S. and C.A. Eledu 1999. Uganda's Agroecological Zones: A guide for planners and policy makers. Kampala, Uganda: Centro International de Agricultura Tropical.

Appendix 1: District Profiles

The following tables attempt to systematically present some key information about the districts in the southwest. A few points need to be highlighted.
First, Kanungu District was only recently formed from Rukungiri and hardly any information exists at the level of the new district boundaries. Hence, we have present data for the former Rukungiri, which includes the area now under Kanungu.
Second, it is easy to observe the variation in data availability across districts. For example, price data for crops is available for only two districts. Even basic figures for crop area or livestock numbers were not available in all districts.

Some of the information is discussed in Chapter 2. A few other details are noted here.

- Total land and arable land area:

The proportion of total surface area that is arable is very high in the southwest – it is at least two-thirds of area in 5 districts. Kabale has the highest percentage at 93%. The exception is Kasese District which contains sizeable lake portions, high elevation mountains, National Parks and some semi-arid lowlands. In terms of cultivated area, only 8% of total area of Kasese is cultivated. For the other districts, the percentage ranges between 45% and 57% of total surface area.

- Road infrastructure:

The density of trunk and feeder roads is relatively constant across southwest districts. The length of tarmac trunk roads per square kilometer (of arable land to proximate the settled area) is around .03 km/km^2. A similar ratio applies to murram trunk roads in most of the districts. But there is significantly higher density in Kisoro and Kasese Districts (.09 and .14 respectively). In terms of feeder roads, the density is around .3 in all districts except for Kasese which is significantly above at .5.

- Extension:

The farmer to extension ratio shows that Ntungamo has a slightly more favorable density of extension workers (852 farmers each) compared to the others. Rukungiri is next at 1,536 and all the other districts have ratios of over 2,000 farmers per extension worker (data on Kasese were not available). Many of the workers do have functional motorcycles and limited operation funds for fuel, but the sheer number of families to reach is daunting.

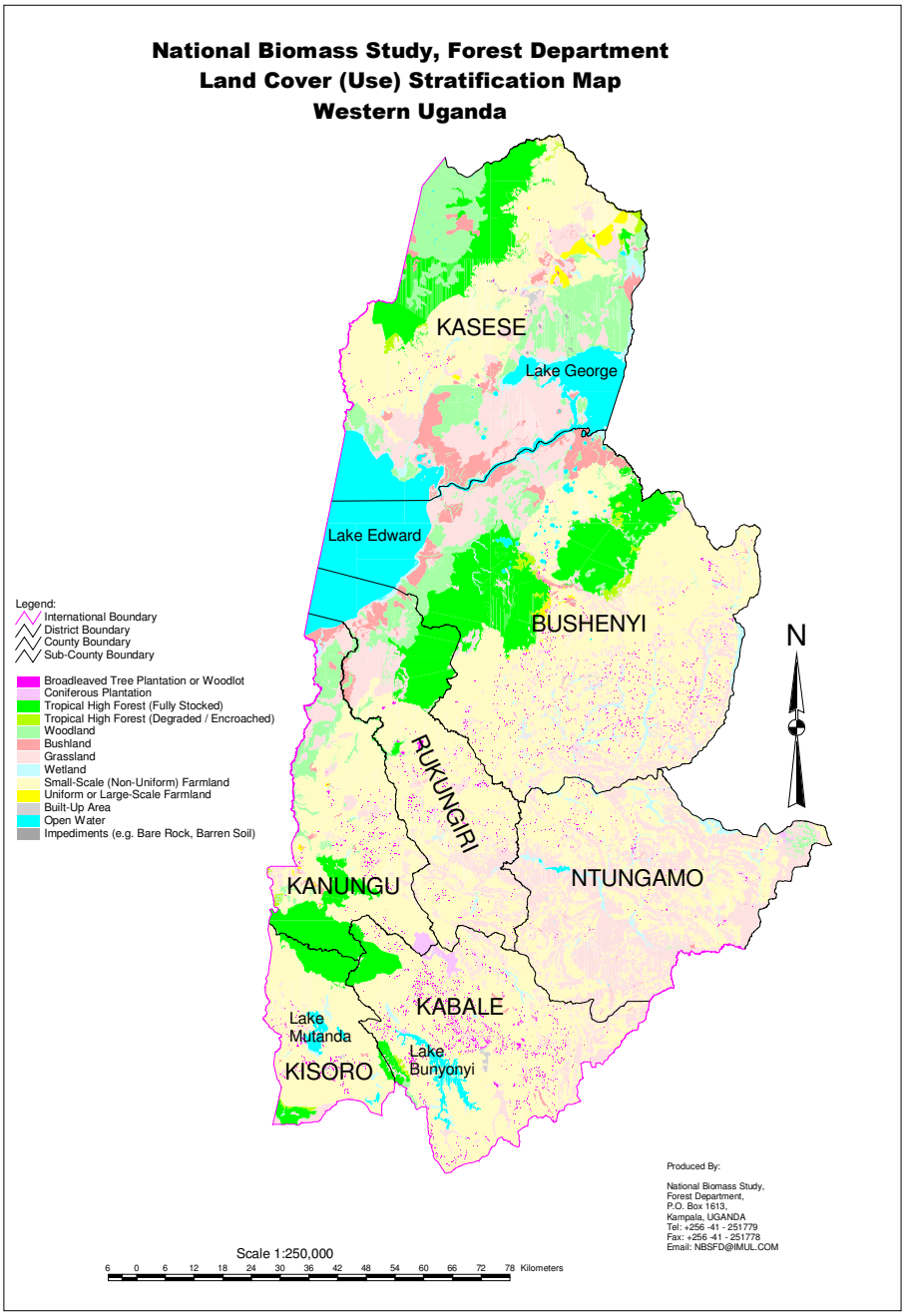
- Crop yields:

Data on crop yields come from district records, usually published in annual reports. Its' reliability is questionable mainly because limited resources prevent district officers from precise measures of areas and production. Coefficients of variation in yields across districts show high variation for bananas, beans, and sweet potatoes but lower variation for irish potatoes, groundnuts, field peas, and finger millet. Banana yields were reportedly highest in Bushenyi and Ntungamo and lowest in Kasese. Bean and sweet potato yields were reported to be twice as high in Bushenyi and Rukungiri as in other Districts. Differences in other crops were less pronounced suggesting relatively equal productivity levels.

- Livestock density:

Calculations were made on the number of head of cattle, goats, and poultry per square kilometer in all districts except for Kasese. Cattle density was highest in Ntungamo (132), followed by Bushenyi and Kisoro at around 50 head per km^2. In terms of goats, Kabale

District had the highest density (115) followed by Kisoro (87). Very few are reported in Bushenyi or Ntungamo. Poultry numbers are much greater and high densities are reported in Rukungiri, Kabale, and Kisoro (Bushenyi only reported exotic breeds). In sum, farmers in Kisoro appear to rely heavily on a range of livestock enterprises while other districts appear to display preferences for different types of livestock.



Ms = missing data; Na = not available

A 1.1 District Profile: Kisoro

Area [km^2]	Total	Arable	Cultivated	Lakes	Wetlands	Forests
	730	520	476	28		114,3

Topography and relief	Southern low lands with volcanic range and northern highlands; average altitude 1981 m.a.s.l.			
Tree cover [%]		# of forest nurseries:		
Climate	Bimodal rainfall, average: 1000 - 1250 mm/yr; June – July driest and coolest; avg temp.: 16° C			
Population	Number by 2001 280,000	Density km^{-2} 356	Growth 3.5 %	Ethnic groups, Bafumbira, Bakiga, Banyarwanda, Batwa
Major towns	Kisoro			
Counties	1 county			
Subcounties	13			
Road network	trunk road: 48 km murram; 261 km feeder; 97 km community			
Literacy rate	32.8 %			
Health indicators	Child mortality: 105 per 1000			
% rural population	96 %; average farm size: 0.8 ha, land fragmented			
Gross Agric. product per capita [Shs]	U Shs ???		$???	
Access to clean water	27%, 7 boreholes, 430 protected springs, 90 rainwater tanks, 3 gravity water schemes			
Number of staff in production & market	30			

Crops	**Area** [ha] **Total**	**Trend**	*Total production [t year^{-1}]*	*Average yield [kg ha^{-1}]*	*Farmgate Price U Shs/kg*	*Constraint Potentials*
1. Beans	4,881	↑	3,745	767	200	Bean root rot
2. Sorghum	5,931	↔	9,423	1589	200	
3. Bananas	1,924	↑	4,113	2138	50	Cigar end rot
4. Sweet potatoes	2,248	↔	4,110	1828	50	
5. Irish potatoes	7,975	↑	46,145	5786	100	Blight, Bacterial Wilt, Millipedes,
6. Maize	5,399	↑	11,000	2037	30	Streak virus
7. Field peas		↑	5,275	-	300	
8. Finger millet	7,380	↑	11,200	-	200	
9. Wheat	Ms	↓		-	200	
10. Tobacco	Lw	↔		-	-	
11. Groundnut	87	↔	59	678	800	
12. Coffee (arabica)	Ms	↔		-	-	Leaf rust, coffee berry disease, coffee wilt
13. Yams	Ms	↔		-	-	
14. Fruits (passion f., avocado)						
15.						
16.						
Overall assessment						

Ranked agricultural problems			
	1. pests and diseases	2. lack of improved seed	3. high post harvest losses
	4. lack of agro-processing	5. rampant soil erosion	6. lack of cash generating crops

Ms = missing data; Na = not available

Livestock	**Number of heads**		*Total production per year*	*Average production*	*Farmgate Price U Shs*	*Constraints Potential*
	Total	**Trend**				
1. Cattle (local)	27,193	↔	4,900 t		1500 / kg	East Cost Fever, Anaplasmosis, Trypanosiamis, Cattle worms, Brucellosis, foot & moth
2. Cattle (improved)	3,700	↑	8,9 m litres		200 /l	
3. Goats	45,210	↑	542 t		200 / kg	Mange, pink eye, worm infections
4. Sheep	25,100	↓	301 t		1500 / kg	
5. Pigs	7,100	↑	213 t		1500 / kg	Worm infections, African swine fever
6. Poultry	510,000	↑	765 t		2000 / kg	New castle disease, coccidosis, fowl typhoid
7. Fishponds	112	↑	Not productive		2000 / kg	
8. Rabbits	3,000	↑	4,5 t		2000 / kg	
9. Donkeys	16	↑			-	
10. Bee keeping	2500 hiv. 145 beek.	↑	3,75 t		3500 / kg	*Kisoro Bee Keepers Association → marketing*
11. Silk farming		-				
12. Zero grazing units	85	↑	204,000 l			

Ranked livestock problems			
	1. communal grazing on poor pastures	2. poor water supply	3. lack of improved breeds
	4. no organized marketing system and milk coolers	5. diseases (incl. Cross-border infections)	6. poor housing and hygiene

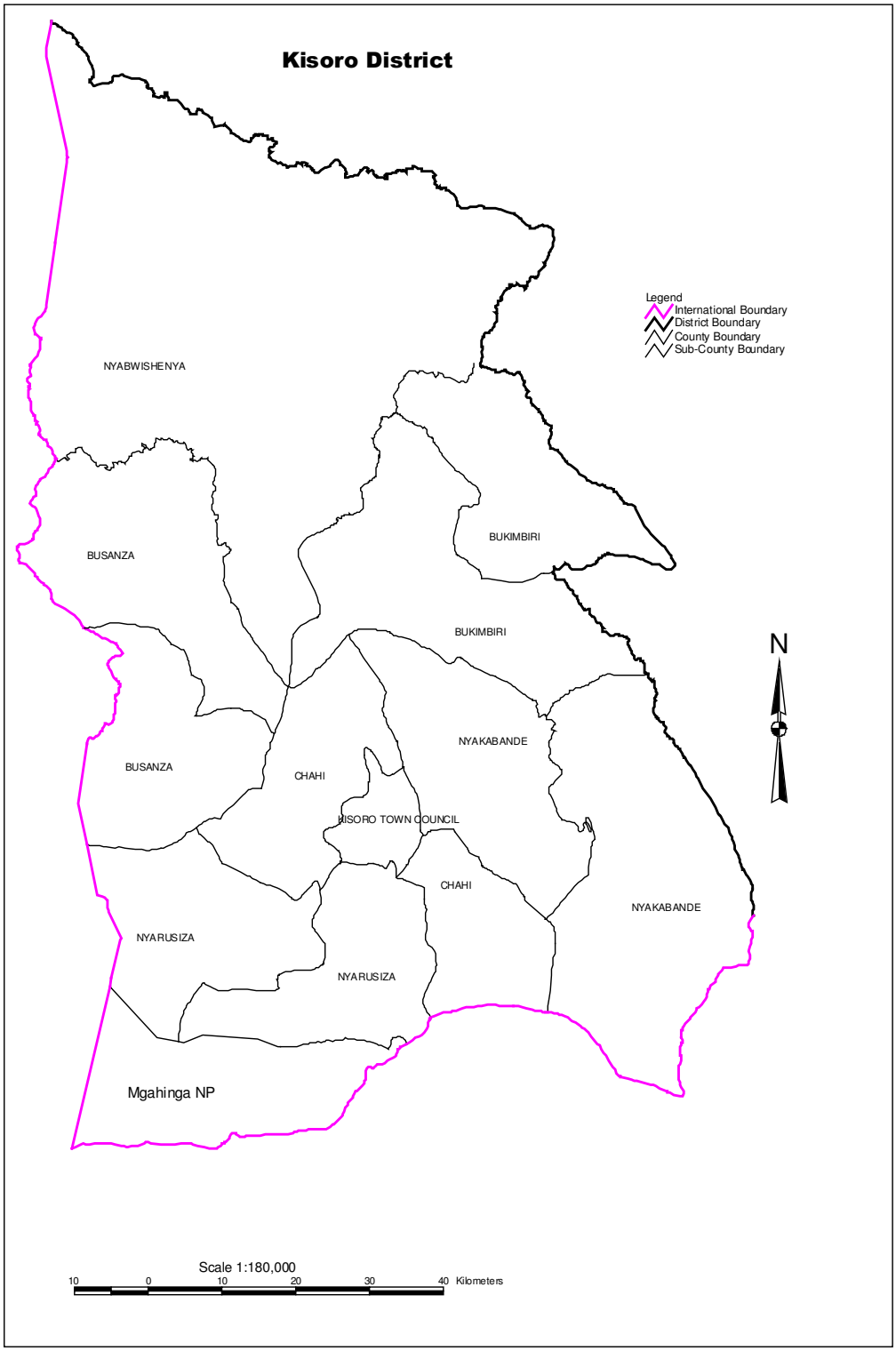
Natural Resources	**Area** [km^2]		*Total production*	*Constraints Potential*
	Total	**Trend**		
Lakes			***9 t year^{-1} fish***	*Restocking of lakes started,*
Forest and plantations				
Forests & agroforestry				*High demand for firewood, willingness to plant trees*

