UPSIDE

Northern Uganda Resilience Initiative (NURI)

Training Manual for Climate Smart Agriculture

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Danida

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List of Acronyms

Abb.	Full text
AEO	Agricultural Extension Officer
AES	Agricultural Extension Supervisor
AFARD	Agency For Accelerated Regional Development
CF	Coordination Function for NURI
CSA	Climate Smart Agriculture
Danida	Danish International Development Assistance
DAR3	Brand name from previous phases used in West-Nile
DFA	District Farmers Association
DKK	Danish Kroner
DLG	District Local Government
DRC	Danish Refugee Council
DPO	District Production Officer
DTPC	District Technical Planning Committee
FPO	Focal Point Officer
GAP	Good Agricultural Practices
Kg	Kilogram
MC	Marketing Committee
M&E	Monitoring and Evaluation
PHH	Post-harvest Handling
PMP	Production and Marketing Plan
RALNUC3	Brand name from previous phase used in Acholi Sub-region
RAU	Resilience Agricultural Unit any of Kitgum / Lamwo, Agago, Moyo, Adjumani
RDE	Royal Danish Embassy
RDNUC	Recovery and Development in Northern Uganda Component
shs	Ugandan Shillings
VSLA	Village Savings and Loan Associations

1. INTRODUCTION

1.1 Purpose and Scope of the Training Manual

The purpose of this training manual is to provide guidelines on how farmers' training is to be conducted in the NURI (Northern Uganda Resilience Initiative) programme, including the scope of the training and technical areas farmers are trained on, including the focus on climate smart agriculture (CSA).

The manual is aimed at staff of implementing partners and the participating District Local Governments involved in NURI CSA extension and training activities. Like all activities of NURI it is guided by the NURI **Management Manual**, which contains the general guidelines for implementation of NURI.

Other manuals and toolkits used in NURI are:

- NURI Programme Document
- Farmer group selection toolkit
- Preparation of PMPs toolkit
- Collective marketing manual
- Toolkit for Preparation of Production and Marketing Plans
- NURI M&E Manual

All NURI guiding documents are available on the NURI website: www.nuri.ag

1.2 Content

This first section provides some background while section two of the manual highlights the different stakeholders in the training program. Section three provides details on how the training is to be conducted and the rationale behind the training methods.

Section four outlines technical areas of the training, starting with guidelines and discussion on farmer group organisation and management / setting the ground, followed by crop specific agronomy and techniques, including CSA practises. There are sections on business skills training and finally on marketing. Section five provides guidance on how to conduct individual farm visits.

Section six covers evaluation of training activities and is followed by annexes including formats for capturing data on groups and trainings, as well as useful details on the agronomy of strategic crops.

1.3 Distribution and Maintenance of the Training manual

This manual is distributed to the IPs and DLGs for use by all those engaged in the training and extension activities of NURI. A distribution list is maintained by the Coordination Function NURI (CF).

CF is responsible for updating the manual based on lessons learnt in the implementation.

2. STAKEHOLDERS

The major stakeholders involved in the climate smart agriculture training of farmer groups are described below. Further details are contained in the NURI Management Manual.

2.1 Farmer Groups

The farmer groups are to participate in all trainings provided by the program, establish and maintain the demonstration plots and replicate what has been learnt at individual household level. It is hoped the groups shall remain active throughout the implementation period and beyond, including in bulk marketing.

2.2 Implementing Partners

The Implementing Partners (IPs) in the program are:

- **Arua DFA**
- **AFARD (Nebbi, Packwach, Zombo)**
- **RAU Kitgum/Lamwo**
- **RAU Agago**
- **RAU Moyo**
- **RAU Adjumani**

The staff of the IPs namely Agricultural Extension Officers (AEOs) will provide the necessary training to the farmers as spelt out in this manual as well as any other program activities as may be organised for the farmers. They will be supported by Agricultural Extension Supervisors (AESs) and Marketing Coordinators when it comes to collective marketing. The training will focus on good agronomic practices, integrating climate smart agricultural practices for the selected strategic crops. Trainings will also including business skills and collective marketing for the crop selected by groups. Support will be for a period of 3 years, with a gradual reduction in the level of support and contact. The staff are also expected to support farmer groups with advisory services for other enterprises beyond the chosen strategic crop. NURI encourages

groups / farmers to diversify their enterprises and therefore advisory services on a wider range of crops will be required.

2.3 District Local Governments

All districts in which NURI is implemented have signed an MoU outlining their support for, and role in NURI activities. The District Executive Committee (DEC) shall carry out quarterly monitoring of NURI activities on behalf of the council while the technical officers shall supervise technical areas of NURI. The DPO will provide technical backstopping of the training and guidance from time to time. The DEC shall give feedback reports through their Focal Point Officer (FPO). The District Technical Planning Committee (DTPC) functions as the District Steering Committee for NURI by making necessary approvals such as lists of farmers groups to benefit under climate smart agriculture etc.

The Lower Local Government (LLG) at Sub-county level will be involved in sensitisation and monitoring of the program activities. They may support farmers groups with agricultural inputs from other programs and access to some of the agricultural infrastructures in the community such as stores, market stalls, open space for farmer field days etc.

2.4 Coordination Function NURI

A Coordination Function for NURI (CF) provides support to programme implementation. CF is responsible for the development of this training manual and updating it if necessary. It has overall responsibility for monitoring and to ensure the training on climate smart agriculture for the farmers is properly done.

CF's first point of contact in NURI program are the Regional Coordinators.

3. AGRICULTURAL TRAINING PROGRAMME

The training of farmer groups in agronomy of strategic crops is the heart of the Climate Smart Agriculture component. The training will be executed in the second agricultural season as this is the season with most reliable rainfall. The first season will only be considered in particular circumstances for particular enterprises. Farmers are particularly busy during the second season as there is some overlap with first season and so the time they avail to participate in the training is precious and must be used wisely to achieve maximum effect. Proper selection and preparation of appropriate training methods and learning materials are vital for successful learning to happen. The AEOs thus need to understand not only the target audience, the message to be passed on to farmers, the training objective but also the timing and availability of resources required for successful implementation and adoption of trainings.

3.1 Beneficiaries of the program

The target beneficiaries are groups of small-scale farmers who have received little or no external support in agriculture in the preceding 3 – 4 years. An assessment has been carried out in the target sub-counties and the target beneficiaries have self-selected prior to the start of trainings. The selected beneficiaries have limited skills in agricultural production and also lack improved technologies such as seeds. The consequence of this is low production and productivity by their households leading to high poverty levels. In the face of climate change they are very vulnerable. The training is aiming at building their capacity to increase production of one crop of their choice through use of improved practices and technologies thus building their resilience to shocks associated with climate change. It is expected that the knowledge gained on the strategic crop much of which is transferable to other crops, the general extension advice availed and the support and ideas of other group members will impact the household income and resilience, not just the production of the strategic crop

3.2 Strategic Crop Enterprises

The program is supporting 3 – 4 strategic crops per district as follows:

Sesame, Soybeans, Sunflower, Cassava, Beans, Potatoes, Onions and Rice.

Details of the selection process, logic and outcomes are provided in other manuals and guidelines, particularly the Report on the Selection of Strategic Crops in NURI. Each farmer group has selected one crop from the strategic crops relevant for their district for production and marketing over the 3 years of support. This information is captured as part of the group's information in the format in annex 2 of this manual. Groups are however encouraged to diversify their production to spread risks. Despite this, the

program will only support one selected crop enterprise as spelt out in the toolkit for preparation of production and marketing plans.

3.3 Rationale for Climate Smart Agriculture training

The main target for Climate Smart Agriculture intervention is to increase agricultural output of small-scale farmers. While trying to achieve this, climate change is one to contend with. This target is to be achieved by focusing on three strategic crops in each district from which farmers have made their choices. Farmers are encouraged to diversify their enterprises to spread risk with their own resources. Climate has changed and farmers need to adapt their farming to match with the changes. The seed varieties to plant and farming practices have to be changed to achieve increased production as well as withstand climate induced shocks.

Farmer groups were guided to prepare their production and marketing plans for 1 year in respect of the strategic crops chosen. The plans spell out clearly yearly targets, activities and support provided in the program for their realisation. Key in supporting farmers achieve their plans is training on CSA practices, PHH training, input distribution for the demonstration activity and seed multiplication using demonstration plots. For further details refer to the toolkit for preparation of PMPs. These activities should contribute to the realisation of the CSA objective above for the program.

3.4 How to use this manual

This manual should be used in association with other resource materials, learning aids, demonstration plots etc. A number of these will be provided to the extension staff. There serves as a guide on what areas that need to be covered. As every group and every season is different the technical information provided may not contain all the details necessary so users should consult other resources and apply the technical knowledge flexibly. Some technical information for the strategic crops is presented separately in the annex sections of this manual. Extension officers should make use of their own knowledge and the knowledge and experience of the farmers in the group to supplement the basic knowledge in this manual and in the various training materials.

The training program for a season (literally 1 year) is divided into 10 sessions (see below and section that follows). Every group needs to be taken through all the 10 sessions. Some sessions are small so more than one may be completed in one meeting. Sessions 1, 2, 3, 9 and 10 are the same across all the groups while sessions 4 – 8 are crop specific and have to be conducted based on the selected crop. Where possible the practical aspects should be brought out clearly during learning including hands-on practice. It is important to utilise the time appropriately and engage the entire group, remembering that there may be a range of farmer profiles; illiterate and literate, men and women, young and old, all of know should follow and benefit from the training sessions.

Structure of 10 sessions to be covered

Sessions	Content / scope	Time(hrs)	When
1. Setting the ground / Farmer Institutional development	What constitutes a well function group, the leadership and what is needed to be put in place for effective participation of the group members in the program	3	Before GAP training kick off
2. Climate, Climate Change and its impact on agriculture and food security	• Definition of climate and climate change with some examples • What is causing climate change? • How climate change is affecting us? • Are we prepared to cope with climate change?	3 - 5	Prior to GAP training
3. Climate Smart Agriculture practices and technologies available	• Introduction to CSA concept • 3 objectives of CSA, • Adaptation and mitigation measures for farmers in northern Uganda, • Review of the farmers' farming system (conventional) and comparison with CSA. • How to improve food security	4	Prior to GAP training
4. Introduction to the selected enterprise for the group	National and local importance of the enterprise, growth requirements, input supply, market for output, PMP implementation	2	Before GAP training
5. Seeds, seed bed preparation, planting, intercropping and weeding	• land preparation, importance of improved seeds, crop varieties and their attributes, and germination test of seeds (practical) • How planting is done with field practical at demonstration plot • Gap filling and thinning Plant nutrients, Timing of weeding and why it is important. Weed control methods	2 – 3	From site selection of the demo plot up to last weeding
6. Major pests and diseases of the given crops and their control	Disease and pest identification and control (presentation and field practical) Paying attention to what is happening in the demonstration plot.	3	From planting to harvest of the demo plot
7. Soil fertility and water management	How to maintain soil fertility Water conservation and management practices Compost making and fertilizer application	3 – 4	When crop is standing in the field.

8. Post-harvest handling and value addition	Harvesting the crop Process from harvest to storage e.g. drying threshing and storage (theory and practical) How you can add value to a product	4	Maturity of demo plot and after post-harvest
9. Business Skills	Profitability analysis, farming as a business, record keeping and saving for investment. Gross margin analysis practically done using demo plot data.	4	After field activities
10. Marketing	What marketing entails, marketing approaches under NURI, market information, forming and training PMCs, and value addition.	4	After field activities

Ideally the given crop specific session should be done relevant to the field activity of the demonstration plot for hands-on learning. Where faced with time constraint, sessions tied with field activities are covered first then other sessions done later say in the dry season such as sessions 1, 2, 3, etc.

The learning should adopt the **DISCUSSION APPROACH** and avoid **LECTURE METHOD,** making use of the vast knowledge that a group of farmers will always have to share on their own needs, conditions and crops. The use of learning aids should be carefully integrated in the relevant sessions. Farmers learn better by not just listening, but also seeing, discussing and doing practically. AEOs must allocate enough time for practical work.

In preparation for each session the AEO should be sure of subject matter to be covered, where the session will be conducted, learning aids needed such as grain sack charts, plant samples required, leading discussion questions, any follow up actions needed and how to evaluate the session. Where samples are to be provided by farmers, they must be informed in advance so that they bring them to the session. The AEO should begin a session with a recap of the previous session and clarifying any issues farmers raise.

Besides running training sessions, the AEO has to organise individual farm visits. This is intended to give support at household level and share experiences. Individual farmer visits need to be conducted and it is spelt out clearly in section 5.

