The Global Water Initiative

A Partnership Funded by the Howard G. Buffett Foundation

Food Security, Water for Agriculture and Farming Practices Baseline Study in Otuke District

June 2013

Executive Summary

The Global Water Initiative East Africa (Water for Agriculture) is one of the programmes being implemented by CARE International in Northern Uganda. Funded by the Howard G. Buffett Foundation, GWI-EA is a five year program of action-research in three countries (Ethiopia, Tanzania and Uganda) that seeks to transform the food security situation in East Africa through improved information flow at different levels and increased pressure on policymakers from both insiders and outsiders. The GWI would like to achieve smarter and increased investments in water for agriculture, especially for women farmers, and the overturning of obstacles to water access and its effective use in smallholder agriculture. The program has four strategic outcomes:

1. There will be greater political attention to water for smallholder production evidenced through changes in policies and plans, and their effective implementation at local, national and regional levels
2. There will be increased investment in smarter, affordable and innovative solutions to providing water for smallholder production, especially for women farmers
3. The voice and influence of smallholders, particularly women, will increase within institutions responsible for access to and control over water for agriculture
4. Smallholder farmers will achieve greater food security through more sustainable access and productive use of water.

The overall objective of the consultancy is to lead the process of documenting a baseline on water and food security in Otuke District, through analysing the current situation in with respect to water for production, farming practices and other uses.

The specific objectives of the consultancy were:

1. Investigate the current food security situation with respect to access, availability, variety and utilisation in the selected sub counties of Olilim, Ogor and Orum in Otuke district, and provide an overall picture of food security for the district as a whole;
2. Investigate current water availability, access and use in agriculture (including livestock husbandry), in the selected sub counties, but also provide an overall picture of food security for the district as a whole;
3. Assess the current level of investment in water for agriculture technologies at house hold, community and district level;
4. Investigate potential water for agriculture technologies that can be tested and applied in each of the three sub counties of Orum, Ogor and Olilim in Otuke district, and across the district as a whole in collaboration with district officials and other groups;
5. Assess the knowledge and levels of awareness of water for agriculture with respect to existing innovations for rainwater harvesting and run off management;
6. Identify and document impediments to investing in water for agriculture across the different strata of stakeholders, and opportunities and related environment issues across the district as a whole;
7. Document important technical considerations regarding the soil physical and chemical properties for consideration by the programme and for future investment in water capture, storage and supply options and soil and water management techniques;
8. Provide appropriate recommendations that are gender-responsive and include rain water harvesting, run-off management and groundwater extraction technologies that can be piloted and tested in Otuke district.

Methodology

GWI-EA contracted Robert Moses Opio, assisted by Martin Omuge of Pedigree Consult Ltd[1] to carry out this baseline. The geographical scope of the study covered the sub counties of Ogor, Orum and Olilim in Otuke district. In total, from the three sub counties, six parishes and twenty five villages were covered, where 191 questionnaires were administered to respondents; of which 43.5% were men and 56.5% were women. The idea was to interview more people and weed off invalid questionnaires, but it turned out that all were valid and had to be included in the analysis. In consideration for more laser-focused monitoring and future longitudinal studies, most of the respondents were GPS marked. This will, in the future, enable accurate measurement of project progress, effects and impact, as the original respondents can be used as measurement points or control groups. In addition, 89 respondents took part in Focus Group Discussions (FGDs) –two per sub county. This included 38 males and 51 females (13 males and 15 females in Orum, 15 males and 22 females in Ogor, and 10 males and 14 females in Olilim). While the proportion of males and females was meant to be the same, most respondents got at homes were mainly women.

Also 28 key informants from the Ministry of Agriculture, Animal Industries and Fisheries (MAAIF) and Ministry of Water and Environment (MWE), Otuke District Local Government (the District Production Coordinator, District Agriculture Officer, District NAADS Officer and the LCIII Chairpersons and Sub county Chiefs of Ogor, Olilim and Orum) NGOs supporting water for agricultural production and food security in Otuke District (NCBA Clusa International, Beads for Life, Welt Hunger Hilfe), Ngetta Zonal Agricultural Research and Development Institute (Ngetta ZARDI), Gulu University –Faculty of Agriculture, water for agriculture technology providers (Davis and Shirtliff, Multiple Industries and Namalere Agricultural Technology Institute). Thus, a total of 302 people took part in the baseline survey.

The Food Security Situation in Otuke District

Before the onset of the two decade-long conflict caused by the Lord's Resistance Army rebels and Karimojong cattle rustlers in Northern Uganda, the Lango people had varied means of livelihoods. The major livelihood types included crop production (commercial agriculture, subsistence farming, mixed cash-crop grain farming and horticulture); livestock production (cattle, goat, sheep, and poultry keeping); hunting and fishing; hence both income and food were obtained from these means of livelihood.

Today, these livelihoods options in Lango are distorted and the social safety nets (like lending seeds, free land offer for cultivation and good animal breeds) through which the Langi used to support one another in times of crisis are since destroyed. Most households have between 3-5 acres under cultivation each season, with only 11% having large land holdings of over 20 acres. This shows that most household land holdings are dwindling, in the face of chronic food insecurity. According to FGDs, in the past, before the advent of cattle rustling most households in Otuke had over 20 acres each, but now many have less than eight acres since some portion had been sold off to meet family's needs and large tracks of land have been set aside as grazing land.

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Otuke experiences Bi-modal rainfall. The first rains in Otuke start in March up to May and the second rains come in August to October, with midyear dry spell in June to July. This agrees with information from Ngetta Zonal Agricultural Research and Development Institute (ZARDI), which is responsible for technical backstopping of agricultural practices in the Lango sub region. While January and February are relatively open months, most garden preparation is done around this time. Planting starts in February till April; then first season weeding is done mostly in May to June. The harvest of the first season crops starts in July and goes on up to October besides, planting and weeding second season crops are also done around the same. The peak labour months are November and December, when the full harvest is done. It is important to note that rainfall and labour demands go hand-in-hand, with the exception of the weeding season and the harvest times.

The production levels in Otuke district are way below the production standards from Serere Nation Semi-Arid Resources Research Institute (NaSARRI). Farmer households in Otuke get only 15 to 20% of the expected yields due to many factors. The most common food crops across the three sub counties by order of occurrence are; rice 19.1%, beans 17.1%, simsim 16.2%, ground nuts 14.8%, field peas 11%, sorghum 8.1%, cassava 6.7%, pigeon peas 2.9%, potatoes 1.4%, millet 1%, soya beans 1%, cow peas 0.5% and maize 0.5%. It had been noted that, farmers have to select a specific garden which suits a particular kind of crop to be grown. For instance, beans does not do well anywhere but farmers have to cultivate former cattle kraals or around the homestead where they throw biodegradable matter, in order to realise good harvest.

Households in Otuke do not produce enough food that could last till the next harvest. The analysis has shown that only 24.1% did have enough harvest while 75.9% confirmed not having enough food to take them up to the next season. Most families in Otuke mainly access food through farming. There is a moderate to worse food insecurity depending on the months and climatic changes in a particular year. For instance post harvest losses are too high; during the dry season, when there are few agricultural activities, many households tend to consume more food stuff than any other seasons and besides; there is a selling of large quantities of food crops compared to what they could have reserved and used in the next season. This can be attributed to poor soils, long dry spells and inadequate farming inputs and innovations. Whatever is produced, a quarter of the output remains at household level for family consumption and three quarters of the produce are pushed to the nearby markets in order to raise income to meet a specific family needs.

The strategies employed by households to cope with food insecurity include casual labour 51.2%, brewing/distilling alcohol 8.9%, use of insecticides for pest and disease control 8.9%, borrowing ox-plough sets 8.1%, selling foodstuff 6.5%, gathering wild vegetables 4.1%, selling small animals (like chicken) 4.1%, planting vegetables 3.3%, brick making 3.3% and swamp fishing 1.6%.

Water availability, access and use in agriculture

Four main challenges face the agricultural sector in Uganda: low production and productivity; low value addition to agricultural produce and limited market access; weak implementation of agricultural laws and policies; and weak public agricultural institutions. As such, the five-year Agricultural Sector Development Strategy and Investment Plan (DSIP) 2010/11 – 2014/15 (DSIP) is designed to address these constraints in four investment programs:

- Increasing agricultural production and productivity;
- Increasing access to markets and value addition;
- Creating an enabling environment for the private sector in agriculture; and
- Strengthening agricultural institutions at the centre and in local governments

In view of the high costs involved in big schemes, in 2011/12 MAAIF carried out demonstrations of household irrigation in Apac, Hoima, Kabaale, Isingiro and Yumbe. Each of these were established on a hectare of land. Focus was on farmers who are willing to allow others access their land for learning purposes. Each of these demonstrations cost UGX 25m (Twenty five million shillings only) for technology, training and accessories. In 2012/13, 33 demonstrations were planned, seven have been done and the remaining 26 will be done under framework contract arrangement due to the bureaucracy involved in government procurement procedures. The government is also planning for six water reservoirs to take water downstream –two in the north, three in Karamoja and one in Isingiro district.

At the national level both the Ministry of Agriculture, Animal Industries and Fisheries (MAAIF) and the Ministry of Water and Environment are working toward provision of water for agriculture.

Rain water harvesting

GWI in the last phase promoted rain water harvesting for human consumption. However, only 20.4% of the households in Otuke harvest water –with 9.9% in Olilim, 5.8% in Orum and 4.7% in Ogor. This is mostly done by those who have tin (iron sheet) roofs. Even then, there is very limited water harvesting technology in use.

Run-off management

Run-off water presents opportunities for accessing water without many costs. People in Otuke trap run-off water. The technology used for run-off water trapping involves the rudimentary pits dug at the end of the compound. The reservoir is a hand-dug pit with no concrete floor as well as walls thus; the trapped water lasts for one to two weeks only, as much water is lost through seeping and evaporation. The community feels that there is no use for run-off water since it is dirty and unfit for human consumption and the water logs breed germs and worms. Run-off water is mostly trapped to mould blocks or bricks.

Other sources of water

The other sources of water available in the project sub counties include swamps, small dams - Oget in Orum; Ikwee dam, Odite dam, Awio dam, Awito dam, Oderokec dam, Anepkide dam in Olilim and boreholes sunk during GWI phase I and by other stakeholders. Besides available natural water sources, there are many boreholes that have been constructed by some Civil Society Organizations for instance; CARE International in Uganda and Action Against Hunger

did built up water points especially in villages where re-settlements from IDPs camps. The boreholes that were constructed by Action Against Hunger (ACF) (a GWI Phases I & II partner) had accompanying waste water pits to collect water away from the boreholes.

Level of investment in water for agriculture technologies

According to the technicians from Namalere Agricultural Engineering Institute, irrigation is useful during dry season, especially in places like Otuke where evapo-transpiration rate is so high normally above 6ml per square metre (m^2) of water is being lost per day. In order to balance this challenge, one has to irrigate each crop by supplying water at least 6 ml and it is supposed to be twice in a week. The volume of water depends on size of the land in terms of acres and spacing of the crops. This calculation aids in knowing the actual volume of water required to irrigate, depending on the size of farm as well as the number of plants to be watered. Good irrigation practice is conducted early morning and the recommended time is 9:00 a.m.

Household

The targeted households in the project sub counties do not harvest water. Neither rain nor run-off water is being harvested for farming purposes. While the majority sleep in grass-thatched houses with no rain water harvesting possibilities, even those with iron sheet roofs are not doing so.

Community

The only attempt at water for agriculture is by farmers growing horticultural crops along swamps and use watering cans to water crops. The boreholes that were constructed by Action Against Hunger (ACF) (a GWI Phases I & II partner) had accompanying waste water pits to collect water away from the boreholes. Additionally the communities were supplied with treadle pumps to draw the water from the pits This water is only used for making blocks for building and bricks for both sale and own construction.

District

The investments in rain-water harvesting technologies are basically being implemented at the government facilities like schools and health centres. This is seen at facilities constructed by Northern Uganda Reconstruction Programme-2 (NURP II), Northern Uganda Social Action Fund (NUSAF II), and Peace Recovery and Development Plan (PRDP II). This water however, is for human consumption and not use in agricultural production. Even extension at the district and community levels has not focused much on irrigation due to low interest expressed by the farmers, high cost involved in acquiring and maintaining the equipment.

Potential for water for agriculture technologies

The dams and large swamps that do not get dried-up in a year are used to cater for animal consumption where farmers would graze their animals and later on take them to drink water which might be of some distance. There is rice farming near swampy areas mean while, cabbages, tomatoes and vegetables growing very scarcely in deed.

In the whole district, there is no set up irrigation system in place but in few locations, farmers do horticulture along swamps during the dry spelt to provide basically family food and some are

sold in the nearby markets. In Adwari, the dam setup is mainly for fish production and animals watering in the surrounding neighbourhood. It would be good for irrigation but at the moment it is not yet established.

Other actors

Other CSOs providing water for agriculture services in clued NCBA Clusa International who are promoting conservation agriculture, Welt Hunger Hilfe who are promoting double-dug trenches as an on-farm water conservation strategy to stave off mid-season crop failures and Bead for Life who are intending to promote rope pumps (which were introduced by GWI) to improve availability and access of water for women.

Water for agriculture technologies available (*See Appendix I for summary of technologies*)

Institutions that produce technologies for water for agriculture are mostly located in Kampala namely at Namalere Agricultural Engineering Institute, Davis & Shirtliff where these equipments are produced. Namalere produces treadle pumps on order. Davis & Shirtliff has both fuel-powered and manual irrigation pumps. For accessories like irrigation pipes, Multiple Industries Ltd is the largest producer/supplier, for different purposes.

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Manual pumps

Treadle pump (from Namalere) -This manual pump used to draw water by means of treads. Namalere is a government Agricultural Engineering Institute that provides appropriate technologies and innovation for prosperity. One of the things that they provide is irrigation technologies and these include drip irrigation and sprinkler irrigation systems. Pumps that could support these are manual and power driven.

Super Money Maker Treadle Pumps (Davis & Shirtliff) -This manual pump can draw water from 7 meters deep and pushes up to 7 meters high. The only known challenge is ware and tire of rubber cups that would requires regular replacement and it is advisable to have in more than two rubber cups in place because it would be very difficult to access in up country markets. This technology poses a problem for women, as it requires a lot of energy to tread.

Super Money Maker Hip Pumps (Davis & Shirtliff) involve the use of the legs as one pumps, water of volume about 1.4 litres are drawn up per stroke made. The force exerted down, would also imply the volume of water that will come out into the gardens. It is easy to use as well as manage by farmers. However, due to the energy required to pump, it is not very friendly, especially to women.

The rope pump is a super trade off in terms of energy requirements. However, it is more expensive in construction, operation and maintenance. As a strategy to mitigate the laborious nature of the hip and treadle pumps, the rope pump (above) is a more women-friendly technology to draw water from the reservoir, for irrigation. GWI phase one promoted rope

pumps to provide water for human and animal consumption. This same technology can be used in providing water for agriculture.

It involves excavating 1.5m diameter (hand dug) traditional water hole and siting them a distance of about 30m from the existing water holes. They are lined with HDPE plastic rings down to the bottom and a rope washer pump is installed as means of extraction. This technology was developed to improve seasonal wells used by community members and to provide improved water supply for the communities. The main advantage associated with this technology is that water does not subside in dry spell.

The major caution with rope wells is that all rotations should be done in the recommended direction. Therefore any contrary rotation will lead to the rope falling and will necessitate replacement. Frequent breaking of the string/rope is also a major challenge

Impediments to investing in water for agriculture

There has been talk of water for agriculture in Uganda for long, that is the concerned ministry and other agencies that would avail information on water for agriculture but at the ground level, implementation would take many years. In Otuke district, the central government has planned by constructing multi-purpose dams. However, while these plans are under way, the general population is not aware. The agriculture practiced in the district is purely rain-fed with no farmer innovation to deal with the dry spelt during the year.