Ranked environmental problems			
	1. deforestation	2. draining of wetlands	3. cultivation in watersheds
	4. flooding in low lands	5. lack of fish fry	6. overfishing

Agricultural Processors	7 grain mills, 3 honey processing plants, 3 weaving workshops, 15 carpentries, 1 bakery
Agric organizations	44 co-operative societies
Agric. Extension	Extension worker : farmer ratio 1: 2000
Soil Management	Some use of compost, manure, terrace bunds
Agroforestry	Interest in contour hedges, boundary planting and fodder
Markets	

Ms = missing data; Na = not available

Map:


Kisoro District
Legend
International Boundary
District Boundary
County Boundary
Sub-County Boundary
NYABWISHENYA
BUSANZA
BUKIMBIRI
BUKIMBIRI
N
NYAKABANDE
BUSANZA
CHAHI
KISORO TOWN COUNCIL
CHAHI
NYAKABANDE
NYARUSIZA
NYARUSIZA
Mgahinga NP
Scale 1:180,000
10 0 10 20 30 40 Kilometers

A 1.2 District Profile: Kabale

Area [km^2]	Total	Arable	Cultivated	Lakes	Wetlands	Forests
	1827	1695	1017	48	79	35.5 + 38 plant.

Topography and relief	High hills and mountains with altitudes between 1200 and 2568 m.a.s.l.
Tree cover [%]	4.05 % # of forest nurseries:
Climate	Bimodal rainfall, average: 1010 mm/yr; June – July driest and coolest; avg temp.: 16.7^o C
Population	Number by 2001 642,000 / Density km^{-2} 351 / Growth 2.2% / Ethnic groups, Bakiga, Banyarwanda, Batwa
Major towns	Kabale,
Counties	4: Municipality, Ndorwa, Rubanda, Rukiga
Subcounties	19
Road network	trunk road: 68 km tarmac, 56 km murram; 505 km feeder; ?? km community
Literacy rate	52.6 % (58% for men and 38% for men)
Health indicators	Doctor : patient ratio: 1: 20,000; 80% latrine coverage; 47 5 children stunted
% rural population	85% ,105,000 households
Gross Agric. product per capita [Shs]	U Shs - / $ -
Access to clean water	68 %
Number of staff in production & market	

Crops	**Area** [ha] **Total**	**Trend**	*Total production* ***[t year^{-1}]***	*Average yield* *[kg ha^{-1}]*	*Farmgate Price (Dec 2001)* *U Shs*	*Constraint Potentials*
1. Beans	27,538	↑	20,847	757	200 / kg	
2. Sorghum	20,580	↔	16,464	800	200 / kg	
3. Sweet potatoes	18,500	↔	79,499	4,297	50 / kg	
4. Maize	19,714	↑	25,675	1,303	30 / kg	
5. Irish potato	23,328	↑	168,877	7,239	100 / kg	
6. Field peas	14,374	↑	7,531	523	300 / kg	
7. Wheat	764	↔	1,531	2,003	200 / kg	
8. Finger Millet	11,873	↔	16,920	1,425	200 / kg	
9. Cassava	4,887	↑	41,834	8,560	150 / kg	
10. Groundnuts	311	↔	236	759	800 / kg	
11. Bananas	40,616	↑	201,615	4,964	50 / kg	
12. Fruits (passion f., avocado,)						
Overall assessment						

Ranked agricultural problems			
	1. pre- and post harvest losses	2. declining soil fertility	3. natural disasters
	4. poor markets and market infrastructure	5. lack of knowledge and low availability of improved inputs	6. land fragmentation

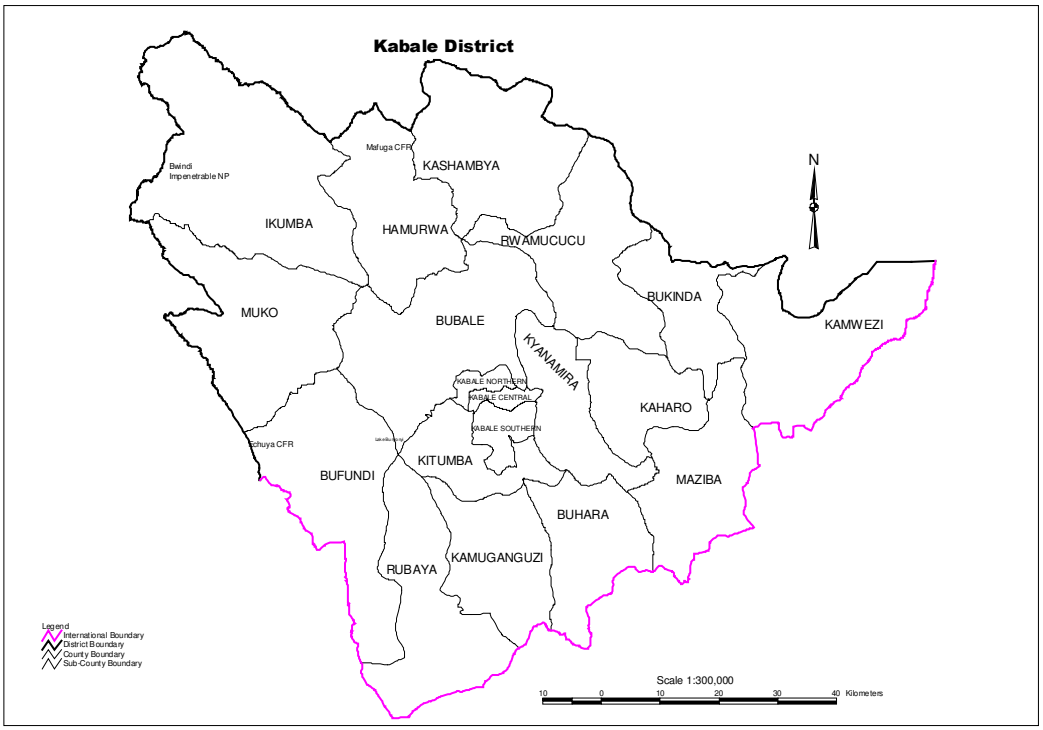
Ms = missing data; Na = not available

Livestock	**Number of heads**		*Total production*	*Average production*	*Farmgate Price*	*Constraints*
	Total	**Trend**	***per year***		*U Shs*	*Potential*
1. Cattle (local)	67,500				150 / kg	Low genetic potential
2. Cattle (exotic)	2,500		7,5 m liters	3,000 l / a	200 / l	Lack of feeds
3. Zero grazing units	498		1,5 m liters	3,000 l / a	200 / l	Lack of feeds
4. Goats	194,688		1,17 m kg	6,0 kg / a	2,000 / kg	Low management
5. Sheep	51,610		300,000 kg	5,8 kg / a	1,500 / kg	
6. Pigs	6,000		120,000 kg	20 kg / a	1,500 / kg	Feeds
7. Poultry	500,000		750,000 kg	1,5 kg / a	2,000 / kg	Feeds, markets
8. Fishponds	236		4.7 t	19,9 kg / a	2,000 / kg	Management, fingerlings
9. Rabbits	Ms				2,000 / kg	management
10. Bee keeping	Ms		5000 kg		3,500 / kg	Management, markets
11. Silk farming	Nn					
Ranked livestock problems	1. Feeds			2. low prices		3. diseases
	4. low milk yields			5. low management		6. expensive services

Natural Resources	**Area** [km^2]		*Total production*	*Constraints*
	Total	**Trend**		*Potential*
Lakes	48	↔		Few fish
Forest	*35*	↔		Forest fires, encroachment
Plantations	*38*	↓		Forest fires, encroachment
Private woodlots	*Ms*	↑		
Ranked environmental problems	1. Soil degradation		2. drainage of wetlands	3. deforestation
	4. floods and land slides		5.	6.
Agricultural Processors				
Agric organizations	222 registered cooperative societies, 1 wheat processors, 4 bakeries, 3 milk coolers, 3 cheese makers, 1 wine factory, 1 honey processor, grain milling facilities			
Agric. Extension	1 extension worker for 2527 farm families			
Soil Management	Bunds, bench terraces, fanya juu, compost, animal manure, contour hedgerows			
Agroforestry	85% don't practice, because: trees compete with crops (34%); no source of seedlings(27%); trees exhaust soil (20%) and no benefit seen (15%)			
Markets	4 main markets, 1 market in each parish			

Ms = missing data; Na = not available

Map:



Ms = missing data; Na = not available

A 1.3 District Profile: Rukungiri (and Kanungu)

Area [km^2]	Total	Arable	Cultivated	Lakes	Wetlands	Forests
	2752	2317	1575	169	145	383

Topography and relief	Northern parts: western rift valley with undulating plains, the central parts comprise of flat topped hills with broad valleys, while the hills gradually increase in the southern part, 900 – 2013 m.a.s.l.
Tree cover [%]	# of forest nurseries: 21
Climate	Bimodal rainfall, average: 1000 mm/yr; June – July driest and coolest; avg temp.: 19° C

Population	Number by 2001	Density km^{-2}	Growth	Ethnic groups,
	584,000	212	2.5%	Bakiga, Bahororo, Bafumbira, Bahima, Batwa

Major towns	Rukungiri
Counties	Rujumbura, Rubabo (Rukungiri) and Kanungu (former Kinkizi county ??)
Subcounties	19: 11 in Rukungiri and 8 in Kanungu
Road network	112 km trunk graveled; 690 km feeder roads; 47 km urban roads; 830 km community roads
Literacy rate	56.6 %
Health indicators	
% rural population	106.000 farm families, average land holding: 2 ha

Gross Agric. product per capita [Shs]	U Shs	$
	???	???

Access to clean water	207 deep boreholes; 13 shallow wells;; 1966 protected springs; 197 gravity flow taps200 rain water harvesting tanks / jars
Number of staff in production & market	69

Crops	**Area** [ha] **Total**	**Trend**	*Total production [t year^{-1}]*	*Average yield [kg ha^{-1}]*	*Farmgate Price U Shs / kg*	*Constraint Potentials*
1. Banana	17,169		109,880	6,400	50	Panama wilt, Sigatoka, Banana weevil, nematodes
2. Beans	3,132		2,505	800	200	Weevils
3. Sweet potatoes	5,876		59,348	10,100	50	Mites
4. Maize	2386		4,296	1,800	30	Borers and weevils
5. Millet	2235		1,788	800	200	
6. Sorghum	1559		1,403	900	200	
7. Field Peas	1225		980	800	300	
8. Tea	1132		6,000	5,300 (g.l.)	150	
9. Tobacco	908		1,292	1,420	1000	
10. Groundnuts	809		971	1,200	800	
11. Irish potatoes	676		7,368	10,900	100	
12. Cassava	445		??	??	150	
13. Rice (upland)	250		250	1,000	600	Mites
14. Coffee (robusta)	Na		Ms	Ms		Coffee borers, mealy bugs
15. Coffee (arabica)	Ms		Ms	Ms		
16.						
Overall assessment						

