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CLIMATE SMART AGRICULTURE** A COMPREHENSIVE SCOPING AND ASSESSMENT STUDY WITH PARTICULAR REFERENCE TO UGANDA

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***** The paper is based on the study carried out by the author for FAO (Food and Agriculture Organization) and FANRPAN (Food, Agriculture and Natural Resources Policy Analysis Network) as a consultant.***

1.0 Introduction

Based on the projection on population growth and food consumption pattern in developing countries, there is likely to be a deficit in the food production by the year 2050. Africa's population has just passed 1 billion and it is expected to double by the year 2050 (FAO 2012) According to FAO, Sub Saharan Africa, Uganda inclusive, is the region that has the highest proportion of poor and undernourished people in Africa (FAO,2011a). Agricultural production will, therefore have to increase by at least 70% in order to ensure that the food demands are met.

Meeting the food demands of a growing population is already a formidable task for agricultural sector of many developing nations like Uganda but this will be further exacerbated by climate change. Largely due to climate change, agricultural productivity is likely to decrease.

Similarly, the stability of production and incomes are likely to change. This trend may be even worse in countries which are already experiencing food insecurity (FAO 2012)

The important implication of this is that for Uganda, policy makers will be faced with an even greater challenge to ensure that agriculture contributes more in addressing food security issues, development and climate change (adaptation and mitigation). In other words, agriculture in Uganda must undergo major and significant transformation in order to address the challenges likely to be faced in achieving food security and responding to climate change. Put in another way, in order to stabilize output and income, production systems must become more resilient or more capable of performing well in the face of disruptive events. This requires transformation in the management of natural resources and higher efficiency in the use of these resources and inputs for production.

According to FAO, approaches that seek to maximize the benefits and minimize the trade-offs across the multiple objectives, often associated with agricultural sector, require more integrated and coordinated planning, policies and institutional arrangements as well as financing and investments. Such approaches and related enabling requirements are referred to by FAO as climate smart agriculture. Climate Smart Agriculture (CSA) is thus a way to ensure the achievements of future food security under climate change. CSA encompasses sustainable agriculture and it includes the need for adaptation and the potential for mitigation with associated technical, policy and financing implications.

This scoping study attempts to review and examine the current production practices as it relates to CSA in Uganda. The study also seeks to conduct comprehensive reviews of the existing policies, analyze gaps and identify relevant policy recommendations.

2.0 Methodology

The study was carried out using two approaches. These includes (i) review of available literature both local and international and reports related to climate change. All relevant information from Makerere University Centre for Climate Change Research and Innovation (MUCCCRI), Institute of Environment at Makerere University, Climate Change Unit in the Ministry of Water and Environment and Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) were consulted and where necessary utilized. (ii) Interviews were conducted either face to face or on phone with selected persons consisting of:

(a) Scientists and researchers involved in Climate Change.
(b) Environmentalist
(c) Extension workers and administrators
(d) (d) Farmers.

3.0 Farming Systems and CSA technologies and practices

3.1 Importance of agriculture

Agriculture has been and continues to be the most important sector in Uganda's economy. It employs about 65.6% of the population aged 10 years and older (UBOS, 2010). In 2010/11, the sector accounted for 22.5 percent of total GDP (MAAIF 2011). Agricultural exports accounted for 46 percent of total exports in 2010 (MAAIF 2011). The sector is also the basis for much of the industrial activity in the country since most industries are agro-based. Even though its share in total GDP has been declining, agriculture remains important because it provides the basis for growth in other sectors such as manufacturing and services. It is also the sector that provides equal opportunities for employment for both men and women in Uganda.

In its Development Strategy and Investment Plan (DSIP), 2010/11-2014/15, Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) has emphasized the renewed recognition of the fundamental importance of agriculture in the Uganda's Economy and the central role it plays in development, economic growth and poverty reduction. In line with this recognition, there is also the Maputo Declaration on the Comprehensive Africa Agriculture Development Program (CAADP).

In CAADP, Uganda has committed itself to three things; firstly, to the principle of agriculture-led growth as a main strategy; secondly, to the pursuit of a 6% average annual growth rate for the agricultural sector and thirdly to increase the share of the national budget allocated to agricultural sector to reach the eventual target of 10%. (MAAIF/DSIP 2011-2015). Therefore, at least for the foreseeable future, agriculture will continue to be one of the most important sectors in Uganda's economy.

3.2 Current Production Practice

Plate 1: Typical Farming activity in Uganda showing Inter-row cultivation using Ox-plough

The majority of people in Uganda depend on Agriculture for their sustenance and livelihoods. The major farming systems are largely determined by the rainfall pattern (total amount and distribution per year). Farming systems cover a wide range of activities including the production of traditional cash crops (Coffee, Sugar cane, cotton and tea) and food crops (banana, cassava, maize, sorghum, finger-millet, potatoes and beans) and keeping livestock (cattle, goats, pigs and poultry). Typically, farm operations are by conventional tillage which involves land clearing, 1st and 2nd ploughing and finally disc ploughing using a wide range of implements, though the majority of farmers often use ox plough or the hand hoe (Plate 1 above).