3.5 Adult Learning

Farmer training will be based on principles of adult learning which are tied to problem solving. By following the 10 adult learning principles below, the extension staff will be able to choose the most practical farmer training methodologies to use:

- **Adults must be motivated:** The farmers must want to learn. If they have no motivation, they will not learn. The skill or technology to be demonstrated must be farmer demanded.
- **Adults have a wide experience** and must use this experience. AEOs must respect the experiences and opinions the farmers bring with them.
- **Adults must see the relationship between what they are learning and the reality they experience:** Farmers are more likely to try new ideas, new ways of doing things, if they can see how they may improve their own and their family's life. Training sessions must be seen to have potential to change things for the better.
- **Adults learn by doing:** Farmers need to be able to do, try using new ideas and new ways of doing things. Practical involvement at the demo-plot and replication of learnt skills in own garden should be emphasized.
- **Adults learn by solving problems:** Farmers have to solve problems every day of their lives. New ideas should be in form of problems to solve and questions to answer.
- **Adults like discussion:** Most Farmers like to discuss things; you share ideas and find new ways to solve problems. Step back, and let farmers discuss when they show interest. Field days and farmer to farmer visits should be encouraged.
- **Adults learn at different speeds:** AEOs must expect this and show that it is acceptable. Arrange your materials and activities to allow for it.
- **Adults need to feel good:** Be friendly and approachable, smile, have a joke. Show that you are human.
- **Adults respond to the classroom atmosphere:** if there is pressure and anxiety, learning will not occur. If the trainer is too casual or seems not to care, learning will not occur. So be professional but not solemn.
- **Adults respond to suitable language and materials:** The language you use should be simple, clear and to the point. No long words, insults or special jargon of your own particular field.

3.6 Establishment of Demonstrations

Under the program every farmer group will be supported with improved seeds to establish a demonstration plot of 1 acre (4,000m^2) or less, depending on the crop. This will serve as a learning site but also a seed multiplication plot as the seeds that come out of it will be shared by farmers for individual production. In this way the farmers are being supported to achieve their production and marketing plans while at the same time gaining skills. The seeds are to be provided once per demonstration plot for two years. For comparison with the demonstration, farmers can plant their own seeds in their homes. The crop varieties for demonstrations were arrived at after consulting the IPs and DPOs.

Procedure;

- The training session on planting should coincide with the planting of the demonstration plot. Inputs should therefore be organized earlier. If the training session is held earlier, then the actual planting should be used as a recap for the group.
- Demo-plots should be established on farmers' fields. These plots will be owned and managed by farmers and they need to be well looked after. An agreement needs to be in place where all members agree on the selected plot.
- The demo-plots should as much as possible be established in a central place easily reached and accessible to FG members. If is preferable if the site is along main village paths and roads in the community so that the public will also see, appreciate and have an opportunity to share in the learning.
- The land should have minimum variation. Where variations occur appropriate measures should be taken to reduce variability for example avoid anthills, trees shades and manure pits. The layout should take note of the slope of land. Soil fertility should be considered.
- Once planting has started it should not take long before it is completed to minimise variation.
- The demo-plot shall have a small plot-level sign, about the size of A4 paper, showing the variety grown and planting date.
- **Protection**: If the demo-plot is likely to be destroyed by animals and/or vandalised by human beings it should be fenced off or guarded in other ways.
- The AEO should regularly visit the demo-plots and record progress. Any problems should be discussed with the farmers. This could include; weeding, thinning, pest and disease management, making sure management operations are implemented appropriately at the correct time. The problems which cannot be resolved should be referred to the AES.

3.6.1 Farmer hosting a demonstration:

A farmer hosting a demonstration plot needs to understand clearly what the demonstration is designed to achieve, and how it will be implemented. This can be achieved in group briefing sessions, or one-on-one visits by AEO. The host farmer should have some qualities as listed below:

- Willing to offer land for the demonstration
- Willing to take responsibility of the demonstration
- Willing to participate actively and voluntarily
- Respected and liked in his/her group and community
- Be trainable and can train others in the practices/technologies
- Be cooperative, dependable/reliable, honest/trustworthy, enterprising and flexible

3.6.2 Taking demo-results measurements

Demo data is very useful and will be collected by AEOs from all demonstrations. Farmers should be encouraged to make frequent observations of the demonstration and to especially note different attributes of the variety demonstrated against the ones they grow e.g. germination, growth vigour, yield, period to maturity, taste etc.

The AEO should collect the following data: area planted and area harvested, date of planting, germination date, weeding frequency, pests and diseases and control methods used, labour for different operations, yield etc. A template for collection of this data will be provided to the AEOs.

4. TRAINING SESSIONS

Session 1: Setting the ground / Farmer Institutional Development

Session 1 Subjects:

- What defines a group?
- How does a group become successful?
- Group governance including roles and qualities of a good leader
- Setting the ground for the training program
- Strategies of implementing group activities

This will be open discussion with group members on various issues notably; review of group constitution, election of leaders if necessary, check registration status of the group, total membership, leaders and their roles, conflict resolution, funds for group activities, workplan / activities/ land for group activities, records to be put in place, how the training program will be run, ground rules during the season, farmers' plan to procure inputs for PMP, leveling of expectations etc. Any other issues deemed relevant should be discussed in this session. Members should be free to air out any concerns related to the group and program. Here below are a few tips on some aspects that should be covered.

Group definition

"A farmer group is a collection of farmers with a common farming interest". They regularly interact and influence each other towards a common goal. Through interactions farmers become interdependent, identify themselves and can be identified by others as an entity/unit. Thus a group has a sense of "we" feeling, a minimum set of agreed values and norms that regulate its operations - group constitution / by-laws. The group can discuss a few things a constitution must have and why is necessary to follow the constitution.

Features of a good group / leadership

Since the program is working with existing farmer groups which have taken over 3 years without support especially in the agricultural intervention, there is a likelihood that organization and management in most groups is wanting. They could have lost the goal, objectives, values, identity etc of being in the group. The leaders could have forgotten their roles or new leaders have been elected. The groups need to have functional leadership structure put in place (chairman, vice chairman, treasurer, secretary) with gender balance and youth inclusion in mind.

The AEO should take the groups through what it takes to be a well-functioning and organized group as highlighted below. AEO may need to assess the group's capacity and work around strengthening any weak areas. This helps the AEO to focus support where it is most needed.

A well-functioning group should have the following characteristics and functions in place:

- a clear goal, objectives and action plan
- a constitution, or a written record of its purpose and rules, which are observed by all members
- good leaders, elected by the members and with term-limits
- a name and a physical address / location
- proper records, accessible to all members to provide transparency
- members who make financial or other contributions and/or group savings, which helps build a sense of ownership
- honest members who are willing to put in work and effort to achieve their shared objectives
- regular meetings where minutes are recorded and kept
- a membership who all participate in decision making, group activities and who share the benefits.

This is done through a discussion and a process to fulfill the characteristics which are not fully met. The groups will need to review each part and begin to address those which need to be worked on. The AEO should lead the group in discussion on the roles of different leaders and the members and where necessary support the election of new leaders and/or replace vacant positions. Furthermore, discuss with them the qualities a good leader should have. By participating the farmers will have these in mind as they elect leaders and roles they are to perform. They need to know that the strength of the group lies in how well the groups is led and much of the success in the group depends on how active the leaders are.

Setting the ground

For smooth engagement with the group during program implementation, it is necessary for farmer groups to develop and agree on by-laws that back up the rules they have agreed on. This relates to how the group members will participate in the training, demonstrations and other program activities, as well as how they will share any benefits. The AEO should guide the group discussion to come up with what needs to be followed up on during program implementation and the mechanism of implementing / enforcing them. Often members leave only a few members to participate in the program wanting only material support. The idea is to encourage all members to participate in the training, demonstration and other related activities.

During this session the AEO should also explain to the group how the training will be run, farmers' involvement and responsibility and agree on the group plan to procure any necessary inputs. A recap of activities in PMP for the year and targets is made and how to achieve them. This is intended to serve as a reminder that farmers need to work towards achievement of their plan. The group agrees on their workplan, records to keep. Expectations are leveled and any issues clarified. At this point, the members for each group are registered for training sessions and other activities as per annex 3.

Session 2: Climate, climate-change and its impact on agriculture & food security

Session 2 Subjects:

- Define weather, climate and climate change with some examples
- What is causing climate change?
- How climate change is affecting us?
- Are we prepared to cope with climate change?

The AEO will be begin this session by asking farmers to define weather and climate. After submissions clarify the difference between the two as stated below:

- **Weather** describes environmental/atmospheric conditions prevailing outdoors in a given place at a given time. It is what happens from minute to minute, day by day. The weather can change a lot within a very short time e.g. cloudy in the morning, shiny in the afternoon and possibly very cold at night.
- **Climate** refers to the average weather experienced over a long period, typically 30 years. The weather elements, which change, include: temperature, wind and rainfall patterns.

When the farmers have understood climate, now ask how do they see climate say 30 years ago and now. Is it the same? If not, what has changed? Is the change positive or negative? After a few submissions from the farmers, agree and say there is climate change. **Climate change** can be detected if significant measurable changes in the long term are observed. Example: mean temperature in 1980 was 36^0C in Kitgum and in 2010 it increased to 38^0C. It refers to long-term variations (over the past decades and centuries). The changes in climate have resulted in changes in temperature and in rainfall patterns. Ask the famers to list some examples that they have observed for rainfall pattern and temperature. Afterwards, give some examples for Uganda.

- **Onset of the rains:** The beginning of the first rains is variable. It has become more unpredictable. Example: in 2018 the rains set in February while in 2019 rains set in April.
- **The duration of the rainy season:** The rainy season has become shorter, reducing the growing period for crops. This has affected farming activities. Example of 2018 second season.

- **Total amount of rainfall:** In recent years, the total daily, monthly or annual rainfall has varied from year to year, thus, there have been wet years (floods) and dry years (drought). Some years have been wetter than others. Example Acholi region 2015 was very dry, likewise 2018 while 2017 was a good year. Studies also indicate modest decrease annual rainfall in the northern districts of Gulu, Kitgum, and Kotido, as well as Kasese in the west.
- **Rainfall distribution:** At present, the rainfall distribution in Uganda varies from place to place and has been variable within a specified period of time, i.e. within a week, a month or a year. The rainfall pattern has been erratic; and has had adverse impact on farming activities. Example Agoro sub county, Lamwo district used to be very wet but now a dry area. Karamoja now receives a lot of rainfall compared to the past.
- **Temperature increase:** Analyses have found a statistically significant increase in temperature in the 30 years period, ranging from 0.5 - 1.2^{0}C across the country.

The AEO should explain that composition of some gases in the atmosphere has changed substantially resulting in higher temperatures of the earth's atmosphere, oceans and seas. This is causing what is called **global warming**. Inform farmers that sun energy (rays / lines) strikes the earth surface with some absorbed, but much of it is reflected to the atmosphere. When reflected back up the sun's rays meet a layer or blanket of gases that trap the heat within earth's atmosphere. Give example of cooking food which is not covered and which is covered, where is more heat? A number of factors are responsible for this scenario. Ask the farmers for some possible causes they know. In Uganda some of the most contributing agricultural factors to changes in the atmospheric gases are:

- Rampant Bush burning
- Draining swamps for farming
- Poor agricultural practices e.g. overploughing our gardens creates dust,
- land-use change and forestry e.g. forests cleared for farming & charcoal, and
- energy e.g. cooking with firewood.

Ask farmers what effects that have come with climate change to them and more so agriculture. At this point tell the farmers that Climate change has brought droughts and floods which impact negatively on our agriculture and food security. They have increased in frequency, intensity and magnitude over the past 20 years. It is estimated that droughts and floods currently affect over a million people annually in Uganda; and that they are the leading causes of chronic food insecurity. Examples of drought and floods occurred in Uganda: From 1991 – 2000, there were 7 droughts compared with 1981 – 1990 where they only two droughts. Floods are also frequent with most report of 2007 in the north and eastern part of the country. In Western Uganda (Kasese), the one in 2013. Numerous flash floods have been recorded with recent one in 2018 in some sub counties in the districts of Kitgum, Lamwo and Agago.

In Uganda, some of the impacts are:

- *Since 1950, average maximum and minimum temperatures have increased;*
- *Extreme rainfall and associated floods resulting in loss of life and property;*
- *Variability in type, amount and frequency of rainfall which affects agricultural productivity;*
- *Regular severe droughts, with associated famine;*
- *Receding and falling water levels in lakes and rivers particularly, Lake Victoria and River Nile;*
- *Increasing incidences of malaria in places such as Kabale where it wasn't prevalent before;*
- *Receding ice caps on mountain Rwenzori.*
- *Conflicts over resources e.g. water and pasture by Karamojong and other neighbouring tribes*
- *Landslides in Bududa, Bugisu region / Elgon.*

Farmers should note that climate change is real and there is need to take it into account in the way they do their farming activities. Droughts and floods in the future will be frequent and severe and consequently have a direct bearing on agriculture and food security. These impacts affect most the small scale farmers of community because they depend on rain fed agriculture and agriculture is their source of livelihood. Anything that disrupts their production puts at great risk of food insecurity and hunger.

Climate change also impacts on other sectors e.g. increasing outbreak of diseases such as malaria, cholera, diarrhoea. It is projected that these negative impacts will continue and increase in magnitude if the causes and effects of climate change are not addressed. These indirectly also affect agriculture e.g. sick people cannot do farming.