Awareness

Over 65% of the farmers in Otuke district are not aware that water for agriculture is one of the remedies to their chronic food insecurity. The only use of water outside rain-fed agriculture is swamp rice growing practiced in many parts of the project sub county. Even then, the way the farming is done does not conform to any technical guidance on swamp soil and water conservation.

Knowledge

While many Ugandans have heard about irrigation, very few have tried it out, because of lack of knowledge on how to go about it. Some farmers (35%) have some knowledge on water for production but have done nothing to put such knowledge to use. This applies mostly to farmers who have moved to other parts of the country or have heard of irrigation. It also includes those who worked in the government citrus farm in Aloi Sub County in Alebtong district, which was using sprinkle irrigation.

Interest

Because most parts of the country have two rainfall seasons, many practice rain-fed agriculture, and are not very keen on additional efforts like water for agriculture. For example, Appropriate Technology International, later AT (Uganda) promoted the *Money Maker Treadle Pumps* in the 1990s, including in Otuke district but there was very low level of adoption of simple technologies for irrigation at household levels. The reasons are; high cost of the equipment which the poor community could not afford to buy, setting up tanks for water storage is too expensive for a village farmer and lack of group commitment to adopt the new idea.

For example, while GWI partners constructed excess water collection pits in Amwa village and Orum Primary school, among others and supplied treadle pumps to draw out water for irrigating horticultural use, but there are no seed beds or irrigation projects around these facilities. The population either use the water for block and brick making, or just pump it out in cases of overflow.

Cost
The second impediment is costs involved. With raving poverty, many households cannot afford the demonstrated water for agriculture technologies. The cheapest manual irrigation technology is in the range of 2,500,000 shillings for technology and accessories. This is more than most farmers can afford at once, under a slowly recovered initiative, farmer households would afford such technologies.

Availability
The other bottleneck is unavailability of the technologies. There are no stockists around, making it difficult even for those who could afford and wanted to try to access the technologies. Most of the technologies available are in the big towns like Kampala, Jinja and Mbale.

Technical considerations
The central part of Otuke district is dominated by Plinthosols which have very poor drainage. The southern part is characterized by Leptosols which drain imperfectly, and only pockets in the north eastern parts (bordering Otuke rock) have Fluvisols which have good drainage. This is the main reason behind the wide spread water logging especially during the second rains.

This means that for much of Otuke district, irrigation should be practiced with caution, otherwise localized water logging could be a problem due to poor drainage, hence slow sinking of water into the soils. This promotes leeching of nutrients and thus soil degradation.

Scenarios

Super Money Maker Hip Pump
The total investment required for a quarter acre plot would be approximately 3,500,600 Shillings. If a farmer were to invest in equipment to grow tomatoes on a quarter acre piece of land. The farmer could expect returns of approximately UGX 8,000,000. This would mean a seasonal net income of UGX 4,500,000 for a farmer household.

Super Money Maker Treadle Pump
The total investment required for a quarter acre plot would be approximately 3,670,000 Shillings. If a farmer were to invest in equipment to grow tomatoes on a quarter acre piece of land. The farmer could expect returns of approximately UGX 8,000,000. This would mean a seasonal net income of UGX 4,330,000 for a farmer household.

The Rope Pump
The total cost of establishment is approximately UGX 1,300,000 for excavation and the rope pump. It would cost approximately 4,300,000 with drip lines. If a farmer were to invest in equipment to grow tomatoes on a quarter acre piece of land. If he uses the recommended spacing, he should get 40,000 plants. An average tomato plant produces 20-50 fruits. The farmer would get 20 fruitsx4,000 plants=80,000 tomatoes. If it were sold at UGX 100 each, the farmer could expect returns of approximately UGX 8,000,000. This would mean a seasonal net income of UGX 3,664,000.

Davey 5165 and 5265H Petrol-powered Pumps
It can pump enough water for even leafy crops like beans, maize, etc. It can supply to irrigate 10 acres in two hours or 20 half acres in one hour, or 40 quarter acres.

If we take a litre of petrol to be UGX 4,000, this means it would cost UGX 16,000 to irrigate the 40 farms in different directions around a dam or reservoir. Irrigating tomatoes for 3 months on a weekly basis would cost the farmers 16,000x12=192,000. Each of these 40 (quarter acre) micro farms would need sprinklers worth UGX 1,500,000 (i.e. 60,000,000). Thus it would cost an initial investment of UGX 64,692,000 to set up a community irrigation system that will serve ten to twenty households. The per capita investment for 20 farmer households would be UGX 3,234,600. This could be recovered over a period of two years, spreading over four planting months.

If each of the farmers grew tomatoes using the recommended spacing, each would get approximately 4,000 plants. Each tomato plant produces 20-50 fruits. Thus, each farmer would get 20 fruitsx4,000 plants=80,000 tomatoes. If they were sold at UGX 100 each, each the farmer could expect returns of approximately UGX 8,000,000. Each farmer would therefore make a net profit of approximately 4,765,400.

Dayliff DC80P Petrol-powered Pump

It can pump enough water for even leafy crops like beans, maize, etc. It can supply enough water to irrigate 10 acres in two hours or 20 half acres in one hour, or 40 quarter acre plots. If we take a litre of petrol to be UGX 4,000, this means it would take UGX 16,000 to irrigate the 40 farms in different directions around a dam. Irrigating tomatoes for 3 months would take 16,000x12=192,000. Each of these 40 micro farms would need sprinklers worth UGX 1,500,000 (i.e. 60,000,000). Thus it would need UGX 60,992,000 to set up a community irrigation system that will serve ten to twenty households. The per capita investment for 20 farmer households would be UGX 3,049,600.

If the farmers grew tomatoes using the recommended spacing, each would get 10,000 plants. Each tomato plant produces 20-50 fruits. Each farmer would get 20 fruitsx4,000 plants=80,000 tomatoes. If it were sold at UGX 100 each, each the farmer could expect returns to investments of approximately UGX 8,000,000. Each farmer would therefore make a net profit of approximately 4,950,400.

Dayliff DC50H Petrol-powered Pump

It can pump enough water for even leafy crops like beans, maize, etc. It can supply to irrigate 10 acres in two hours or 20 half acres in one hour, or 40 quarter acres. If we take a litre of petrol to be UGX 4,000, this means it would take UGX 16,000 to irrigate the 40 farms in different directions around a dam. Irrigating tomatoes for 3 months would take 16,000x12=192,000. Each of these 40 micro farms would need sprinklers worth UGX 1,500,000 (i.e. 60,000,000). Thus it would need UGX 61,692,000 to set up a community irrigation system that will serve ten to twenty households. The per capita investment for 20 farmer households would be UGX 3,084,600.

If the farmers grew tomatoes using the recommended spacing, each would get 10,000 plants. Each tomato plant produces 20-50 fruits. Each farmer would get 20 fruitsx4,000 plants=80,000 tomatoes. If it were sold at UGX 100 each, each the farmer could expect returns of approximately UGX 8,000,000. Each farmer would therefore make a net profit of approximately 4,915,400.

Conclusions

Food Security

A combination of erratic rains, poor soils (sandy but also with poor drainage), limited innovation and a host of endogenous and exogenous factors render household in Otuke district food insecure, with only one quarter of the population food secure. While there is no land shortage in the district yet, acreages opened are small in spite of animal traction.

The other factor perpetuating food insecurity in the district is that the same food stuff are also sources of income. When people sell away their harvest at low farm gate prices, the result is that later they have no food reserves for bad times.

Farming Practices

Many farmers in the district have failed to recognize the change in seasons, thereby failing to adapt their farming to the current situation. FGDs revealed that farmers still time their crops based on routines years past. The result has been wastage of inputs and low yields. The production volumes of all crops grown in the district are below standard. The farmers continue to plant traditional varieties that take very long to mature and hence are susceptible to mid-season failure due to the prolonged dry spells and erratic weather.

With the exception of maize and beans which are planted in rows, farmers in Otuke mainly sow their seeds. Additionally most crops are weeded only once. Weed management is a big problem to farmer households, with the arrival of new weeds which farmers are not familiar with. *Striga* continues to be a big challenge to farmers in Otuke. There is also an unnamed weed that appears in ground nuts gardens after the first weeding and affects yields directly.

Soil and water conservation practices like mulching, contouring, etc are practiced by less than 10% of the farmers. This leave the fertility of the soil to chance and with the increasing dry spells, returns to investments are very low.

Water for Agriculture

Rain water harvesting

Rain water is harvested in the district and is basically for domestic use and never for agricultural purposes. Thus, it represents an underutilized potential in the district.

Run-off management

Run-off water is trapped only for making brick and blocks. Beyond that farmers do not see any use for it considering that is dirty and likely to breed unwanted animal life.

Technologies available

There are technologies in the market. These vary from on-farm double-dug trenches for water retention, to manual -rope, hip and treadle pumps with water yields of between 600 and 1,000 liters, suitable for household-level irrigation undertakings, to petrol-powered Davey and Dayliff pumps from Davis & Shirtliff with capacities of over 15m^3 per hour, suitable for communal irrigation projects.

Impediments to investments in water for agriculture technologies

Farmers in Otuke have heard of irrigation but have not been very keen in applying it to their situations. While ACF supplied treadle pumps for horticultural and agro-forestry purposes, these have not been used. This has been either due to change in position of owners of land where

boreholes were constructed or lack of community initiative to use the available waste water for agricultural purposes. Thus, limited awareness and lack of initiatives on the part of the farmer have combined to stifle water for agriculture use in the district.

The other factor is the inhibitive cost of technology and accessories. The average cost of manual technologies, which can produce water pressure of less than 3 Bars and therefore only suitable for drip irrigation is UGX 3,500,000. This is way beyond what most farmer households can afford. In addition, irrigation equipments are not available in Otuke or nearby towns, but are found in Kampala, Jinja and Mbale.

Gender Considerations

It is important to remember that irrigation requires a lot of labour, and in view of the fact that most of the farming is done by women, caution is in order. FGDs revealed that on average men work in their farms only 3-4 hours, and women work 7-10 hours depending on the season. For champion farmers who will be chosen by GWI EA, there will be need to involve the men for the success of the irrigation initiative.

Recommendations

Global Water Initiative East Africa

On-farm technology

GWI EA should encourage farmers, especially champion/model farmers to adopt soil and water management practices to check erosion. This would involve physical conservation structures like ridges and contours, cover crops and manure. Soil fertility improvement practices, e.g., manure, organic matter and crop residue recycling coupled with irrigation would also improve the texture and structure of the sandy loam soils thereby boosting yields and returns to investments. The farmers need to adopt conservation farming practices.

Conservation Agriculture (CA)

Taking into account the erratic rainfall pattern, soils and temperatures of Otuke district, it is prudent to promote conservation agriculture. Conservation agriculture (CA) aims to achieve sustainable and profitable agriculture and subsequently aims at improved livelihoods of farmers through the application of the three CA principles: minimal soil disturbance, permanent soil cover and crop rotations. It is a way of growing crops that conserves the soil and maintains soil fertility. It combines three principles -disturb the soil as little as possible – i.e. minimum tillage, keep the soil covered with cover crops, crop residues or mulch and rotate or mix crops (e.g., planting a cereal such as sorghum, millet, maize and a legume such as pigeon-peas, beans, etc.).

These three principles have many advantages: they conserve moisture in the soil, maintain a good soil structure (making it easy for roots to grow), regenerate the soil's fertility, encourage earthworms and other soil life, and protect the soil from erosion hence gullies. Conservation agriculture needs less labour than conventional farming because it avoids ploughing. It produces higher yields because it maintains the soil fertility. Weed control may be a problem, especially in the first few years after farmers start practicing conservation agriculture. They can control weeds by slashing them or using herbicides. Eventually, the cover crops will smother most weeds, making them easier to control. However, the farmer households in Otuke are not practicing conservation agriculture.

CA holds tremendous potential for all sizes of farms and agro-ecological systems, but its adoption is perhaps most urgently required by smallholder farmers, especially those facing acute labour shortages like those in Otuke district. It is a way to combine profitable agricultural production with environmental concerns and sustainability and it has been proven to work in a variety of agro-ecological zones and farming systems. It is been perceived by practitioners as a valid tool for Sustainable Land Management (SLM)[2].

Better Agronomic Practices

Farmers in the project sub counties should be encouraged to practice modern agronomy - planting in rows, mulching, use of manure, thinning crops, weeding crops twice and applying approved post harvest handling techniques. These strategies will help increase production, productivity and quality which will improve both food and income security for the households.

There is need for improved dissemination of knowledge and for capacity building to help farmers and other land users in Otuke to develop farming practices and systems that conserve soil and water resources, ensure sustained fertility and, where possible, reverse chemical, structural and biological degradation of the soil

Rain water harvesting

As many households are not harvesting water for agricultural practices, it would be good to initiate manageable household-based irrigation systems that farmer households would use in a field as a pilot (contract farmers) and the following could be considered; where loans are given to individual farmers within a group, both men and women would be benefited highly. Most farmer groups may receive the money as loans through the village savings and loans associations (VSLAs) or on a 50:50 grant that can be stipulated in the agreements. Most of the grant money could be used to buy irrigation equipment/inputs. Women would be more committed to saving than men therefore are more reliable to be use in case of any pilot project

The GWI EA's strategy of using champion/model farmers to promote improved food security, land and water management in Otuke district would yield commendable achievements. However, care should be taken so that only committed and willing farmers are targeted, not just anybody. They will show that land degradation and food insecurity can be reduced and livelihoods improved through water for agriculture. Concerted efforts from all stakeholders – central government, Otuke DLG, civil society and communities, are needed to invest in this type of practice and scale up the successes created by this pilot water for agriculture project.

Introduction of fast-maturing crop varieties

Since the first rains last less than two months and the second rains last longer but cause water logging, fast maturing crops should be introduced and promoted by GWI EA in collaboration with the Production Directorate of Otuke District Local Government. This could include yellow beans which mature in 60 days, and needs rain only for the first month. Seremi I and II millet varieties from NaSARRI Serere mature in 65 to 70 days also needs only one month of good rainfall. Sesame I and II simsim varieties from NaSARRI Serere mature in 110 days. There are a host of other drought-resistant and fast maturing ground nuts and other crops which the project can introduce to farmers in the three project sub counties.

[2] www.fao.org/ag/ca

Otuke District Local Government

Investment in land and water management
In implementing central government plans, ODLG should increase investment in land and water management at the community and district levels must be a priority to sustain the resource base that produces food and livelihoods. Local people can neither invest nor bear the burden by themselves. The government must provide incentives for communities to improve their management of natural resources, so benefiting the nation and the global environment.
Knowledge generation, management and innovation

Farmer households should be encouraged to experiment and innovate in view of the changing weather patterns instead of clinging to old ways. This should be in the specific areas of new fast-maturing crops, water for agriculture (irrigation) technologies, etc. Farmers should be motivated to learn how to build on and use their own knowledge. In the beginning, model/champion farmers/technology adapters should be rewarded by ODLG with GWI EA facilitation, to consolidate learning, and become reference/learning points in their communities. This will make extension services become more demand-driven, and farmers can tell if they are getting value for money. Innovators**,** under Farmer field schools involve many people within a watershed area, so speeding up adoption of improved land management techniques.

Build long-term resilience
Extension efforts should focus more on practices that build long-term soil fertility and the efficient use of every drop of water –rather than focusing only on commercial enterprises. This will help farmers benefit from sustained provision of ecosystem goods and services, and cope better with poor soils, dry spells, water logging and other challenges.
Bye-laws and regulations
Bye-laws relating to farming, food security and water for agriculture must be formulated and enforced effectively to promote appropriate land and water management practices. Byelaws to conserve and make more productive use of land and water must be developed and enforced, with the full participation of local stakeholders. This is will not only improve food and income security but also soil and water resources.

Farmer households/groups

Stronger leadership and voice
Farmer field schools strengthen the farmers' "voice" for advocacy and enable strong and responsive leaders to emerge. The farmer field school approach in general, and its use for improving soil, land and water management, should be scaled up so it can reach a larger number of farmers in Otuke. It should be incorporated into the district extension system rather than implemented on a project-by-project basis. Extension staff (from NGOs, NAADs and local government) can play a key role to initiate and backstop farmer field schools. Close collaboration between government and NGOs will assure success.