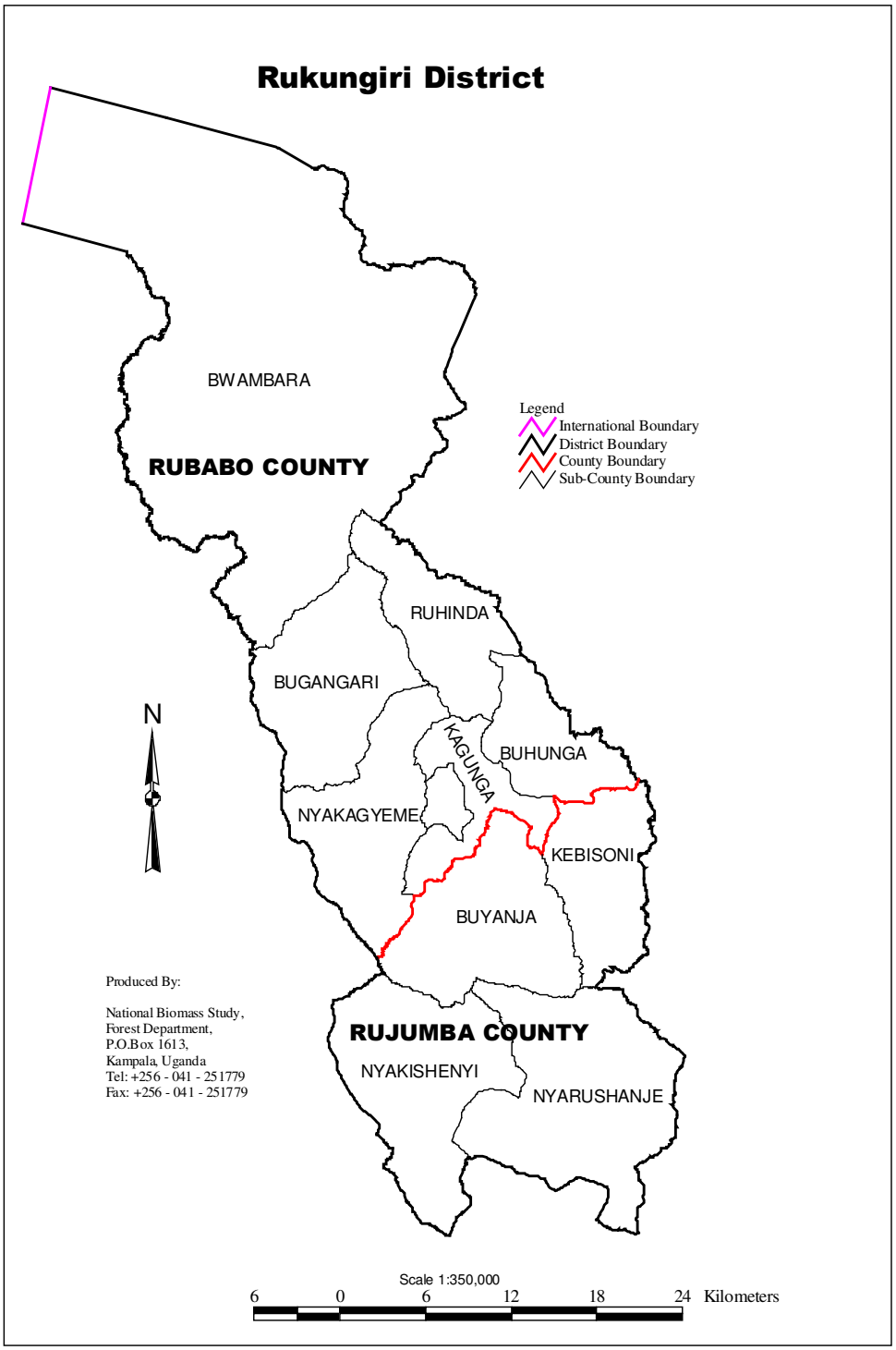
Ranked agricultural problems			
	1. Pests and diseases	2. Inadequate sources of improved seeds	3. Land fragmentation
	4. Low production levels	5. post harvest losses	6. land degradation
	7. Poor marketing system	8. indebtness to credit institutions	9.

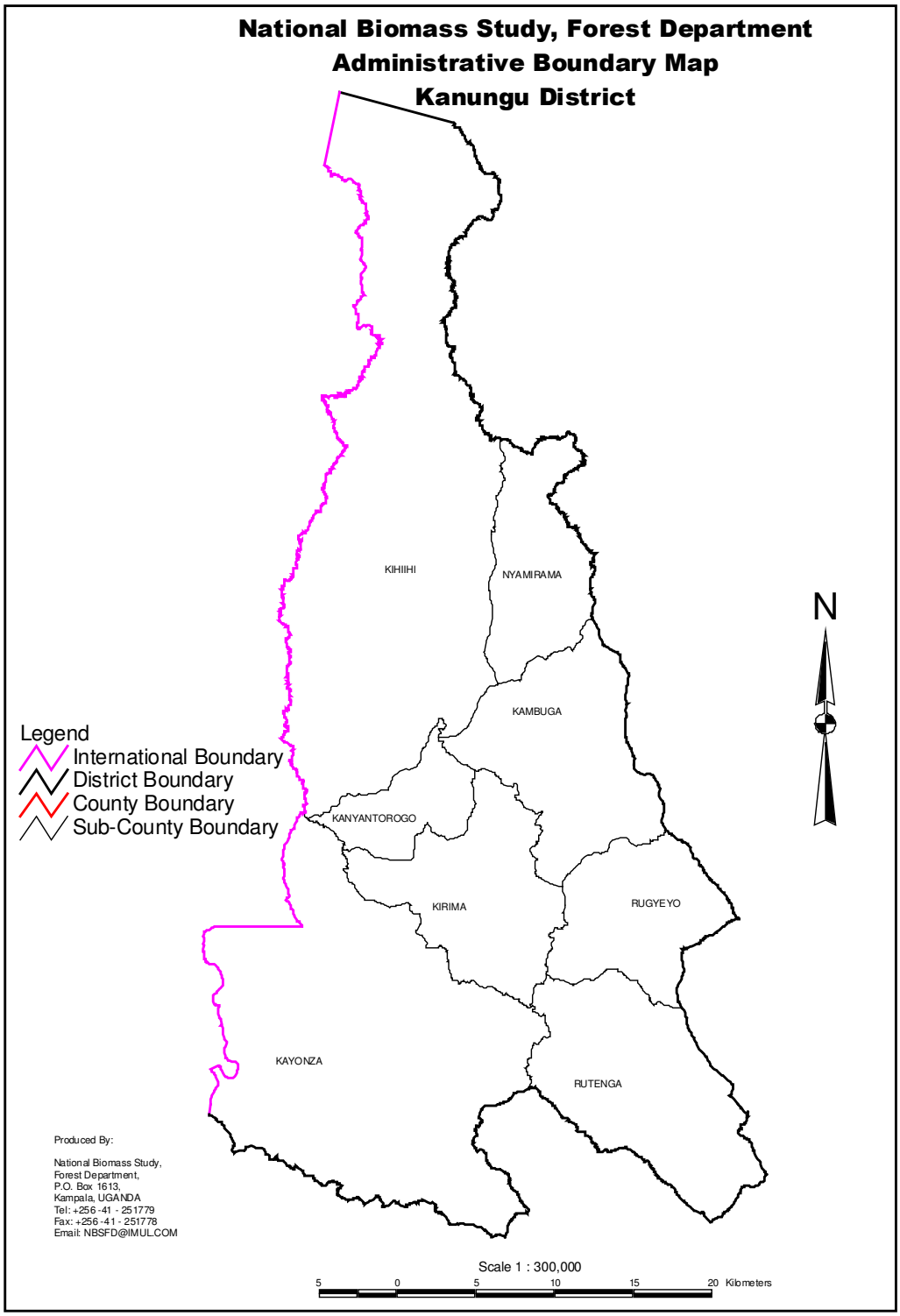
Ms = missing data; Na = not available

Livestock	**Number of heads**		*Total production* per year	*Average production*	*Farmgate Price U Shs*	*Constraints Potential*
	Total	**Trend**				
1. Cattle (local)	61,500		3,2 m liters milk year^{-1}, 542 t hides ; 383,400 skins	Ms	200 / kg	Intestinal worms, flukes, ticks, nasal flies
2. Cattle (exotic)	500				200 / l	
3. Cattle (crosses)	11,000				200 / l	
4. Goats	112,000		1,344 t		2,000 / kg	
5. Sheep	28,000		336 t		1,500 / kg	
6. Pigs	4,500		13,5 t		1,500 / kg	
7. Poultry	290,000		435 t		2,000 / kg	mites
8. Fishponds	211, 4.5 ha		2 t		2,000 / kg	
9. Rabbits	Ms		Ms	Ms	2,000 / kg	
10. Bee keeping	6494 hives		9,7 t		3,500 / kg	*521 farmers*
11. Silk farming						
Ranked livestock problems	1. insufficient cold chain		2. unplanned bush burning		3. distance to markets	
	4. diseases		5. pests		6. Tse tse	

Natural Resources	**Area** [km^2]		*Total production*	*Constraints Potential*
	Total	**Trend**		
Lakes	***169***		***1100 t fish***	Little protection, few fish
Forests	***362.5***			Poor management, fires
Plantations	***21***			
Private woodlots	***4***			Lack of seedlings, lack of awareness
Ranked environmental problems	1. –illegal fishing	2. illegal forest practices	3. overharvesting of forests	
	4.	5.	6.	
Agricultural Processors	6 milk coolers, 20 coffee factories, 1 tea factory, 49 grain milling machines, 99 carpentry workshops			
Agric organizations	120 registered co-operative societies; 20 registered co-operative groups, 2 registered cooperative unions; 5 micro finance institutions			
Agric. Extension	69 extension staff			
Soil Management	Trenches, mulch, bunds, comport			
Agroforestry				
Markets	12 monthly market centres, 24 weekly market centres, 3 daily market centres			

Ms = missing data; Na = not available


Rukungiri District
BWAMBARA
RUBABO COUNTY
Legend
International Boundary
District Boundary
County Boundary
Sub-County Boundary
RUHINDA
BUGANGARI
N
KAGUNGA
BUHUNGA
NYAKAGYEME
KEBISONI
BUYANJA
Produced By:
National Biomass Study,
Forest Department,
P.O.Box 1613,
Kampala, Uganda
Tel: +256 - 041 - 251779
Fax: +256 - 041 - 251779
RUJUMBA COUNTY
NYAKISHENYI
NYARUSHANJE
Scale 1:350,000
6 0 6 12 18 24 Kilometers



Ms = missing data; Na = not available

A 1.4 District Profile: Ntungamo

Area [km^2]	Total	Arable	Cultivated	Lakes	Wetlands	Forests
	2055	1388	922	107.6		0.03

Topography and relief	600 – 2000 m.a.s.l.			
Tree cover [%]		# of forest nurseries: 13		
Climate	Bimodal rainfall, average: 900 mm/yr; June – July driest and coolest; avg temp.: 20° C			
Population	Number by 2001 417.000	Density km^{-2} 202	Growth 2.8%	Ethnic groups, Banyankole, Bakiga, Banyarwanda
Major towns	Ntungamo			
Counties	Ruhaama, Kajara, Rushenyi			
Subcounties	14			
Road network	trunk road: 51 tarmac, 59 km murram; 389 km feeder; 832 km community			
Literacy rate	52.8 %			
Health indicators	Doctor: patient ratio: 74,280, nurse: patient ration: 16,882Latrine coverage 48%,			
% rural population	99.1 %, total number of farm families 42603 (1991 census) average farm size: 1 ha			
Gross Agric. product per capita [Shs]	U Shs ???		$???	
Access to clean water	Ms, 503 protected springs, 320 unprotected springs, 4 gravity flow schemes, 98 boreholes,			
Number of staff in production & market	50			

Crops	**Area** [ha] **Total**	**Trend**	*Total production* ***[t year^{-1}]***	*Average yield [kg ha^{-1}]*	*Farmgate Price U Shs kg^{-1}*	*Constraint Potentials*
1. Banana	29,700	↑	455,250	15,328	50	
2. Maize	735	↔	1029	1400	30	
3. Coffee (robusta)	10,000	↔	10,156	1015	300	
4. Beans	1,473	↑	884	600	200	
5. Sorghum	224	↔	135	600	200	
6. Sweet potato	1,539	↑	8927	5,800	50	
7. Irish potato	34	↑	197	5,800	100	
8. Field peas	135	↑	135	1,000	300	
9. Finger millet	373	↔	335	994	200	
10. Cassava	573	↑	5672	9,900	150	
11. Groundnuts	514	↔	463	900	800	
12.						
13.						
14.						
15.						
Overall assessment	Poor farmer response to sensitization and mobilization					

Ranked agricultural problems	1. frequent droughts	2. pests and diseases	3. lack of tree germplasm
	4. inadequate agro processing	5. low yielding varieties	6. low prices