However, over the years farmers have badly managed their land largely through the use of conventional tillage leading to severe degradation of their farm land. Consequently, average yields are low. The national situation indicates that land and land resources degradation accounts for over 80% of the annual cost of environmental degradation (Slade and Weitza, 1991). Wide spread forest clearing, continuous cultivation, crop residue burning and overgrazing have exposed land to agents of degradation thus raising serious concern about conventional tillage (Plate 2 below).

Plate 2: Typical example of burning of crop residues during land preparations. 2a: Burning crop residues after crop harvest and before ploughing. The whole field is set on fire during land clearing. 2b: Burning crop residues after crop harvest. The residues are collected together and set on fire. Both practices are destructive often leaves the land bare and prone to soil erosion.

The main disadvantages of conventional tillage is that it destroys soil structure and creates compact layers below the surface of the soil often called plough pans leading to reduced development of plant roots system.

Plate 2a

Plate 2b

Land degradation is also evident in the dry lands of the cattle corridor of Uganda where land management is threatened by overgrazing by local and mobile pastoralist herds, deforestation by excessive use of fuel wood resources and poor and inappropriate agricultural practice on marginal land. CSA offers farmers a wide range of benefits including increased productivity, better management of resource base and reduction of Green House Gas (GHG).

A large component of CSA in Uganda involves Conservation Agriculture (CA) which includes minimum tillage, permanent soil cover, and crop rotation and agroforestry practices. The aim is to manage agro-ecosystems for improved and sustainable productivity, increased profits and food security while preserving and enhancing the resource base and environments including adaptation to climate change.

Based on this, the general principles of CSA are fairly well known to most agricultural scientists and institutions in Uganda though the larger proportion of the farming community is largely ignorant of CSA related principles. Thus actual practice has been minimal in most parts of the country. Surprisingly even the major Government Agencies like the National Agricultural and Advisory Services (NAADS) and Non-Governmental Organizations (NGOs) have rarely emphasized CSA in the major farming systems.

4.0 Conventional tillage

Definition of Tillage. – The act of disturbing the soil with implements powered manually, by animals or tractors. Other names of tillage include ploughing, cultivation and digging (largely using the hand hoe).

Tillage forms an important part of Agricultural production. In Uganda, a typical conventional tillage comprises land clearing, 1st and 2nd ploughing and finally disc harrowing (process of breaking big lamps of soil into fine tilth). Plant residues are usually burnt before ploughing.

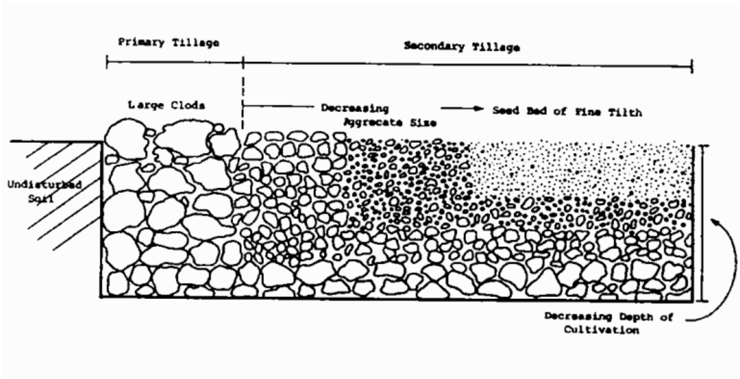

Plate 3: Standard practice in conventional tillage. Secondary tillage leads to breakdown of soil aggregates and clogging of soil pores.

However, although conventional tillage has been practiced for ages, it has numerous disadvantages. The practice leads to breakdown of soil aggregates and clogging of soil pores (Plate 3).

In Uganda, over cultivation and burning of crop residues leaves the soil bare and prone to soil erosion (Plates 2 and 4).

Conventional Tillage also breaks down soil aggregates, leading to clogging of soil pores and reduced infiltration of water (Plate 3). The ultimate effect is increased surface run-off, and loss of soils and nutrients through soil erosion. The extent of soil loss can be visualized from Fig. 1 which compares the relative loss of soil from bare surface and other management practice.

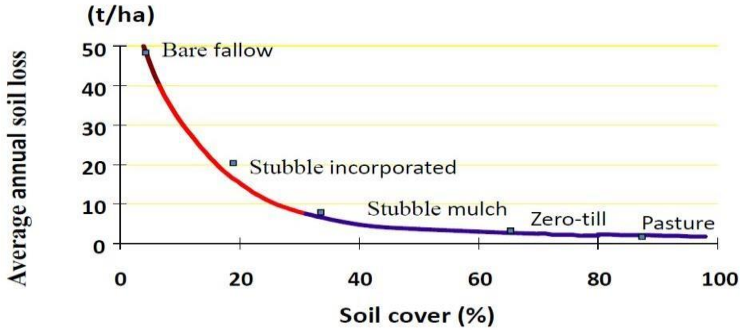

Figure 1: The influence of wheat stubble (mulch) on soil loss.