Better planning through farmer field schools could enable efficient community action planning. This is because farmers become more aware of their farming environment, so can plan better for drought, pests and other problems. These can be used to locate sites for irrigation investments,

Networking
Farmers should arrange exchange visits to be able to further benefit through exchange of information with each other and with research and extension agencies. The farmers in the

project sub counties could organize and visit farmers in Adwari where Welt Hunger Hilfe is promoting double-dug trenches and within the district where NCBA Clusa Uganda is promoting conservation agriculture, etc.

Funding

Adequate funding support is needed if farmers are to succeed. For individual groups to be sustainable, they need to develop their own sources of funding – through revolving funds, group-owned businesses and other self-financing mechanisms. Strong farmer organizations can reduce costs because they can buy inputs at lower prices, and can sell their output for more. Farmers must manage (and contribute to) their farmer grants if avails to them so that they can demand good facilitation and make their own decisions.

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List of acronyms

ACF	Action Against Hunger
ALREP	Agriculture Livelihood Recovery Programme
AT (U)	Appropriate Technology-Uganda
CBOs	Community-Based Organizations
CDF	Commissioner Farm Development
DCP	Director Crop Production
DSIP	Development Strategy and Investment Plan
DWD	Directorate of Water Development
FAO	Food and Agriculture Organization
FGDs	Focus Group Discussions
FIEFOC	Farm Income Enhancement Forestry Conservation
GDPs	Gross Domestic Product
GoU	Government of Uganda
GWI-(EA)	Global Water Initiative East Africa
ICT	Information and Communication Technology
IDPs	Internally Displaced Persons
KIIs	Key Informant Interviews
LC	Local Council
LPA	Learning and Practice Alliance
MAAIF	Ministry of Agriculture, Animal Industries and Fisheries
MFPED	Ministry of Finance, Planning and Economic Development
MWE	Ministry of Water and Environment
NAADS	National Agricultural Advisory Services
NaSARRI	National Semi-Arid Research and Resources Institute
NCBA	National Cooperative Business Association
NDP	National Development Plan
NGOs	Non-Governmental Organizations
NURP	Northern Uganda Reconstruction Programme
NUSAF	Northern Uganda Social Action Fund
ODLG	Otuke District Local government
PFA	Prosperity for All
PMA	Plan for Modernization of Agriculture
PRDP	Peace Recovery Development Plan for Northern Uganda
SLM	sustainable Land Management
SPSS	Social Package for Social Scientists
UBoS	Uganda Bureau of Statistics
UN	United Nations
W4A	Water for Agriculture
WFP	World Food Programme
ZARDI	Zonal Agriculture Research and Development Institute
O & M	Operation and Maintenance
WHH	Welt Hunger Hilfe

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Alan Nicol

Director, Global Water Initiative East Africa

Part One: Introduction and Methodology

1.1 Brief introduction of the project

CARE International is a federation of 12 member countries in America, Europe, Asia and Australia that implement programmes in over 70 countries worldwide. In Uganda CARE International has been active since 1969 and working in the country continuously since 1979, implementing a diverse portfolio of programs and projects ranging from emergency services to economic development and civil society building.

CARE's first projects in Uganda focused on agricultural development, animal husbandry, health education and community development. CARE Uganda's current initiatives cover; women's empowerment, economic development, governance, civil society strengthening, orphans and vulnerable children, and support to marginalized groups.

Within the past few years CARE Uganda has implemented projects on a national scale as well as in Northern, Central, Western and South-Western Uganda. CARE Uganda's current programming targets vulnerable groups such as the extreme poor, internally displaced people, and women and children, to provide assistance and opportunities for empowerment and sustainable development.

A key program principle for CARE Uganda is working with partners. This is consistent with CARE International's desire to become a partner of choice for its allies. In line with this programming principle, CARE Uganda designs, implements and monitors its work in partnership with other organizations. Partners include community-based organizations (CBO), national and international NGOs, alliances, networks and coalitions, the private sector, academic and research institutions, the government (both central and local), and the media. All CARE Uganda interventions are implemented exclusively through partnerships.

The Global Water Initiative East Africa (Water for Agriculture) is one of the programmes implemented by CARE International in Northern Uganda. Funded by the Howard G. Buffett Foundation, GWI-EA is a five year program of action-research in three countries (Ethiopia, Tanzania and Uganda) that seeks to transform the food security situation in East Africa through improved information flow at different levels and increased pressure on policymakers from both insiders and outsiders. The GWI to achieve smarter and increased investments in water for agriculture, especially for women farmers, and the overturning of obstacles to water access and its effective use in smallholder agriculture. The program has four strategic outcomes:

1. There will be greater political attention to water for smallholder production evidenced through changes in policies and plans, and their effective implementation at local, national and regional levels
2. There will be increased investment in smarter, affordable and innovative solutions to providing water for smallholder production, especially for women farmers
3. The voice and influence of smallholders, particularly women, will increase within institutions responsible for access to and control over water for agriculture
4. Smallholder farmers will achieve greater food security through more sustainable access and productive use of water

In Uganda, the program is implemented in collaboration with the district local government, civil society, private sector, small holder farmers and research institutions through the establishment

of a Learning and Practice Alliance in Otuke District. CARE international in Uganda hosts the regional program, and other local partners provide the critical assistance necessary to operationalize GWI-EA program activities.

The program aims at influencing policy through advocacy based on local and national action research activities, increasing awareness and behaviour change with regard to the enhanced adoption of and investment in innovative technologies and other management techniques of water for agriculture.

GWI EA aims at catalysing change that is required for more widespread and rapid improvement in sustainable water use in agriculture production to achieve food security at farm, community and national scales.

The GWI EA- W4A Launch meeting was organised and held from the 12th-13th February 2013. The Purpose of the workshop was to introduce GWI 2 activities to stakeholders and to agree on a road map for the remainder of 2013.

Research Baseline on food security, water harvesting innovations in Otuke should be carried out to determine the current status quo. Crop production in Otuke needs to be supported to facilitate the cultivation of more land, more diverse crops including food and commercial crops to secure Household nutrition and Household incomes.

In view of the increasing risk of weather irregularities, rain Water harvesting and more resistant and fast maturing crops (vegetables) need to be promoted especially during dry season. And that Dry Season productivity should be enhanced by strengthening farmer capacity to develop small scale surface irrigation facilities and training in different production techniques needs to be further pushed in order to increase food production all year round.

1.2 Purpose and Specific Objectives

1.2.1 Purpose

The overall objective of the consultancy was to lead the process of documenting a baseline on water for agriculture and food security in Otuke District, through analysing the current situation in with respect to water for production, farming practices and other uses.

1.2.2 The Specific Objectives

The specific objectives of the consultancy were:

1. Investigate the current food security situation with respect to access, availability, variety and utilisation in the selected sub counties of Olilim, Ogor and Orum in Otuke district, and provide an overall picture of food security for the district as a whole;
2. Investigate current water availability, access and use in agriculture (including livestock husbandry), in the selected sub counties, but also provide an overall picture of food security for the district as a whole;
3. Assess the current level of investment in water for agriculture technologies at house hold, community and district level;
4. Investigate potential water for agriculture technologies that can be tested and applied in each of the three sub counties of Orum, Ogor and Olilim in Otuke district, and across the district as a whole in collaboration with district officials and other groups;

5. Assess the knowledge and levels of awareness of water for agriculture with respect to existing innovations for rainwater harvesting and run off management;
6. Identify and document impediments to investing in water for agriculture across the different strata of stakeholders, and opportunities and related environment issues across the district as a whole;
7. Document important technical considerations regarding the soil physical and chemical properties for consideration by the programme and for future investment in water capture, storage and supply options and soil and water management techniques;
8. Provide appropriate recommendations that are gender-responsive and include rain water harvesting, run-off management and groundwater extraction technologies that can be piloted and tested in Otuke district.

1.3 Scope of the Assessment

The geographical scope of the study was in Otuke district. In total, from the three sub counties, six parishes were covered. The thematic scope of the baseline included review of secondary data on water for production, food security and farming practices. It also included primary data collection, particularly using Questionnaires, FGDs and KIIs.

1.4 Methodology

At the beginning, the study team held preparatory meetings with CARE International GWI EA staff in Uganda in Gulu and Kampala. The outcomes of the meeting were; the harmonized understanding of the terms of reference, the scope of work agreeing on the study sample, the methodology, work plan and required logistical support. The team reviewed a number of documents relevant to the study particularly water for agriculture technology at national level. These included the GWI EA Water for Agriculture project proposal, the GWI EA Water for Agriculture project launch report, the Agriculture sector strategic investment plan, National Water Policy, the National Development Plan (NDP), the Peace, Recovery and Development Plan for northern Uganda II (PRDP II).

The survey was done in 25 villages in Ogor, Orum and Olilim sub counties of Otuke district. While originally 180 questionnaires had been planned, 191 were administered to respondents, of which 43.5% were men and 56.5% were women. The idea was to interview more people and weed off invalid questionnaires, but it turned out that all were valid and had to be included in the analysis. In consideration for more laser-focused monitoring and future longitudinal studies, most of the respondents were GPS marked. This will enable accurate measurement of project progress, effects and impact, as the original respondents can be used as measurement points or control groups.

In terms of age groups, 41.9% (16.2% males and 25.7% female) were less than 30 years old, 31.4% (13.6% male and 17.8% female) were between 31 and 45 years old and 26.7% (13.6% male and 13.1%) were above 45 years of age. The age group choice was to balance between the young, middle-aged and aged farmers. This was due to the fact that the younger generation would be more adaptable and easily accept water for agriculture technologies and be more willing to try out new ideas to improve their lot in life.

Geographically, 32.5% of the questionnaire respondents were from Orum, 35.6% from Ogor, and 31.9% from Olilim sub-county as shown in Table 1 below. In addition, 89 respondents took part in 6 focus group discussions (FGDs) –two per sub county. This included 38 males and 51

females (13 males and 15 females in Orum, 15 males and 22 females in Ogor, and 10 males and 14 females in Olilim). While the proportion of males and females was meant to be the same, most respondents got at homes were mainly women.

Also 28 key informants from the Ministry of Agriculture, Animal Industries and Fisheries (MAAIF) and Ministry of Water and Environment (MWE), Otuke District Local Government (the District Production Coordinator, District Agriculture Officer, District NAADS Officer and the LCIII Chairpersons and Sub county Chiefs of Ogor, Olilim and Orum) NGOs supporting water for agricultural production and food security in Otuke District (NCBA Clusa International, Beads for Life, Welt Hunger Hilfe), Ngetta Zonal Agricultural Research and Development Institute (Ngetta ZARDI), Gulu University –Faculty of Agriculture, water for agriculture technology providers (Davis and Shirtliff, Multiple Industries and Namalere Agricultural Technology Institute). Thus, a total of 302 people took part in the baseline survey.

Table 1: Background of respondents

	Gender		
Sub County	**Male (n=83)**	**Female (n=108)**	**Total (n=191)**
Orum	26 (13.6%)	36 (18.8%)	62 (32.5%)
Ogor	36 (18.8%)	32 (16.8%)	68 (35.6%)
Olilim	21 (11.0%)	40 (20.9%)	61 (31.9%)
Age Group			
Below 30 years	31 (16.2%)	49 (25.7%)	80 (41.9%)
31-45 years	26 (13.6%)	34 (17.8%)	60 (31.4%)
Above 45 years	26 (13.6%)	25 (13.1%)	51(26.7%)
Education level			
None	8 (4.2%)	34 (17.8%)	42 (22.0%)
Primary	42 (22.0%)	65 (34.0%)	107 (56.0%)
Secondary	20 (10.5%)	7 (3.7%)	27 (14.1%)
Post Secondary	11(5.8%)	2 (1%)	13 (6.8%)
Vocational	2 (1%)	0 (0%)	2 (1%)
Marital Status			
Single	10 (5.2%)	7 (3.7%)	17 (8.9%)
Married	70 (36.6%)	75(39.3%)	145(75.9%)
Widowed	3 (1.6%)	20 (10.5%)	23 (12%)
Divorced	0 (0%)	6 (3.1%)	6 (3.1%)

Most respondents were from Ogor Sub County with 35.6% compared to Orum and Olilim sub counties with an average of 33%. Most respondents were below 30 years (41.9%) followed by the age range of 31-45 years (31.4%) and only 26.7% of the respondent were above 45years.

Many of the farmers interviewed had attained primary education (56.0%), 22% had basically no education, 14.1% had attained secondary education and only 6.8% of the respondents with post secondary education. More than three quarters (75.9%) of the respondents were married while 12% were widowed, 8.9% were single and only 3.1% were divorced. From the survey sampled, more women were interviewed than men because they were found at home compare to men, but also because women do the majority of farming activities.

1.4.1 Data Collection

The study was carried out in Otuke district and three sub-counties of Ogor, Orum and Olilim. Simple random sampling technique was used to arrive at the sample of respondents to whom questionnaires were administered. This continued until the desired number of respondents was reached. The questionnaire sample size was approximately 191 respondents and FGD (60) comprising of men and women from the three sub counties.

At the district and sub county level, interviews were held with the District Production Coordinator, District Agriculture Officer, the District NAADS Coordinator and sub county Chiefs, Chairmen LCIII, sub county NAADS coordinators, and other extension staff.

1.4.1.1 Questionnaires

Researcher-administered questionnaires were the main tool for information gathering. This was meant to cater for respondents who may not be able to read and write. This approach was also meant for high levels of consistency of information generated and to avoid wastage of time and other resources.

1.4.1.2 Focus group discussions

There were two FGDs per project Sub County with an average of 12 respondents in each focus group discussion. Respondents were randomly sampled from the people mobilized by the local council one of the village. This tool was used to triangulate data gathered using questionnaires and from key informants; to reduce or control biases of respondents exhibited in personal interviews. Focus group discussions with men and women separately ensured better accuracy of data.

1.4.1.3 Key informant interviews

The respondents were relevant stakeholders at District, Sub County and Partners at National level. The sampling technique for focus groups and key informants were purposive to cover those with vital information about water for agriculture. Officials from the production department of Otuke district; and Ogor, Orum and Olilim sub counties were interviewed. This included Local Government leaders from Otuke districts, Sub county officials and from the Ministry of Water and Environment (DWD –CWP, Irrigation Consultant and Irrigation Officer), Ministry of Agriculture, Animal Industries and Fisheries (Director Crop Production, Commissioner Field Development and Water Engineer), Namalere Agricultural Engineering Institute, Davis & Shirtliff, Multiple Industries were interviewed too. NGOs operating water for agriculture projects in Otuke district –NBCBA Clusa International, Beads for Life and Welt Hunger Hilfe were interviewed. Staffs from CARE International in Uganda and the Programme Director GWI-(EA) were also interviewed.

1.4.2 Data Analysis and Reporting

1.4.2.1 Data Analysis

Qualitative Data
Data from the field was edited, assigned to baseline objectives and project information requirements hence; data analysis of the input was critically analyzed. Data from focus group discussions and key informant interviews was progressively analyzed. Codes (i.e. descriptive categories) were systematically applied to data in order to identify emerging themes or categories of information. It was then related to the baseline objectives.

Quantitative data
Data inspection was done at the end of each day to ensure completeness. After field work, data was cleaned, entered into a database in Statistical Package for Social Scientists (SPSS) and analysed. Descriptive and measures of association analysis was then done.

1.4.2.2 Reporting

The research team prepared a draft report of the assignment and submitted it to the Programme Director GWI-(EA), CARE International in Uganda for comments. The draft report was also presented to a stakeholder debriefing meeting held at Margaritha Palace Hotel in Lira before completion of the assignment. Stakeholder comments were addressed to refine the report. This ensured incorporation of stakeholder ideas into the final report and improved its acceptability and value.