Discuss the vulnerability of the farmers in the context of climate change; examine the common farming practices which are mainly rain fed, it means most our farmers are very sensitive to climate changes (see box 1) because any dry spell can affect their crops thus making them very vulnerable. Example is the prolonged dry season 2019 in Uganda, how prepared were we? Farmers have lost cattle in central / western Uganda due to lack of water and pasture. The way farmers will be able to cope with food shortage / bad weather / poor harvest and how quickly to responding to the conditions there on determines their adaptive capacity. This is the aim for climate smart agriculture. Climate-smart agriculture is an approach that works to

Box 1: Specific attributes make some households more sensitive to climate change. More vulnerable households are those with many of the following characteristics:

- Lower proportion of able-bodied (working) members;
- Less well educated;
- More likely to be headed by female;
- Less likely to sell a portion of their crops or livestock;
- Participate less frequently in community groups such as producer associations, cultural or labour savings groups, and religious organizations; and
- Earn income less frequently from off-farm sources (and when they do, that income is less than the amount that more secure households earn).

maximize the adaptive capacity of farmers is built and in so doing minimises their ultimate vulnerability to changing climate conditions.

Session 3: Climate Smart Agriculture and technologies / practices available

Session 3 subjects:

- Introduction to CSA concept
- 3 objectives of CSA,
- Adaptation and mitigation measures for farmers in northern Uganda,
- Review of the farmers' farming system (conventional) and comparison with CSA.
- How to improve food security

CSA is not a single specific agricultural technology or practice that can be universally applied. It is an approach that requires site-specific assessments to identify suitable agricultural production technologies and practices.

CSA aims to improve food security, help communities adapt to climate change and contribute to climate change mitigation by adopting appropriate practices. These set of practices when implemented in an integrated farm approach and in context of the local social and physical ecology should ensure increased production and profitability, enhance resilience and adaptation to climate change effects. These practices which may be applied alone or in an integrated approach, include those that:

- Increase the quantities and qualities of farm yields as well as profitability without destroying the environment (sustainable production).
- Cushion farmers from the effects of climate extremes such as floods and droughts.
- Increase the general resilience of households to all kinds of shocks

Why Climate Smart Agriculture

- CSA reduces the bad gases in atmosphere by storing carbon, which is a green-house gas, in the soil (soil-carbon content), improves nutrients and water-use efficiency as well as water-holding capacity, and makes soils easy to work.
- CSA increases cost-benefit returns.

Some of the CSA practices include terraces and bunds, strip and contour cultivation, planting pits, crop residue mulching, composting, cover cropping, improved high yielding varieties, crop rotation, intercropping and agroforestry. Details of these practices will be covered in the different crops. There are CSA practises beyond the scope of this manual which farmers can explore e.g. apiary, irrigation, mixed farming, minimum / zero tillage etc as groups or individuals.

Farmers should be discouraged from using conventional practices like burning of farmland/crop residues, continuous/over cultivation, over grazing, destructive land

opening/cultivation and deforestation. These leave the soil bare and prone to erosion, destroys soil structure and creates compact layers below the surface.

Session 4: Introduction to specific crop enterprise for the group

Session 4 subject:

- Introduction to enterprise
- Market outlook
- Input availability
- Profitability of the enterprise
- How to implement/review PMP

CSA emphasizes timely implementation of activities with focus on viable crops which have a good market outlook (availability of market, stable commodity price and transparent value chain) in order to achieve maximum effect. Discuss and review with the farmers how market of the chosen crop has been in the past 3 years and what the future is likely to be based on available information.

The production of a given crop is partly dependent on a reliable supply of inputs. At this point discuss with famers how, when, where and what prices they can get inputs. Poor supply of inputs will undermine the commercialization of any enterprise.

The AEO will advise on agricultural input service providers in the region as a source of good seed. This can be UNADA stockists, seed input shops and seed suppliers/company.
The AEO should be sure to orientate themselves on where the best stockists and input shops are located.

Annex 5 contain details of the technical agronomic and CSA technologies/practices of the selected crops (list of strategic crops).

The AEO will expose farmers to advantages and disadvantages of varieties of the chosen crop including growth characteristics, maturity period, yield estimate, market outlook and profitability. S/he should explain that the crops perform best in particular regions, or under conditions that cannot be the same everywhere. The effects of the weather changes on crop performance is emphasized. This is a basis of deciding when to plant this crop.

The AEO should emphasise the importance of timeliness of crop production practices for better yields. The farmers are encouraged to implement what they will have learnt in their individual fields in order to build resilience and achieve their PMP targets. Members are reminded about their targets in the PMP.

Session 5: Seeds, seed bed preparation, planting, intercropping and weeding

Session 5 subjects:

- Type of seeds / varieties to plant
- How to prepare a seedbed
- How and when to plant a given crop
- Intercrop where applicable
- Weed control

The AEO shall begin this session by asking what farmers know on subjects listed above. Some of these should be done practically in the field. Where it does not coincide with field activities it should be re-capped at an appropriate time when the field activity is due. Refer to annex 5 for additional information.

The quality of seeds to plant is very important. Farmers should plant certified seeds and viable. It is necessary to test the germination of seeds. The AEO should discuss with farmers how to carry out seed germination test. For vegetatively propagated crops, they should be in good state (not damaged / dried). The crop variety selected should be early maturing, drought tolerant and pest and disease resistant. The AEO should list some of these varieties. These are the ones suited to unpredictable / changing climate.

Early planting is determined by timely preparation of the seedbed. The seedbed preparation depends on the seed size to plant. When practicing CSA during seedbed preparation, minimum soil disturbance and minimal tree cutting should be encouraged while burning of trash is discouraged. The site of the field / garden should match the crop to be grown considering soil fertility, flood risk, previous crop and topography. Discuss with farmers why this is necessary in CSA.

The AEO discusses with the group when to plant a given crop and how it is planted. This should be done in the demonstration plot of the group. Where applicable early planting at the onset of rains is recommended. If the crop is suitable for intercropping and the group wants, this should be done / decided. Line planting and correct spacing should be explained. Discuss some of the CSA approaches and why they are important for the small-scale farmers. Emphasize that intercropping with preferably cover crops / legumes/ crops that have different root depth, plant height and maturity. Right intercropping pattern and spacing is recommended. Under dry conditions low plant density should be used. Refer to section 3.6 on how to establish a demonstration for a

group. Thinning and gap filling as applicable to a given crop and situation must be timely and properly done.

The AEO should discuss with farmers why, when and how weeding is important. Tell farmers that weeds are hidden thieves for them. Timely weeding should be emphasized and followed. Alternative methods of weed control applicable to a given crop and small scale farmers should be discussed with farmers. The type of weeds may also influence the control measure applied. Weeds may be controlled by hand weeding which is the most common method used by small-scale farmers. Mechanical and chemical methods of weed control also exist. Cultural methods can also help to control weeds for example a good seed bed preparation, proper spacing, timely planting, mulching, improving soil fertility and good seeds can help minimise growth of some weeds as well as crop rotation. A combination of methods can help give best results. Discuss some of the CSA practices applicable here in the circumstances facing this particular group of farmers.

Session 6: Major pests and diseases of the given crops and their control

Session 6 subjects:

- Major crop pests
- Major crop diseases
- Control of pests and diseases

In this session the different pests and diseases which affect the selected crop are discussed and their control measures explained and if possible, demonstrated. The details for the different crops can be got in the annex 5. This should be accompanied by practical sessions in the demonstration plot or farmers' fields. Cultural control measures such as crop rotation, early planting as well as host resistance should be discussed. With climate change pest and disease incidence and severity is likely to escalate. In CSA plant resistance, crop rotation, fallowing, right spacing are emphasized. A combination of different control measures (IPM) is the best win. Farmer fields and group demonstration are used for the learning process. Regular field scouting to check health status of the crop should will be emphasized. Chemical control should be used only as a last resort, as it is expensive and often detrimental to the environment. There are many organic methods of pest and disease control, for example using tobacco, soap and chilies as insect repellents. Discuss with farmers the methods they are familiar with, and introduce new ideas. There are huge resources on IPM and natural pest control

available on-line and in various literature. Extension officers should build their knowledge in this area.

Session 7: Soil fertility and water management

Session 7 subjects:

- causes of soil infertility
- how to maintain soil fertility
- way of soil and water conservation
- caution on compost and manure making / application, fertilizer use

Begin this by asking some of the ways in which soil fertility is lost. The AEO then highlights some of practices that promote soil fertility and soil and water conservation as applicable to the specific enterprise / crop of the group. The AEO should discuss soil and water conservation methods they are familiar with and why these are relevant and important to CSA? Common methods include; mulching, use of cover crops, constructing terraces, bands, trenches, contour cultivation, fallowing of land, no burning of trash, crop rotation, inoculation of legumes with rhizobia. For some crop specific information refer to annex 5. In some cases, the farmers have to deploy water harvesting techniques and simple irrigation where this is applicable which is also informed by crop enterprise engaged. The AEO should advice farmers that should flooding be experienced then they construct drainage channels they will need to find ways to lead surplus water away from the crop. The type of crop and duration of flooding has to be assessed to design a suitable drainage system.

On compost making and manure application, the AEO should guide farmers on the right way of making and applying them. The aim is to avoid evaporation of nitrogen to atmosphere. For manure from cattle, anaerobic fermentation is recommended – this means air/oxygen should be excluded from the process. Where farmers can manage, judicious use of inorganic fertilizers should be considered. Use of nitrogen fertilizer at the right time can give a real boost to production and profitability. Application should be done correctly, in moist soil, with the fertilizer covered by soil to avoid wasting fertilizer and get the full benefit. Discuss why should farmers follow these in CSA practices, and before the session make sure you can add value to farmers' existing knowledge and answer as many questions as possible.

Session 8: Post-harvest handling and value addition

Session 8 subjects:

- maturity indicators
- different post-harvest handling practices
- storage pests
- value addition

The AEO shall lead farmers through; maturity indicators of the crop, causes of post-harvest losses, methods of harvesting of the crop, threshing / shelling, drying & methods, testing for dryness, cleaning, grading/sorting, transportation, storing of the produce and methods, and storage pests and their control. The AEO should as much as possible reinforce farmers responses to bring out best practices. The farmers should know that the market want quality products to fetch better prices. Some guiding information is found in annex 5 for specific crops. The demo plot or farmers' gardens may be used for learning. Discuss with the farmers why the trash / stalks should remain in the field. Similarly, after cleaning the crop, the remains should be returned to the field and not burnt. How are these practices relevant to CSA?

It must be emphasized that farmers should be able to store foodstuffs without going bad till next harvest with minimal losses as a way of building their household resilience and coping with climate changes. This can be by use of indigenous or modern knowledge. Sound PHH practices have to be emphasized. Also the farmers will be introduced to simple value addition options for the different crops as well as the quality issues. Discuss some of the value addition options available to the different crops and what quality measures should be upheld. Discuss the availability and characteristics of the market for the products that farmers are planning to sell.

Session 9: Business Skills

Session 9 subjects:

- Profitability analysis
- Benefit-cost analysis
- Farming as a business
- Record keeping
- Saving for investment

Profitability Analysis

Profitability analysis includes two closely linked steps. The first step involves the gross margin analysis while the second step is the risk or sensitivity analysis. Gross margin analysis matches the costs (production and marketing) against the benefits or returns from the enterprise. Risk analysis on the other hand is aimed at finding out how changes in the three key determinants of gross margin affect the overall profitability of the enterprise namely:

- ✓ Changes in costs of production
- ✓ Changes in output or yields
- ✓ Changes in market prices

Farmers should be made aware that any sharp rise in costs of production will render the enterprise less or even unprofitable while a sudden fall in output/yields and market prices too will reduce the profitability of the enterprise. The AEO together with groups should carry out both gross margin analysis and risk analysis.

Gross Margin Analysis

Using data from the demonstration plot perform a Gross Margin Analysis (see annex 8). The gross margin analysis should be calculated on per acre basis. Revenue can be estimated based on the prevailing market prices in case the products have not been sold. Farmer group members should check their records and find the relevant information about inputs used, prices, number of days worked in the field etc. A Gross Margin analysis was done during crop enterprise selection based on estimates, and this now serves to use real time data from the demonstration plot rather than estimates.

The key steps in carrying out gross margin analysis using income and expenditure grain sack chart include the following:

i. List and quantify all inputs used in production of the crop in the demonstration plot. This include: Land, labour (impute the cost since group members did the work), hand tools & implements, seed, agro-chemicals, actual marketing costs.
ii. Establish the unit cost (price) of each input
iii. Calculate the total costs of production for the enterprise by multiplying the total quantity of inputs by the cost price of each input.
iv. Establish the total output or yield of the enterprise.
v. Establish the market price for the end product (this information could be obtained by marketing committee)
vi. Compute returns by multiplying output/yield by the market price per unit of output.
vii. Gross margin = Expected Total Returns – Estimated Total costs

The Gross margin must be positive to a reasonable margin for the enterprise to be profitable.

Risk analysis

Farmers should know how changes in production (productivity) and product prices affect the profitability of the enterprise. Risk analysis looks at scenarios involving changes in cost of production, yields and market prices and how they affect the profitability of the enterprise. The key steps include;

i) compute changes in gross margin arising from increased cost of production e.g. labour and seeds
ii) Similarly compute changes in gross margin due to fall or increase in yields / outputs.
iii) Do the same with increase and fall in market prices and determine gross margin.
iv) Farmers need to know how to deal with such situations e.g. storing and selling later for better prices, increasing productivity through improved seeds, lowering production costs.