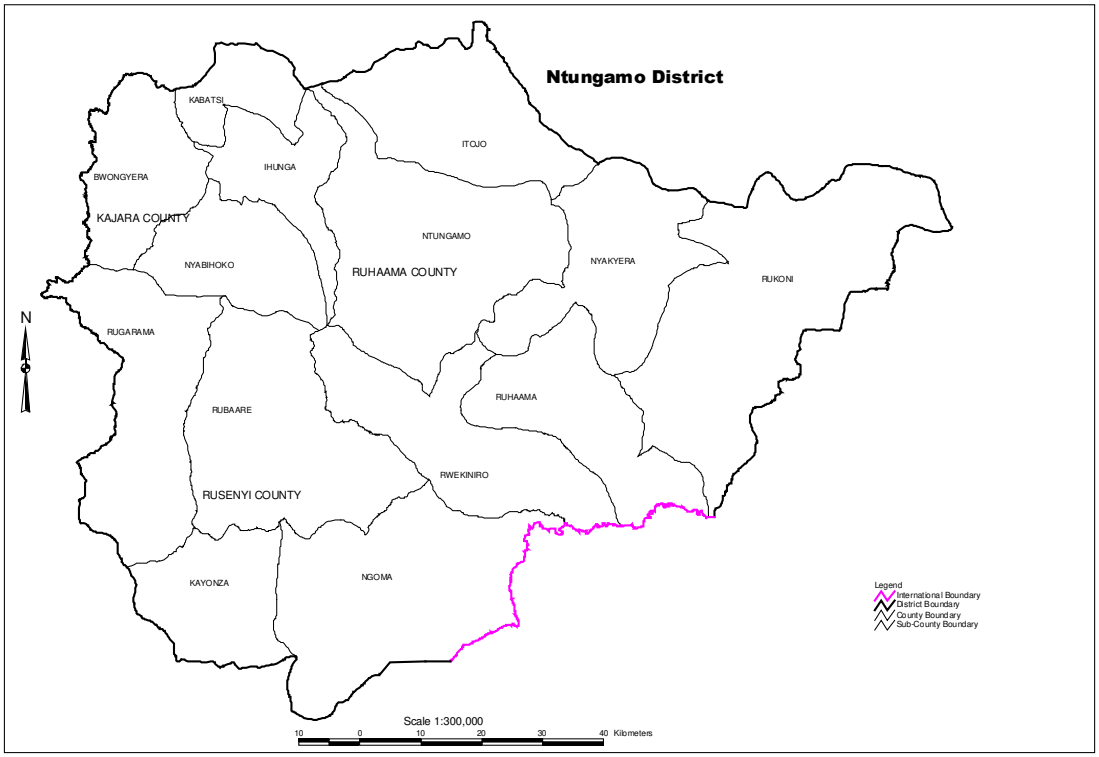
Ms = missing data; Na = not available

Livestock	**Number of heads**		*Total production* per year	*Average production Per year*	*Farmgate Price U Shs*	*Constraints Potential*
	Total	**Trend**				
1. Cattle (local)	175,866	↔	26,380 t	150 kg / a	1,500 / kg	
2. Cattle exotic	7,925	↑	19 m l	2400 l	200 / kg	
3. Zero grazing units	285	↑	684,000 l	2400 l	200 / kg	
4. Goats	19,200	↔	230 t	12 kg	2,000 / kg	
5. Sheep	9,950	↔	119 t	12 kg	1,500 / kg	
6. Pigs	13,200	↑	158 t	12 kg	1,500 / kg	
7. Poultry	30,890	↑	46 t	1,5	2,000 / kg	
8. Fishponds	122	↑	Ms	Ms	2,000 / kg	
9. Bee keeping	1,465 hives	↔	4 t	2.7 kg	3,500 / kg	
10. Rabbits	4,500	↔	6 t	1,5	2,000 / kg	
11. Silk farming	12 units		0.53 t cocoons year $^{-1}$			
Ranked livestock problems	1. expensive drugs		2. water shortage		3. overgrazing	
	4. lack of fish fry		5.		6.	

Natural Resources	**Area** [km^2]		*Total production*	*Constraints Potential*
	Total	**Trend**		
Lakes			30 t fish yr $^{-1}$	
Valley dams	6 dams	↑	10 t fish yr $^{-1}$	
Eucalyptus plantations	0.013			
Forests & agroforestry				
Ranked environmental problems	1. bye-laws not enacted and not enforced	2. overgrazing	3. soil erosion	
	4. bare hills	5. fires	6.	
Agricultural Processors	28 grain millers, 28 coffee factories, 8 milk cooling plants			
Agric organizations	130 registered societies, 145 produce buyers, 6 micro finance institutions			
Agric. Extension	50 extension staff			
Soil Management	compost, trenches, mulch,			
Agroforestry				
Markets	5 grade one, 5 grade 2 and 22 grade 3 markets			

Ms = missing data; Na = not available

Map:



Ms = missing data; Na = not available

A 1.5 District Profile: Bushenyi

Area [km^2]	Total	Arable	Cultivated	Lakes	Wetlands	Forests
	4026	3239	2157	370	83	784

Topography and relief	Undulating with broad ridge tops and generally small valleys around Bushenyi, but more steeply sloping in the southern and northern parts. Altitude 910 to 2500 m.a.s.l			
Tree cover [%]		# of forest nurseries: 6 (150,000 seedlings/year), 58 clonal coffee nurs.		
Climate	Bimodal rainfall, average: 1137 mm/yr; June – July driest and coolest; avg temp.: 19° C			
Population	Number by 2001 805,000	Density km^{-2} 200	Growth 3.1 %	Ethnic groups, Banyankole
Major towns	Bushenyi, Ishaka, Kabwohe			
Counties	Buheweju, Igara, Sheema, Bunyaruguru, Ruhinda			
Subcounties	27:			
Road network	trunk road: 90 tarmac, 110 km murram; 1124 km feeder; 1433 km community			
Literacy rate	54% (1998)			
Health indicators	Doctor : population ratio 30,992; childhood malnutrition: 43%;			
% rural population	130.000 farm families, average farm size: 0.9 ha			
Gross Agric. product per capita [Shs]	U Shs Ms		$ Ms	
Access to clean water	Safe water coverage: 49.6 % of population			
Number of staff in production & market	116			

Crops	**Area** [ha] **Total**	**Trend**	*Total production [t year^{-1}]*	*Average yield [kg ha^{-1}]*	*Farmgate Price U Shs*	*Constraint Potentials*
1. Banana	170,000	↑	1,700,000	10,000	700- 2500 per bunch	Diseases: Fusarium, B. Sigatoka etc.; markets, multiplication
2. Beans	15,000		18,000	1,200	6-8000 per tin	Pests: aphids, stem maggot Diseases: root rot, anthracnosis
3. Finger millet	10,000		16,000	1,600	6-7000 per tin	
4. Sweet potatoes	9,000		90,000	10,000	1-3000 per tin	
5. Maize	5,500		8,250	1,500	2-5000 per tin	
6. Coffee (robusta)	5,000	↓	5,000	1000 (clean)	150 / kg	30% infected with coffee wilt, declining price
7. Cassava	3,500		35,000	10,000	2-3000 dry per tin	
8. Field peas	2,800		1,960	700		
9. Ground Nuts	2,000		2,000	1000	12-20,000 per tin	
10. Tea	1,800	↑	9,000 (g.lf)	5,000(g. leaf)	150 / kg	monthly income
11. Coffee (arabica)	2,000					
12. Sorghum	1,000		1,500	1,500		
13. Cotton	1,000		600	600		New export options →USA
14. Irish Potatoes	800		5,600	7,000	2,5-3,000 per tin	
15. Fruits (passion f., avocado, mango, citrus, pineapple)		↑				Quality of fruits
Overall assessment	According to technical staff on average only 30% of potential yields are achieved					

Ranked agricultural problems	1. Attractive markets	2. Lack of germplasm	3. Land shortage
	4. Decreasing soil fertility except for one subcounty with volcanic soils	5. Pest and diseases	6. Lack of credit facilities

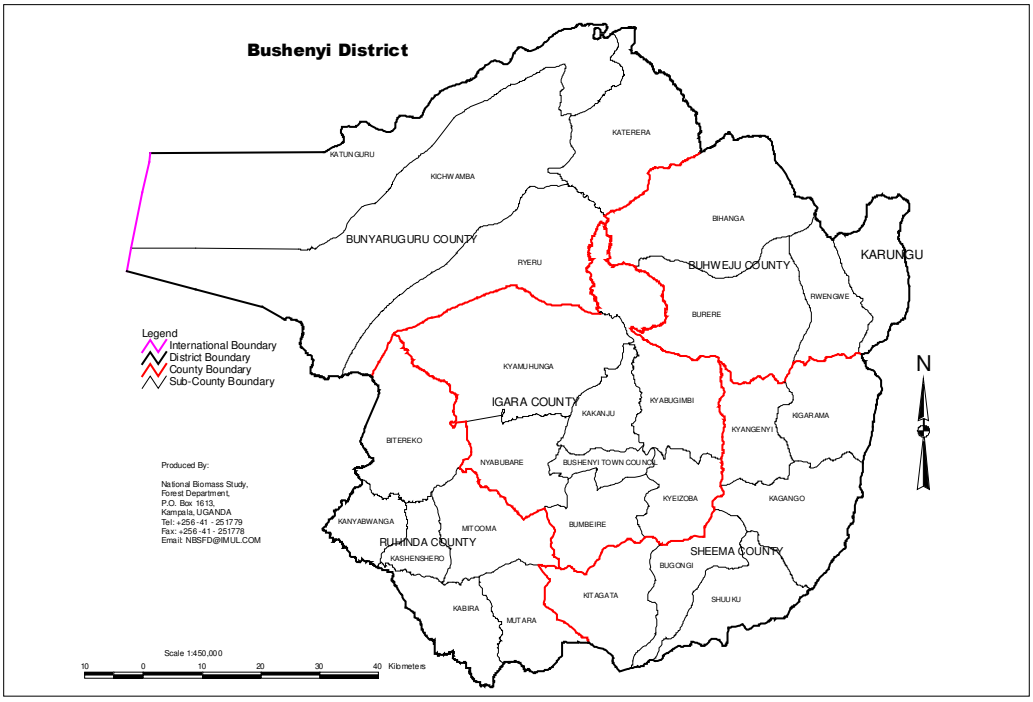
Ms = missing data; Na = not available

Livestock	**Number of heads** Total	Trend	*Total production per year*	*Average production*	*Farmgate Price U Shs*	*Constraints Potential*
1. Cattle	173,756		> 6,9 m liters milk	2000 l	200 / l	Price: < 200 U Shs / l Smallholder dairy/good pasture
2. Goats	64,227	↑	771 t	12 kg/ a	2,000 / kg	Relatively stable price; crossbreeds
3. Sheep	22,495		270 t	12 kg / a	1,500 / kg	
4. Pigs	6,306	↑	190 t	30 kg / a	1,500 / kg	Local market
5. Poultry	15,088 (exotic)	↔	38 t	2,5 kg / a	2,000 / kg	
6. Fishponds	544 (351 farmers)	+ 11%	23.1 t	42.5 kg	2,000 / kg	Insufficient fingerlings District fish fry production center exists
7. Rabbits	Ms	↑	Ms	Ms	Ms	Activity for the youth on most farms
8. Bee keeping	On 850 farms	↑	11 t		3,500 / kg	No research; quality not sufficient for int. markets
9. Silk farming	On 80 farms	↑	1999: 2 t 2000: 5 t	Ms	Ms	2000 U Shs / kg fresh cocoons 4 established silk dev. centers
Ranked livestock problems	1. Low milk prices		2. Diseases			3. lack of improved breeds
	4. overgrazing		5.			6.

Natural Resources	**Area** [km^2] Total	Trend	*Total production*	*Constraints Potential*
Lakes			***1117 tons ~***	1117 tons ~ 1.2 billion U Shs Overfishing, no buffer strip around lakes
Forest and plantations	***784***	↔	***3000m^3 round wood***	
Forests & agroforestry		↑	***700,000 m^3 firewood***	1m^3 : 20,000 U Shs at tea factory → agroforestry
Ranked environmental problems	1. soil fertility		2. Fuelwood scarcity	3. Overgrazing / bush fire
	4. Conflict around National Parks		5. widespread use of acaricides (tick contr.)	6. Overfishing
Agricultural Processors	29 coffee factories, 2 tea factories, 37 grain milling factories, 1 Hides and Skins factory, 2 animal feeds industries, 2 bakeries, 3 rice milling machines, 4 distillers, 16 dairy cooling plants, 1 sawmill and 2 sunflower oil mills *needs:* milk processing; fruit canning			
Agric organizations	253 registered cooperative societies; 84 active, capital base: 807 million Shs, NGOs: Care, ????			
Agric. Extension	8000 of 130.000 farm families have access to extension; Extension : farmer ratio 1: 3300; transport constraints; use of model ~ 50 villages 35 clonal coffee nurseries			
Soil Management	Fertility: compost / manure common; inorganic fertilizer hardly used Conserv.: bunds, trenches common Soil testing difficult			
Agroforestry	Boundary planting; trees integrated in crops			
Markets	65 gazetted, 7 untendered markets			

Ms = missing data; Na = not available

Map:



Ms = missing data; Na = not available

A 1.6 District Profile: Kasese

Area [km^2]	Total	Arable	Cultivated	Lakes	Forest	National Parks
	3205	1478	270	461 part of NP	58	1537

Topography and relief	2 distinct zones: 1. Rwenzori Footslopes: very steep slopes with fertile valleys 2. Lowlands: parallel to the footslopes with alluvial and lacustrine plains in the east
Tree cover [%]	# of forest nurseries:
Climate	Bimodal rainfall, average: 800 - 1600 mm/yr; June – July driest and coolest; avg temp.: C
Population	Number by 2000: 409,500; Density km^{-2}: 220; Growth: 2.1 %; Ethnic groups: Bakonzo, Basongora, Banyabindi
Major towns	Kasese, Kilembe, Katwe, Kabatoro
Counties	
Subcounties	18
Road network	trunk road: 212 km; feeder 437 km; community: 200 km
Literacy rate	53%
Health indicators	> 65% live less than 5 km from a health unit,
% rural population	86%
Gross Agric. product per capita [Shs]	U Shs[1]: 116,000; $: 68
Access to clean water	Safe water coverage: 43%
Number of staff in production & market	44 (1996)