1.5 Limitations of the baseline study

The Food, Security and Water for Agriculture baseline survey was constrained with a number of things namely; the months of April and May is the time when this survey was carried out are the busiest periods to farmers with a lot of work in the gardens. Many farmers were not found at homes and this led to working in a particular village for longer hours in order to interview respondents.

There was poor mobilisation of respondents especially for the FGDs at some sub counties leading to rescheduling to meet them for the same discussion at a later date. At the National and District offices, some of the key informants were not available for interviews due to their busy schedules as others were out of offices for meetings and workshops.

Significantly, however, these shortcomings did not affect the study outcome because the team compensating by spending more days than earlier planned, to reach the targeted respondents.

Part Two: Key Baseline Findings

2.1 Introduction

This chapter presents the major findings of the baseline, and are presented by the baseline objectives as much as possible. The report presentation adopts a funnel approach –reviewing data from the international, national (Uganda), the district (Otuke), the sub county (Ogor, Orum and Olilim) the parishes and villages, where possible; and corroborates with primary information got during the baseline. These include the current food security situation, water availability and investment, water for agriculture technologies, level of awareness of water for agriculture, document impediments to invest in water for agriculture, document technical considerations on soil properties and appropriate recommendations on rain water harvesting/run-off management/groundwater extraction technologies.

2.2 Sources of Livelihood

Agriculture remains one of Uganda's core sectors owing to its contribution to employment and Gross Domestic Product (GDP), and yet as in many other Sub-Saharan African countries, agricultural productivity in Uganda has stagnated relative to population[3]. Registered growth in the sector has mainly through increases in land under cultivation rather than increase in productivity. By 2005 it accounted for 73 percent of the employed labour force (UBOS, 2005). In 2008/09, it contributed 23.7 percent of total GDP and exports accounted for 47 percent. It also provides raw material for Ugandan industries. In 2010 the overall growth in the agriculture in grew by a mere 2.4% but fell to 0.9% in 2011 due to poor rainfall and draught, lack of significant investment in agriculture and limited commercial farming skills. Although its contribution to GDP has diminished to less than 32% in 2010, agriculture sector remains a critical area given that 80% of the population depend on it for their livelihood.

Agriculture plays a key role in Uganda's economy by providing employment and incomes to the majority who are poor in the rural. In spite of its importance to the economy, the sector continues to receive little attention from the government with budgetary allocations not exceeding 4 percent annually. The National Development Plan (NDP) 2010/11 – 2014/15 which is the country's overarching development framework points out access to critical production inputs as one of Government of Uganda (GoU) priority areas for investment. Key constraints to the agriculture sector in Uganda include: high risks and cost of investment in relation to commercialization; high cost and limited availability of improved farm inputs; weak farmer organizations in production, processing and marketing; traditional and cultural attitudes that entrench subsistence agriculture; absence of data and information; land tenure and access to farmland; inadequate meteorological services; inadequate pest and disease control; inadequate production and post-harvest handling facilities; limited extension support and weak value chains.

In responding to these constraints, the NDP more specifically, highlights the following strategic actions for the agriculture industry: local production of phosphate fertilisers, reduction of dependency on rain-fed agriculture through rehabilitation and construction of irrigation schemes, support to provision of water for livestock and production activities, increasing access to high yielding seed varieties and promoting mechanisation of agriculture. The proposed actions contribute to the realisation of some of the strategic priorities of GoU in particular objective 1-

[3] Ministry of Finance and Economic Development, The National Development Plan

Enhance agricultural production and productivity, strategy 8 which seeks to improve agricultural livelihoods in northern Uganda through increasing agricultural production and productivity with a focus on providing productive assets, agricultural knowledge and pro poor services; promoting value addition (agro-processing); and improving access to markets therefore:– strengthening input market chains, capacity of producer groups and information on markets. The proposed actions also contribute to strategy 9 on accelerating the development of strategic commodities through value chain development.

2.3 The Food Security Situation in Otuke District

Food security is a complex sustainable development issue, linked to health through malnutrition, but also to sustainable economic development, environment, and trade. The World Food Summit of 1996 defined food security as existing "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life". Commonly, the concept of food security is defined as including both physical and economic access to food that meets people's dietary needs as well as their food preferences[4].

The Declaration of the World Summit on Food Security held at FAO in 2009, stressed the urgent need and concrete actions to promote "new investment to increase sustainable agricultural production and productivity, support increased production and productivity of agriculture", and for the implementation of "sustainable practices, improved resource use, protection of the environment, conservation of the natural resource base and enhanced use of ecosystem services"[5]. There are previous and on-going GoU interventions through Peace Recovery and Development Plan (PRDP), National Agricultural Advisory services (NAADS), Programme for Modernization of Agriculture (PMA), Prosperity for All (PFA), Northern Uganda Social Action Plan (NUSAF) I & II, (Agriculture Livelihood Recovery Programme (ALREP) and also those of non-governmental organization, international agencies FAO, WFP and other participating partners, from subsistence to sustainable commercial production.

In Northern Uganda, food security is still fragile due to difficulty in accessing agricultural inputs, poor post-harvest practices, plant pests/diseases and animal diseases management, erratic rainfall, serious erosion of the basic agricultural skills for *former* internally displaced persons (IDPs) who have spent decades in camps, difficult access to markets and alternative livelihood opportunities.''[6] A recent study commissioned by Agri-ProFocus Uganda noted that commercialization of farming in Northern Uganda is faced by a number of challenges including: erratic climate, low productivity, poor infrastructure, inadequate business development support services, low levels of mechanization, weak farmer institutions, inadequate post-harvest and processing capacity and the dependence syndrome attitude held by the previously displaced population.[7]

Other issues based on feedback from communities include, land access, control and utilization; fluctuation in world market prices; inadequate quality planting materials and stock breeds; inadequate markets and market information; and inadequate farm power. The study also observes that opportunities for commercialization of farming in the sub-regions exist given the existing markets (local and regional), the dual rainfall pattern especially in some parts of Lango

[4] www.who.int

[5] Opening remarks of Changchui He, Deputy Director-General FAO, at the International Scientific Symposium "Biodiversity and Sustainable Diets: United Against Hunger" organized jointly by FAO and Biodiversity International, Rome 3 November 2010

[6] UN (2011), Uganda: Humanitarian Profile 2011, pg. 5 (source: www.internal-displacement.org)

[7] Agri-ProFocus Uganda, May 2011; Food Security and farmer entrepreneurship in areas that are in transition from emergency to development: A case of Lango and Acholi sub-regions.

and the good soils. Some of the crops mentioned as suitable for commercialization include: simsim, rice, honey, soya beans, and chillies which are also targeted by the proposed actions.

The production of cotton, the sub-region's traditional cash crop has significantly declined as a result of the war and unstable world market prices, and in its place a number of non-traditional cash crops like cassava, potatoes, sunflower, soybeans, oranges, chillies, and bananas have been introduced. The high demand for agricultural products from local markets as well as regional and international markets presents a great opportunity that could help propel the sub-region and its population towards sustainable livelihoods[8].

Before the onset of the two decade-long conflict caused by the Lord's Resistance Army rebels in Northern Uganda and Karimojong cattle rustlers, the Lango people had varied means of livelihood. The major livelihood types included agriculture (commercial agriculture, subsistence farming, mixed cash-crop grain farming and horticulture); Livestock production (cattle, goat, sheep, and poultry keeping); Hunting and fishing hence both income and food are obtained from these means of livelihood.

Today, these livelihoods in Lango are distorted and the social safety nets (like lending seeds, free land offer for cultivation and good animal breeds) through which the Langi used to support one another in times of crisis are since destroyed. For incomes and food security to improve, each farmer has to do the followings namely; the land should becomes more productive and farmers produce more so that they have more to eat, and are better able to deal with risks and therefore less susceptible to food and income shocks. In Otuke District, for example, if yields of groundnuts quintupled – from 400 kg to two tons per hectare, every household would have enough to eat till the harvest and sell off the excess to meet other household demands.

Table 2: The main crops grown with yearly outputs

Food Crop	Acreage	Yields (Kgs)	Planting season
Bananas	1-2	Below 100	March- May
Finger Millet	1-2	Below 100	March-April
Maize	1-2	Below 100	March-April
Sorghum	1-2	Above 200	April-May
Rice	1-2	Above 200	May
Sweet Potatoes	Below 1	Below 100	April
Irish Potatoes	1-2	Above 400	April
Cassava	1-2	Below 100	March-April
Beans	1-2	Below 100	June
Field Peas	1-2	Below 100	March
Cow Peas	1-2	Below 100	May
Pigeon Peas	1-2	Below 100	April
Ground Nuts	1-2	Below 100	May
Soya Beans	1-2	Below 100	April
Simsim	1-2	Below 100	July

[8] Ibid.

From Table 3 below, the production levels in Otuke district is way below the production standards from Serere National Semi-Arid Resources Research Institute (NaSARRI). Considering that Otuke is within the catchment area of NaSARRI, these yields are really low and need serious intervention to rectify. Table 2 above shows that farmer households in Otuke get only 15 to 20% of the expected yields due to many factors.

Table 3: Production Standards for selected crops

Crop	Spacing (cm)	Yield Kg/Acre	
		Local	Improved
Finger Millet	30x10	600	800
Pearl (Bulrush) Millet	50x20	n/a	1,000
Field peas	50x20	n/a	600-800
Soya beans	60x10	n/a	800
Sorghum	45x15	500	900
Ground nuts	45x15	500	800
Maize	75x30	1,800	2,800
Beans	60x10	400	1,000
Cow peas	60x30	300	600
Simsim	60x30	400-500	600-800
Pigeon peas	60x30	400	1,000
Sunflower	75x25	n/a	720

Source: NaSARRI, 2011

2.3.1 Crops grown

Locally producing staple food is the best way to ensure food security and to avoid disturbances due to globalization and international uncertainties. In line with the above points, this implies productions in season with minimal inputs to improve sustainability. This would stimulate the search for adapted species and varieties and thus increase cultivated biodiversity. These seasonally produced foods should be better consumed locally. It will optimize the flavours, tastes and nutritional quality of those foods harvested[9].

The agriculture referred to here is crop farming on a small scale and over 80% of the respondents are involved in agriculture. This is higher than the national situation where Agriculture sector engaged 66% of the working population[10]. According to Focus Group Discussions (FGDs), the output from such activity was not enough to sustain a family. As corroborated by information from the FGDs, this is because of the small acreage (less than 2) under cultivation, low production and productivity.

From the Table 4above, it is clear that different crops are being grown in Otuke district namely; beans, soya beans, sorghum, simsim, ground nuts, cow peas, pigeon peas, cassava, finger millet, bananas, rice, sweet potatoes, Irish potatoes and maize among others.

[9] Ibid, Denis Lairon: Biodiversity and Sustainable Nutrition with a Food-Based Approach; in FAO 2012: Biodiversity and Sustainable Diets: United Against Hunger

[10] UBOS, Statistical abstract 2012

2.3.2 Food crops grown

The most common food crops across the three sub counties are; rice 19.1%, beans 17.1%, simsim 16.2%, ground nuts 14.8%, field peas 11%, sorghum 8.1%, cassava 6.7%, pigeon peas 2.9%, potatoes 1.4%, millet 1%, soya beans 1%, cow peas 0.5% and maize 0.5%. It had been noted that, farmers have to select a specific garden which suits a particular kind of crop to be grown. For instance, beans does not do well anywhere but farmers have to cultivate former cattle kraal in order to realise good harvest.

Ogor Sub County has vast quantities of harvested crops at year's end meaning Ogor has the largest food basket. Orum Sub County ranked second and lastly Olilim Sub County. Conclusively, Ogor with the highest food basket is more food secured followed by Orum and the worst affected sub county is Olilim with minimal food basket.

Otuke as a whole does not produce enough food that could last till the next harvest. The analysis has shown that only 24.1% did have enough harvest while 75.9% confirmed not having enough food to take them up to the next season. This might have been contributed by poor soil, long dry spell and inadequate farming inputs. Whatever could have been produced, a quarter of the output remains at household level for family consumption and three quarters of the produce are pushed to the nearby markets in order to raise income to meet a specific family needs

2.3.3 Acreage under cultivation

With the exception of sweet potatoes which are grown on small tracks of land, most of the crops are grown in the range of one to two acres. Most households have between 3-5 acres under cultivation each season. This shows that most household land holdings are dwindling, in the face of chronic food insecurity. According to FGDs, in the past, before the advent of cattle rustling most households in Otuke had over 20 acres each, but now many have less than eight acres since some portion had been sold off to meet family's needs.

2.3.4 Yields

The most common crop produced for home consumption by farmers is sorghum (over 200kgs) followed by rice (over 200kgs). Other major crops produced by farmers in their order included field peas, finger millet, simsim, ground nuts, cassava, sweet potatoes, and maize. These serve as food crops; however some are sold to raise income to meet children's education and family's basic needs. The least produced crops included beans, bananas, cow peas and pigeon peas.

Table 4: Major food crops

Food Crop	Sub county		
	Orum	Ogor	Olilim
Bananas	50%	50%	-
Finger Millet	28.9%	36.8%	34.2%
Maize	42.9%	32.1%	25%
Sorghum	29.9%	45.3%	24.8%
Rice	41.6%	34.8%	23.6%
Sweet Potatoes	37.2%	39.5%	23.3%
Irish Potatoes	-	100%	-
Cassava	45.5%	34.5%	20%
Beans	34.7%	34.7%	30.6%

Field Peas	33.1%	37.9%	29.0%
Cow Peas	16.7%	66.7%	16.7%
Pigeon Peas	20.5%	50.0%	29.5%
Ground Nuts	31.6%	36%	32.5%
Soya Beans	31.2%	37.5%	31.2%
Simsim	36.4%	40.3%	23.3%

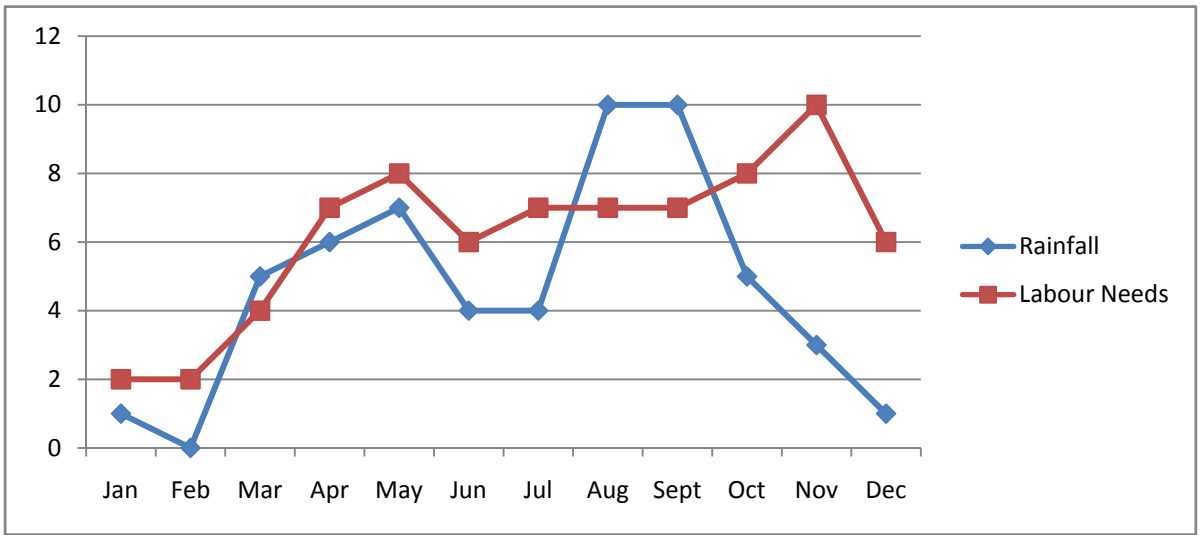


Figure 1: Rainfall and household labour needs in Otuke district

Otuke district lies within the Famine Early Warning System Network (FEWSNET) Livelihood Zone (LHZ) 18 -The Mid-north Simsim, Maize, and Cassava livelihood zone is a bimodal area located in north-central Uganda. Livelihoods in this area focus predominantly on crop production, with some complementary livestock rearing and fishing activities. The area receives approximately 1000-1400 mm of rainfall during the mid-March to mid-June and mid-July to mid-November rainy seasons, and soils in this zone are moderately fertile. The main foods households consume in this zone include cassava, sorghum and millet, and beans. Households also sell beans, as well as simsim and maize. Household food sources in this zone consist mainly of own crop production and market purchases[11].