Note: *it is important to note that although the group can cut on cost of production and /or increase output by use of productivity enhancing technologies, this can hardly influence market prices. Market prices are therefore in most cases the most critical factor determining the overall profitability of the enterprise.*

Example: Risk analysis for Sesame enterprise

Risk analysis looks at scenarios involving changes in cost of production, yields and market prices and how they affect the profitability of the enterprise

Scenario 1: An increase in yield of Sesame from 200 to 250 kg/ acre

Parameter	Product	Yield (kg)	Market price (shs)	Total (shs)
Expected revenue	Sesame	250	3,000	750,000

Total cost				405,000
Gross margin				**345,000**

Scenario 2: A decrease in yield of Sesame from 250 to 200 kg/acre

Parameter	**Product**	**Yield (kg)**	**Market price (shs)**	**Total (shs)**
Expected revenue	Sesame	150	3,000	450,000
Total cost				405,000
Gross margin				**45,000**

Scenario 3: An increase in market price of Sesame from 3,000 to 3,800/ kg

Parameter	**Product**	**Yield (kg)**	**Market price (shs)**	**Total (shs)**
Expected revenue	Sesame	200	3,800	760,000
Total cost				405,000
Gross margin				**355,000**

Scenario 4: A decrease in market price of Sesame from 3,000 to 2,000/kg

Parameter	**Product**	**Yield (kg)**	**Market price (shs)**	**Total (shs)**
Expected revenue	Sesame	200	2,000	400,000
Total cost				405,000
Gross margin				**-5,000**

Note: It can be seen that under scenarios 1 and 2 above, changes (decrease and increase) in yield affected profitability but in scenario 3 and 4 the changes (decrease and increase) in market price drastically affected profitability of the enterprise. A fall in market price has a far reaching effect on gross margin than a fall in yield, hence famers need to be encouraged to see how to exploit markets.

Benefit-cost analysis

The AEO and the farmers may also do a Cost-Benefit analysis where costs and benefits are compared to determine whether a business is profitable and therefore financially viable. A benefit–cost ratio is calculated by dividing total revenue by total costs. It is used to judge the efficiency of the farm business. When the ratio is > 1 it means the business is profitable. A ratio > 2 is preferred in order to take into account unforeseen events associated with agricultural production.

Farming as a business

A business is any activity that aims to earn a profit through providing a service or a product. Farming is also a business that aims to earn profits if it is to grow and sustain itself. Before starting a farm business, farmers should find out if they are capable of running it. Treating farming as a business helps farmers to get the best out of their

farms and their resources. For one to succeed it requires resources, knowledge and skills in a given enterprise and marketing skills.

The following are some of the benefits from taking a business approach to farming:
- Farm goals are defined, e.g. Where is the business going?
- Commitment to making it succeed
- Record keeping for making better decisions
- An organized farming business is more likely to attract capital from lenders, banks, trusts, government, etc.

Farmers can only have good margins if they take farming as a business because every aspect is looked at critically and objectively.

Record keeping and its importance

Record keeping is a systematic compilation of certain types of information. Reliable and accurate records are useful for making better decisions. Farmers able to read and write should keep basic farm records. For example, farmers should have:

1. *Activity records*- When different activities are carried out in the farm
2. *Input record*- inputs, the prices, and quantity
3. *Labour record* - details the labour used for the various tasks on the farm and costs.
4. *Production record* – quantity produced of the different enterprises
5. *Sales record*- volumes of the produce sold, price, buyers etc
6. *Financial records* –compiles information on farm money in and out.

The AEOs and AES' should support this by providing farmers with simple templates to use.

Saving for investment

Saving means keeping some valuable resources e.g. money for future use. It entails discipline and sacrifice, as one postpones consumption from now to a future date. It leads to capital accumulation over time, which can be invested in profitable enterprises. In groups, the principle purpose for saving is to build up a group fund from which it is lent to individual members and to fund group economic activities or enterprises. This requires mutual trust and a high level of integrity among members, especially from the leaders. AEO should emphasize proper records and accounts to be maintained and regularly reported to the group members for audits and scrutiny.

Groups need to save some resources to invest if their production is to expand to fulfill their PMPs. As a minimum they need to save enough to buy seeds and other inputs for the next crop. A poor savings culture can undermine the future of the enterprise, and make the household vulnerable to shocks such as climate-change. A separate training will be organized on VSLA depending on needs assessment of the various groups.

Session 10: Marketing

Session 10 Subjects:
- marketing concepts (marketing, marketing mix, supply and demand)
- marketing approaches
- usefulness of market information and intelligence
- formation of marketing committees and their roles

Marketing
Marketing is an important element in profitable commercial farming. Farmers should be able to sell their produce at a profit. When buyers offer stable and profitable prices, farmers are able to gradually increase their production and improve their livelihoods. Marketing activities feed into the commodity value chain, the value chain being all those activities that link producers and consumers. Marketing is everything an individual or entity does to find out who their customers are and what they need or want. In other words, marketing is about finding out what the customer needs or wants, producing and selling the things that people need or want, letting people know about your products/service(s), selling your products/services in the right place(s), making your products/services unique and more attractive than of other similar businesses/suppliers and setting the right price so that people will buy your products/services rather than those of your competitors.

Marketing mix
Successful marketing is premised on the ***'4 Ps',*** commonly known as the marketing mix. The marketing mix comprises the product, price, place (distribution) and promotion decisions and is the right combination of marketing activities to ensure customer satisfaction, as explained below:

Marketing Mix	Meaning and Reflection Question
Product	• Product means what farm produce a farmer is ready to sell. Good quality products generally fetch higher prices. **Reflection Questions!** What product is needed in the market? What quality? What quantity? When?
Price	• Price means how much you will charge for your farm produce. • Price will depend on what customers are prepared to pay for the product. • The price offered should as a minimum cover the costs of producing the product. Selling collectively as a farmer group might fetch a better price than doing it individually. **Reflection Question!** At what price will I sell my produce/product? What are the advantages of bulk selling?

Place (Distribution)	• Place means where you are going to sell your product from. • The location is always very important for farmers. If your business is not located where customers are, you need to find ways to get your product to them. To be economically profitable, you will need to reduce transport costs by marketing as a group. **Reflection Question!** Where am I going to sell my product(s)? At the farm gate? At the market? At the distant high-price market?
Promotion	• Promotion means informing and attracting customers to buy your product. **AEOs** need to inform farmers that this aspect of marketing is best done as a group. • Farmers can use advertising to inform customers of the availability of their products for sale. For farmers, advertising is done best under common marketing, as you need big volume to supply the market. **Reflection Questions!** How will I promote the product? How will I convince traders/buyers to buy from me?

What influences the price of a product?

Farmers should know that prices of their produce/products are largely determined by market forces of demand and supply. Prices for agricultural produce/products can fluctuate significantly. If large quantities of a certain commodity/product are offered to the market, for example during the harvesting period, prices will fall. When there is a shortage of supply in the market, prices usually rise. Knowing what is happening with demand and supply is essential to sell profitably. Farmers therefore, need to plan when to market their produce/products and also make proper choices of the enterprise to undertake, as explained below.

Think of what happens just after the grain harvest. Lots of farmers want to sell their grain at the same time: they need money to pay their expenses, repay debts and buy seed for next season. Typically all farmers bring their grain to the village market place on the same day. But there are only a few people who want to buy grain. So when there are many suppliers and there are fewer buyers, the price of grain will fall. This is even worse when the weather has been very good, many farmers will produce a lot of grain. On the other hand if there is a drought and the grain harvest is bad. Only a few farmers have any grain to sell. Customers are desperate to buy grain, so they are willing to pay more. The price will rise. That is why the price of many crops goes up and down over the years / seasons.

There is a logical reason why prices always seem to be low when you have a lot to sell and high when you only have a little!

Why is understanding supply and demand important to farmers?

If farmers understand supply and demand, they can plan what crops to grow, when to plant and harvest, and where to sell.

- They can plan to harvest their crops at the beginning or the end of the season, when prices are higher.
- They can grow a crop variety that fetches a higher price. For example improved mangoes may fetch a higher price than local ones.
- They can decide when best to sell their crop – for example by storing it until the price goes up.
- They can try to increase the quality of the crop (for example, by protecting it from pests and diseases or cleaning and sorting) so it fetches a higher price.

Other factors that influence prices

- **Quality of the produce**- Good quality produce definitely fetches better
- **Location of the produce-** The further the market is the higher the final price of the commodity because of transportation costs.
- **Cost of production-** The cost of production influences the price at which a farmer is willing to sell, as they need as a minimum to cover costs and make some profit.
- **Personal preference-** At times consumers pay a higher price simply because they are interested in particular commodity e.g. yellow beans may fetch a higher price because people prefer it to other varieties.
- **Government regulation-** Government sets minimum for cotton as example. Generally, government will only interfere in prices if there is a strong strategic reason to do so. This is because the huge quantities of products sold makes any interference highly expensive and risky.
- **Competition / Alternative products -** The presence of alternative products that offer the same satisfaction to consumers is likely to determine the price trend of a particular commodity in the market. For example, some oil crops may be targeting the same market.
- **Seasonality-** Crop products fetch different prices depending on the time and season in which the commodity is produced.

Marketing Approaches under NURI

The following are the marketing approaches that farmers may use, depending on which one is a better option for them. The program is not going to be directly involved in the marketing of farm commodities/products for the farmers but, will support in aspects like training in marketing and establishment of marketing committees in the groups.

a. Bulking and selling

Here, the farmers bring their commodities/products to one place at a given time or date, agreed place and sell jointly.

b. Bulking, Storing and Selling

This approach adds the element of storing. The rationale is that price increases during the storing period normally will exceed the costs of storing and therefore increase the

net payment to the participating farmers. The bulked produce should be stored in a suitable store (dry and ventilated) where the quality of the produce not will deteriorate. The development in market prices should then be followed closely in order to decide the optimal time of selling.

The farmers will receive training on these two these approaches as part of the agricultural training support.

Success of bulking / collective marketing will depend on but not limited to the following:

- Mutual trust among members
- Clear and enforceable by-laws
- Members all engaged in a clear and transparent process with no outside interference
- Zero tolerance to corrupt and unaccountable leaders by members
- Committed and dedicated leadership
- Regular meetings and active participation of members
- Proper and up-to-date record keeping

Advantages of collective marketing

- Economies of scale: If farmers combine their commodities/products together, they can get better prices from traders who want to buy large quantities.
- Cost sharing: Farmers can share costs of, for example, transport to take their produce to more distant markets, where they may get a better price.
- Reduced transportation costs: transporting small quantities is far more expensive than bulking and organizing transport of large quantities at a time.
- Fewer links on the value-chain: If farmers can reach distant markets, the number of middle business persons will be reduced. This will mean a bigger share of the final price goes to farmers.
- Improved quality: Working together, farmers can clean and sort their products and sell them to a market that values quality and is willing to pay for better produce.
- Building knowledge and capacity: An organized group is more likely to receive trainings in crop management, PHH and build their capacity over time.
- Incentive to increase production: When farmers are able to market their produce/products and to get better prices, they will be incentivized to increase their production to raise their profits.
- Communal equipment and services: It is much cheaper and easier for government and development agencies to organize trainings and agricultural extension services for farmer groups rather than for individual farmers. Farmers can share the equipment provided in the community easily, for example, tarpaulins, stores, etc.
- Access to credit: When farmers market their produce/products together, it becomes easy for them to access credit facilities from financial institutions.
- Social Cohesion: Marketing produce/products as a group may strengthen mutual trust among group's members and this can increase the level of transparency in a community.

c. Individual selling

Farmers can sell their commodities/products to any buyer(s) of choice at any time at any place at any price. Nothing is regulating the farmer in selling his/her commodities/products. This is the most common approach used by small-scale farmers. The risk is that middlemen will have more information on process than the farmer and will be in a stronger position in negotiating the price, thus pressing the price downwards and reducing the share of the final market price that goes to the farmer.

d. Linkages to big buyers or processors

This takes any of the 3 approaches above. It will be done on a case-by-case basis when a marketing opportunity has been identified. Some buyers supply inputs to farmers at certain terms and conditions and will come to buy their produce. One such a buyer is Mukwano Group of Companies that buys sunflower seeds from farmers it contracts to produce. The advantage here is that there is assured price and market for the farmer's produce. Farmers can also be encouraged to explore such avenues as new markets are emerging in Northern Uganda and as the road network improves more buyers are becoming interested in buying produce.

Market information and market intelligence

Market information refers to facts and figures that will help farmers, consumers and others involved in the marketing process to make better decisions and minimize their risks. Market information includes all kinds of information business people (including farmers) need in order to market their products and produce for the markets. Such information may include the price of inputs, the current selling price of produce/product, potential buyers of the produce/product, and quantities of produce/product required by different buyers, quantity of produce/product available for sale, etc.

This can increase farmers' bargaining power, enable farmers to access more markets, and improve farmers' decision-making on production and marketing.

Types of market information

- Agricultural inputs: What are prices of seeds, fertilisers and pesticides? Who stocks them?
- Product marketing: What products are needed in the market? What is the price offered? Who can you sell to? Where can they be stored? How can you arrange transport? What is the cost of transport?