5. 0 Climate Smart Agriculture

5a. Definition: Climate Smart Agriculture (CSA) is an agricultural system that sustainably increases productivity, resilience (adaption), reduces/removes greenhouse gases (mitigation) and enhances achievement of national food security and development goals. It promotes agricultural best practices particularly integrated crop management, Conservation Agriculture, use of improved seeds and fertilizer management practices. It is an approach that ensures proper management of agro-ecosystems for improved and sustainable productivity, increased profits and increased food security while at the same time preserving and enhancing the resource base environmental protection ensure minimum damage to the environment.

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5b. Selected Climate Smart Agriculture Related Practices

Typical soil conservation measures in Uganda include: terracing, strip and contour cultivation, ridge and tie ridging practices. These practices are commonly used on the hilly terrain particularly in Kabale Districts and the slopes of Mt Elgon in Western and Eastern Uganda respectively.

Annual crops are planted on the flat area and tree species are planted on the edge of the terrace (Fig. 2). Many of these practices were introduced by the colonial Governments but have since been largely abandoned. In some cases, farmers are already destroying the terraces in a bid to expand their cultivation areas and this has led to disastrous effects of soil erosion.

The main reason is the increasing pressure on the land as a result of increased population density. In addition, the majority of the smallholder farmers have inadequate knowledge of improved farming practice and lack awareness of land degradation problems.

Increasingly, farmers continue to cultivate on steep hill slopes and river banks (Plate 5), often without soil conservation measures in place. Part of the reason is that bye-Laws are poorly enforced due to inadequate and poorly facilitated extension staff in the country. There is therefore need to facilitate extension staff and improve their services.

Plate 4a above: Recently ploughed field showing excessive tillage (pulverized soils) giving rise to very fine tilth prone to being washed away after heavy rains. Plate 4b: Bare soil typical of conventional tillage showing evidence of soil erosion.

Plate 4b below: The problem begins as sheet erosion which eventually builds up into galleys.

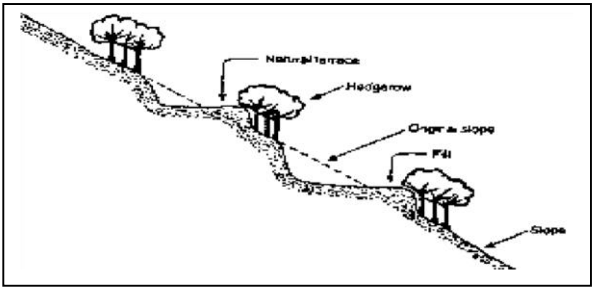


Figure 2: Typical example of Terrace. And tree species Annual crops are planted on the flat area and tree species are planted on the edge of the terrace.

Plate 5: Cultivation on River Banks at Manafwa River

There is also need to review and strengthen the soil conservation measures including terracing, contour and strip cultivation, ridge and tie ridging practice. Farmers should be sensitized on the dangers of cultivating on river banks. Cultivation should begin at least 20m from the river as required by the National Environment Management Authority (NEMA) regulations.