Figure 1 above shows that the first rains in Otuke start in March up to May and the second rains come in August to October, with midyear dry spell in June to July. This agrees with information from Ngetta Zonal Agricultural Research and Development Institute (ZARDI), which is responsible for technical backstopping of agricultural practices in the Lango sub region. While January and February are relatively open months, most garden preparation is done around this time. Planting starts in February till April; then first season weeding is done mostly in May to June. Harvest of the first season crops starts in July and goes on up to October. Planting and weeding second season crops are also done around the same. The peak labour months are November and December, when the full harvest is done. It is important to not that rainfall and labour demands go hand-in-hand, with the exception of the weeding season and the harvest times.

[11] USAID/Famine Early Warning Systems Network (FEWS NET) 2010, Livelihood Mapping and Zoning Exercise: Uganda

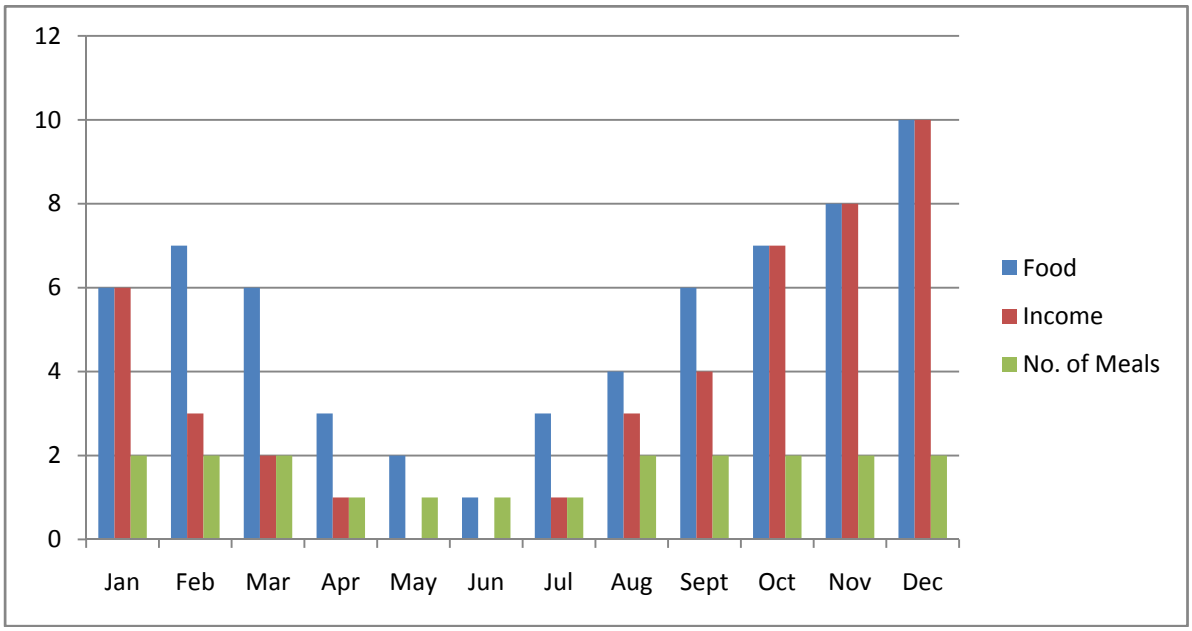


Figure 2: Food availability, income and number of meals eaten

Figure 2 shows that the worst months in Otuke district in terms of food insecurity are May and June. At this time there are very little if any food stocks and the new harvest is not yet in. Most households do not have any veritable income source to buy food, and therefore have to forage to get something to eat. July marks the beginning of the harvest; mostly the first fruits. The full harvests of first season millet, beans, etc. are brought in by August.

> *During these terrible months of May and June we survive on mangoes and Shea nuts, and cook only once a day. So if we are supported with irrigation to grow tomatoes and other vegetables, we shall sell some and eat some. That would help a lot.* –Woman, Orum

Due to the fact that foodstuff is also the source of household income, the two are clearly interlinked as seen in Figure 2 above. Most families in Otuke eat two meals for three quarters of the year. In dire months –April to June, most households serve only one meal a day. This is due to the dwindling food stocks and the labour demands in the fields. This is a time when many survive on Shea nuts, mangoes and early maize.

2.3.4 Number of meals per day

Most households in the project sub counties (61.3%) eat two meals a day, while 33% eat only one meal a day. Only a small minority (5.8%) eat three meals in a day. Ogor Sub County is a little better than its neighbours in terms of the number of meals eaten in households per day, followed by Orum and lastly Olilim. A relatively higher percentage of the households that have three meals a day are found in Ogor and Orum (13.1%) compared to 6.8% in Olilim Sub County. This agrees with the proportion of households producing food lasting till the next harvest where Olilim is worst followed by Orum and Ogor. Thus, many households in Otuke district are food insecure due to the fact that the food they produce does not last till the next harvest.

Table 5: Number of meals eaten per day

Meals eaten in a day	Percent
Breakfast	5.2%
Lunch	39.1%
Supper	55.8%

In spite of the fact that many households have food stores in the form of granaries -22.5% in Ogor, 19.9% in Orum and 17.8% in Olilim, households are still food insecure. The major reasons behind food not lasting till the new harvest, include low yields (65.4%), competing household requirements like school fees, clothing, etc (27.7%), big family sizes 3.1%, poor soils 2.3%, inadequate seeds 0.8%, and land shortage 0.8%. It should be noted that the major contributors to low yields are dry spells and poor soils.

In sub counties surveyed, as shown in

Table 5, households who eat breakfast comprise 5.2%, those who have lunch 39.1% and majority who never miss supper are 55.8%. This is true for the case of a farmer who to have much energy for the next day's tasks and therefore he/she has to eat supper. Thus many people do eat twice namely; at lunch and supper time and a few individuals have breakfast.

2.3.5 Access and availability of food

In the Lango sub-region, the post-conflict period starting from 2006 to 2012 has been characterised by low agricultural production, while food insecurity and malnutrition remained challenges to deal with. Though access to land in the region is high at 60-80%-which presents a huge untapped potential for large scale agricultural productivity-other factors like displacement, widespread poverty, gender inequality in land access, climatic changes and related phenomena like water logging and dry spells have left the area vulnerable and in need of stabilisation for sustainable livelihoods.

Most families in Otuke mainly access food through farming. There is a moderate to worse food insecurity depending on the months and climatic changes in a particular year. For instance; during the dry season, when there are few agricultural activities, many households tend to consume more food stuff than any other seasons and besides; there is a selling of large quantities of food crops compared to what they could have reserved and used in the next season.

Almost all households interviewed agreed that they would look for other available activities in order to raise income. This would be through for instance cultivating a middle-income person's gardens, baking pancakes and local brewing to meet the family's urgent needs like buying food for home consumption from the available markets.

2.3.6 Food varieties and utilization

In Otuke, the main crops grown are majorly food crops like -millet, maize, beans, cow peas, pigeon peas, sorghum, ground nuts, and simsim among others. Crops grown for commercial purposes these include green grams, sunflower, soya beans, rice etc.

Almost half of the crops harvested are consumed at the household level while the remaining half is utilized through selling in the local markets at very low prices. The income collected from the sale of these crops is commonly drunk by men, with a limited percentage used in meeting children's education expenses, buying household utensils and to meet other family expenses. To illustrate, some of the common crops grown, acreages, planting seasons and the yields obtained are as expanded below;

2.3.6.1 Millet

The largest acreage of millet grown per household is 1-2 acres with a percentage of 85.3% and followed by 12.0% of those who grow on a piece of land less than an acre. During the first season, millet being the common cereal crop is highly grown with an average of 35.4% from the month of March-April and in the second season; it is grown from the month of July-August with an average of 9.4%. These months are appropriate because, rainfall is high both in the first and second seasons respectively. The millet yield is poor with 50% recorded for output less than 100kgs got per harvest and 26.3% with a harvest of above 400kgs.

2.3.6.2 Maize

In the first season, maize is grown in the months of March and April with an average percentage of 28.6. The largest acreage per household to grow maize is between 1-2 acres with a percentage of 53.6% and followed by 46.4% of those who grow on a piece of land less than an acre. Before the maize would get dried and harvested, its yields are highly affected by early consumption through roasting and boiling either for home use or for sale as local snacks in local markets. Because the time it takes goes into June when there is a brief dry spell in June, maize is normally affected, except those planted in former kraals.

2.3.6.3 Beans

Beans are normally planted at the end of the first season –in June. Even then, just like maize it does not yield well. With the exception of those planted at the edge of the compounds and in former kraals. This is because the level of soil fertility does not support these two crops, and can only be supported by soils that have additional manure or fertilizer. However, even with minimal mulching and household residues, these crops can do well.

2.3.7 Separate Stocks of Food and Cash Stocks

As soon as stocks are gathered at homes, the farmers always put their stocks in stores where some farmers do separate these stocks into food and cash with 15.2% compared to those who do not separate theirs with 16.8%. This analysis portrayed that most households do not separate their stocks but rather would keep them as a whole in sacks waiting either for future consumption or sell in the available market.

2.3.8 Food Reserves

Farmers in Otuke have stores either inside their houses or built granaries at courtyards where they do keep their dry food stuff after managing post-harvest. Many of the respondents did agree that they reserve their food with a percent of 60.2 whereas 39.8% did not reserve food.

Reasons as to why this happens is that limited yields are always realised despite the fact that, there are many people in a family and other essential expenses like medical care and education that still does depend upon selling little food harvested

2.4 Food security challenges in Otuke district

At the national level, four main challenges face the agricultural sector in Uganda: low production and productivity; low value addition to agricultural produce and limited market access; weak implementation of agricultural laws and policies; and weak public agricultural institutions. For households in Otuke, there are many challenges relating to food security. The major food security challenges facing households in the district include unreliable rainfall 25.1%, low yields 19.7%, limited farming tools 17.9%, little funds for investments 14.3%, crop pests and diseases 12.1%, lack of access to bulk storage facilities 3.1%, soil infertility 2.7%, water logging 2.2%, large family sizes 1.3%, weed management 0.4%, lack of seeds 0.4% and food shortage 0.4%.

Where agricultural production is rain-fed as is in Otuke, vagaries of weather (high temperatures, unreliable rainfall, water logging) are the most formidable of challenges. This is because it affects the fertility of the soil either through leaching of nutrients or affecting the composition of soil due to caking resulting from high temperatures. This affects yield volumes. Then there is the size of households –most have 5-8 people. This requires a lot of resources to feed and sustain.

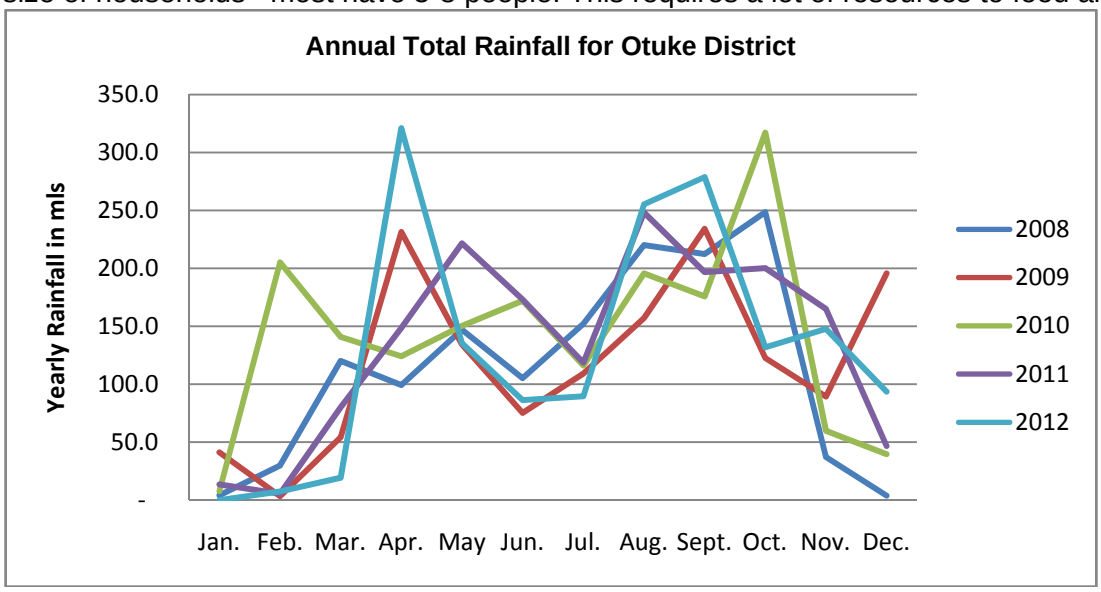


Figure 3: Annual rainfall trends in Otuke from 2008 to 2012 Source: Ngetta ZARDI

From Figure 3 above, it can be seen that while there have been variations in the return of rains the pattern has been that the first rains do not last long enough to sustain crop maturity. The most dreaded month of dry spell is June where farmers would be expecting some of the crops planted in the first season to be maturing for harvest but unfortunately the mid-season dry spell destroys some crops or affect yields leaving farmers with very little, hence food shortage.

Table 6

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
2008	4.2	29.8	120.2	99.3	147.1	105.3	152.2	220.1	212.4	248.6	37.2	3.9	**1,380.3**
2009	41.1	3.3	54.2	231.4	134.3	75.3	109.2	157.1	234.2	122.6	89.4	195.7	**1,447.8**
2010	7.7	205.2	140.8	124.1	150.4	172.0	116.1	195.7	175.8	317.2	59.8	39.6	**1,704.4**
2011	13.5	5.5	80.0	148.5	221.6	173.1	118.6	248.2	196.7	200.1	165.0	46.6	**1,617.4**

2012	-	7.4	19.3	321.1	135.5	86.3	89.7	255.3	278.9	131.9	147.8	93.6	**1,566.8**
Total	**66.5**	**251.2**	**414.5**	**924.4**	**788.9**	**612.0**	**585.8**	**1,076.4**	**1,098.0**	**1,020.4**	**499.2**	**379.4**	**7,716.7**

Source: Ngetta ZARDI

Water-logging and dry spells have been noted to occur in a pattern where one phenomenon precedes the other. The result is that often when communities build capacity to cope with one (say water-logging) then droughts strikes overwhelming consequences as communities are ill equipped to cope with its impact. Over the years weather patterns have increasingly become unpredictable and variable affecting the household's ability to plan and ultimately their resilience. While in the past rains would come back in late February, in the last four years it has been coming back in late March and early April. This has affected the planting seasons.

The situation is further aggravated by the lack of farmer knowledge of national policies regarding land use, soil management, inadequate linkages between research, extension, policy makers and farmers. The needs of farmers and rural communities are not sufficiently linked to the national research and extension agendas, resulting in a generally poor relevance of the outputs of these systems.

The technologies generated by the research system, even when relevant, are not widely taken up by farmers. This is partly because of limited participation of farmers in technology development and evaluation through the reductionist approaches to research. As a result there is limited ownership and adoption of technologies. In addition, poor linkages between research, extension and policy makers are key bottlenecks in agricultural development.

> *At the height of food shortages, there is increased domestic violence because the man would come home and sometimes, there is nothing cooked. So we run to our maternal homes to stay there for awhile and return when things improve food wise* –Woman, Orum

2.4.1 Coping Strategies

It is important to note that the coping mechanisms adopted by the households in Otuke do not sustainably deal with the challenges they face in ensuring food security. The strategies employed include casual labour 51.2%, brewing/distilling alcohol 8.9%, use of insecticides for pest and disease control 8.9%, borrowing ox-plough sets 8.1%, selling foodstuff 6.5%, gathering wild vegetables 4.1%, selling small animals (like chicken) 4.1%, planting vegetables 3.3%, brick making 3.3% and swamp fishing 1.6%.