Discuss with farmers how they get market information. Farmers can market information in several ways; Traders/buyers, Input dealers/traders Fellow farmers, Media (newspapers, radios, televisions, farmer bulletins), Family members and friends, Agricultural extension officers, Non-governmental organizations, Farmer groups own surveys, Farm records of previous season, and internet.

Market intelligence

Market intelligence is the proper understanding of markets and marketing. It includes the types of information needed, knowing where to get this information and knowing how to use it.

Benefits of market intelligence

• It allows better decision-making at the time of production. It helps you decide:
– What to plant
– Quantities
– Methods
– What to finance
• It allows better decision-making at the time of selling. It helps you decide:
– Where to sell
– When to sell
– To whom to sell
– Price
• It attracts traders by informing them about the quantity and quality of produce you have available.

Tips to help farmers to access better markets and harness high prices

- Ensure good quality produce/products by practicing good harvest and post-harvest interventions
- Do no adulterate your produce/product for example by adding stones in millet or sesame.
- Talk about your product to your neighbours, who can spread the word further
- Visit the nearest market and talk about your product before you take it there
- If possible, establish storage facilities at your farm to keep the produce safe and dry for a better price
- Add value to the produce/product in order to earn more from it, by cleaning, sorting or doing primary processing as appropriate and possible within your means.
- Go for a market that you can comfortably satisfy, don't make promises you can not keep.
- Advertise your produce/product in the media

Establishment and Training of marketing committees

Under this program, marketing will be done by the farmers themselves. Each farmer group should elect/form a marketing committee for their produce/products. The Marketing Committee can consist of the existing group leadership or it can be a separate committee with members who are have special interest and skills in marketing. It should at least have the following members; Chairperson, Secretary and Treasurer among others. In electing the members, trustworthiness and ability to read and write would be greatly emphasized. These committees will be trained and mentored by the AEOs, supported by the marketing coordinators who are staff of the IPs and RAUs. The training should last 3 to 5 days. Below are the proposed training topics, roles of farmer groups in marketing, and the roles of the marketing committees (MCs).

Training topics for MCs

- Business management skills
- Financial management basics
- Effective leadership skills
- Marketing
- Innovation and agro-product development
- Record keeping
- Store management
- Quality control and quality assurance
- Others

a) Roles of farmer groups

- Produce for the market
- Comply with quality requirements of buyers
- Identification of produce collection points/bulking centres in their locations
- Bulking of produce
- Provision of security for the bulked and/or stored produce
- Provision and/or sharing of market information
- Providing inputs market
- Transportation of produce to collection points and/or markets

b) Roles of marketing committees

- Mobilization of farmer groups for marketing activities
- Maintenance of up-to-date register of members for production and marketing
- Information dissemination to or share-out with groups' members
- Receipt of produce payments on behalf of members and pay members promptly
- Mobilization of members to attend pre-production planning
- Mobilization of members to market as per agreed arrangements with buyers
- Bulk members' produce/product together and provide such data to IPs/RAUs and buyers
- Ensure members produce quality commodities/products
- Enter into contracts with buyers
- Sourcing for potential buyers
- Negotiation of terms and conditions of marketing with buyers
- Maintain up-to-date transaction records
- Exchange market information with IPs/RAUs and fellow farmers

5. INDIVIDUAL FARM VISITS

Group members and AEOs should make visits to individual members' farms to find how they are implementing what has been learnt during the training and help them with any challenges related to the training. AEOs during 2nd – 3rd years should devote much of the time to individual farm visits giving technical advice to the individual households. This however will be based on how the 1st year training was concluded.

Where the AEO finds it can be useful they can organise joint visits to individual farmers by the group. Farmers to be visited are selected during group gathering such as training or any activity and the date and time of the visit communicated. In case many farmers are to be visited, 3 mini groups should be formed and each assigned a leader. The AEO should take members through what they need to do during individual farm visits. There is also a farm visit form to be filled. When AEO is alone, s/he should draw his/her plan approved by AES to visit the farmers individually.

1. At the member's farm, have the farmer tell you the following:
   - The agronomic practices used at farm for production of the strategic crop, and assess if they have been correctly applied
   - The challenges faced in applying the skills learnt.
2. Write down the information provided during the farm visit on the farm visit form (annex 7).
3. Encourage farmers to ask as many questions as possible related to the enterprise as this an opportunity of learning in the field. AEO should try to answer the questions on the spot, but where s/he does not have the answer, writes down the question (to seek further clarification from elsewhere) and tell the farmers the answer will be given later.
4. Based on the information given and your own assessment, provide recommendations to the farmer. Try to provide practical solutions to the problems.
5. Discuss the farm household production in general and the integration of various enterprises, including how the strategic crop fits into the overall household production and income.
6. Talk about how the farmer is addressing climate risks, and ensuring that soil and water are well conserved.
7. Wrap up the session by thanking the farmer and encourage him / her to act on the advice given.
8. Visit the next farmer as per set program.

6. EVALUATION & PLAN FOR NEXT SEASON

a) Training Evaluation will be done in the following ways:

- AEO will help farmers FG to assess the impact of training by examining/ comparing what aspects of the training worked or did not work and what has been implemented in their own gardens.

- The AEO will evaluate each session by observation of farmers and use of questions and answers during the training. Information obtained from this will enable the AEO to adjust the training accordingly. To keep track of the training offered to the FGs, the AEO should prepare a report immediately after each training session with a farmer group (Annex 4). A copy of the report should be given to the AES and one copy kept by the AEO.

- FG members will carry out own session evaluation before the beginning of the next training session, using guided questions to be provided by AEOs. This information will allow AEOs to adjust the training process for the next sessions accordingly.

- The impact of the training will be evaluated through review of the PMPs developed by each group. Part of the information in PMP to be captured is provided in the PMP manual. How the training has helped them implement their PMPs will be emphasised. Information obtained from this evaluation will be used for design of future training programmes.

- End of season open days: these days will be organised by the IP in every sub county and all participating groups should attend. The groups should show-case what they learnt and how they have benefited from the program. A wider section of the community will be mobilised to attend including the district and sub-county officials. Here successes and failures of all the groups will be compiled by AES with support from the AEOs. This report will provide information that can inform the next course of action.

- The District Executive Committee will be carrying out quarterly monitoring and their feedback shall also help in feeding how the training is run and what changes are needed if any.

- Compiling of success stories from the FGs and individual farmers as a result of the training should be done to capture what has changed in the group or for individual farmers as a result of the training. Success stories that are

documented can be shared and used to better understand and appreciate the programme.

b) Plan of action

- Based on the various feedback and monitoring tools above adjustments in the training can be made within the season in discussion with the AES.
- If there are major lessons these can be taken into account in future seasons and adjustments can be made to the training programme.
- Farmer groups evaluation of training sessions can guide the individual AEO on what works well in terms of training methodologies with this particular group, keeping in mind that the make-up and characteristics of each group are different.
- NURI aims to be a learning programme, where everyone learns from their successes and mistakes, and where errors are not to be hidden or punished, but should be considered lessons to be learnt from and tools for improving implementation.

7. ANNEXES

Annex 1. Register of Farmer Groups per AEO

Year…… **Season……** **Date……**

District…… **Sub county……** **Name of AEO……**

SN.	Name of farmer group	Chairperson	Contact (phone no.)	Enterprise	Membership			
					F	M	T	Youth
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
	TOTAL							

Annex 2. Register of Farmer Group Members

District..... Sub county..... Parish.....

Membership: Male..... Female..... Total.....Enterprise: .....

Name of group..... Name of Group Leader.....

SN.	Name of farmer (Start with surname)	Age	Sex		Village
			F	M	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					

Annex 3. Attendance Register of Farmer Group Members for Training

Year…… **Season……** **Group……**

District…… **Sub county……** **Name of AEO……**

No.	Name	Training sessions attended															Total

Annex 4. Report Format for each Training Session

Report from Training of farmer Group				NURI		
District		Group		Attendance		
Sub County		Date		M	F	Total
Parish		Session no.				

Demonstration Plot Status	Crop		Planting date	
Activities (since last session)				
Condition (stage, weed, diseases, pests, etc.)				

Training (this session)	
Subjects covered	
Discussion (and decisions taken)	

Other Issues	
(e.g. attendance, motivation, conflicts)	

Administration			
AEW Name		Next session	
DES comments			

Annex 5: Crop specific agronomic information

a). Sesame

Variety selection

Many varieties of sesame are available. The new improved varieties are Sesim 2 and Sesim 3. The new varieties are non-shattering and resistant to the gall midge. Average maturity is attained 120 days after planting. Most cultivars take between 90 and 130 days.

Variety	Maturity period(days)	Yield (Kg/acre)	Attributes
Sesim I	110	200 – 320	42% oil content, green stem, white seed. Non shattering. Resistant to the gall midge.
Sesim II	120	240 - 360	42% oil content, purple stem, white seed. Non shattering. Resistant to the gall midge.
Sesim III	90 – 100	240 - 360	over 41% oil content, green stem, white seed. Non shattering. Hairy, resistant to the gall midge.

Improved seeds are fundamental for high production, why? Sesame is normally self-pollinated, although cross pollination by insects is common. With this happening, farmers need to replace their seeds after a few years with new seed.

Growth environment

Sesame does best in drier climates. In humid conditions the crop gets foliage diseases.

Land Preparation

Sesame is often sown as an opening crop in a rotation, as it requires a fertile soil. In this case grasses must be eradicated as sesame is a poor competitor to weeds. Planting must be done as early in the rains as possible. A fine seedbed is required as the seed is very small. "Starting with a clean field**"** can help minimise the growth of weeds.

Planting

The optimum depth to sow is around 1.5 to 2.5 cm. It is important to sow at an even depth to ensure simultaneous and uniform growth of the crop. Small-holder farmers will often sow by hand. This method requires 3 kg/acre of seeds. Mixing seed with sand or dry soil will help to make seed distribution more uniform. When grown in pure stand, the seed is broadcast or drilled in rows at spacing of 30 x10 cm. The crop should be thinned when 10 – 15cm high after the first weeding.

Sesame can be intercropped with maize, sorghum, groundnuts, finger millet, beans, pigeon peas, and sunflower, among others. Space maize at 90 cm between rows and plant one row of sesame in the middle. As for millet, 2:1 sesame: finger millet rows mixture is the best, but farmers who prefer millet will use the 1:2 mixture with less reduction in finger millet yield. Both are grown at 30 cm x 10 cm spacing.

Weeding

Weeding is a must and must be done as soon as weeds emerge. Weeding is done once or twice depending on the field conditions.

Soil fertility management

Most soil in Uganda is depleted of essential soil nutrients. Good management of crop residue like returning the stalks of the sesame to the field after drying can help maintain and improve the soil fertility. Some of the practices are:

- Improvement of nutrient-retaining ability of soil by adding organic manures to the soil.
- Improvement of soil drainage
- Control of soil erosion
- Crop rotation by growing crops which have different growth habits and nutrient requirements. Rotate sesame with crops like cotton, maize, sorghum, groundnuts or soybeans.
- Minimum tillage practices
- Timely weed control.
- Use of both organic and inorganic fertilizers.

Pest and disease control

The gall midge and webworm are major pests. They are controlled by spraying with insecticide e.g. FENKILL or Bulldock. Spray at flowering, bud and capsule formation at 2 weeks interval.

Control fungal diseases using Dithane M45, mix 45-60 gm in 20 litres of water. It is important when there is excessive rainfall and especially at capsule stage

Powdery mildew (*Sphaerotheca fuliginea)*

The disease can infect all aerial parts: leaves, flowers and pods. Characteristic of the disease is white greyish powdery fungal growth on affected plant parts. With time the powdery growth covers the entire lower leaf area. Severe infection causes heavy leaf drop. The fungus survives on perennial pigeon peas and volunteer plants, and on the ratoon growth of the harvested plants

Cercospora and Cylindrosporium leafspots

These are major fungal diseases of sesame which attack leaves. Severe for early planted crops. Control by spraying using Dithane is effective.

Post-harvest handling

Sesame matures between 3-4 months. Harvest when crop has started to shed leaves but before pod shattering. If harvesting is delayed, most of the yield will be lost. The plants are cut at height of 10-15 cm from the ground, or uprooted before the capsules are fully ripened and tied in bundles, which are tied of racks to dry. The capsules are then beaten with sticks to separate the seed. Dry the grain or seed on stabilised floors, tarpaulins or mats.

b). Soybean (Glycine max)

Variety selection

Soybeans has a number of varieties, so when selecting a particular variety, farmers need to consider characteristics such as growth habit, shattering resistance, pod height and resistance to pests and diseases.

Varieties of soybean

Variety	Maturity period (days)	Yield (Kg/acre)	Attributes
Namsoy 4M	100	800-1200	Has large seeds with black hilum, resistant to soybean rust; tolerant to pod shattering. May shatter if harvesting is delayed. Protein content is 43% and oil content 20 %
Maksoy 1N	90	800-1200	Small seeded variety with brownish helium, resistant to rust; very resistant to shattering. Protein is 41% and oil content 17 %
Maksoy 2N	105	800-1200	Excellent seed appearance, Large seeds with white helium, resistant to soybean rust, tolerates pod shattering. Protein content 38%, Oil content 20%
Maksoy 3N	100	1000-1400	Medium large seeds, yellow helium, resistant to pod shattering, resistant to lodging and tolerant to soybean rust. Protein content 36% and Oil content 22%

Growth environment

Soybean requires ample rain during its growing period from germination up to pod filling and development stages. There should be adequate sunshine at physiological maturity and drying period.