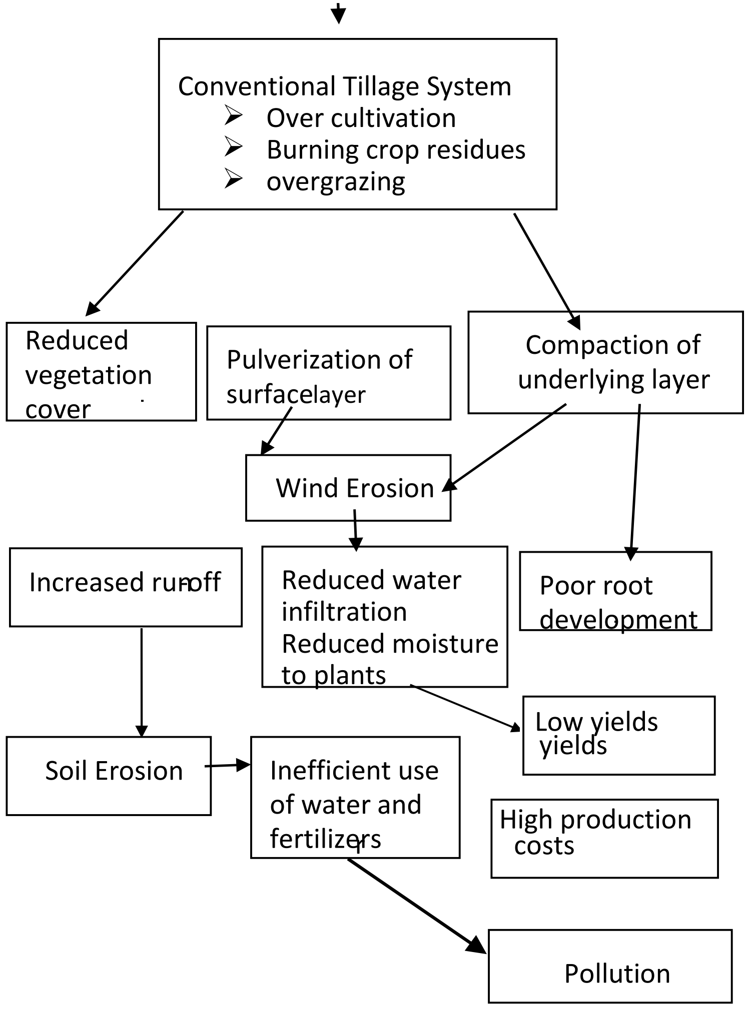


Fig. 3: Summary of the major disadvantages /consequences of conventional tillage.

6. Climate Smart Agriculture Related Principles

There are essentially four principles of CSA related Practices and these are:

a. Minimum soil disturbance/No tillage or minimum tillage.

b. Permanent soil cover, especially by crop residues (mulch) and cover crops. c. Crop rotation.

d. Multiple cropping/Intercropping/Agroforestry.

These are briefly outlined below:

(a) Minimum soil disturbance or No-Tillage

This is sometimes referred to as Zero-Tillage or minimum Tillage. It means growing crops without mechanical seedbed preparation or with minimum soil disturbance. The objective is to reduce run off and soil erosion. It can be achieved by reducing cultivation and maintaining soil surface cover. In general, it consists of the following procedures or practices.

Direct seeding through crop residues in which seeds are planted directly into the field covered with crop residues. (See Plate 6a).

(Plate 6a). Minimum tillage or zero tillage in which the ground is not ploughed except where the seed is to be planted. (Plate 5b)

Minimum tillage or zero tillage in which the ground is not ploughed except where the seed is to be planted.
(Plate 6b)

Plate 6a: Example of Minimum Tillage involving direct seeding through crop residues (Courtesy of REDS LTD). The

residues protect the soil from the impact of rain drops and reduce run off. It also improves infiltration of moisture into the soil. Plate 5b: Example of minimum tillage or zero tillage.

Minimum tillage or zero-tillage has numerous advantages over conventional tillage and these include: Minimum destruction of soil structure by avoiding pulverization, compaction and plough pan development.

The impact of rain drops is cushioned and consequently surface sealing is reduced. Under the conventional tillage high energy rain drops dislodge soil particles which are then carried a way in runoff water. Over 100 tons/ha of top soil can be carried away, from exposed soil. There is slower and better mineralization of soil organic matter through less exposure to climatic agents and soil micro and macro-fauna. There is also reduced evaporations. This together with increased infiltration allows maximum utilization of rainfall.

Crusting and compaction are reduced thus resulting into better seedling emergence. Better infiltration and circulation of air and water through the soil profile largely by maintaining bio-pores and vegetative cover and thus ensuring optimal rooting.

(b) Maintenance of permanent soil cover or crop residues

A soil cover is extremely important in protecting the soil against the impact of rain and direct sun. It also provides the micro and macro-organisms in the soil with constant supply of food. It alters the microclimate in the soil for optimal growth and development of soil organisms including plant roots. (Plate 5 and 6)

Plate 7: Maintenance of soil cover or crop residues in Banana Plantation to ensure reduced impact of rain drops and reduced soil erosion.

Surface crop residues or mulch is also important in soil and water conservation. It reduces wind and water erosion by maintaining soil cover. Additionally, mulch reduces the amount of weeds by chocking the established weeds and denying light to those that require it for germination. In Climate Smart Agriculture, crop residues play a major role in soil quality improvement, erosion control, nutrient recycling, carbon sequestration and improving soil structure and soil tilth. Residues also provides better conditions for root development and seedling growth and Mitigates temperature variation on and in the soil. Bare soils can, reach temperatures of 55–60 C which leads to death of seedlings. Mulching, therefore, provides resilience for the system.

C) Crop Rotation

Rotation of crops is the practice of growing different crops in succession on the same piece of land. The aim is to preserve the productive capacity of the soil. Selection of suitable crops for rotation should ensure that the component crops establish their roots at different layers of the soil. This makes them capable of exploring the different soil layers for nutrients and moisture. Nutrients that have been leached to deeper layers and that are no longer available for the crop, can be recycled by the deep rooted crops in a rotation. In this way the components of crop rotation function as biological pumps.

Furthermore, a diversity of crops in rotation leads to a diverse soil flora and fauna, as the roots excrete different organic substances that attract different types of bacteria and fungi, which in turn, play an important role in the transformation of these substances into plant available nutrients. Integrating leguminous plants into the rotation provides the added advantage of fixing nitrogen and improving the nitrogen levels in the soil. (Plate 6).

The transformation of these substances into plant available nutrients. Integrating leguminous plants into the rotation provides the added advantage of fixing nitrogen and improving the nitrogen levels in the soil.