2.6 Farming practices

The majority of the working population in Uganda is engaged in agriculture, which is the main economic activity. One of the guiding principles of the National Agricultural Advisory Service (NAADS) is to ensure sustainable management of the environment and natural resources. But there are concerns NAADS is not well suited to provide advisory services on environmental and natural resources management. This is because NAADS concentrates on supporting enterprises that farmers select, not on general services and practices required during agricultural production.

The enterprise selected by farmers (piggery, animal traction or apiary) would be the one that fund is granted for and its procurement committee will select the potential firm to supply the required products or services. That means there is a critical need for farmers to be in groups on food security, land and water management in Uganda. Continuously review NAADS and reflect

on ways on how to integrate environmental and natural resource issues. Farmers forum on food security, land and water management provide key lessons on doing so.

The National Agricultural Research and Extension Policy reforms being implemented in Uganda aim to build a more client-responsive and effective research system that fully recognizes and builds on the NAADS concepts of pluralism in agricultural services delivery, technology innovation and a client-driven approach to service delivery and technology uptake. The policy urges research institutions to develop partnerships with a variety of providers of advisory services, particularly NAADS, to orient themselves towards clients and disseminate technologies and information to poor farmers. Reviews of the research system state that farmer institutions will be at the core of the research programme, with grassroots responsibility vested in farmer groups established under the NAADS programme.

The Ugandan government's National Development Plan (NDP) identifies agriculture as the engine of efforts to combat poverty. The government's plan for modernizing agriculture attributes falling agricultural productivity to weak farmer–extension–research linkages that fail to respond to the real needs of farmers. The government aims to enhance extension and research efforts through increased responsiveness to farmers' needs. Farmer field schools offer one way to do this.

In almost all the sub counties in Otuke, subsistence farming is practiced with the highest production of cereal crops compared to other indignant crops. This is possible due to the type of soil texture in place combine with the semi-arid climate that this area usually experienced.

Understandably, the area has a good number of cattle possibly through animal re-stocking despite the fact that most of the animals were grabbed away by cattle rustlers. Almost three quarters of the households did have ox-ploughs to easy in land cultivation of major crops. They make good use of this during the first and second land preparations as well as normal crop sowings and plantings. However, this does translate in to good harvests due to a number of factors like poor soils, poor farming practices, unreliable rainfall pattern and lack of alternatives to rain-fed agriculture. The farmers, who could not afford this kind of equipment, would use local available tools such as hand hoes and pangas.

Families did expand especially at the time of cattle rustling where young boys were coerced into marriage as a way not to lose animals. A scenario where a father has to divide 30 acres among three or more married sons is common. He would leave 10 acres for animals grazing, each son to cultivate 5 acres each and the father remains with five acres.

With the local farmer's attitude to plant all sorts of crops, it will leave no land vacant during the two rainy seasons. In most households, farmers do use traditional methods of farming namely; cereals are sowed through scattering process and very few crops are planted in lines with the help of strings. Besides, there is limited soil enrichment through crops mulching, crops rotation, land fallowing and application of natural manual in the respective gardens.

In Otuke, the soil is being degraded at a fast rate –being washed away and nutrient leaching and soil fertility loss. Soil and water conservation practices like mulching, contouring, etc are practiced by less than 10% of the farmers. This leave the fertility of the soil to chance and with the increasing dry spells, returns to investments are very low.

2.7 Water availability, access and use in agriculture

2.7.1 National

To mitigate the challenges facing agricultural production, the DSIP is designed to address these constraints in four investment programs:

- Increasing agricultural production and productivity;
- Increasing access to markets and value addition;
- Creating an enabling environment for the private sector in agriculture; and
- Strengthening agricultural institutions at the centre and in local governments[12].

To this end, the Ministry of Agriculture, Animal Industries and Fisheries has come up with various programmes and projects. These include;

- Bulk water supply strategy of pumping water from large water sources - The aim of this programme is to transfer water from areas of plenty to areas of scarcity in order to ensure adequate supply of water all year round for multi-purpose use. This is a countrywide strategy that will result in construction of bulk water supply schemes in various areas to ensure easy and reliable access to water for productive uses. Construction of the pilot scheme in Rakai District commenced in the 4th quarter of FY2010/11. Government's priority in the Water sector will be to provide water for production. The component for bulk water supply previously under the Agricultural Sector has now been transferred to the water sector. As a result, the total allocation to the water sector in the Financial Year 2012/13 has increased from Shs 271 billion to Shs 355 billion. Government's priority in the Water sector will be to provide water for production. The component for bulk water supply previously under the Agricultural Sector has now been transferred to the water sector. As a result, the total allocation to the water sector in the Financial Year 2012/13 has increased from Shs 271 billion to Shs 355 billion.[13]
- Construction of dams and valley tanks - The Government through the Ministry of Water and Environment is implementing several activities to increase water storage for agricultural and multipurpose use throughout the country. Construction of the facilities below is ongoing in various districts around the country and upon completion; all the facilities shall create storage capacity of over 10 million cubic meters.
- Provide irrigation facilities in the drought prone areas - The Ministry of Water and Environment is in the process of developing an irrigation master plan. Currently, the Ministry is overseeing reconstruction of four irrigation schemes of Mobuku in Kasese District, Doho in Butaleja District, Agoro in Kitgum District and Olweny in Lira District under the Farm Income Enhancement Forestry Conservation (FIEFOC) Project.[14] The 1,000-hectare Doho scheme was reconstructed at 18 billion shillings and Agoro scheme was expanded from the original 350ha to 650ha at a cost of 29 billion shillings[15].

In view of the high costs involved in big irrigation schemes, in 2011/12 MAAIF carried out demonstrations of household irrigation in Apac, Hoima, Kabaale, Isingiro and Yumbe. Each of these irrigation demonstrations were established on a hectare of land. Focus was on farmers who are willing to allow others access their land for learning purposes. Each of these demonstrations cost UGX 25m (Twenty five million shillings only) for technology, training and

[12] *MAAIF 2010: Agriculture for Food and Income Security:* Agriculture Sector Development Strategy and Investment Plan: 2010/11-2014/15
[13] Ministry of Finance, Planning and Economic Development, Budget Speech Financial Year 2012/2013
[14] www.maaif.go.ug
[15] Interview with James Sunday Mutabaazi, Commissioner Farm Development

accessories. In 2012/13, 33 demonstrations were planned, seven have been done and 26 will be done under framework contract arrangement to beat the bureaucracy involved in government procurement procedures[16]. The government is also planning for six water reservoirs to take water downstream –two in the north, three in Karamoja and one in Isingiro district.

At the national level both the Ministry of Agriculture, Animal Industries and Fisheries (MAAIF) and the Ministry of Water and Environment are working toward provision of water for agriculture. Government of Uganda has identified areas of weakness in the PMA and earlier policy frameworks and addressed them in this five-year Agricultural Sector Development Strategy and Investment Plan (DSIP) 2010/11 – 2014/15, which is in line with the agricultural priorities in the National Development Plan (NDP).

The strategic objective of the NDP and its agriculture sector component, the DSIP, is the achievement of Prosperity for All, which is our national development objective. The DSIP will be implemented to raise rural household incomes and improve the food and nutrition security of all Ugandans.

2.7.2 Otuke district

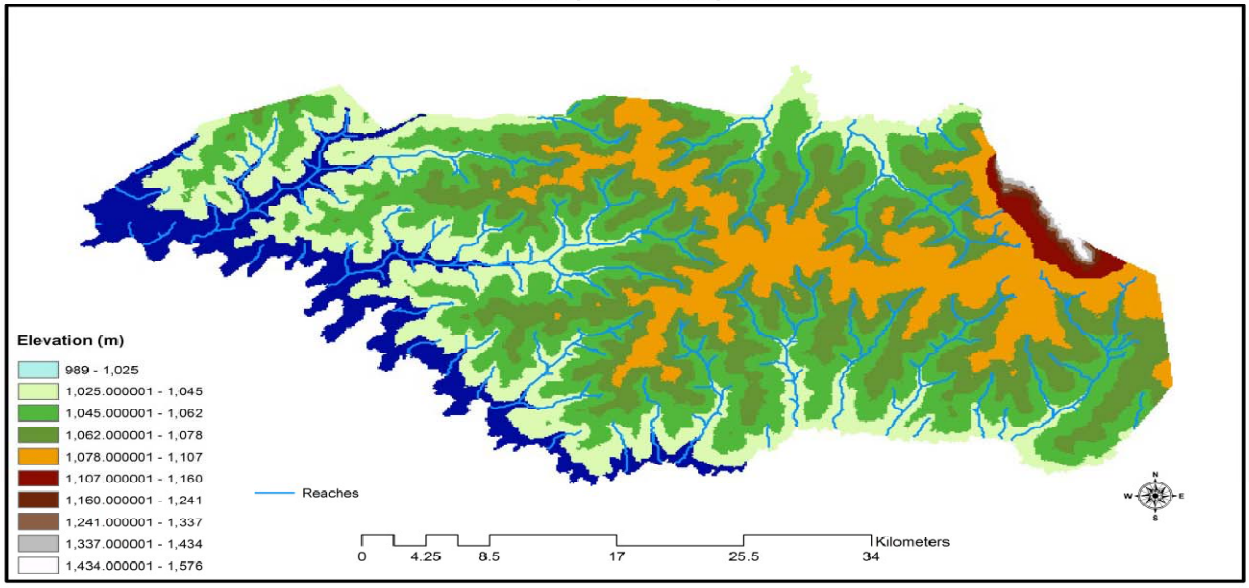
There is substantial water coverage in Otuke as there are water points like man-made dams constructed by government, large swamps with nearby shallow wells and dug boreholes a round schools, health centres and trading centres. There are areas also with tap water facilities especially in locations where former displaced persons had settled and these taps were provided on a humanitarian ground by some local and International NGOs that came in through the Government of Uganda.

According to the Department of Meteorology, Ministry of Water and Environment, generally there is an increased likelihood of near normal to above normal rainfall (more rain than usual) over most parts of Uganda. The region where Otuke falls is experiencing occasional light showers and thunderstorms up to date. The onset of steady rains is expected early April and relaxes a bit towards end of May thus; near normal to above normal rainfall is being experienced in this region. However, the actual situation on the ground was different. Most places were dry with no rain at all. This illustrates the difficulty in linking technical information to

[16] Interview with Eng Kato Andrew, Water Engineer, MAAIF

farmers.

Watershed and major drainage in Otuke



Otuke experiences bimodal rainfall, having two rainfall seasons –March to May and August to October, with the rest of the months dry. The brief dry spell of June-July is the main cause of mid-season crop failures and yet ironically, the water logging due to the heavy rains in August to October destroys harvests. The area receives approximately 1000-1400 mm of rainfall during the mid-March to mid-June and mid-July to mid-November rainy seasons, and soils in this zone are moderately fertile.

2.8 Rain water harvesting

Only 20.4% of the households in Otuke harvest water –with 9.9% in Olilim, 5.8% in Orum and 4.7% in Ogor. This is mostly done by those who have tin (iron sheet) roofs. Even then, there is very limited water harvesting technology in use. Apart from government institutions like the one shown here, most houses do not have gutters and tanks for rain water harvesting. The harvested water is mostly for washing and drinking. There is a problem with storage as many households said the water goes bad quickly. The 79.6% did not harvest water as many of the households have grass-thatched houses that make harvesting difficult.

2.8.1 Run-off water

The technology used for run-off trapping involves the rudimentary pits dug at the end of the compound. The reservoir is a hand-dug pit with no concrete floor as well as walls thus; the trapped water lasts for one to two weeks only, as much water is lost through seeping and evaporation. The community feels that there is no use for run-off water since it is dirty and unfit

for human consumption since this water logs breed germs and worms. Run-off water is mostly trapped to make blocks or bricks.

2.8.2 Other Sources of Water

The other sources of water available in the project sub counties include swamps, small dams - Oget in Orum; Ikwee dam, Odite dam, Awio dam, Awito dam, Oderokec dam, Anepkide dam in Olilim and boreholes sunk during GWI phase I and by other stakeholders. Besides available natural water sources, there are many boreholes that have been constructed by some Civil Society Organizations for instance; CARE International in Uganda and Action Against Hunger did built up water points especially in villages where re-settlements from IDPs camps. The boreholes that were constructed by Action Against Hunger (ACF) (a GWI Phases I & II partner) had accompanying waste water pits to collect water away from the boreholes. Additionally the communities were supplied with treadle pumps to draw the water from the pits for whatever uses they deemed fit. The water is used to make blocks or bricks.

As noted above, Otuke farmers still use traditional method of farming whereby things like soil moisture is a new concept that would required systematic sensitization and training and could be demonstrated on a plot for quick and easy assimilation of knowledge.

2.9 Current level of investment in water for agriculture technologies

2.9.1 Household

The targeted households in the project sub counties do not harvest water. Neither rain nor run-off water is being harvested for farming purposes. While the majority sleep in grass-thatched houses with no rain water harvesting possibilities, even those with iron sheet roofs are not doing so. However, in nearby Adwari sub county, Welt Hunger Hilfe is promoting double-dug trenches to trap run-off water in the gardens. This staves off water-logging and retains water for the crops during the brief dry spells. This is a good strategy to reduce the mid-season crop failures during June and July.

2.9.2 Community

The boreholes that were constructed by Action Against Hunger (ACF) (a GWI Phases I & II partner) had accompanying waste water pits to collect water away from the boreholes. Additionally the communities were supplied with treadle pumps to draw the water from the pits This water is only used for making blocks for building and bricks for both sale and own construction.

2.9.3 District level

The investments in rain-water harvesting technologies are basically being implemented at the government facilities like schools and health centres. This is seen at facilities constructed by Northern Uganda Reconstruction Programme-2 (NURP II), Northern Uganda Social Action Fund (NUSAF II), and Peace Recovery and Development Plan (PRDP II). This water

however, is for human consumption and not use in agricultural production.

2.10 Potential water for agriculture technologies

The dams and large swamps that do not get dried-up in a year are used to cater for animal consumption where farmers would graze their animals and later on take them to drink water which might be of some distance. There is rice farming near swampy areas mean while, cabbages, tomatoes and vegetables growing very scarcely in deed.

In the whole district, there is no set up irrigation system in place but in few locations, farmers do horticulture along swamps during the dry spelt to provide basically family food and some are sold in the nearby markets. In Adwari, the dam setup is mainly for fish production and animals watering in the surrounding neighbourhood. It would be good for irrigation but at the moment it is not yet established.

2.10.1 Other Actors

There organization supporting improved livelihoods in Otuke district. These include NCBA Clusa, Welt Hunger Hilfe and Beads for Life.

2.10.1.1 NCBA Clusa

The organization is supporting increased production and productivity by promoting conservation agriculture in Otuke district. They are working in Adwari, Ogor and Orum. They are promoting value chain in beans, soya and maize. They link farmers to inputs, financial, tiller and marketing services (through bulking centres and marketing committees are being formed).

2.10.1.2 Welt Hunger Hilfe

WHH is promoting double-dug trenches as an on-farm water conservation strategy to stave off mid-season crop failures. Farmers are encouraged to dig off the top soil and heap where they will plant crops. It is mostly done for horticultural crops. They dig the trenches at intervals, allowing for space to walk between the heaps where plants are planted. Since the trench stops at the beginning of the sub soil, when it rains, water collects in the trenches and slowly seeps under the heaps thereby watering the plants. The heaps are mulched for further moisture retention.