Land Preparation

A fine seed bed and fertile loam soils are required to ensure good crop growth and development. Soils should be deep and well drained

Planting

Planting should be done early and when there is sufficient moisture in the soil to ensure good germination. Plant seeds with high germination rate of over 85 %. In fields where inoculated soybean has never been grown, seed should be inoculated with *Rhizobium japonicum.* To inoculate 20 - 25 Kg of soybeans, mix with one sacket (200g) of rhizobia before planting. Plant treated seeds immediately so that the bacteria does not die.

Spacing is 60 x 5cm for 1 seed/ hole or 60 x 10 cm for 2 seeds/ per hole. Recommended plant population is 120,000 plants per acre and depending on the seed size, seed rate is 25- 30 Kg/ acre. Gap filling may be done 7 days after emergence.

Soybeans intercropped with other crops such as maize, cassava, sweet potatoes, cotton or bananas, among others. The spacing is 90 X 30cm for 1 maize seed per hole or 90 X 60cm for 2 maize seeds per hole then 1 line of soybeans in between. Farmers can have 1, 2, 3 or more rows of soybeans between maize rows but adjust spacing accordingly.

Weeding

Keep the fields free of weeds at all times. Weeding is done in 3rd and 6th weeks after planting. Third weeding is only done where necessary.

Soil fertility management

Soybean being a legume and if properly inoculated, can use the nitrogen in the atmosphere (N_2) for plant growth by entering into symbiotic associations with *Rhizobium japonicum.* This also enriches the soil with nitrogen for subsequent crops. Soil fertility can be improved by:

- Improvement of nutrient-retaining ability of soil by adding organic manures to the soil.
- Improvement of soil drainage
- Control of soil erosion
- Crop rotation by growing crops which have different growth habits, nutrient requirements.
- Minimum tillage practices
- Timely weed control.
- Resting / fallow periods where feasible

Pests, diseases and control

Although soybean diseases have increased in Uganda, the available varieties are resistant to most of them.

1. Soybean rust; this is the most destructive disease so far and requires immediate attention. Resistant varieties such as Namsoy 4M and Maksoy 1N are the cheapest control against this disease

However fungicides such as Dithane M45, Saprol and Felicur can be used to control soybean rust if susceptible varieties have been planted.

2. Soybean Mosaic Virus and Bacterial pustule; to control use clean disease free seeds, resistant varieties and crop rotation.

Pests and control:

Stink bugs - Use recommended insecticide e.g. thionex or rogor to spray when the situation warrants after careful scouting to assess the level of injury. For leaf eaters and rollers, spray with insecticide or use also resistant varieties.

Rats - To control use traps and when necessary rodenticides.

Birds – They are a menace at emergence of the crop (during 1st 2 weeks after onset of germination). The birds include guinea fowls, doves, chicken and other domestic birds. Scaring is the best solution

Harvesting

The crop is ready for harvesting when pods dry and give rattling sound when shaken. If harvesting is delayed for so long, the pods may start shattering. Prolonged delay to harvesting can also lead to poor seed germination later, after planting.

The mature plants may be uprooted or cut at ground level and loosely shaken for later threshing. Never heap harvested soybeans when they are damp; it reduces seed quality. Harvest in dry conditions.

Threshing

Harvested plants should be kept dry. They may be spread on a platform and sun dried. Hand threshing is suitable for small quantities. Threshing should be done as soon as possible.

Storage

Dry the seeds thoroughly to about 10% moisture content it should not be possible to dent the beans with your teeth store grains in sacks/ bags.

It is preferred you store seeds for planting in polythene bags to prevent moisture absorption. Until planting time, keep the seed in a cool dry part of the house on raised benches. At every planting time, use seed harvested in the preceeding season to avoid poor germination.

c). Beans

Variety selection

There are many improved varieties available in the market. Examples of Bush beans: K20 (Nambale), K131 (Kabalira), K132 (Kawomera), NABE 1, NABE 2, NABE 3, NABE 4, NABE 5 and NABE 6. Early maturing beans like K20, K131 and NABE 4 can be harvested in 10-11 weeks after planting, with green pods harvested at 6- 8 weeks.

Variety	Maturity period (days)	Yield Kg/ acre	Attributes
K131	90	600-1200	Bush type. Small, brown, mottled
K132	80	600-1200	Large, red, mottled seed
NABE 1	80-85	600-1200	Bush type. Small, red seed
NABE 2	90	600-1200	Bush type. Small, black seed
NABE 3	88	600-1200	Bush type, disease resistant, high yielding
NABE 4	82	600-1200	Bush type. Medium size, red, mottled seed
NABE 5	85	600-1200	Bush type. Medium size, cream, mottled seed, lodges
NABE 6	90	600-1200	Bush type. Small, white seed
NABE 15	58-70	700-800	Medium seeded pink with red striped variety. Early maturing. Resistant to foliar diseases.
NABE 16	62-75	700-800	Cream with red mottles, resistant to foliar diseases (Common bean blight, Rust, Halo blight, Anthracnose). Early maturing

Growth Environment

Beans can be grown on almost all soil types so long as the required nutrients are in correct proportions. The soil should be free draining. The pH should be above 5.0 although some varieties tolerate acidic soil (K131) but not below pH 4.0. Rainfall above 1000mm per annum is satisfactory for bean growth. Very wet conditions during planting and harvesting should be avoided as they encourage spread of diseases.

Beans are not suitable for areas where temperatures exceed 35°c. They perform best with high sunshine; under humid conditions, beans are prone to fungal and bacterial diseases.

Land Preparation

Prepare a fine seedbed to ensure uniform and proper growth right from germination. This also reduces the number of times to weed.

- Land for beans should be cleared by late December/ early January: bush must be removed
- First ploughing should be deep
- Do a second ploughing three weeks after the first one to kill weeds
- Dig or harrow two weeks after ploughing to soften the soil remove any remaining weeds and to make a flat seed bed.

Planting

Farmers should plant beans at the beginning of the rains when soil moisture is enough. Beans can be produced in both first and second seasons although this varies from one place to another.

- Spacing: 50 cm x 10 cm. This makes it easier to weed and carry out other operations.
- For certified seeds plant one seed per hole while for locally acquired plant 2-3 seeds per hole
- Seed rate is 20 kg/acre for small seeded varieties and 35 kg/acre for large seeded varieties. Plant seeds with over 80% germination rate.
- Planting depth should be 2-3 cm and not deeper than 5 cm.
- Gap filling done in case of poor germination 7 days after emergence.

Intercropping beans with other crops such as maize, cassava, sorghum, bananas, cotton is common. Various plant patterns can be used but row planting is recommended.

- Beans and maize intercrop: Maize planted at 90 cm between rows and one or two lines of beans are planted in between.
- Beans and cassava: cassava spaced at 1.5m X 1.5m and 2 rows of beans in between.
- The beans need to be planted at the same time as maize, sorghum and cassava.
- Note that intercropping makes the management of the crop more difficult and harvest of beans is less.

Soil Fertility management

Locally available organic material like cow dung, compost, green manure and mulching are sufficient. Apply 5-10 tons/ha or 2-4 tons/acre of organic material or 1 kg of compost per 8 holes depending on the fertility status of the soil. No training will be given on inorganic fertilisers.

Weeding

It is important that beans be weeded at the earliest possible time because beans are weak competitors compared to weeds. Weeding at 3 weeks after planting and later at 6 weeks should control the entire weed. If herbicides are used at the beginning then weeding once should suffice.

Pests and diseases control

Because beans are attacked by a wide range of pests and diseases, the most effective control measures farmers should use are integrated management approaches which combine different measures such as resistant or tolerant varieties plus cultural practices and chemicals. AEO should discuss available options to use with farmers.

- **Aphids and Flower Thrips:** Use Dimethoate (Rogor) or Sumithion against aphids and flower thrips.
- **Pod Eating Caterpillars:** Use Ambush or Bulldock against pod eating caterpillars.
- **Leaf Eaters:** Unless they are removing more than 1/3 of the total leaves. If this is the case, use same chemicals as pod eating caterpillars
- **Bean Stem Maggots:** treat your seed before planting with systemic insecticides such as Endosulfan, Acephate; early planting, earthing up and mulching after the first weeding; application of manure or fertilizer at planting.
- ***Fungal diseases***: Anthracnose, angular leaf spot, bean root rot, seedling and collar rots, rust, ascochyta blight, web blight, floury leaf spot, powdery mildew and white mould. To control use clean seed, observe crop hygiene or spray with protectant or systemic fungicides like benlate and Dithane M45 and use resistant varieties.
- ***Bacterial Diseases:*** Common bacterial blight and halo blight. Control measures include**:** Use of clean seeds and resistant varieties, uprooting of infected plants (rogue), crop rotation 3-years and elimination of weed reservoirs.
- ***Viral diseases:*** Bean Common Mosaic Virus (BCMV) and black rot. Control measures include**:** Plant resistant varieties like K131 and use of virus free seeds. Spray the aphids, which transmit the disease with Ambush and Sumithion.
- ***Nematodes:*** Root knot nematode. This is controlled through**;** Crop rotation, fallows, and burial of debris to reduce nematode populations. Some common weeds (e.g. Tagetes minuta) are antagonistic to nematodes. Nematicides are effective but usually impracticable.

Post-harvest Handling

At physiological maturity bean seeds have moisture content of 35 -55% and the pods have just turned yellowish. Majority of the pods usually does not reach this stage at the

same time. When the maturity is not uniform, do selective harvesting. Harvest timely for a better quality product. Harvest is preferably done in the morning to avoid shattering by uprooting the entire plant. Don't leave beans to dry in the field after harvesting.

After harvesting, dry beans in pods for about 3 - 4 days before threshing on raised ground or tarpaulins till they become fairly hard. Thereafter thresh the beans to expose the seeds on a tarpaulin or threshing rack. This can be done by beating using sticks. This is followed by winnowing to remove chaff, dust and other rubbish.

Dry the threshed and cleaned again on clean surface such as tarpaulins, mats, plastic sheets etc. for 1 - 3 days to reach 13 – 15% MC. If not properly dried they may rot.

Beans are best stored as grains/seeds in PICS bags, gunny bags, silos etc. The bags/containers should be put on a raised flat surface or platform. Don't store old and new stock of beans together. Observe cleanness in the store and control storage pests.

In storage, beans may be attacked by bruchids also known as weevils. To reduce losses, practice timely harvesting, sort out damage grains before storage, proper drying, use of botanical e.g. ground tobacco leaf powder, neem powder.

d). Cassava

Variety selection

There are very many local and improved varieties of cassava in Uganda. Many are susceptible to diseases. Currently recommended varieties due to cassava brown streak disease (CBSD) are NAROCAS 1, NAROCAS 2, NASE 19. These are all sweet varieties, low cyanide content and are resistant to cassava mosaic virus disease and CBSD.

Variety	**Maturity period (months)**	**Yield T/acre**	**Attributes**
NAROCAS 1	12	25	Large roots with brown outer skin colour, resistant to CMD and brown streak disease, sweet with low cyanide content
NAROCAS 2	12	20	Roots are moderate and brown in colour, resistant to CMD and brown disease, sweet with low cyanide content. Requires fertile soil.

NASE 19	12	25	Roots are moderate, resistant to CMD and brown streak disease, sweet with low cyanide content

Growth environments

Cassava grows on poor soils, but for good growth and yield it requires friable, light textured and well drained soils containing sufficient moisture and a balanced amount of nutrients. Stress of Phosphorous in soil increases cyanogenic content in tubers.

Land Preparation.

A rough seed bed will do. Cassava responds positively to deep tillage especially in drought prone areas. Flat seedbed is a common practice Uganda. First and second ploughing will give a good seedbed.

Planting

Healthy, fresh stem cuttings (or stakes) from mature plants are best for planting. Over mature and tender stems give poor germination. If planting is delayed stems should be stored in dry, well ventilated, shaded areas away from direct sunlight. For example stems can be arranged vertically under a tree with the oldest part of the stem buried in the soil.

Planting is recommended at a spacing of 1m x 1m for optimum plant population of 4,000 plants per acre. Stake length of 25 - 30cm is recommended. Use pest and disease free cuttings which should not be bruised or which have not started sprouting, Horizontal planting of stems is a common practice and deeper planting is recommended for dry, sandy soils and shallow planting for moist and heavy soils. Plant at the onset of each rainy season for proper establishment and tuberization.

Cassava can be grown together with other crops. For example in cassava and bean intercrop, good performance is realised when cassava is spaced at 1m x 1m and beans 50cm x 20cm, both crops planted at the same time. In Cassava and maize intercrop, it is important to introduce maize 2 months after planting cassava.

Weed Control

Weeding is necessary every 3-4 weeks until 3 months after planting. Afterwards the canopy may cover the soil and weeding is less frequent. The number of times a farmer has to weed will depend on the type of weeds present and the varieties of cassava grown. Early branching varieties develop canopies which reduce weed growth. Mulching cassava, especially after planting, is helpful when growing cassava in dry areas or on slopes.