This typically involves cereal crop (maize), root crop (Cassava/Sweet potato) Grain legumes (Groundnuts and soybean). Proper rotation plays an important role in nutrient recycling and improving nutrient availability in the system. In general, the main advantages of crop rotation include:

- The restoration and maintenance of soil fertility thereby improving crop production over the long term.
- The reduction of risks from pest, disease and weed infestations
- Greater distribution of channels or biopores created by diverse root types (which vary in forms, size and depths of rooting)
- Better distribution of water and nutrients through the soil profile. This gives rise to improved exploration of nutrients and water of the whole soil profile by roots of many different plant species resulting in an optimal use of the available nutrients and water.
- Increased nitrogen fixation where leguminous plants are integrated in the rotation and improved balance of NPK from both organic and mineral sources.
- Crop rotation improves humus formation and enhances soil organic matter content.

The success of crop rotation depends on:

(i) Proper design and implementation of crop rotations according to the various objectives:
These may include improved food and fodder production, residue production, pests and weed control and nutrient uptake.

(ii) Use of appropriate/improved seeds for high yields as well as the production of above-ground and below ground plant residues.

(D) Multiple Cropping

Multiple cropping are forms of cropping systems where total production per unit area is often achieved through growing crops in sequence, simultaneously or together. These are important in CA. And they also ensure ground cover most of the year. They may be:

Sequential cropping

This is a system which involves planting sole or pure stands of crops in sequence in the same field. The succeeding crop is planted immediately after harvesting the previous crop. Depending on the number of crops grown in sequence in a season, we may have double cropping i.e. growing two crops per season or Triple cropping in which three crops are grown in sequence per season. The succeeding crop may be planted after the first crop has reached reproductive stage. This cropping system is often called Relay cropping. The advantage in either case is that ground cover is maintained over a longer period and the straw/stovers from previous crop provides mulch for the subsequent crop.

(Plate 7).

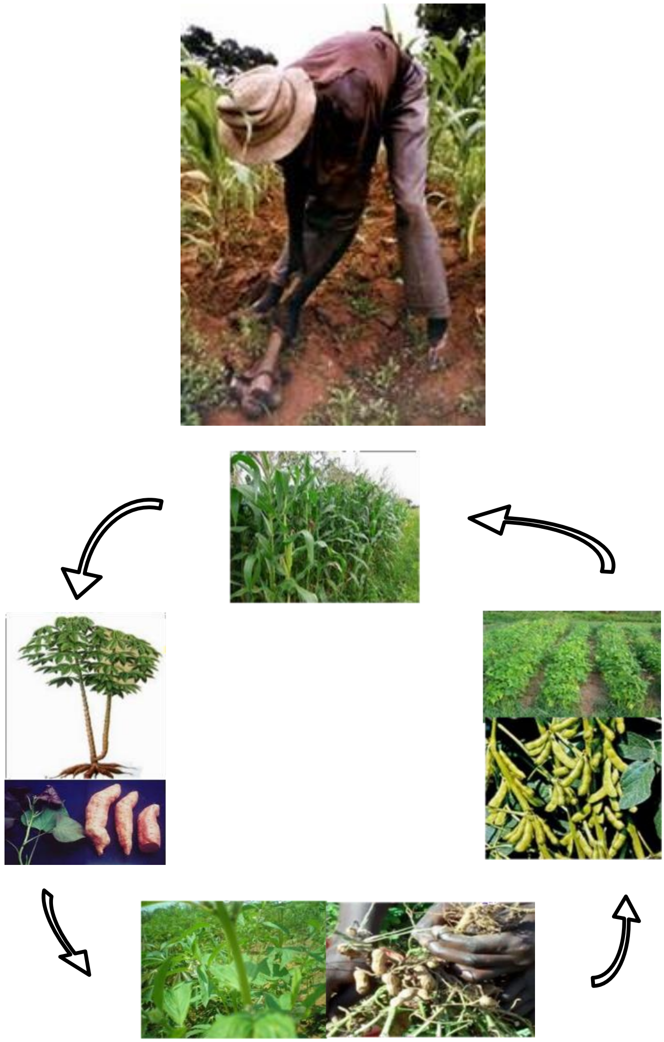


Plate 7: Typical example of crop rotation Mixed cropping and intercropping

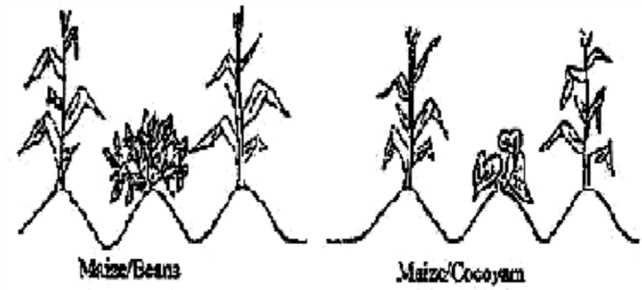
This is the cropping system that involves growing a combination of two or more crops simultaneously on same piece of land. Production is therefore intensified both in space and time. The benefits are:

- More total yield per unit area of land
- Reduction in the chances of crop failure
- Protection of the soil from erosion.