Crops	**Area** [ha] **Total**	**Trend**	*Total production [t year^{-1}]*	*Average yield [kg ha^{-1}]*	*Farmgate Price U Shs / kg*	*Constraint Potentials*
1. Beans	8000	↑	6,000	750	450	
2. Maize	6000	↑	7,500	1,250	130	Low price
3. Cotton	4800	↑	3,6-6,000	750 –1,250	255	
4. Cassava	3200		9,6-12,800	3 – 4,000	157	
5. Coffee (arabica)	2500	↓	1,875-3,125	750 – 1,250	400	
6. Banana	1000	↓	3 - 4,000	3 – 4,000	132	
7. Irish potatoes	500	↑	4200	8,400		
8. Sweet potato	400	↔	1,152	2,880	157	seed
9. Soya bean	160	↑	269	1,680	476	
10. Ground nuts	140	↑	111	792	877	
11. Tomatoes	120	↑	2,160	18,000	300	
12. Onions	100	↔	960	9,600	300	
13. Passion Fruits	44	↔	144 – 193	3,600 – 4,3,75	100	

Overall assessment	
Mubuku irrigation scheme	Gravity and open channel based irrigation scheme of 2000 ha Options for other schemes in Bukonzo county: Nyakatonzi, Katojo and Kiburara

Ranked agricultural problems			
	1. Infrastructure (transport)	2. poor marketing system	3. pests & diseases
	4. Extension	5. Seeds	6. Land degradation

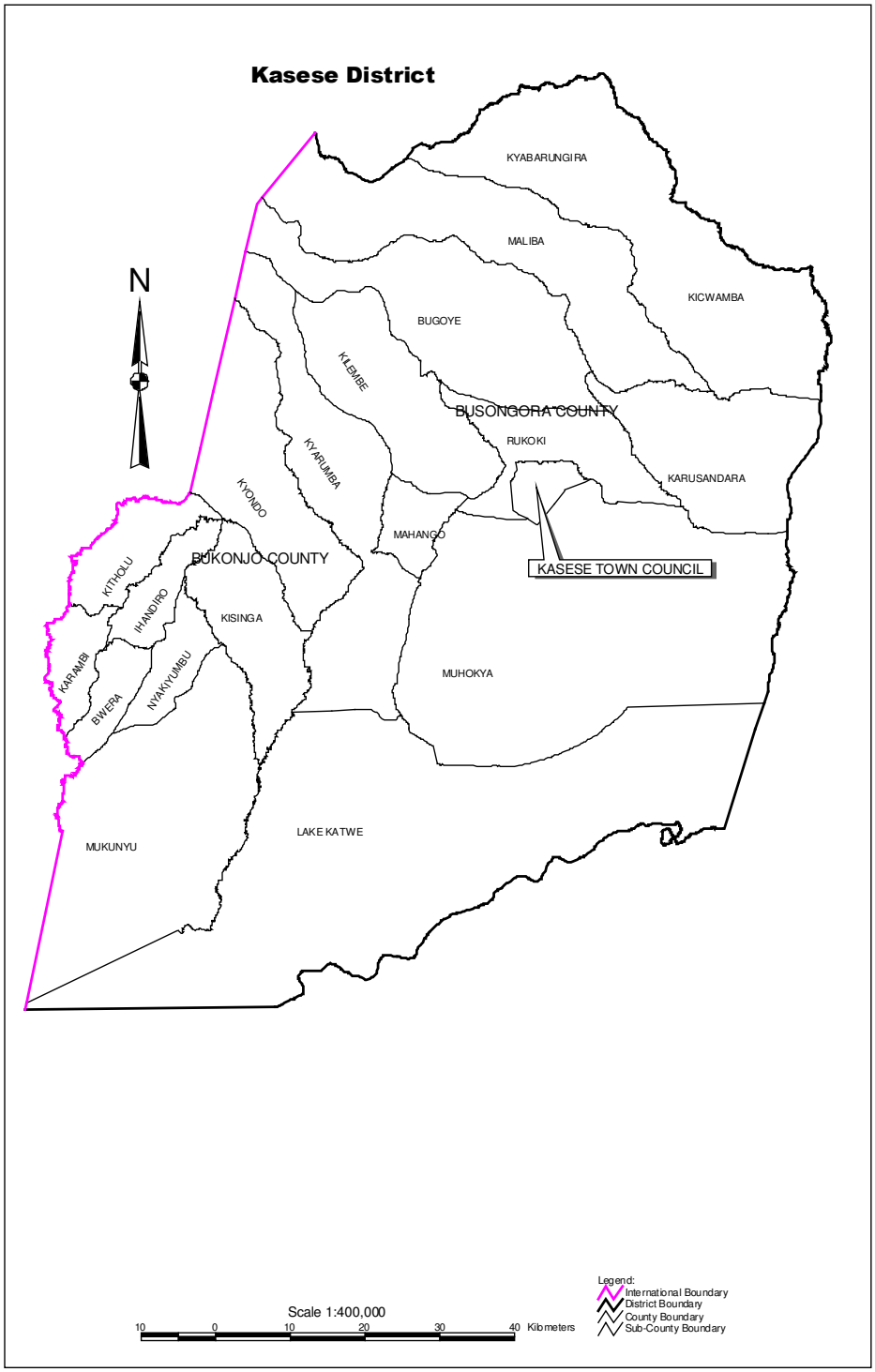
[1] See: 3-year rolling District Development Plan 2000/1 – 2002/3, p 46 (more info per subcounty)

Livestock	**Number of heads** **Total**	**Trend**	*Total production* ***per year***	*Average production*	*Farmgate Price U Shs*	*Constraints Potential*
1. Cattle	17,701	↔	2,600 t	146 kg / a	1,500 / kg	
2. Goats	50,123	↑	602 t	12 kg / a	2,000 / kg	
3. Sheep	10,123	↔	122 t	12 kg / a	1,500 / kg	
4. Pigs	1,960	↑	59 t	30 kg / a	1,500 / kg	
5. Poultry	11,983	↔	18 t	1,5 kg / a	2,000 / kg	
6. Fishponds	436	↑	5 t	11,5 kg / a	2,000 / kg	
7. Rabbits	3,494	↔	5 t	1,5 kg / a	2,000 / kg	
8. Bee keeping	350	↑	0,5 t	1,4 kg / a	3,500 / kg	
overall				District total product animal sector: 6.6 billion U Shs/year		
Ranked livestock problems	1. pests and diseases			2. lack of capital for zero grazing etc.		3. inadequate extension
	4. communal grazing			5. expensive drugs & feeds		6. lack of improved breeds

Natural Resources	**Area** [km^2] **Total**	**Trend**	*Total production*	*Constraints Potential*
Lakes		↓	***2200 t (1994)*** 13000 (1978)	Overfishing, inappropriate fishing methods
Forest and plantations	*58*	↔		
Forests & agroforestry				Lack of seedlings, Termites, drought in low-lying areas, grazing animals, bush fires
Ranked environmental problems	1. Soil erosion		2. Poor health and sanitation	3. Loss of soil fertility
	4. Reduced tree cover		5. Conflict with protected areas	6. Poor waste disposal
Agricultural Processors				
Agric organizations	NGOs: RDP, Church of Uganda, Catholic Relief Services, Care Int., KDFA, URDP,			
Agric. Extension				
Agric. Markets	Lack of facilities, i.e. permanent all weather shades, concrete platforms etc. Lack of uniform measures and quality standards			
Soil Management				
Agroforestry				
Markets				

Ms = missing data; Na = not available

Map:



Ms = missing data; Na = not available

A 2 Technology Profiles

A 2.1 Crop profiles :

- **Banana**

Improved Varieties	*Status **	*Yield potential*	*Agronomic characteristics*	*Farmers' preferred attributes*	*Associated problems*	*Success in SW Uganda ***	*Prospect ***
Kabana 1	3	20-40 MT/ha	-High yields -resistant to sigatoka, nematodes & weevils -Shorter -bigger stem girth -bunch has more hands -more leaves at harvest -less affected by leaf diseases like sigatoka	-Big bunch size	- cooking quality not as good as the matooke	1	4
Kabana 2	3	20-40 MT/ha				1	4
Kabana 3	3	20-40 MT/ha	- dessert like bogoya	Big bunch size	- not as tasty as bogoya	1	4 due to attack by panama wilt on the local type
Kabana 4	3	20-40 MT/ha	- dessert like bogoya -resistant to fusarium wilt	-big bunch size	Less tasty	1	4
Kabana 5	3	20-40 MT/ha	-juice like Kayinja & Kisubi beer types -resistant to fusarium	-prolific juice production	- low juice quality	1	5 because beer types are threatened by fusarium wilt

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

Management options for banana

Management Options	Status *	Impact on productivity **	Impact on the environment **	Farmers' preferred attributes	Associated problems	Success in SW Uganda ***	Prospects/ Opportunities ***
Mulch	6	6 -conserves soil moisture -adds OM & nutrients -reduces soil erosion -smoothers weeds	6	-dry & light in order to reduce labour requirements	-Fire -termite damage -labour demand -dependecy on off-farm source -coffee husks may spread coffee wilt	4 Moderate with commercially oriented farmers practising	5 -fire & termite prevalency lowest in the country
Spacing/ Plant population	5	5 -determines marketable bunch and finger size	4 proper spacing reduces soil degradation	-Wide spacing for matooke & dessert -ignored in beer types	-labour demanding -land scarcity leading to a few plants -intercropping with other crops	5 -High with commercial matooke growers	5 -appropriate spacing important for product quality and hence marketability
Weevil trapping	4	5 -reduces weevil damage -minimizes wind damage	5 helps reduce use of pesticides	- only requires own labour	-Labour intensive -continuous	3	5
Use of clean planting materials	4	5 -disease control	4	-be of preferred variety -should be affordable	-unavailability of material -expensive (600-1000= per plant) -lack of awareness of benefit	3	6 as a result of the wilts
Semio-chemicals	1	4 -weevil control - less labour	5 Reduces pesticide use	N/A	N/A	N/A	5
Biological control	1	4 -weevil control	5	N/A	N/A	N/A	5

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

Management Options	Status *	Impact on productivity **	Impact on the environment **	Farmers' preferred attributes	Associated problems	Success in SW Uganda ***	Prospects/ Opportunities ***
Use of break crops	2	4 -reduce soil nematode nos.	5	N/A	N/A	N/A	4
Sanitation (weed control, de-trashing, pruning)	5	4 -reduce competition for nutrients & water -weevil control	5	N/A	-labour intensive	4	6
Water trenches, channels	4	4 -adds soil moisture -reduces soil erosion	5	-utilise roof and road runoff	Trenches require space	4	6

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

Bush beans

Varieties	Status *	Yield potential	Agronomic Characteristics	Farmers' preferred attributes	Associated problems	Success in SW Uganda **	Prospects/ opportunities **
K20	6	1500-2500 Kg/ha	-disease tolerance -large seed size	-marketable large seed	-susceptible to bean root rot & stem maggots -susceptible to drought	6	3 Dwindling as was released 30 years ago
K131	5	1500-2500 kg/ha	-resistant to BCMV -small seeded -short maturity -withstands low soil fertility -cream mottled -matures 85-90 days	-disease tolerance	-un-preferred small seed size -susceptible to bean root rot & stem maggot -poor taste -fresh leaves & pods not suitable for vegetable sauce	2	2
K132	5	1500-2000 kg/ha	-large seed size -red mottled seed color -matures in 80-85 days	-large seed size -good seed colour -market potential -cooks faster	-Susceptible to drought -susceptible to bean root rot & stem maggot	3	4
NABE 1	1	1500-2000 kg/ha	-medium size seed -pink mottled	Not yet tested in the zone	Not yet tested in the zone	N/A	Not yet tested in the zone
NABE 2	1	1500-2500 kg/ha	-small seeded -black seed color -resistant to BCMV -matures in 85-90 days	-do-	-do-	-do	-do-
NABE 3	1	1500-2500 kg/ha	-small seeded -red seed color -resistant to BCMV & black rot -matures in 85-90 days	-do-	-do-	-do-	-do-

BCMV – Bean Common Mosaic Virus

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

Varieties	Status *	Yield potential	Agronomic Characteristics	Farmers' preferred attributes	Associated problems	Success in SW Uganda **	Prospects/ opportunities **
NABE 4	1	1500-2000 kg/ha	-medium seed size -red mottled seed color -tolerates low soil fertility -matures in 80-85 days	-do-	-do-	-do-	-do-
NABE 5	1	1500-2000 kg/ha	-large seeded -cream mottled seed with light red bands -matures in 80-85 days	-do-	-do-	-do-	-do-
NABE 6	1	1500-2500 kg/ha	-small seeded -white seed color -good canning qualities -excellent for export & local market -matures in 85-90 days	-do-	-do-	-do-	-do-