Pests and Diseases Control

Major diseases	**Casual-agent**	**Control**
Cassava mosaic	Viral	Resistant variety, rogue infected plants, plant clean materials
Cassava Brown Streak Disease (CBSD)	Viral	Use clean planting materials, resistant variety, destruction of infected plant debris and strict by-laws to reduce spread
Minor disease		
Bacterial wilt	Bacterial	Resistant variety
Major pests		
Cassava green mite		Early planting, use of resistant varieties.
Cassava mealy bug		Introduce biological enemy such as E.Lopez for biological control; plant Nase 1 which is resistant.

Harvest and Post-Harvest

Harvesting can be piece meal or entire plant harvested. Avoid damaging the root tubers during and after harvest. Keep fresh tuber roots under shade or in soil if their use is extended to a period exceeding one day. Process bitter cassava varieties using manual /power graters, chippers/slicers, or a hydraulic press

Dry chips / slices in a clean dryer such as clean surface free of soil, tarpaulins, drying racks, or biomass dryers. The shelf-life of cassava is prolonged by processing it into bakery and confectionery products using a range of processing equipment available on the market. Storage technologies include cement brick silo, mud-straw and basket woven granaries and drum hermetic storage. Store in cool, dry and hygienic place.

e). Rice

Variety Selection

There are two types of rice grown in Uganda: Upland rice which can complete its production cycle while depending on rainfall. It is less adapted to high water levels. Then the other is lowland rice (paddy) commonly grown is swampy or water logged areas. Farmers need to make clear selection of the type to grow. A number of varieties

for each type have been released in the country. The varieties and subsequent discussion will majorly focus on upland rice. NURI program will focus on NERICA 4 (also known as NARICE 3 or SUPERICA 2 or Bukenya) and others deemed fit.

Varieties	Maturity period (days)	Date of sowing	Yield / acre
NARIC 1	115	Late Feb – mid March Late Jul – mid Aug	1,400 – 1,600 Kg
NARIC 2	120	,,	1,200 – 1,400 kg
NERICA 1	110-115	,,	1,200 – 1,600 Kg
NERICA 4 (SUPARICA 2)	120	,,	1,600 – 2,000 Kg
NERICA 10	110	,,	1,200 – 1,600 Kg
SUPARICA 1	120	,,	1,400 – 1,800 kg

Growth environment

Rice grows well in warm climate. Temperature requirement is 25 - 30^{o}c but not in highlands. Upland rice varieties require a rainy season of at least 100 days. Rain is most important in the flowering and podding stages. It requires heavy soils with good water holding capacity and pH of range 5.0 - 6.6. The soil needs to have a lot of clay or organic matter. It has an average maturity period of 120 days.

How to prepare the land

If possible, select a plot that has been used to plant legumes. If the field is new, cut down trees before the rainy season then clear the stumps and roots. To prepare a fine seed bed deep ploughing (10-25 cm) twice and harrow to level the field to ensure uniform water depth throughout the season which contributes to uniform ripening across the field. A well prepared seed bed will avoid serious weed problems. A poorly prepared field will make the crop to emerge differentially hence harvesting differently. For fields that are prone to erosion, farmers should divide the land into plots of 50x50 m or 50x100 m and construct bunds, depending on the slope, to accumulate rain water and also to allow good drainage.

Seed preparation

After deciding on the rice variety to use, select viable seeds that will grow vigorously. Key aspects that a farmer needs to do in seed preparation include:

- **Breaking seed dormancy.** Dry the seeds in the sun for 1 or 2 days before planting. NERICA 4 and other upland rice varieties have short dormancy period 4-7 days
- **Seed cleaning.** Seeds should be cleaned by winnowing to remove the chaff. The remaining poorly filled grains should be removed by use of water (soak the seeds in water and skim-off the floating seeds).

- **Germination test.** Plant seeds with over 80 % germination rate.
- **Pre-germinating seed**. Some farmers can pre germinate seeds before planting to increase the rate and percentage of seedlings established. Submerge a bag of seeds in water for 24 hours, then keep under shade for another 24 hours before planting. Do not risk sowing pre-germinated seeds in a dry seedbed as the scorching sun may kill emerging small shoots.

Planting rice

There are 3 methods of planting rice namely: drill, dibble and broadcast. The seed rate is 20 – 25 Kg per acre. Drilling and dibbling allow for straight row planting using planting ropes or line markers.

- **Drill Seeding:** Furrows are opened by hand hoes, wooden or metallic line markers. The seeds are then dropped manually and thinly in a line at approximately 50 – 60 seeds per 1 M and distance between furrows (rows) is 30 cm. A smooth, levelled seedbed is necessary to ensure that seeds are not planted at depths greater than 3 to 5 cm. A good plant stand should have 35 to 40 plants established per meter of drill row after emergence.
- **Dibbling:** In dibbling method, 4 - 6 seeds are planted per hole at 30 cm x 15 cm. The recommended seeding is 3-4 seedlings per hill, excess are thinned.
- **Broadcast**: common method where farmers scatter seeds by hand on a prepared field and covered manually or other means. The crop tends to lodge more because the seed germinate at the surface.

It is recommended that rice be planted at a depth of 2 - 4 cm, as deeper planting is discouraged. Planting depth affects both crop establishment and lodging potential. During planting it is advisable to divide field and seeds into 4 equal parts for optimal seeding.

Intercropping, gap filling and thinning

- Rice can be intercropped with maize, bananas, coffee etc.
- Gap fill missing stands by sowing at one week after planting if plant establishment is less than 80%. Alternatively set up a small nursery bed besides mother garden to raise seedlings for gap filling and transplant at 15-20 days after sowing. Do not fill the gaps late.
- Thinning done at 2 weeks after sowing to reduce plant competition for light, nutrients and water.
- Quality seeds and right seed rate will minimize the need for gap filling and thinning.

Weed control

First weeding should be done as soon as the rice rows are visible. Second weed done before flowering and 3rd weeding is optional. Avoid weeding when rice has flowered, as it causes flower abortion leading to low yield.

Soil fertility and water management practices

The farmers can maintain and/or improve soil fertility by; improving nutrient-retaining ability of soil by adding organic manures to the soil, control of soil erosion, crop rotation, timely weed control, use of both organic and inorganic fertilizers, resting / fallowing of the land where feasible.

The water management practices should start before planting by levelling the field, constructing bunds / channels etc.

Post-harvest handling

NERICA crops are ready for harvest 28 - 30 days from full flowering. Harvest when most leaves have turned yellow and the grain is gold in colour. Cut the stem 10 - 15 cm above the ground. Harvest quickly so the plants do not fall over.

Thresh the rice immediately after harvest. Do not heap the harvested rice. It generates heat, which molds the rice and reduces its taste and market value. Thresh by gently beating the panicles/ears to release the grain. Alternately you can use a thresher. The threshing is done on a tarpaulin, concrete floor or hard rock. Do not thresh on bare ground to avoid mixing rice with stones.

After threshing use tarpaulins, mats or concrete floors to dry the rice. Do not make a thick layer. The rice layer should be a maximum of 5 cm deep. Turn over the rice grain every 30 - 60 minutes so all the grains are exposed to the sun. It should be dried for 1 - 2 days. Test for dryness by biting into it. If the grain is easily broken, it is ready. If it is not, dry the grain for some more days. Do not over dry the grain or dry rapidly. Do not cover rice with polythene sheets while drying. This will lead to broken rice when milling.

Winnow to separate the chaff and empty grains from the mature grains and store or take for milling.

Pests and diseases of rice and their control

- **Vertebrate pests:** This includes birds, rodents, livestock etc. The most damaging are the birds at dough stage. Control is by scaring away pests, use of scarecrows, planting resistant varieties with awns for case of birds, trapping for rodents.
- **Stalked-eyed flies:** The larvae bore and feed on plant tissue inside the rice stem causing dead heart. The most serious pests of rice and infest plants from seedling stage to maturity. Resistant varieties do exist, but it is not known which varieties are resistant in Uganda. Chemical control is by use cypermethrin.

- **Stem borers:** The larvae bore through the stem and eat up the plant tissue resulting in a condition called dead heart and / or white head. Control measures include early planting, crop rotation with none cereals, deep ploughing of stubble, seed dressing with fipnoril. Stem borers are difficult to control with insecticides
- **Termites:** Termites are a problem in upland rice and attacks are severe on light textured soils with low moisture content. Control is through destruction of nests.
- **Rice Blast:** Rice blast is one of the most destructive diseases of rice. It has a potential to cause up to 50 – 100 % yield loss when conditions are favourable. Blast can infect rice from seedling stage through to maturity producing spots or lesions on leaves, leaf collar, stems, nodes, panicles and grains. Control is by planting resistant varieties such as NERICA 1, 4 and 10 and avoiding excess nitrogen application.
- **Rice Yellow Mottle Virus:** Most damaging disease of rice and now a severe problem in eastern and northern Uganda. The symptoms are stunting of rice plants if infected at early stage, reduced tiller number, and yellowing and mottling of leaves. Control is by planting resistant varieties - NERICA 4, 6, NARIC 1, 2 and rogueing (removing) infected rice plants.
- **Sheath Blight:** Sheath blight causes spots on the leaf sheath. High temperature and humidity increase the severity. Damage under severe attack results in many of the leaves killed and yields may be reduced by 20-25%. No control recommended.

f). Sunflower

Sunflower is a very important crop for vegetable oil production in Uganda. It has become a cash crop especially with the introduction of hybrids and their popularisation.

Variety selection

Sunflower has many varieties, both local and improved. Plant hybrid seeds because of their many advantages. Currently, improved varieties promoted by different seed dealers like Mukwano and Mt. Meru are PAN 7057, 7033, 7158HO and NK Ferti.

Variety	**Maturity period (days)**	**Yield (Kg/acre)**	**Attributes**
New sunfola	100-110	240 - 320	OPV with oil content of 35%. Seeds have soft black seed coat. Susceptible to major diseases
PAN 7057	100 – 110	320 - 600	Hybrid, stripped, and high oil content
PAN 7033	100 – 110	320 - 600	Hybrid, black, and high oil content
AGSUN 8251	110 – 120	320 - 600	Hybrid, black and high oil content
DK4040	110 – 120	320 - 600	Hybrid, black and high oil content
Sesun 1H	89 – 100	600 - 700	Plant height 106-148cm, oil content 43%, seed coat black and a goose neck
Sesun 2H	89 – 100	Upto 640	Plant height 107-146cm, oil content 36% and a goose neck.

In order to ensure a good quality harvest, it is better to avoid planting local seeds and also be aware of fake seeds on the market. It is better to consult your extension worker for guidance.

Growing sunflower

Sunflower can grow in a variety of soil types but the soil should be well drained and relatively fertile. It grows well with 400 - 600 mm of well distributed rainfall. The maturity should coincide with the dry weather which is required for harvesting it as well as to reduce incidence of stem and head rot disease.

Plough twice to make a fairly smooth seed bed. However, do not over work the soil to avoid water run-off which can also lead to reduced water, air and nutrient uptake. Herbicides can also be used to clear weeds before planting. A good seed bed helps minimize weed problems.

Plant seeds with over 80% germination. Plant when there is enough moisture in the soil, for the seeds to germinate. Don't dry plant sunflower as the seeds loose viability very fast.

Plant the seeds in rows: 75 cm x 25 cm for 1 seed/hole or 75 cm x 50 cm for 2 seeds/hole and at a depth less than 5 cm. Plant 2 kg of seed per acre but for small seeded varieties e.g. NK Ferti it is 1.6 kg per acre. Plant sunflower early in the season i.e. March - April or July - August. Sunflower can be intercropped with other crops such as sesame, maize, soybeans, groundnuts and cowpeas, among others. Adopt a specific pattern for intercropping.

- For soybeans and sunflower intercrop, soybean is planted between sunflower rows with a constant arrangement of 2 rows of sunflower followed by 4 rows of soybean with rows spaced at 60cm apart.
- For maize, the best results are attained with 3 rows of maize followed by 1 row of sunflower and spacing of 75cm between rows and 30 cm between plants for maize, 30 cm for sunflower

Keep the field free of weeds at all times. The first weeding is done during the 2nd - 3rd week after planting. The second weeding is optional. Gap filling and thinning are discouraged. If poor germination takes place, do it when plants are 10 - 15 cm tall. As for thinning, do it when plants are 10 - 15 cm high, leaving one or two plants per hill, depending on spacing used.

Soil fertility management

When planting with fertilizers avoid direct contact with the seed. Fertiliser recommendations vary as per the soil nutrients. Apply Phosphorus (basal fertilizer) - NPK or DAP at the time of planting (25 kgs/ acre). Apply Nitrogen (Urea) as top-

dressing fertiliser in 2 equal splits, the first 25 kg at 4 weeks after emergence then the second 25 kg at 6 weeks after emergence. Do not plant sunflower in the same field before 2 years elapse to maintain soil fertility.

To help maintain soil fertility farmers should practice crop rotation.

Pests and diseases and their control

Sunflower has relatively few pests and diseases. Use crop rotation to avoid build-up of pests and diseases. Some of them are as below:

Vertebrates and control: These include birds, rodents etc. Control by physical bird scaring and use of scarecrows, farmers planting at the same time to spread damage, keep the surrounding of the field clear, do not plant in fields near breeding areas of birds, planting in second season, restraining animals, use of traps.