Mixed cropping has no distinct arrangement of the component spp. and it is closely associated with the traditional broadcasting method found in many peasant farms in Uganda. (Plate 8 below)

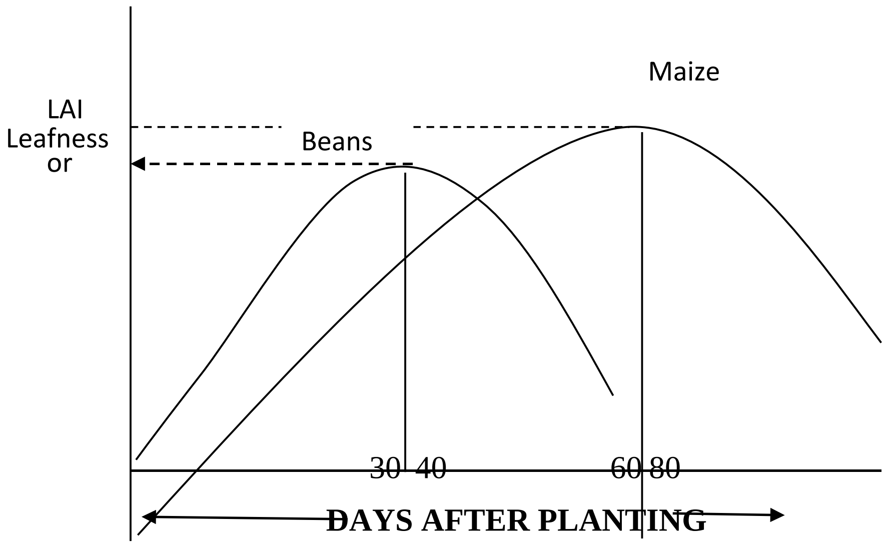
Plate 8: Typical example of mixed cropping showing maize and beans growing together with no definite arrangement of the component crops.

Intercropping on the other hand is growing a combination of two or more crops together but at least one of them is planted in rows:



In both mixed cropping and intercropping, selection of the component species is based on the fact that they have different growth cycles and their growth requirements also differ. Common combinations often include early maturing component (Beans) and a late maturity one (Maize). Such combinations offer ground cover for longer periods and ensure minimum impact of rains on the soil (Fig. 3). This is because their peak Leaf Area Indices occur at different times. The advantages include: Higher diversity in crop production and consequently in human and livestock nutrition.

Improved protection of the soil through prolonged soil



cover and reduced risk of pest and disease infestation.

Other advantages include:

- Greater recycling of nutrients particularly where combinations of deep rooted (Pigeon peas) and shallow rooted spp (Finger millet) are grown.
- Roots of the different component spp explore different layers of the soil profile thus ensuring optimal utilization of Nutrients and moisture.
- Because of the different growth cycles of the component spp. ground cover is provided for longer periods leading to less effects of rain on the soils. (Fig. 3)

7. Selected case studies of Climate Smart Agriculture in Uganda

The history of mitigation and soil conservation measures in Uganda is a long one particularly in the South Western Uganda. The Natural resources of Kagera River Basin, for example, have been facing increasing pressure and degradation for decades. Worse still, farming systems in the catchment area have remained largely traditional. The inappropriate use of arable land including excessive cultivation, baring of soil through grazing or removal of crop residues have put considerable pressure on the land. Generally arable land is left bare for extended periods and thus exposing the soil to agents of erosion.

Traditional Agricultural Extension Approach has largely failed because it is characterized by “top down” transfer of knowledge and heavy dependence on “demonstration plots” which are largely managed by outsiders. This is a situation in which improved modern farming methods are demonstrated on small plots so that the farmers can see and learn. The problem is that many of these are set up and managed by extension staff with little participation by the farmers.

Largely for this reason, the approach has failed. The TAMP (Transboundary Agroecosystem Management Program), an FAO funded project in Kagera river Basin, has adopted Farmer Field School (FFS) approach. FFS comes from the Indonesian Expression “Sekolar Lapangan” meaning “Field School”,(Okoth et. al. 2010). The name reflects the three educational goals of FFS which are (i) learning takes place in the field (ii) Field conditions define most of the curriculum and (iii) real field problems are observed and analyzed from planting to harvesting.

FFS bring together concepts and methods from agroecology, experiential education and community development. At FFS, a group of farmers come together with common interest or issues which they wish to learn about and find solutions.