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

Climbing beans

Varieties	Status in the zone *	Yield potential	Agronomic characteristics	Farmers' preferred attributes	Associated problems	Success in SW Uganda **	Prospects/ opportunities **
NABE 7C (Vuninkingi)	Kabale & Kisoro: 5 Rest: 2	2500-4000 kg/ha	-tolerates major diseases e.g bean root rot -small seeded -red/maroon color -adapted to both high & low altitude -tasty both fresh & dry form -matures in 90-115 days	-Cooks quickly -tolerance to bean root rot -drought tolerant -maximises productivity per unit area	-needs a lot of stakes & labour -low marketability due to small seeds -attack by birds	-Moderate in Kisoro 4 -Low in Kabale 2	6 Very high because of the rampart bean root rot
NABE 8C (Ngwinurare)	Kabale & Kisoro: 5 Rest 2	2500-3,500 kg/ha	-tolerant to bean root rot -large seeded -short maturity period -red seed color -tasty -green pods & leaves good for consumption -matures in 90-110 days	-good taste -large seeds with high market -tolerance to bean root rot	-needs a lot of stakes & labour -susceptible to vermin & birds	-Moderate in Kabale 4 -Low in Kisoro 2 2	6
NABE 9C (Gisenyi)	Kabale & Kisoro : 5 Rest: 2	2500-4000 kg/ha	-matures in 90-115 days -tolerant to bean root rot -large seeded -white/black speckled color -adapted to highlands	-good taste -large seeds have market -tolerance to bean root rot	-needs a lot of stakes & labour -susceptible to vermin & birds	-Moderate in Kabale 4 -Low in Kisoro 2	6
NABE 10C (Umubano)	Kabale & Kisoro :5 Rest: 2	2500-4000 kg/ha	-small seeded -tolerant to bean root rot -red in color -green pods & leaves consumed -adapted to low & high altitude -matures in 90-110 days	-resistance to bean root rot -cooks quickly	-low marketability due to small seeds -needs a lot of stakes & labour -susceptible to vermin & birds	High in Kisoro 5 Low in Kabale 2	5

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

Management options for beans

Management option	Status in the zone *	Impact on productivity **	Impact on environment **	Farmers' preferred attributes	Associated problems	Success in SW Uganda ***	Prospects/ opportunities ***
Spacing for bush & climbing types	4	5 -optimise land use -optimise productivity -ease of agronomic practices	5	-spacing which allows fast & timely weeding	-skill to plant in lines manually -slow manual planting which affects timeliness	4	6 . High especially for climbing beans
Bean recipes (12)	1	5 -widen utilization -improve nutritional value	3	Not yet tested	-time & skill to prepare -may require ingredients that are not available at households	N/A	5 hgh especially for feeding children
Staking methods	5	6 -Is a must in climbing beans -increase photosynthetic area -reduce amount of staking materials, reduces bird damage	4	-re-useable stakes -cheap method e.g using banana strings	-expensive if bought off-farm -labour demanding to stake & remove them	High in Kisoro & Kabale 5	6 Very high
IPM against bean root rot, stem maggot & bean bruchid	3	6 -varietal tolerance -earthing-up helps plant to regenerate damaged roots -improved plant nutrition helps reduce susceptibility -sieving, biorationals, sunning & solarisation reduce pest damage	6	-reduced chemical use is friendly to environment & cheap	-use of fertilizer increases production costs -more labour input in earthing-up, sieving, sunning & solarisation. -biorationals not widely available	Kisoro & Kabale 4	6
Intercropping	6 with some farmers	4 -alternative source of stakes -maximize land productivity -may reduce pest & bird damage	4	-different maturity periods for crops optimizes labour	-in case of climbers not easy to do cultural practices	Is a traditional practice for subsistence farmers	5
Optimum weeding frequency	1	5 -reduce competition with weeds -minimize production costs	4	-less labour & hence fewer weedings	N/A	4	5

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

Management option	Status in the zone *	Impact on productivity **	Impact on environment **	Farmers' preferred attributes	Associated problems	Success in SW Uganda ***	Prospects/ opportunities ***
Soil fertility management	1	-supply deficient soil nutrients 6 -increase productivity	6	N/A	-attitude that legumes do not need fertilizer -increased costs & labour -needs skill -use of leguminous plants for soil fertility improvement is laborious & costly.	2	5
Post harvest storage	3	-reduce quantitative crop losses by insect pests -maintain quality by reducing rottage & moulds 6	4	-match the small quantities with the technology	-costs & labor increased	2	4 limited by small quantities harvested

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

Potato

Varieties	Status In the zone*	Yield potential	Agronomic characteristics	Farmers' preferred attributes	Associated problems	Success in SW Uganda	Prospects/ opportunities
Uganda 11/ Rutuku (CIP 720097)	5	30-35 MT/ha	-matures in 110-130 days -resistant to late blight (LB) -Pink skin -dormancy of 14--16	-good taste -high marketability due to pink skin -tolerant to LB -low degeneration rate -high yield with large tubers	-susceptible to bacterial wilt (BW) & hence rottage in stores -Long tuber dormancy -restricted to >1800m -long maturity -large seed tuber size increases costs	5 High in Kabale & Kisoro due to premium market	5 High for processing into chips and crisps -High yields -limited to cool highlands above 1800 metres
Victoria (CIP 381381.20)	5	20-30 MT/ha	-matures in 80-90 days -dormancy of 8-10 wks -tolerance to BW -widely adapted to warm lowlands and cool highlands	-pink skin colour has market -good for chips -average seed size -short dormancy -short maturity & hence can have 2-3 crop cycles a year -high yield with large tubers	-susceptible to LB	5 High in Kabale & Kisoro	5igh due to high marketability, short dormancy & adaptability
Kisoro (CIP 381379.9)	4	20-30 MT/ha	-matures in 110-120 days -resistant to LB & BW -dormancy of 10-12 wks -white skin with pink eyes	-Quick maturity -marshing quality -medium seed size -high yield	-Cream skin colour not marketable in SW but is preferred in eastern -degenerates quickly	2	2 Lw due to low marketability
Sangema (CIP 800949)	4	20-25 MT/ha	-Matures in 90-110 days -Dormancy of 10-12 wks -Moderate resistance to LB	-good cooking quality -pink skin preferred in market -High yield -wide adaptability	-degenerates in yield -susceptible to BW	4 -Moderate in Kabale	4 moderate due to high marketability & adaptability

LB – Late Blight, BW – Bacterial Wilt

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

characteristics	Farmers' preferred attributes	Associated problems	Success in SW Uganda	Prospects/ opportunities
10-130 days f 4-6 wks LB BW	-high tolerance to late blight & bacterial wilt hence can get a crop without a spray. -good starchy taste -short dormancy means 2-3 crop cycles/ yr which is good for food security.	-does not sell in urban markets -short storability	4 moderate in Kabale & Kisoro subsistence & poor farmers	2 Low due to poor marketability despite its food security potential for the poor
10-130 days f 10-12 wks.	-good taste with local dishes	-white skin does not sell in urban markets of Kabale, Kanungu & Kisoro.	2	2 low due to poor marketability & de-emphasis in research
10-125 days f 11-13 wks. purple white skin hite flesh.	-excellent storability -large tubers	-susceptible to LB & BW -low marketability due to skin color	2	2 low due to poor marketability & de-emphasis by research.
0-90 days f 9-12 wks val large tubers LB & tolerant to lity bility in warm ool highlands	-large tuber size -resistance/tolerance to diseases			

tial dissemination 5: widely disseminated 6: common option for farmers

N/A: Not available; ND: not disseminated

Management options for potato

Management option	Status in the zone *	Impact on productivity **	Impact on environment **	Farmers preferred attributes **	Associated problems	Success in SW Uganda ***	Prospects/ opportunities ***
IDM against LB	4	6 reduce disease incidence -increase productivity -reduce pesticide use & maintain ecological soundness	5	-resistant varieties -less costly options	-needs skills & knowledge & hence is costly e.g using farmer field schools.	4	-High especially on resistant varieties 5
IDM against BW	4	6 reduce disease incidence & spread in crop and land -increase productivity	-use of tolerant varieties, clean seed & crop rotation effective 5	-tolerant varieties -affordable clean seed of improved varieties -less costly options	-limited & fragmented land for rotation -Knowledge based & is costly	2 low due to knowledge gap	5
Use of clean seed	5	6reduce disease spread	5	-affordable seed	-not readily available -expensive	2 -4 moderate in Kabale & Kisoro:4 -low in the rest: 2	-High as seed production is being strengthened 5
Earthing up	5	6 - crease moisture retention -maximise tuberisation -reduce tuber greening -increase tuber size -protect from pests like potato tuber moth	5	-less labour	-needs to impart skill	2-4 -moderate in Kabale & Kisoro 4 -low in rest of SW 2	5
Proper pacing	4	6 -optimise land utilization -optimise tuber size for seed & consumption -ease agronomic practices e.g weeding, spraying	5	-easy & less labor especially weeding & spraying	-needs training	5	6
Dehaulming	3	4 harden tuber skin to reduce tuber damage	5	N/A	-more labor	3 limited to seed production	5

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

Management option	Status in the zone *	Impact on productivity **	Impact on environment **	Farmers preferred attributes **	Associated problems	Success in SW Uganda ***	Prospects/ opportunities ***
Soil fertility management	3	6 - increase per unit land productivity by replenishing deficient nutrients -increase disease tolerance/escape 6	5	-affordable options e.g compost	-mixed results -costly fertilizers -lack of skill & knowledge to prepare organic fertilizers. -lack of knowledge & skill to apply inorganic fertilizers	2	4
Seed multiplication & distribution strategies	5	6 -clean affordable seed of improved varieties	5	-affordable -high quality	-costly investiment -based on skills & knowledge	2-4 -Moderate in Kabale & Kisoro:4 -low in rest 2	6

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

Maize:

Varieties	Status *	Yield potential (MT/ha)	Agronomic characteristics	Farmers preferred attributes	Associated problems	Success in SW Uganda **	Prospects/ opportunities **
Longe 1	5	5	-open pollinated variety -matures in 115 days -adapted to mid-altitudes (850-1500 m) -resistant/tolerant to maize streak virus & northern leaf blight	-short maturity -re-useable seeds	-not as tasty as local varieties	3	4 has wide adaptability
Longe 2H	3	8	-Single cross hybrid -matures in 125 days -disease resistant/tolerant	-High yield of grain & flour	-requires high input levels	Not yet widely tested	5 mainly for low & medium altitudes
Longe 3H	3	8	-Single cross hybrid -matures in 125 days -disease resistant/tolerant	-High yield of grain & flour	-requires high input levels	-do-	-do-
Longe 4	3	5	-open pollinated variety -matures in 102 days -adapted to mid-altitudes -disease resistant/tolerant -drought tolerant	-earliness -can re-plant the seed	N/A	-do-	5
Longe 5 (Nalongo)	3	5	-open pollinated variety -matures in 117 days -adapted to mid-altitudes -high quality protein maize rich in lysine & tryptophan amino acids -disease resistant/tolerant	-double cobs -can re-plant the seed	N/A	-do-	6
SC 627	3	8	-3-way hybrid -matures in 125 days -disease resistant/tolerant	-high yield -appealing to the eye	-requires high input levels -low flour output	Under testing	4
PAN 67	3	8	-double cross hybrids -matures in 125 days -disease resistant/tolerant	-high yield -appealing to the eye	-requires high input levels -low flour output	-do-	4

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

N/A: Not available; ND: not disseminated

Rice

Variety	Status in the zone *	Yield potential (MT/ha)	Agronomic characteristics	Farmers preferred attributes	Associated problems	Success in SW Uganda **	Prospects/ opportunities **
UK-2	2	4	-Upland rice -matures in 120 days -disease resistant -non-shattering	N/A	-high cost of seed	1	4 High in low & mid-altitude areas
NP 2	2	4	-upland rice -matures in 120 days -disease resistant -non-shattering	-do-	-do-	1	4
NP 3	2	4	-lowland rice -matures in 120 days -disease resistant -non-shattering	-do-	-do-	1	4
Abilony	2	4	-upland rice -matures in 115 days -disease resistant -non-shattering	-do-	-do-	1	4

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

Management options for maize & rice

Management option	Status in the zone *	Impact on productivity **	Impact on environment **	Farmers, preferred attributes	Associated problems	Success in SW Uganda ***	Prospects/ Opportunities ***
Control of stem borers (maize)	3	3 -reduce insect pest damage	2 -options that do not use pesticides 4 -Use of pesticides	N/A, no experience synthesized from the SW	-pesticide use not ecologically friendly -costly to use pesticides	2	3
Weed control (maize)	3	5 -reduce competition for light, nutrients & water	3	-do-	-herbicide use not ecologically friendly -costly	2	4
Termite control (maize)	3	4 -reduce crop damage	2 for use of pesticides	-do-	-pesticide use not ecologically friendly -costly	2	3
Spacing (maize)	3 for maize	5 -optimise land utilization	3	-do-	-skill required	3	4
Fertility management (maize)	3 in mono-crop	6 -replenish depleted nutrients -maize is highly responsive to improved plant nutrition	4	-do-	-requires skill & knowledge	2	5 -high due to high soil degradation in the zone
IPM against RYMV & ARGM	1	5 -reduce damage by diseases	4	-do-	Lowland rice seedlings is usually raised in nurseries	2	4 -moderate due to land scarcity