2.10.1.3 Beads for Life

Bead for Life is supporting poor women in Otuke district. Poor women identified based on a set of criteria. They make beads that are bought by the organization and sold. There are 700 Shea nut gatherers, who collect organic Shea nuts and sell to Beads for Life. Each woman gathers nuts worth UGX 130,000 season. But this is not enough to meet their household needs. An assessment was done and it was found they have land but no ploughs to open land. Women were organized into groups of tens. They are given an ox-plough set and they have to pay back until they finish. When the women get a bumper harvest, they ask Beads for Life to help them get market.

Another need that came up during their initial assessment was water. There are many boreholes in Otuke, but they are not operational for one reason or another. Due to operation and maintenance (O&M) issues, Beads for Life is interested in hand dug wells with pumps or roller pumps.

2.10.2 Water for Agriculture technologies available[17]

Institutions that produce or sell technologies for water for agriculture are mostly located in Kampala namely at Namalere Agricultural Engineering Institute, Davis & Shirtliff where these equipments are produced. Namalere produces treadle pumps on order. Davis & Shirtliff has both fuel-powered and manual irrigation pumps. For accessories like irrigation pipes, Multiple Industries Ltd is the largest producer/supplier, for different purposes.

Irrigation is useful during dry season, especially in places like Otuke where evapo-transpiration rate is so high normally above 6 ml per square metre of water is being lost per day. In order to balance this challenge, one has to irrigate each crop by supplying water according to the respective crop co-efficient. The volume of water needed for irrigation depends on the size of the farm in terms of acres and spacing of the crops. This calculation would aid one to know the actual volume required to irrigate the size of land as well as the number of crops planted to be watered. Good irrigation practice is conducted early morning and the recommended time is 9:00 a.m.[18]

In the whole district, there is no set up irrigation system in place but in few locations, farmers do horticulture along swamps during dry spelt to provide basically family food and some are sold in the nearby markets. In Adwari, the dam was setup mainly for fish production as well as for animal's watering in the surrounding neighbourhood. It would be so good for irrigation but at the moment it is not yet established.

The deeper the tank constructed the better. For example a pit of about 6 meters deep with a narrow width and length would reduce the surface area to limit evaporation. The activity should move hand-in-hand with crop mulching and the positive aspect of this venture is that it saturates the soil hence; crops would do well without much stress that could lead to withering.

2.10.2.1 Manual Pumps

Treadle pump -Namalere is a government Agricultural Engineering Institute that provides appropriate technologies and innovation for prosperity. One of the things that they do provide is irrigation technologies and these include; drip irrigation and sprinkler irrigation. Pumps that could support in this are manual and power driven. No two irrigation systems are the same but it depends on the terraces surface. At Namalere, one has to place an order for the pump and pays an instalment before it is made.

Super Money Maker Treadle Pumps (Davis & Shirtliff) -This manual pump can draws water from 7 meters deep and pushes up to 7 meters. The only known challenge is wear and tear of rubber cups that would requires replacement every two years and it is advisable to have in more than two rubber cups in place because it would be very difficult to access in up country markets. This technology poses a problem for women, as it requires a lot of energy to tread.

Super Money Maker Hip Pumps (Davis & Shirtliff) involve the use of the legs as one pumps, water of volume about 1.4 litres are drawn up per stroke made. The force exerted down, would also imply the volume of water that will come out into the gardens. It is easy to use as well as manage by farmers. However, due to the energy required to pump, it is not very friendly, especially to women.

[17] See Appendix I for a summary of water for agriculture technologies available
[18] Tobias Oker, Water and Irrigation Research Officer, Namalere Agricultural Engineering Institute

2.10.3.2 Fuel-powered pumps

Davis & Shirtliff Group is a supplier of water related equipment in the East African region. Founded in 1946, business activities are focused on six principal product sectors - water pumps, borehole equipment, water treatment, swimming pools, solar products and generators. The group is Kenyan based and operates through a network of Kenyan branches as well as regional subsidiaries in Uganda, Tanzania, Zambia, Rwanda and Ethiopia.

Davis & Shirtliff regionally distributes water equipment from a number of industry leading companies from around the world as well as carrying out manufacture and assembly of various water related products. With a total staff complement of over 250, particular emphasis has been placed on infrastructure investment and the company is extremely well resourced with modern office facilities, a fully integrated ICT network and large product and spare parts stocks. It is also ISO 9001:2000 certified to demonstrate its quality focus. Recognizing that the provision of efficient water supply is essential for the region's economic development, Davis & Shirtliff is committed to playing a major role in this vital industry by offering a comprehensive and competitive product range with regional availability and unrivalled technical and service support.

The Davey 5 Series Engine Pumps are innovative high performance products that have been specially developed to meet wide-ranging requirements for water supply including irrigation and fire fighting. With the benefit of many years experience in the production of high-pressure engine pumps, Davey has engineered a completely new and highly advanced design incorporating a number of unique features in a robust pump with the following features:-

- Large capacity pumps casings providing highly effective self-priming performance.
- Large priming and drain ports with twist-action bayonet type plugs for simple use.
- Multiport discharge heads with convenient integral lifting handle.
- Patented clamped impeller design for improved efficiency and easy obstruction removal.
- Impellers also feature floating seal rings and thrust balancing for extended pump life and optimal performance in the most arduous of operating condition

There are various technologies on display at the show room. Bulk orders are delivered within one month of order/payment. Davey (High pressure) -This is a power driven pump that pushes water up to an altitude of 70 pushing to approximately 200 meters, drawing from a depth not exceeding 7 meters from the water source.

2.10.3.3 Double-dug trenches

Double-digging is loosening the soil more than 12 inches down to create conditions under which plants' roots thrive. At one end of the bed a foot-wide by a foot-deep trench is dug across the bed's width, placing the excavated dirt in a wheelbarrow. Next, a garden fork is worked into the floor of the trench and slowly rocked back and forth to loosen the soil. A second, similar-sized trench is excavated next to the first, this time placing the excavated soil in the first trench. Loosen the soil at the bottom of the second trench with the garden fork. Dig another trench and backfill the second trench, loosen the bottom of the third trench, and continue this process until you reach the end of the bed. Then the last trench is filled with the soil excavated from the first, and the series continues. This technology is gender-neutral.

Reasons for double digging -Carrots, potatoes, beets, and other root crops need deep, loose soil to grow well. More important, double-

digging is the first step in creating the most productive garden bed possible, insists John Jeavons, author of How to Grow More Vegetables (Ten Speed Press, revised 2002). "Double-digging adds air deep into the soil and enables roots to grow and the microbes to create good soil structure," Jeavons says. This is, no two ways about it, a labor-intensive approach. But if the soil where you want your garden is very dense or hard-packed, making the effort to do this will pay you back handsomely as your garden grows.

2.10.3.4 Rope pumps

As a strategy to mitigate the laborious nature of the hip and treadle pumps, the rope pump (above) is a more women-friendly technology to draw water from the reservoir, for irrigation. GWI phase one promoted rope pumps to provide water for human and animal consumption. This same technology can be used in providing water for agriculture.

It involves excavating 1.5m diameter (hand dug) of traditional water holes or siting them a distance of about 30m from the existing water holes. They are lined with HDPE plastic rings down to the bottom and a rope washer pump is installed as means of extraction. This technology was developed to improve seasonal wells used by community members and to provide improved water supply for the communities. The main advantage associated with this technology is that water does not subside in dry spell.

The major caution with rope wells is that all rotations should be done in the recommended direction. Therefore any contrary rotation will lead to the rope falling and will necessitate replacement. Frequent breaking of the string/rope is also a major challenge

2.11 Impediments to investing in water for agriculture

There has been talk of water for agriculture in Uganda for long, that is the concerned ministry and other agencies that would avail information on water for agriculture but at the ground level, implementation would take many years besides politicking. In Otuke district, the central government has planned by constructing multi-purpose dams. However, while these plans are under way, the general population is not aware.

According to the Director Crop Production (MAAIF), a team was sent to verify data and finalise the plans to use Akwera dam for irrigation purposes, but the population chased the technical team away. This, according to district authorities, was due to lack of information and community mobilization. The people of Otuke are farmers who grow traditional crops for consumption purposes while selling surpluses to meet income needs of their households. The agriculture practiced in the district is purely rain-fed with not much farmer innovation to deal with the dry spelt during the year, save for swamp rice growing and small scale horticultural production.

2.11.1 Awareness

Over 65% of the farmers in Otuke district are not aware that water for agriculture is one of the remedies to their chronic food insecurity. The only use of water outside rain-fed agriculture is swamp rice growing practiced in many parts of the project sub county. Even then, the way the farming is done does not conform to any technical guidance on swamp soil and water conservation.

2.11.2 Knowledge

While many Ugandans have heard about irrigation, very few have tried it out, because of lack of knowledge on how to go about it. However, with the advent of climate change, many farmer

households are increasingly failing to sustainably feed their families. Even extension at the district and community levels has not focused much on irrigation due to high cost involved in acquiring and maintaining the equipment.

Some farmers have some knowledge on water for production but have done nothing to put such knowledge to use. This applies mostly to farmers who have moved to other parts of the country or have heard of irrigation. It also includes those who worked in the government citrus farm in Aloi Sub County in Alebtong district, which was using sprinkle irrigation.

2.11.3 Interest

Because most parts of the country have two rainfall seasons, many practice rain-fed agriculture, and are not very keen on additional efforts like water for agriculture. For example, Appropriate Technology International, later AT (Uganda) promoted the *Money Maker Treadle Pumps* in the 1990s, including in Otuke district but there was very low level of adoption of simple technologies for irrigation at household levels. The reasons are; high cost of the equipment which the poor community could not afford to buy, setting up tanks for water storage is too expensive for a village farmer and lack of group commitment to adopt the new idea.

For example, while GWI partners constructed excess water collection pits in Amwa village and Orum Primary school, among others and supplied treadle pumps to draw out the water agricultural use, there are no seed beds or irrigation projects around these facilities. The population either use the water for block and brick making, or just pump it out in cases of overflow.

2.11.4 Cost

The second impediment is costs involved. With raving poverty, many households cannot afford the demonstrated water for agriculture technologies. The cheapest irrigation technology is in the range of 2,500,000 shillings for technology and accessories. This is more than most farmers can afford at once.

2.11.5 Availability

The other bottleneck is unavailability of the technologies. There are no stockists around, making it difficult even for those who could afford and wanted to try to access the technologies. Most of the technologies available are in the big towns like Kampala, Jinja and Mbale.

2.13 Technical considerations

2.13.1 Soil and water management

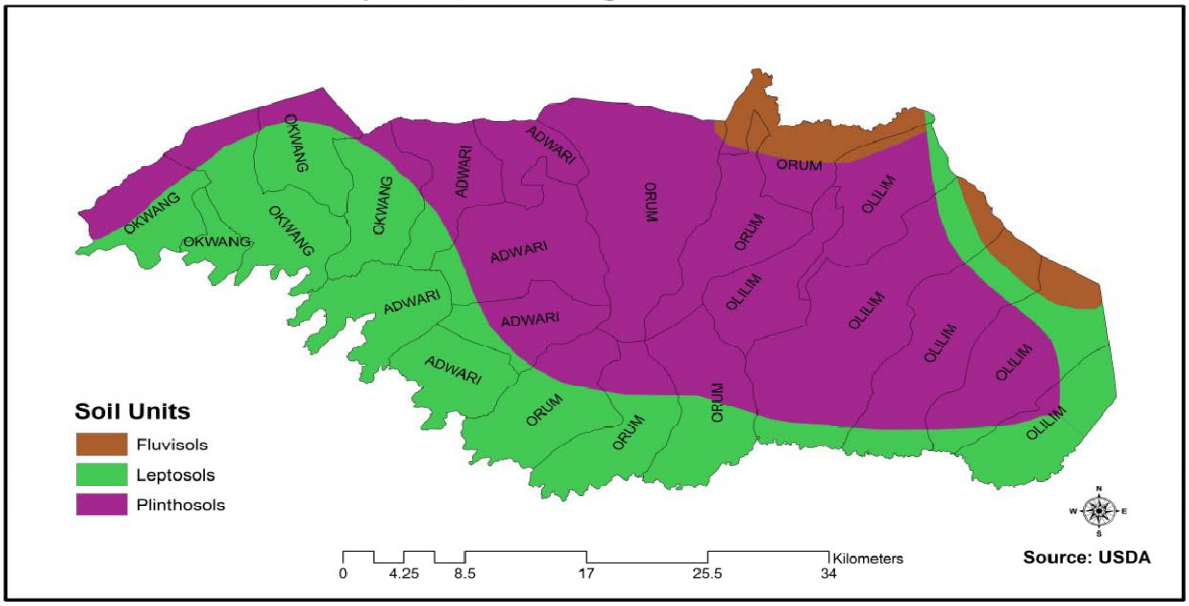
Inappropriate land and water management is a major problem constraining the development of agriculture in Africa. Soils are being depleted year by year. Once-fertile soils are becoming less productive because of poor management and inappropriate farming practices. The soil is compacted or pulverized by repeated ploughing, and nutrients are run down through continuous growing of the same crops and inadequate measures to restore organic matter – the basis for soil life and productivity. Rainwater fails to seep into compacted or crusted soil; so much of it runs off, carrying with it the valuable topsoil with substantial losses of precious water and plant nutrients. Crops suffer due to impeded rooting, water shortage and nutrient deficiencies, and the build-up of weeds and soil-borne diseases further compromise crop productivity. Soil nutrient depletion is one of the major constraints to food security and economic development in sub-Saharan Africa. Research has indicated declining soil productivity, relatively low nutrient

stocks and negative balances for major nutrients (nitrogen, phosphorus and potassium) (Stoorvogel et al., 1993).

Major causes of soil degradation are poor farming methods, including nutrient mining without replenishment, soil erosion, deforestation; poverty and land fragmentation; and rising human populations. Land degradation has far-reaching implications on livelihoods, ranging from low agricultural productivity (posing a risk of food insecurity, poor nutrition and health) to poverty (resulting in a failure to meet basic social needs such as food, shelter and education).

The Soil Fertility Initiative, supported by the World Bank, FAO and other partners in 20 countries in Africa, highlighted the need to mobilize behavioural changes in the use and management of land and water resources and to provide a supportive policy, technical and institutional environment for ensuring the long-term productivity of farmed lands.

Soil map of Otuke showing different soil units



The soil map above shows that the central part of Otuke district is dominated by Plinthosols which have very poor drainage. The southern part is characterized by Leptosols which drain imperfectly, and only pockets in the north eastern parts have Fluvisols which have good drainage. This is the main reason behind the wide spread water logging especially during the second rains. It is only patches of the north-eastern parts (bordering Otuke rock) that have Fluvisols which have good drainage.

2.13.2 Approximate irrigation water volumes for selected crops

Different crops require different amounts of water for irrigation depending on the evapo-transpiration rates of the area and the water needs of the plant. Using a quarter acre, the

following crops would require the volumes of water below. These calculations would help in determining the size of the water reservoir a household will need for particular crops.

Table 5: Water needed for selected vegetables grown on quarter acre land

Crop	**Crop Coefficient (K_c) average**	**Plant population per $^1/_4$ acre**	**Water required (litres) per irrigation session**
Onions	0.9	10,000	972
Tomatoes	0.85	5,625	516
Cabbages	0.9	5,625	547
Egg plant	0.85	10,000	918
Green pepper	0.85	10,000	918
Indigenous vegetables	0.7	10,000	756

Source: Namalere Agricultural Engineering Institute

2.13.3 Investment in water capture, storage and supply for agricultural use

To provide water for agriculture for households, the levels of investment will be dictated upon by many factors. This will include nearness to a permanent water source, the topography of a household's land holding, the available labour force and the kind of crops to be grown. The good news is that with the exception of Ogor, Otuke is endowed with many perennial water sources. These include swamps, dams, springs, wells and boreholes. The water from these points can be drawn to farms in the vicinity by farmers.