The TAMP project aims at combating land degradation through the use of Climate Smart Agriculture related practices and ensuring sustainable land productivity. Through the FFS approach, the farmers have been able to clearly identify the problems and priorities and how they can attempt to provide solutions. As can be seen from selected sites, the farmers have been able to integrate the different principles and practice of CSA to ensure improved productivity and minimum soil loss. The farmers are greatly motivated apparently because, for decades, they have witnessed their soils being washed down into Kagera River and now they see real possibility of reducing this loss. But perhaps more importantly, because they are able to achieve better yields from their crops. FFS has enabled them to build confidence not only in the practice of CSA but also among themselves. Below is a description of selected sites where farmers have successfully adopted CSA related principles.

i. Katongelo Watershed Management - Kyobe

The site is very steep and stony and appears to be extremely difficult to manage (plate 9). Despites this, however, the farmers have recognized the importance of ensuring sustainable management of their resources and improve productivity of the four major crops – Coffee, Bananas, Cassava and Sweet potatoes (Ipomea batatas). Other crops include beans and groundnuts. The project provides only coffee seedlings. Farmers obtain other planting materials from previous crops or from other farmers. They work in groups and meet regularly to identify the problems (which varies from farm to farm) and help one another to ensure that a given task is performed.

Plate 9: Showing meandering Kagera River and part of the stony terrain typical of the catchment area.

Plate 10: Typical intercropping of Coffee and Banana in Katongelo water shed management. Coffee and Banana leaves provide mulch for ground cover.

Plate 11: The use of stones to stop run off. Rows of stones are arranged 3 -4 metres apart in the coffee field. Maize straws are used as mulch to ensure minimum run off.

CSA management is based on the integration of different principles including use of mulch in banana and coffee, use of trenches to prevent run off and harvest water and the use of various combinations of intercropping which include Coffee/Banana, to ensure good ground cover (plate 10). Perhaps the most innovative practice is the use of stones arranged in rows roughly 3 m apart across the steep slopes in the coffee fields. These are reinforced with grass bands or strips (Plate 11 above).

The combination of mulches and stone rows/strips, ensure improved infiltration of water and minimum run off. Maize straws are used as mulch. Apparently, there is serious shortage of mulching materials as the farmers depend only on banana leaves and maize straws. The available grass spp (not identified) appear to cause problem where they are used for mulching because they decompose slowly and consequently lock up nutrients. Because of the difficult terrain and stony ground, the hand hoe breaks easily thus slowing farming activity.

ii) Sanga – Kiruhura Watershed Management

Sanga – Kiruhura is an area where the management of natural resource is clearly at advanced level. The reasons are not clear but the farmers are definitely motivated. It is a good example of where the principles of CSA are very well integrated to ensure minimum soil loss and improved productivity. Nearly all the Banana plantations are very well mulched and there are various combinations of intercropping including banana/coffee, maize/cabbages; calliandra trees spp with cabbages. Many farmers grow crops and keep cattle.

Such farmers have well organized paddocks and well-established pastures e.g. Rhodes grass (chloris gayana) and lablab (lab lab purpuureus) (Plate 12 and Plate 13). Lablab or sometimes called dolicos beans is a species of beans in the family fabaceae and cultivated in many countries in the tropics for food or forage. In the case of Sanga, farmers produce lablab as a forage but in addition, lablab provides live mulch and improve soil organic matter. On steep hills, many farmers have planted trees (largely pines). Because of the effective integration of the key principles of CSA, soil erosion is largely under control and the land appears to be very productive as evidenced by the large bunches of Banana. The wide spread practice of mulching is an indication that farmers are well aware of the benefits. There are attempts to heal the land from gulleys. Land with gulleys are being reclaimed by planting perennial crops like sugar cane and building cross ridges to check the speed of water.

Plate 12: Rhodes grass (Chlorisgayana) one of the pastures spp used in rotation in a farm in Sanga –Kirihura

Plate 13: Lab lab (lab lab purpureus) another pasture spp used in the rotation.

iii. Rubangano Watershed Management – Mwizi

The terrain of the area is extremely hilly but the land appears to be generally fertile. Like the other areas, the Farmer Field School approach has considerably improved the farmers understanding of the problems associated with farming in this area. The farmers appear to be very motivated and well organized. They organize regular meetings to discuss progress and identify new problems and solutions.

The main crops grown are bananas and coffee. Other crops include sweet potatoes, maize, beans and cabbages.

Because farming is largely on the steep hill slopes, farmers have welcomed the concept of CSA. The main practice include planting grass strips (plate 15), terracing, and making trenches in combination with grass strips, (plate 14). Elephant grass from the strips is cut and carried to be used to feed animals (goats) whose dropping are collected and used in the preparation of manure.

Plate 14: Showing strips of Elephant grass below sweat potato field. This is one of the conservation practices being used in Rubangano Watershed Management at Mwizi

The trenches are about 60 cm wide and 60 cm deep across the slope. The soils are typically put on the upper side of the trench (referred to as Fanya juu). These are reinforced by planting grass bands on the side where soils are heaped. Fanya juus prevent the soil being washed down the slope when it rains and also increase infiltration. Mulching of banana is a universal practice. Other CSA related practices include planting trees and manure preparation. Manure is prepared in large trenches called 'Orusaniya' or large plates which feed at least four stools of bananas.