Cutworm: controlled by early planting, removal of crop debris, chemical spraying e.g. dimethoate, cypermethrin etc.

Aphids: controlled by early planting, field sanitation, chemical spraying e.g. Dimethoate, Cypermethrin etc.

Bacterial leaf spot: Controlled by crop rotation, field sanitation, and planting resistant varieties.

Leaf rust: Controlled by crop rotation of 4 years, early planting, planting resistant varieties, and spraying using fungicides

Sunflower mosaic virus: Controlled by crop rotation, early planting, field sanitation/roguing affected plants, and planting resistant varieties.

Verticillium wilt: Controlled by crop rotation, field sanitation and planting resistant varieties.

Phoma black stem: controlled by deep ploughing to burry plant residue, crop rotation and control of insects such as sunflower stem weevils can help minimise the spread of the disease.

Post-harvest handling of sunflower

Sunflower attains physiological maturity in 90 days but harvesting is done after 100 - 110 days to allow field drying. Harvest when the stem and the back of the head have turned yellow or brown. Thresh immediately and dry grains to a moisture content of 8 - 10% on tarpaulins, mats etc. During the harvest period leave the stalks and trash in the field to restore soil fertility or nutrient recycling.

Store clean and dry grain in bags and the bags stack on pallets and away from the walls. The storage should not allow re-wetting of the grain and should be easy to inspect. It is necessary to protect stored grain from rats.

g). Irish Potato production

Variety selection

There are many varieties however Victoria and Rutuku are the most common commercial varieties. Victoria is high yielding, early maturing, tolerant to bacteria wilt (BW), but susceptible to late blight (LB). Rutuku is highly sought after by traders, for its chip making quality.

Variety	Maturity period(days)	Yield (Kg/acre)	Attributes
Victoria	90 -110	3000 - 4000	Tubers are large with red skin colour and light yellow flesh. It is moderately resistant to Late Blight and tolerant to Bacterial wilt. The tuber shape is round and has storability.
Rutuku	110 - 130	3000 - 4000	Tubers are large with light red skin colour and cream flesh. It is tolerant to Late Blight and susceptible to bacterial blight. The tuber shape is oval round and has good storability.

Growth environment

A good site for potato growing should be identified based on climate, soil fertility, site history and topography. Potatoes grow well in cool areas with regular but moderate rainfall. Soils should be well-drained, fertile and slightly acid. Poorly drained and water-logged soils increase the risk of soil-borne disease infection and tuber rotting. The field should not have been used to grow potato or other solanaceous crops like tomatoes, pepper or eggplants for at least three seasons. This helps control soil-borne diseases especially bacterial wilt and pests.

Land Preparation

Seedbed should be well prepared and preferably plough or dig the land twice and early enough to allow decay of the grass.

Planting of Potatoes

The planting must be done as early in the rain season and when there is enough moisture in the soil. Good seed is characterized by having at least two good "sprouts". Quality seed is acquired from a certified source, or established potato seed producers.

Spacing is at 75cm by 30cm for ware potato and 60cm by 30cm for seed potato. Plant in rows/furrows. Dig furrows that are 10-15cm deep, apply fertilizer in the furrow, mix with soil, place seed tubers and cover seed tubers by ridging or hilling up to 30cm high. Ridges preserve moisture in the soil and prevent damage from pests such as the potato tuber moth, and for better rooting establishment

Weed control in Irish potato

Weeding is an important practice for increased yields. Hilling is the drawing of soil on to the base of a plant to encourage the development of stolons where tuberisation takes place. First

weeding and hilling is done about 2 weeks after crop emergence. Second weeding is done 3 weeks after the first weeding. Third weeding if weeds re-appear.

Soil fertility and water management practices

There are a number of practices that promote soil fertility and these include crop rotation, control of soil erosion, compost application. Equally are a number of water concertation practices which include ridging, hilling up, terracing for hilly areas.

Pests and diseases and their control

Potato Tuber Moth: Potato tuber moth affects both the foliage and tubers. It thrives in warmer regions and damage is caused by larvae only. Controlled by; use clean seed, cover potato tuber with soil to avoid the moths laying eggs on them, destroy tuber moth infested tubers, volunteer potato plants and plant debris, Do not plant potatoes in or near fields which were previously infested, spray / dust with insecticide and use of natural repellants e.g. African marigold weed (Targetes minuta), lantana camara , etc.

Cutworms: they cut down seedlings, usually right at or near the soil surface. Attack many other crops. Control is by; turn and till your garden soil at least 2 weeks before planting then collect and destroy any cutworms you find hiding in the soil, remove any plant debris and pull weeds to minimise places for small cutworms to shelter, spray with insecticides. At season's end, turn and till your garden soil again.

Aphids: Aphids are tiny insects that can transmit virus diseases. Warm and dry weather is conducive for aphids, plus the presence of alternative host plants like legumes. Control; Insecticidal sprays, weed early and properly, plant on the right planting date and spacing, and avoid haulm regrowth after dehaluming.

Bacterial Wilt: Bacterial wilt, or brown rot, is the most serious bacterial disease that affects potato crops. Control by; Plant bacterial wilt-free seed, plant in bacterial wilt-free fields, restrict movement of people, especially in seed potato fields, fallow field for at least 3 consecutive seasons without planting potato and other Solanaceae crops, minimum tillage to reduces damage to roots, ridging at planting to reduce damage to roots and tubers, destroy volunteer potato plants and other alternate hosts, and plant disease-tolerant cultivars.

Late Blight: Symptoms can be observed in the leaves, stems and tubers. Control is by; Planting disease-free seed bought from reliable seed growers, use protective and systemic fungicides, conduct proper hilling and earthing up to prevent tuber infection, do not store disease-infected tubers, plant resistant varieties, destroy sources of primary inoculum (volunteer potato, dumps and cull piles), store seeds separately from ware potato and practice a 3 season rest/fallow period and potato crop rotation.

Harvesting and post-harvest handling

Harvesting is done when the plant has reached maturity, depending on the variety. For example, Victoria (90-110 days), Rutuku (110 -130 days). Potatoes should be harvested in dry weather to avoid disease infection and tuber rotting. Harvest the crop 10-15 days after dehaulming. Harvesting should be done with great care to avoid bruising of tubers; otherwise, tubers become susceptible to rot diseases.

After harvesting, sort to remove of damaged and diseased or malformed tubers. The first sorting of damaged tubers is done in the garden. Only good-looking tubers are left, from which seed potato can be selected. Grading is the exercise of separating tubers according to size for different purposes. The sizes include ware, seed and chats.

Harvested tubers should be spread on the floor for 4-5 days to let them cool from field heat, dry the moisture on the skin and to heal any bruises before being transferred to storage shelves/racks. Thereafter, sort the potatoes again to remove any diseased or damaged tubers.

h). Onion Production

Onions are a popular, high-value crop, but onion production is also labour intensive if good results are to be achieved. Onions are a source of income to a number of farmers and can be grown in rainy season or during dry season by using irrigation methods to supply water to plants.

Variety selection
The common Onion varieties grown in Uganda include; Jambar F1, Red passion F1, but Bombay red and Red Creole much as they have a lower yield but are popular and in high demand at the market and they fetch a high price than the Jambar F1.

Variety	Days to maturity	Seed rate/acre	Spacing	Characteristics
Red Creole	165	1.2-1.4kgs/acre	30x10cm	▪ Fairly flat shape ▪ Red skin color ▪ Good storage quality ▪ Medium size bulbs
Bombay Red	160	1.2-1.4kg/acre	30x10cm	▪ Globe shape ▪ Dark red skin color ▪ Very pungent (strong smell) ▪ Does not store for long

Growth requirements
Soil requirements: Bulb onions do best in well drained, sandy loam soils with a pH range between 6.5 to 7.0. Seedlings are fairly tolerant to high rainfall, which towards crop maturity may result in increased incidences of thick necks. Adequate soil moisture is required throughout the growing season for optimum yields. Bulb onions require soils rich in organic matter. Sandy loams are most suitable.

Onions need a dry period prior to harvest, therefore plan to start your nursery bed according to the dry season of your planting area. Count back 4 and ½ months so that you can harvest the during a dry period.

Nursery bed and transplanting

Seedbed should be well prepared and preferably plough or dig the land twice and early enough to allow decay of the grass.

Onions are best planted at the onset of the rains to maximize the growth period. If some form of irrigation is available planting date is more flexible. It may take up about one month for onions to be ready for transplanting.

Onions can be planted from seeds, sets or transplants. An onion set is a small dormant bulb that will produce a larger bulb once it's planted. Onion transplants are where seeds are germinated in a nursery bed before transplanting to the main garden thus the seedlings can best be watered and kept weed-free. Onion can also be sown directly in the field which is less laborious than transplanting, but thinning is required.

- The nursery bed should be raised at least 10cm- 15cm from the surrounding ground. The recommended dimensions are 1 meter wide by any convenient length. Add well-decomposed manure before sowing the seeds.
- Sowing of seed in the bed: Make drills 5cm apart and 2cm deep. Sow the seeds thinly and cover with a thin layer of soil. Apply mulch and water through the mulch.
- Continue watering to keep the soil moist. Seeds should germinate 4-7 days after planting. Once the seedlings are established, water periodically.
- In hot areas, a shade is necessary to protect seedlings. The shade should be 1m above the ground.
- After about one month harden the seedlings in preparation to transplant.

Rows should be 30 cm apart, and onions transplanted 10 cm apart in 1cm deep holes in the soils. If possible mix manure into the soil of the furrow prior to planting. Transplanted onions should be pencil thick at the time of transplanting. Gently cover the new transplants with soil. Water thoroughly after planting, and regularly thereafter when it does not rain.

Weed Control

In the seedbed and in the nursery bed the young onions do not compete well with weeds and the field should be kept weed free. Weeding should be done regularly to remove weeds between and within rows. During weeding, it is also important to earth up by adding soil to the base of plants.

Pests and Diseases and their Control

Diseases and pests vary with weather. Common disease is downy mildew and it is controlled by use of clean propagules, crop rotation and spraying every seven days with a fungicide (mancozeb, dithane M45) when signs of infection intensify. The other is Purple blotch and control is same as for downy mildew

The most serious pest is thrips. IPM approach**;** (spray with Spinosad -an organic pesticide), cypermethrin, neem products, irrigation and other biological agents like predatory mites. Other common pests are onion fly, and onion neck rot disorder.

Soil fertility and water conservation

Mulching: Mulch helps maintain soil moisture content and reduces stress on the plants from large moisture and temperature changes. Use soft grass if possible for mulching and a thick layer laid.
Manure application: Organic fertiliser is very important. It supplies plants with necessary nutrients and improves the water holding capacity of soil, resulting in higher yields. Apply 1 spade full per 1 square meter. Organic fertiliser can be made from crop residues (like maize stover, cassava peelings etc.), green manures, and animal waste (e.g. cow and chicken manure). These fertilisers can be applied individually and directly or can be combined and composted to be incorporated into the soil during seedbed preparation. Plant species such as Mucuna and Canavalia can be processed and applied along with fertilisers or composted manure to increase soil fertility and productivity.

Harvest and Post-Harvest

Onions need around 4 months to mature. The last 3 weeks before harvesting the weather should be rain free. To avoid sprouting in storage onions require 'curing'. Curing involves bending the 'necks' on the plants when they are mature. The plants are then left in the field for 7 to 10 days, during which a chemical process takes place within the plant which prevents sprouting during storage.

When the tops of the onions turn brown or yellow and fall over, they have reached maturity ad it is time to plan for harvest; ideally the plant will have about 13 leaves at this point. Pull the onions early in the morning on a sunny dry day, shake off excess soil.

Cure the onions by putting them in to sun to dry for at least 2 days. Then transfer your onions to a shaded warm, dry, and well-ventilated room to enable them to completely dry and cure. Proper treatment at harvest maximizes the amount of time you will be able to store your onions without rotting and sprouting.

Annex 6. Individual Farm visit form

Name of farmer……

Village ……Parish ……Sub county……

Date of the farm visit ……District……

1. Comment on the agronomic practices used on farm

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2. Challenges faced by the farmer

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……

3. Solutions proposed for the challenges faced by the farmer

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……

……

4. Questions asked by the farmer(s) regarding crop enterprise on the farm

a)……

b)……

c)……

d)……

Annex 7. Format for Profitability Analysis

GROSS MARGIN ANALYSIS PER ACRE					
District:			Group:		
Sub-County:			Crop:		
Parish:			Treatment:		
Item	**Unit**	**Quantity**	**Price**	**Total**	**Sum**
SALE OF PRODUCE	Kg			0	**0**
COST OF INPUT					
Seed	Kg			0	
Pesticides	Kg			0	
Bag	Pcs			0	
Others				0	
Total Input Costs				**0**	**0**
GROSS MARGIN 1					**0**
LABOUR COST					
Land preparation	Manday			0	
Planting	Manday			0	
Weeding	Manday			0	
Scaring birds	Manday			0	
Harvesting	Manday			0	
Drying	Manday			0	
Shelling	Manday			0	
Packing bags	Manday			0	
Others	Manday			0	
Total Labour Costs				**0**	**0**
GROSS MARGIN 2					**0**

Prepared by		
Name:		
Signature:		
Date:		