RYMV= rice yellow mottle virus ARGM= African rice gall midge

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

Cassava profile

Variety	Status in the zone *	Yield potential	Agronomic characteristics	Farmers, preferred attributes	Associated problems	Success in SW Uganda **	Prospects/ opportunities in the zone **
Nase 1	1	23.0 MT/ha	-matures in 14 months	-tolerance to CMD	-not good for fresh tuber cooking	2 -low due to lack of dissemination strategy	3 - due to poor cooking qualities of fresh tubers
Nase 2	4	27.0 MT/ha	-matures in 14 months	-tolerance to CMD	-do-	2	-do-
Nase 3	4	26.0 MT/ha	-matures in 12 months -good storability in soil	-in-ground storability	-do-	2	-do-
Nase 4	4	50.0 MT/ha	-matures in 12 months -resistant to CMD -low in cyanogenic potential	-low cyanogens	-do-	2	-do-
Nase 5	1	40.0 MT/ha	-matures in 12 months -resistant to CMD -low cyanogenic potential	-short maturity -high yield	-do-	-Not yet tested	-do-
Nase 6	1	35.0 MT/ha	-matures in 12 months -resistant to CMD -low cyanogenic potential	-short maturity	-do-	-do-	-do-
Nase 7	1	45.0 MT/ha	-matures in 12 months -resistant to CMD -low cyanogenic potential	-short maturity -high yield	-do-	-do-	-do-
Nase 8	1	40.0 MT/ha	-matures in 12 months -resistant to CMD -low cyanogenic potential	-short maturity	-do-	-do-	-do-
Nase 9	1	45.0 MT/ha	-matures in 12 months -resistant to CMD -low cyanogenic potential	-short maturity -disease resistance	-do-	-do-	-do-
Nase 10	1	35.0 MT/ha	-matures in 12 months -highly resistant to CMD -good cooking qualities & mealy	-cooking quality is excellent	Short stalks make tubers susceptible to vermin	-do-	-High due to good cooking qualities 6
Nase 11	1	35.0 MT/ha	-matures in 12 months -moderate resistance to CMD -very good cooking quality & very mealy	-cooking quality	Has susceptibility to CMD	-do-	6
Nase 12 (Vvumba)	1	35.0 MT/ha	-matures in 13 months -Highly resistant to CMD -very good cooking qualities & mealy -stores long in the soil	-cooking quality -fresh root tuber market	Tubers susceptible to vermin	-do-	6

CMD= Cassava mosaic disease

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

N/A: Not available; ND: not disseminated

Management options for cassava

Management option	Status in the zone *	Impact on productivity **	Impact on environment **	Farmers. Preferred attributes	Associated problems	Success in SW Uganda ***	Prospects/ Opportunities ***
IPM options	2	6-reduce disease & insect pest damage	4	-affordable -less labor	-high cyanogenic potential	2	6
Spacing	2	5 -optimise land utilization	4	-less labor	-compatibility with intercrops	3	4
Intercropping	1	5 -optimise benefit from cassava-based-cropping system	4	-growth habit compatible with other crops	-compatibility with other crops	2	4
Rapid multiplication techniques	1	5 -quick dissemination of improved varieties	3	-easy & less labour active	-demands skill, knowledge and labor	3	5
Stake length	1	-optimise improved planting materials 4	3	-cover a large area	N/A	3	4
Processing & Utilization options	1	6 -widen utilization base -add value to increase incomes	5	-less labor & costs	-demands labor, skills, equipments & labor	2	5
Planting material strategies	2	6 -provision of clean planting materials of improved varieties	3	-informal farmer based	-	3	5

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

Sweet potato varieties

Variety	Status in the zone *	Yield potential	Agronomic characteristics	Farmers preferred characteristics	Associated problems	Success in SW Uganda **	Prospects/ opportunities **
Bwanjule	4	21.4 MT/ha	-matures in 120-150 days -30 % dry matter -fairly adapted to cool highlands	-wide adaptability	-fair adaptability	1	2
New Kawogo	3	23.3 MT/ha	-matures in 130-150 days -32 % dry matter	ND	-not adapted to cool highlands	ND	-moderate in the low & mid-altitude areas
Sowola	3	25.6 MT/ha	-matures in 100-120 days -34 % dry matter	ND	-do-	ND	-do-
Tanzania	4	22.9 MT/ha	-matures in 120 days -32 % dry matter -widely adapted to warm & cool areas	-wide adaptability -high DM	Low vine / planting material production	3	4
Wagabolige	3	24.1 MT/ha	-matures in 120-150 days	ND	Not adapted to cool highlands	ND	4 -moderate in the low & mid-altitudes
Naspot 1	1	26.0 MT/ha	-matures in 120 days -31 % dry matter	ND	-not widely tested in the zone	ND	-need for wide-scale testing
Naspot 2	1	20.0 MT/ha	-matures in 120 days -28 % dry matter	ND	-do-	ND	-do-
Naspot 3	1	17.0 MT/ha	-matures in 150 days -38 % dry matter	ND -high DM	-do-	ND	-do-
Naspot 4	1	21.5 MT/ha	-matures in 150 days -29 % dry matter	ND	-do-	ND	-do-
Naspot 5	1	17.5 MT/ha	-matures in 120 days -30 % dry matter -high levels of vitamin A	ND	-do-	ND	-do-
Naspot 6	1	17.5 MT/ha	-matures in 120 days -32 % dry matter	ND	-do-	ND	-do-
Nsovu	4	20.0 MT/ha	-matures in100-120 days in the highlands	-matures fast -highly adapted to cool highlands	-low vine production	-moderate in Kabale	-High

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

Management options for sweet potato

Management option	Status in the zone *	Impact on productivity **	Impact on environment **	Farmers' preferred attributes	Associated problems	Success in SW Uganda ***	Prospects/ Opportunities ***
IPM to control weevils & vine caterpillars	3	5 -reduces pest damage -improve root tuber quality	2	-less labour demanding	-dependant on pesticide use	3	6
Seed multiplication strategies	3	6 -disease free planting materials -avail improved varieties	5	-profuse vine production	-conservation of vines in dry season	3	6
Root tuber storage	1	4 -enhance storability of fresh tubers for at least 3 months	3	-long in-ground storage rather storage after harvesting	-labor demanding to store in pits -thefts	Not disseminated	2
Processing & utilization	1	6 -widen utilization -add value to increase incomes	3	-meets local tastes	-may not be compatible with conventional tastes	Not disseminated	5
Spacing	4	5 -optimise land productivity -optimise planting materials	5	-less land & labor	Favors weed growth	2	4
Planting method	6	5 -minimise soil erosion -reduce labor & land requirement	5	-less labor	Favors weed growth	6 -recommended ridging method is widely used	6
Intercropping with beans	6	5 -optimise land utilization -provide a variety of foods -optimise labor utilization	-mixed results	-compatible	-technique adapted to local practice lacking	6 -intercropping is widely practiced	6

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

A 2.2 Livestock profiles:

Livestock type	Status in the zone *	Production potential	Characteristics	Farmers' preferred attributes	Associated problems	Success in SW Uganda **	Prospects/ Opportunities **
Dairy cattle	5	15-30 lts of milk per day	-exotics are mainly friesians and a few guernseys -crosses are better adapted to local conditions -require good management -highly productive	-high milk yield -fast maturity -big size	-susceptible to diseases e.g ECF -costly investment e.g fencing, feeding, watering, treatment	4	6
Dual purpose cattle	6	-3-5 lts/day -200-400 kg live weight	-produce some milk mainly for household use -can be used for farm traction & transport -are kept for beef -serve cultural purposes like dowry & for prestige -based on the indigenous long horned Ankole cattle and Kigezi short horned	-adaptability/ hardiness to local conditions -resistance to diseases -lean meat with white fat	-slow growth rate -low fertility rate -low productivity of milk & beef	5	6 -High -Indigenous breeds can be improved through selections & crossing
Goats	6	-3 litres of milk /day for dairy goats -25-40 kg live weight	-dairy goats are mainly exotic breeds e.g toggenburg -local goats & exotics for meat production	-hardy -tolerant to diseases -fast growth rates	-exotics are expensive & susceptible to diseases -locals have slow growth rates, small body weight & low milk production	2 -Low for exotics 5 -High for indigenous	5 -High -Local breeds can be improved through selections & improved management
Chicken	6	-3.5 to 5 kg live weight	-egg & broiler production is based on exotics -can have crosses for egg and meat production -local for meat & cultural functions	-hardy -quick maturity -high productivity	-exotics costly to purchase and manage -locals have low productivity	-moderate for exotics 4 -crosses not yet tested -locals prevalent 6	6

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

Management options for livestock

Management option	Status in the zone *	Impact on productivity **	Impact on environment **	Farmers' preferred attributes	Associated problems	Success in SW Uganda ***	Prospects/ Opportunities ***
Tick control	5	6 -ticks are the major threat to keeping of exotics	-conventional method 2 -improved method 4	-less costs	-cost of acaricides -resistance to acaricides -pollution to environment	2 -Spray races are common in dairy farms 5 -Communal cattle dips not sustained	6 -regime based on individual farms needs to be promoted -Judicious use of acaricides possible
Tsetsefly control	2	6 tsetseflies affect both livestock & humans at lower altitudes hence their control is a pre-requisite to a productive livestock industry	4	-breeds resistant -affordable options	-insect is mobile and difficult to control	4 -tsetsefly is resilient & is still a threat	6 -control methods using individuals & communities need to explored & strengthened
IDM against Nagana, ECF, FMD, CBPP	1	6 -critical to livestock production especially cattle	4	-resistant breeds -affordable control options -options that can be adapted to indigenous practices	-presence of nomadic pastoralists in the zone who move animals	4 -Under control but occasionally outbreaks are a setback to the livestock industry	6 Commercial oriented livestock production would reduce disease spread -Valley dams would also reduce nomadism
Worm control	4	6 -reduce stress & enable the livestock be more productive	4	-cheaper options -options adapted to local circumsatnces	-costly as it requires regular purchase of wormicides -uncontrolled communal grazing & free range rearing makes animals pick diseases	5 -current regimes based on drugs	6 -need for an overall management strategy to augment use of drugs. This would involve revisit the grazing & watering system including the need for controlled grazing

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers

**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high

***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

N/A: Not available; ND: not disseminated

Management option	Status in the zone *	Impact on productivity **	Impact on environment **	Farmers' preferred attributes	Associated problems	Success in SW Uganda ***	Prospects/ Opportunities ***
Feed resources improvement	1	6 -strategically important during the dry season to maintain productivity -minimise movement & reduce disease & parasite attacks	5	-less labor	-traditional practice of free range feeding of livestock -Costs & labor for the extra effort	-this strategy is still being studied on-farm by Mbarara ARDC	6 -High because the critical periods are in Feb-March & June to Aug -Planning for these 2 periods of likely shortages is possible
Pasture seed production	1	5 -enrich the pastures for higher productivity	5	-fire resistant -species that adapt well to existing pastures	-need for knowledge & skill -make it a commercial sustainable venture	-initial phase at Mbarara ARDC	5 High because most dairy farms are commercial with controlled grazing
Genetic improvement	3	6 -To achieve higher productivity of products like milk, meat, eggs, etc. -impart some resistance/ tolerance to diseases	-Mixed depending on the numbers kept per unit area	4 -well adapted & yet more productive breeds	-cultural love for indigenous breeds -free range grazing with uncontrolled breeding	4 -Many crosses especially of cattle in the region	6 -Commercial orientation is making farmers look for more productive breeds

ARDC=Agricultural research and development center

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

A 2.3 Technologies for Natural Resources Management

- **Contour hedgerows**

Definition:= a managed hedge of shrubs or trees planted densely along the contours, mainly to conserve soil and water

Used species	*Status* *	*Main By products*	*Impact on productivity* **	*Impact on the environment* **	*Farmers' preferred attributes*	*Associated problems*	*Success in SW Uganda* ***	**Prospect** ***
General	3 - 4	• Fodder • Stakes • Firewood: • Mulch	4	5 Conserves ~ 0.2 t soil m^{-1} $year^{-1}$	• Efficient in conservation • Provides products • Management associated with products	• Non availability of seed / seedlings • Labour for establishing	Kabale D.: 4 Rest: 3	5
Calliandra calothyrsus	4	• Wood: 1.5-2 kg m^{-1} $year^{-1}$Stakes: 6-8 m^{-1} $year^{-1}$ • Mulch: 3.5 kg d.m. m^{-1} $year^{-1}$ (100 g N, 35 g P_2O_5)Fodder: 125 to 250 m of hedge required per cow	4	5	• Provides many products • Grows fast • Easy to establish	• Labor for planting • Some competition with crops if not well managed • Diseases	Kabale D.: 4 Rest: 3	5
Dodonea	1	• Stakes • Firewood • Medicine	3	5	• -Easy access to seed • -	• Poor coppicing ability	2	2
Acacia angustissima	2	• Fodder • Stakes • Firewood • Mulch	4	4 (risk of weediness)	• Grows very fast • Produces many seeds • Provides many products	• Risk of becoming a weed	Tests ongoing	6
Leucaena diversifolia	4	• Fodder • Stakes • Firewood:	4	5	• Grows fast • Produces good wood	• Less leaf biomass (fodder)	3	3
Leucaena trichandra	2	• Fodder • Stakes • Firewood • Mulch	4	4	• Grows very fast • Provides many products	•	Tests ongoing	5

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

- **Physical soil conservation**

Definition:= physical structures along the contours, mainly to conserve soil and water