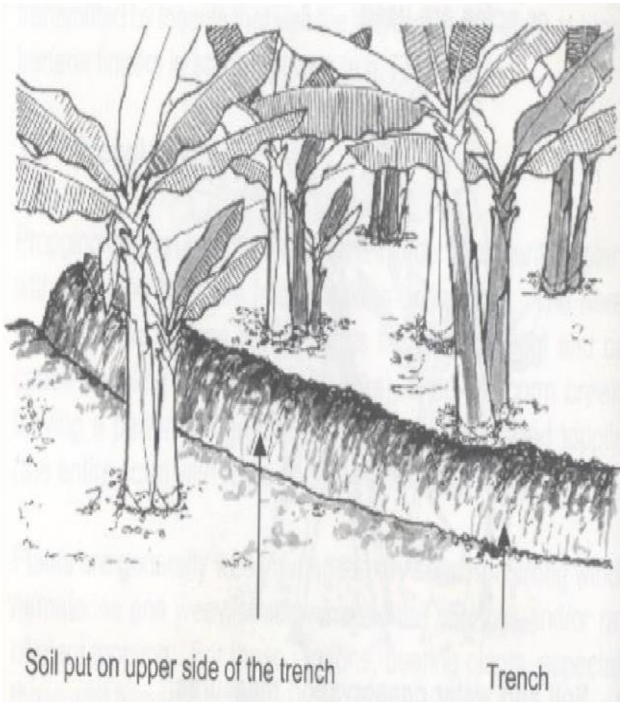


Plate 15: A good example of trenches used in the banana fields. This is very useful when the banana is growing on very steep slopes. The soils are put on the upper side, of the trench (a practice often called Fanya juu).

7. Lessons from the case studies and recommendations

Clearly farmers are benefiting from the use of Climate Smart Agriculture related activities and the FFS approach appears to be the best method for improving farmer knowledge. The main aim of CSA is to maximize soil cover throughout the year. However, there are many challenges. One is that maintaining the cover for a long period is a problem particularly where the dry period is long and there is shortage of mulching materials.

In Katongelo watershed for example, farmers lack mulching material and they are even suspicious of the available grass which they claim does not decompose easily. Grain legume and maize crop residues disintegrate easily and the land does not appear to be fertile enough to support good vegetative growth. Farmers should be encouraged to plant elephant grass, Guatemala grass and guinea grass particularly as grass strips. This would provide mulching materials when required and some would be used for feeding livestock. Secondly, termites are a major problem; crop residues like maize straws are prone to termite damage.

This problem becomes more serious during the dry reason. In addition, the practice of communal grazing and bush fires often reduce available residues which may be used for mulching. Even when mulching materials may be available in the surrounding bush, the actual cutting and transfer of biomass can prove to be difficult and costly. This discourages farmers who would be willing to adopt the practice.

Thirdly, farmers do not seem to be aware that mulching sometimes provide good homes for pests such as the banana weevil. Full integration of all aspects including pest and disease control appears to be the best way of ensuring that farmers benefit from the practice.

Fourthly, it was noted that most of the facilitators do not have agricultural background. They therefore lack confidence. Facilitators should therefore be well grounded and to ensure confidence.

13. Conclusions

CSA is a relatively new concept in Uganda and there is no policy yet on CSA in Uganda. Many farmers are, however already practicing CSA related activities and are being supported by many donor agencies and NGOs. In addition, there are many policies that are related to CSA including DSIP National Climate Change Policy, National Agriculture Policy, National Land Use Policy National Environment Management Authority (NEMA) and Forestry Policy.

However, the major challenges include:

- Limited knowledge of the concept by many actors especially farmers
- Limited investment by the government. Initiatives are mostly left to the private sector.
- Weak Extension and financial support for CSA activities.
- Poverty among the majority of farmers, they are more interested in finding the next meal than changing their way of farming.
- Lack of coordination between the different actors. There are many small initiatives that are scattered and uncoordinated.

The opportunities which exist include the fact that many farmers recognize that the environment has changed and that business cannot be as usual. In addition, there is a lot of global interest in climate change which include the opportunities for sourcing of funds for preparation and implementation of CSA.

Key recommendation that emerges is that there should be massive sanitization of the major actors including farmers, policy makers and donor agencies.

There is need to retool current extension personnel so that they can be well grounded in the concepts and practice of CSA.

The DSIP is addressing major concerns and constraints in the agriculture sector which are relevant under CSA point of view. Investments in the sustainable land management, soil and water conservation, irrigation and institutional aspects show the potential for a climate readiness of the overall plan. Other issues are mentioned in the document, but not reflected in the investment part. One of them is related to improved livestock and range management. According to the plan the cattle corridor suffers from droughts and insufficient water for livestock which causes major problems for the pastoralists. This aspect however, is hardly reflected in the DSIP. In the fishery chapter aspects of over-fishing and declining catches are expressed as concerns in the document. In terms of funding few activities are planned to face the challenges.

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