Used species	*Status* *	*Main By products*	*Impact on productivity* **	*Impact on the environment* **	*Farmers' preferred attributes*	*Associated problems*	*Success in SW Uganda* ***	**Prospect** ***
General	6	• Trapping fertile soil	4	4	• Common	•		
Earth bunds	2	• none	3	4	•	• Laborious	4	5
Infiltration ditches	5	• Trapping fertile soil	4	5	• Usually trapping fertile soil	• Limited to banana areas • Labor to dig and maintain trenches	4	5
Fanya-juu / Fanya-chini terraces	4	• Trapping fertile soil • Fodder from associated grass strip	4	5	•	• not easy to lay out • very labour intensive	3	4
Stone/ Trash lines	6	• none	3	4	• Usually found at site	• Labor to carry stones • Often collapse on steep slopes	3	4
Contour farming	6	• None	3	4	• Easy to carry out • Minimizes water and soil movement	• Does not follow contours • Easily broken by running water	5	5
Bench terraces	5	• None	3	4	• delineating boundaries	• Terrace scouring • Very laborious	5	5

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

- **Boundary planting**

Definition:= Single lines of trees planted along external and internal farm boundaries, usually for the production of poles or timber

Used species	*Status* *	*Main By products*	*Impact on productivity* **	*Impact on the environment* **	*Farmers' preferred attributes*	*Associated problems*	*Success in SW Uganda* ***	**Prospect** ***
General	3 - 4	• Mulch • Fodder • Firewood from prunings	2-3	5	• Grow fast • Produce timber • Produce firewood and mulch during management •	• Annual managemt. required • Attract wildlife (birds) near fields	4	5
Grevillea robusta	4 - 5	• Firewood from prunings	2-3	5	• Grows fast • Easy to establish	•	5	5
Alnus acuminata	4	• Mulch • Fodder • Firewood from prunings	2-3	5	• Grows very fast • Fixes nitrogen	• Diseases • Difficult to raise	4	5
Casuarina spp	3	• Firewood from prunings	2-3	5	• Not liked	• Grows slowly • Competes strongly	1	1
Prunus africana	3	• Firewood from prunings • Medicine	2-3	6	• Medicinal components	• Seed handling • Diseases • Slow growth	2	5

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

- **Grass strips**

Definition:= Strips of grass established along contours to reduce runoff

Used species	*Status* *	*Main By products*	*Impact on productivity* **	*Impact on the environment* **	*Farmers' preferred attributes*	*Associated problems*	*Success in SW Uganda* ***	**Prospect** ***
General	4 - 5	• Fodder • Thatching material • Mulch	3	4	• Easy to establish • Low labour demands • Efficient runoff control during small and moderate rainfall events	• Not very effective in heavy storms • Attracts rodents • Competitive with adjacent crops	4	4
Natural grass	6	• Fodder • Thatching material	3	4	• Very easy to establish • Low labour demands • Efficient runoff control during small and moderate rainfall events	• Not very effective in heavy storms • Attracts rodents • Competitive with adjacent crops	5	4
Vetiver grass	3	• essential oil from roots • moderate thatching material	3	4	• Easy to establish • Low labour demands • Efficient runoff control during small and moderate rainfall events	• Not very effective in heavy storms • Attracts rodents • Competitive with adjacent crops	3	4
Napier grass	4	• Fodder	3	4	• Fodder for dairy animals • Easy to establish • Low labour demands • Efficient runoff control during small and moderate rainfall events	• Invasive, needs regular control • Not very effective in heavy storms • Attracts rodents • Competitive with adjacent crops	4	4
Setaria	3	• Fodder • Mulch	3	4	• Easy to establish • Fast growing	• Germplams procurement	3	4

See also: 'Fanya-juu terraces' under physical soil conservation

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

- **Mulch**

Definition:= Biomass applied on the soil surface to enhance soil chemical and physical conditions and to reduce runoff as well as weed growth

Used species	*Status* *	*Main By products*	*Impact on productivity* **	*Impact on the environment* **	*Farmers' preferred attributes*	*Associated problems*	*Success in SW Uganda* ***	**Prospect** ***
General	4	• some with medicinal values	4	4	• reduces labour for weeding • Soil moisture conservation • +	• Labour intensive • Access to sufficient amounts of material	4	4
Natural grass	4	• none	3	4	• easy to access	•	5	4
Banana leaves	5	• none	4	4	• easy to access	• Limited to banana areas	5	5
Biomass transfer	3	• none	5	4	•	• access to sufficient material • Labour intensive • Depletion of the source's soil	2	3
Cover crops	3	• none	4	4	•	• difficult to establish • labour intensive	2	3
Tree leaves	3	• none	5	4	• very efficient for yield improvements	• access to sufficient material • Labour intensive	3	4
Coffee husk	2	• None	4	4	•	• only in coffee areas • usually sold by factories	2	3

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

- **Soil fertility management**

Definition:= Methods aimed at enhancing the soils physical and chemical fertility status

Used methods	*Status* *	*Potential species / types*	*Impact on productivity* **	*Impact on the environment* **	*Farmers' preferred attributes*	*Associated problems*	*Success in SW Uganda* ***	**Prospect** ***
General	4	• variable (see below)	4	4	• reduces labour for weeding • Soil moisture conservation • +	• Labour intensive • Access to sufficient amounts of material	4	4
Natural fallow	6	Any type of vegetation	3	4	• provides pasture, medicine and other materials • labour only required at clearing	• Soil fertility recovery takes long • -Land out of production for 2-5 years • -Land preparation difficult • Weed infestation	6	3
Inorganic fertilizer	4	• NPK • Urea • Muriate of potash • Singe or Triple Superphosphate	6	4	• Yields are excellent with good rains • Replenishes missing nutrients • Little labour	• Price is high • Often uneconomical • Not accessible in retail shops • Lack information	3	4
Improved fallow	3	• *Calliandra calothyrsus,* • *Sesbania sesban,* • *Acacia angustissima* • *Tephrosia vogelii* • *Tephrosia candida* Tephrosia for lower altitudes only (< 1500 m.a.s.l.)	6	5	• Locally available • provides many products, • Intercropping possible in first two seasons • minimum transport • Improvement of both soil physical and nutritional status	• -Plots are small • -Information not available to farmers • Access to seed • -Takes time to bring benefits • -Labour • -Land out of production	3	5
Cover crops	2	• *Lupinus spp.* • *Vetches*	4	4	• Easy to establish • Fodder	• Grow slow at high altitude and on degraded soil	2	3

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

Used methods	*Status* *	*Potential species / types*	*Impact on productivity* **	*Impact on the environment* **	*Farmers' preferred attributes*	*Associated problems*	*Success in SW Uganda* ***	**Prospect** ***
Rotational fallow	3	• *Calliandra calothyrsus* • *Alnus acuminata*	5	6	• provides many products including poles and timber • Intercropping possible in first two seasons • more suited for degraded areas	• -Plots are small • Information not available to farmers • -Takes time to generate benefits • -Access to seed • -Labour demands	2	5
Inter-cropping	6	Maize/ bean, Coffee/banana Banana/beans Sorghum/maize	4	5	• Covers the soil • Weed suppression • Apparent increased output • Multiple products • Labor saving	• Management of crops is hard eg harvesting • -little or no improvement in soil fertility • Mines soil	6	5
Crop rotation	5	Annual crops	4	4	• Weed, pest and disease reduced • Extends production life of a plot	• Mismatch of fields with crops	5	6
Compost	5	All biodegradable refuse	4	6	• It is home made • It is cheap	• Transport to fields • Usually available in small quantities • Labor to apply the same	5	6
Animal manure	5	Animal refuse	5	5	• Improves chemical and physical status of the soil • It is cheap for those with animals • Many crops respond well and quickly	• Few animals available • Requires land to graze the animals • Transport is difficult • Zero grazing limited • Lacks certain nutrients	4	5

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

Used methods	*Status* *	*Potential species / types*	*Impact on productivity* **	*Impact on the environment* **	*Farmers' preferred attributes*	*Associated problems*	*Success in SW Uganda* ***	**Prospect** ***
Biomass transfer systems	2	Leafy biomass of nutrient rich plants (natural or planted vegetation)	4	4	• It is cheap • Niches for growing leafy biomass available •	• Labour intensive • Insufficient production • Lack of information	2	3

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

- **Water management / irrigation**

Definition:= Physical structures to access and distribute water for domestic and agricultural purposes

Used methods	*Status* *	*Potential types*	*Impact on productivity* **	*Impact on the environment* **	*Farmers' preferred attributes*	*Associated problems*	*Success in SW Uganda* ***	**Prospect** ***
General	4	• various (see below)	5	Various	• allows targeting food shortage- and peak market periods • enhances returns for other investments • creates employment	• Often high investment costs	3	5
Roof water harvesting	3	• Fiberglass tanks • Locally made mud tanks • Dug-out earth tanks	4	6	• Except for construction, low labour demand	• requires corrugated roof • expenditure for the tanks • often not sufficient in long dry season	3	5
Ponds / pans / catchments	3	• Trapping runoff from roadsides, slopes etc. and channeling it to the required places	4	5	• cheap	• regular maintenance required • more for supplementary irrigation	3	4
Pumps *(manual and power)*	3	• treadle pumps • diesel pumps	5	5	• provide stable water; • enhances returns for other investments; • widens the range of crops that can be grown	• power pumps are expensive to acquire and run; • availability of foot pumps • availability of water sources	2	4
Used methods	***Status*** *	***Potential species / types***	***Impact on productivity*** **	***Impact on the environment*** **	***Farmers' preferred attributes***	***Associated problems***	***Success in SW Uganda*** ***	**Prospect** ***
Wells	6	• open wells	5	5	• provides stable water; • enhances returns for other investments; • widens the range of crops that can be grown	• initial investment costs • lack of information and skills	1	4

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

Used methods	*Status* *	*Potential types*	*Impact on productivity* **	*Impact on the environment* **	*Farmers' preferred attributes*	*Associated problems*	*Success in SW Uganda* ***	**Prospect** ***
Wetland farming	6	• horticulture • pasture	6	2	• cheap • provides soil moisture; • enhances returns for other investments; • widens the range of crops that can be grown	• loss / reduction of wetland functions • labour for clearing and draining	6	6
Gravity irrigation schemes	3	• unimproved channels • improved channels	6	4	• provides stable water supply; • enhances returns for other investments; • widens the range of crops that can be grown	• requires collective action and good management; • labour for channel maintenance; • investment at outset; • sites limited; • health risks	3	5
Drip irrigation	3	• underground hose / pipe	6	5	• efficient use of water – good for dry areas	• expensive to establish • requires specialized knowledge and regular maintenance	ND	2

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

- **Farm woodlots**

Definition:= Woodlots established in niches on farm for the production of primarily poles and timber

Suitable species	*Status* *	*Main products*	*Impact on productivity* **	*Impact on the environment* **	*Farmers' preferred attributes*	*Associated problems*	*Success in SW Uganda* ***	**Prospect** ***
General	4	• Timber • Poles • Stakes • Firewood • Mulch • Medicine • Bee forage	3 (1)	5	• Source of income • Source of wood products for home consumption	• Insufficient information • Lack of planting material	4	5
Eucalyptus	6	• Timber • Poles • Stakes • Firewood • Medicine • Bee forage	2 (1)	4	• Source of income • Seedlings easy to establish • Straight poles • Good firewood • Ability to coppice	• Limits undergrowth • Cannot be intercropped with annual crops	6	5
Grevillea robusta	5	• Timber • Stakes • Firewood	4 (1)	5	• Intercropping possible during first years •	• Seed not freely available • Not suited for infertile plots	4	4
Acacia mearnsii	6	• Poles • Stakes • Firewood • Mulch • Bee forage	3 (1)	4	• Good for charcoal • Increases soil fertility	• Browsed by animals • -Does not coppice	5	5
Alnus acuminata	4	• Timber • Poles • Stakes • Firewood • Mulch • Bee forage	5 (1)	5	• Increases soil fertility • Straight poles • Good firewood • Ability to coppice • Fodder • Mulch	• Seed not freely available • Seedlings difficult to raise • diseases • expensive to establish system;	3	6

(1) only relevant when intercropped at early growth stages of tree growth and at the edge of the woodlots: tree: crop interface

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

N/A: Not available; ND: not disseminated

Suitable species	***Status ****	***Main products***	***Impact on productivity *****	***Impact on the environment *****	***Farmers' preferred attributes***	***Associated problems***	***Success in SW Uganda ******	**Prospect *****
Cuppressus lustanica	3	• Timber • Poles • Stakes • Firewood	2 [(1)]	4	• Good for timber widens the range of investments;	• Attacked by aphids • Investments are high	4	4
Pinus patula	6	• Timber • Poles • Stakes • Firewood	2 [(1)]	4	•	• initial investment costs are high	3	3
Markhamia spp	6	• Timber • Poles • Stakes • Firewood • Mulch	2 [(1)]	4	• Mixes well with crops • Good for poles	• -flooded at some times in the year • requires fertile soil	6	5

[(1)] only relevant when intercropped at early growth stages of tree growth and at the edge of the woodlots: tree:crop interface

* Score:_1: on-station 2: on-farm testing 3: pilot location 4: initial dissemination 5: widely disseminated 6: common option for farmers
**Score 1: very low 2: Low 3: fair 4: Moderate 5: High 6: very high
***Score 1: very low 2: low 3: fair 4: moderate 5: high 6: very high

N/A: Not available; ND: not disseminated