2.13.3.1 Rain water harvesting

With two rainfall seasons, the population of Otuke need to invest in rain water harvesting for agriculture. PVC tanks are available in the market, at various prices. A $5m^3$ tank costs between two and three million shillings. Water harvesting can also be done by digging up pits to capture water from roofs or gardens to be used for irrigation. These need to be pits that can collect an average of 10 cubic meters of water. The advantage of water collection pits dug in the gardens is that the pumping distance is shorter and thus less laborious. The approximate cost for constructing a 1mx2mx3m pit with a six cubic metre ($6m^3$) capacity is 300,000 shillings, without irrigation accessories. This would include excavation, some base screening to reduce water seeping and logs to cover it to prevent accidents and reduce evaporation, as noted by the Irrigation Research Officer at Namalere Agricultural Engineering Institute.

2.13.3.2 Run-off management

Farmers can dig up pits at the edge of the compounds, near roads that are close to their gardens, at the end of off-shoots branching into their gardens or even in the middle of gardens. The costs involved are similar to rain water harvesting above. It should however be noted that the availability of water of this source is purely dependent on rainfall, and during extended dry spells, this technology is rendered redundant.

2.13.33 Water from Swamps

There are many perennial swamps in Otuke. These can be source of water for agriculture all year round for households in their vicinity. They could also be locations for group irrigation projects, where simple technologies like treadle and hip pumps can be used to produce crops for food and the market. In this instance, what would be required are a hip pump worth 200,000 shillings and irrigation pipes worth approximately 3,000,000 shillings for drip irrigation; and 1,500,000 for sprinkler irrigation, if the gradient allows.

2.13.3.4 Double-dug trenches

Digging up the double-dug trenches, which is the only cost, would need approximately 50,000 shillings for a quarter acre plot of land. This technology is gender neutral as it does not impose additional burdens on the farmer household irrespective of the gender of the household head. However, double-dug trenches can only be treated as a water conservation technology, but not an irrigation technology. It improves plant growth rates and water retention for crops.

2.14 Scenarios[19]

Based on the irrigation technologies available, the following options are proposed. Generally, with water pressure of 2 bars or below, only drip irrigation is possible. If the water pressure is between 3 and 8 bars, sprinkler irrigation is possible. An acre costs drip lines worth 11 to 12 million depending on the spacing of the crop[20] and the sprinkler system costs 6 million per acre. Drip lines exist in 16mm, 24mm, etc dimensions. Acre would require 40 sprinklers with a radius of 12 meters each i.e. 5 lines of 8 sprinklers each.

Scenario One: Super Money Maker Hip Pump

The pump will cost UGX 200,600 (inclusive of taxes). It can pump from a depth of 7 meters and can push water up to 200 meters away. It yields 600 liters per hour, with two people pumping. It is labour intensive. Since that a quarter acre of tomatoes would require 516 m^3 for irrigation per season; the farmer would require drip lines worth 2,500,000 to 3,000,000.

If the farmer dug a 1mx3mx3m (9,000,000 litre capacity) reservoir, it would cost approximately UGX 350,000 (including logs for covering the reservoir. It would take two people to tread for 30 minutes each per irrigation session. Labour hire for pumping the water would be UGX 3,000 per session. For 12 weekly irrigation sessions, it would cost UGX 36,000. Thus, the total investment required would be approximately 3,500**,**600 Shillings. If a farmer were to invest in equipment to grow tomatoes on a quarter acre piece of land. If he uses the recommended spacing, he should get 4,000 plants. Each tomato plant produces 20-50 fruits. The farmer would get 20 fruitsx4,000 plants=80,000 tomatoes. If it were sold at UGX 100 each, the farmer could expect returns of approximately UGX 8,000,000. This would mean a seasonal net income of UGX 4,500,000.

It has the risk of tiring the rib cage and arms and is not very sensitive to women, since they do most of the work at home and in the field.

Scenario Two: Super Money Maker Treadle Pump

[19] These scenarios are based on researcher's computations, corroborated with scientific facts.

[20] 30cm spacing cost UGX2,000/meter, 45cm costs 1,800/meter, 60cmcosts 1,600/meter, blanks cost 1,200/meter and drippers cost 1,000 each.

The pump costs UGX 370,000 (inclusive of taxes). It can pump from a depth of 7 meters and can push water up to 200 meters away. It yields 600 litres of water per hour, with two people pumping. Considering that a quarter acre of tomatoes would require 516 litres for irrigation per session; the farmer would require drip lines worth 2,500,000 to 3,000,000.

If the farmer dug a 1mx3mx3m (9,000,000 litre capacity) reservoir, it would cost approximately UGX 350,000 (including logs for covering the reservoir. It would take two people to tread for 30 minutes each per irrigation session. Labour hire for pumping the water would be UGX 3,000 per session. For 12 weekly irrigation sessions, it would cost UGX 36,000. Thus, the total investment required would be approximately 3,500,600 Shillings. If a farmer were to invest in equipment to grow tomatoes on a quarter acre piece of land. If he uses the recommended spacing, he should get 4,000 plants. Each tomato plant produces 20-50 fruits. The farmer would get 20 fruitsx4,000 plants=80,000 tomatoes. If it were sold at UGX 100 each, the farmer could expect returns of approximately UGX 8,000,000. This would mean a seasonal net income of UGX 4,500,000.

It is labour intensive. It has the risk of accidents, as the tread pedal has no straps to secure the foot of the pumper. So as water splashes around, one could slip off. It tires the hip and legs. It is not very sensitive to women, since they do most of the work at home and in the field.

Scenario Three: Rope Pumps

It involves excavating 1.5m diameter (hand dug) of traditional water holes or siting them a distance of about 30m from the existing water holes. Then a rope washer pump is installed as means of extraction. The total cost of establishment is approximately UGX 1,300,000 for excavation and the rope pump. It would cost approximately 4,300,000 with drip lines.

It can pump from a depth of 10 meters and can push water up to 100 meters away. It yields approximately 1,000 litres of water per hour, with two people pumping. Considering that a quarter acre of tomatoes would require 516 litres for irrigation per session; the farmer would require drip lines worth UGX 2,500,000 to 3,000,000.

It would take one person to pump for one hour each per irrigation session. Labour hire for pumping the water would be UGX 3,000 per session. For 12 weekly irrigation sessions, it would cost UGX 36,000. Thus, the total investment required would be approximately 4,336,000 Shillings. If a farmer were to invest in equipment to grow tomatoes on a quarter acre piece of land. If he uses the recommended spacing, he should get 4,000 plants. Each tomato plant produces 20-50 fruits. The farmer would get 20 fruitsx4,000 plants=80,000 tomatoes. If it were sold at UGX 100 each, the farmer could expect returns of approximately UGX 8,000,000. This would mean a seasonal net income of UGX 3,664,000.

It is less labour intensive and is energy saving and appropriate for women farmers too.

Scenario Four: Davey 5165 and 5265H Petrol-powered Pumps

The pump has a 3.8-liter tank. It can pull water from a depth of 7 meters and head of 70 meters and can push water up to between 500 meters and one kilometre. It yields 15 cubic meters per hour using 1.8 litres of petrol. Davey 5165 costs UGX 3.5m and 5265H costs UGX 4.5m (inclusive of taxes). It can pump enough water for even leafy crops like beans, maize, etc. It can supply to irrigate 10 acres in two hours or 20 half acres in one hour, or 40 quarter acres.

If we take a litre of petrol to be UGX 4,000, this means it would take UGX 16,000 to irrigate the 40 farms in different directions around a dam. Irrigating tomatoes for 3 months would take 16,000x12=192,000. Each of these 40 micro farms would need sprinklers worth UGX 1,500,000 (i.e. 60,000,000). Thus it would need UGX 64,692,000 to set up a community irrigation system that will serve ten to twenty households. The per capita investment for 20 farmer households would be UGX 3,234,600.

If the farmers grew tomatoes using the recommended spacing, each would get 4,000 plants. Each tomato plant produces 20-50 fruits. Each farmer would get 20 fruitsx4,000 plants=80,000 tomatoes. If it were sold at UGX 100 each, each the farmer could expect returns of approximately UGX 8,000,000. Each farmer would therefore make a net profit of approximately 4,765,400.

Scenario Five: Dayliff DC80P Petrol-powered Pump

The pump has a 3.8-liter tank. It costs UGX 800,000 (inclusive of taxes). It can pull water from a depth of 7 meters and head of 70 meters and can push water up to 500 meters to one kilometre. It yields 20 cubic meters per hour using 1.8 litres of petrol.

It can pump enough water for even leafy crops like beans, maize, etc. It can supply to irrigate 10 acres in two hours or 20 half acres in one hour, or 40 quarter acres. If we take a litre of petrol to be UGX 4,000, this means it would take UGX 16,000 to irrigate the 40 farms in different directions around a dam. Irrigating tomatoes for 3 months would take 16,000x12=192,000. Each of these 40 micro farms would need sprinklers worth UGX 1,500,000 (i.e. 60,000,000). Thus it would need UGX 60,992,000 to set up a community irrigation system that will serve ten to twenty households. The per capita investment for 20 farmer households would be UGX 3,049,600.

If the farmers grew tomatoes using the recommended spacing, each would get 4,000 plants. Each tomato plant produces 20-50 fruits. Each farmer would get 20 fruitsx4,000 plants=80,000 tomatoes. If it were sold at UGX 100 each, each the farmer could expect returns of approximately UGX 8,000,000. Each farmer would therefore make a net profit of approximately 4,950,400.

Scenario Six: Dayliff DC50H Petrol-powered Pump

The pump has a 3.8-liter tank. It costs UGX 1,500,000 (inclusive of taxes). It can pull water from a depth of 7 meters and head of 70 meters and can push water up to 500 meters to one kilometre. It yields 20 cubic meters per hour using 1.8 litres of petrol.

It can pump enough water for even leafy crops like beans, maize, etc. It can supply to irrigate 10 acres in two hours or 20 half acres in one hour, or 40 quarter acres.

If we take a litre of petrol to be UGX 4,000, this means it would take UGX 16,000 to irrigate the 40 farms in different directions around a dam. Irrigating tomatoes for 3 months would take 16,000x12=192,000. Each of these 40 micro farms would need sprinklers worth UGX 1,500,000 (i.e. 60,000,000). Thus it would need UGX 61,692,000 to set up a community irrigation system that will serve ten to twenty households. The per capita investment for 20 farmer households would be UGX 3,084,600.

If the farmers grew tomatoes using the recommended spacing, each would get 4,000 plants. Each tomato plant produces 20-50 fruits. Each farmer would get 20 fruitsx4,000 plants=80,000 tomatoes. If it were sold at UGX 100 each, each the farmer could expect returns of

approximately UGX 8,000,000. Each farmer would therefore make a net profit of approximately 4,915,400.

Part Three: Conclusions and Recommendations

3.1 Conclusions

3.1.1 Food Security

A combination of erratic rains, poor soils (sandy but also with poor drainage), limited innovation and a host of endogenous and exogenous factors render household in Otuke district food insecure, with only one quarter of the population food secure. While there is no land shortage in the district yet, acreages opened are small in spite of animal traction.

The other factor perpetuating food insecurity in the district is that the same food stuff are also sources of income. When people sell away their harvest at low farm gate prices, the result is that later they have no food reserves for bad times.

3.1.2 Farming Practices

Many farmers in the district have failed to recognize change in seasons, thereby failing to adapt their farming to the current situation. FGDs revealed that farmers still time their crops based on routines years past. The result has been wastage of inputs and low yields. The production volumes of all crops grown in the district are below standard. The farmers continue to plant traditional varieties that take very long to mature and hence are susceptible to mid-season failure due to the prolonged dry spells and erratic weather.

With the exception of maize and beans which are planted in rows, farmers in Otuke mainly sow their seeds. Additionally most crops are weeded only once. Weed management is a big problem to farmer households, with the arrival of new weeds which farmers are not familiar with. There is a weed that appears in the gardens after the first weeding and affects yields directly.

Soil and water conservation practices like mulching, contouring, etc are practiced by less than 10% of the farmers. This leave the fertility of the soil to chance and with the increasing dry spells, returns to investments are very low.

3.1.3 Water for Agriculture

Rain water harvesting
Rain water is harvested in the district and is basically for domestic use and never for agricultural purposes. Thus, it represents an underutilized potential in the district.

Run-off management
Run-off water is trapped only for making brick and blocks. Beyond that farmers do not see any use for it considering that is dirty and likely to breed unwanted animal life.

Technologies available
There are technologies in the market. These vary from on-farm double-dug trenches for water retention, to manual -rope, hip and treadle pumps with water yields of between 600 and 1,000 liters, suitable for household-level irrigation undertakings, to petrol-powered Davey and Dayliff

pumps from Davis & Shirtliff with capacities of over 15m^3 per hour, suitable for communal irrigation projects.

Impediments
Farmers in Otuke have heard of irrigation but have not been very keen in applying it to their situations. While ACF supplied treadle pumps for horticultural and agro-forestry purposes, these have not been used. This has been either due to change in position of owners of land where boreholes were constructed or lack of community initiative to use the available waste water for agricultural purposes. Thus, limited awareness and lack of initiatives on the part of the farmer have combined to stifle water for agriculture use in the district.

The other factor is the inhibitive cost of technology and accessories. The average cost of manual technologies, which can produce water pressure of less than 3 Bars and therefore only suitable for drip irrigation is UGX 3,500,000. This is way beyond what most farmer households can afford. In addition, irrigation equipments are not available in Otuke or nearby towns, but are found in Kampala, Jinja and Mbale.

3.1.4 Gender Considerations

It is important to remember that irrigation requires a lot of labour, and in view of the fact that most of the farming is done by women, caution is in order. FGDs revealed that on average men work in their farms only 3-4 hours, and women work 7-10 hours depending on the season. For champion farmers who will be chosen by GWI EA, there will be need to involve the men for the success of the irrigation initiative.

3.2 Recommendations

3.2.1 Global Water Initiative East Africa

3.2.1.1On-farm technology

GWI EA should encourage farmers, especially champion/model farmers to adopt soil and water management practices to check erosion. This would involve physical conservation structures like ridges and contours, cover crops and manure. Soil fertility improvement practices, e.g., manure, organic matter and crop residue recycling coupled with irrigation would also improve the texture and structure of the sandy loam soils thereby boosting yields and returns to investments. The farmers need to adopt conservation farming practices. Double dug trenches should be widely promoted as a water retention technology to stave off mid season crop failures orchestrated by erratic dry spells.

3.2.1.2 Conservation Agriculture (CA)

Taking into account the erratic rainfall pattern, soils and temperatures of Otuke district, it is prudent to promote conservation agriculture. Conservation agriculture (CA) aims to achieve sustainable and profitable agriculture and subsequently aims at improved livelihoods of farmers through the application of the three CA principles: minimal soil disturbance, permanent soil cover and crop rotations. It is a way of growing crops that conserves the soil and maintains soil fertility. It combines three principles -disturb the soil as little as possible – i.e. not ploughing,

keep the soil covered with cover crops, crop residues or mulch and rotate or mix crops (e.g., planting a cereal such as sorghum, millet, maize and a legume such as pigeon-peas, beans, etc.).

These three principles have many advantages: they conserve moisture in the soil, maintain a good soil structure (making it easy for roots to grow), regenerate the soil's fertility, encourage earthworms and other soil life, and protect the soil from erosion hence gullies. Conservation agriculture needs less labour than conventional farming because it avoids ploughing. It produces higher yields because it maintains the soil fertility. Weed control may be a problem, especially in the first few years after farmers start practicing conservation agriculture. They can control weeds by slashing them or using herbicides. Eventually, the cover crops will smother most weeds, making them easier to control. However, the farmer households in Otuke are not practicing conservation agriculture.

CA holds tremendous potential for all sizes of farms and agro-ecological systems, but its adoption is perhaps most urgently required by smallholder farmers, especially those facing acute labour shortages like those in Otuke district. It is a way to combine profitable agricultural production with environmental concerns and sustainability and it has been proven to work in a variety of agro-ecological zones and farming systems. It is been perceived by practitioners as a valid tool for Sustainable Land Management (SLM)[21].

3.2.1.3 Better Agronomic Practices

Farmers in the project sub counties should be encouraged to practice modern agronomy - planting in rows, mulching, use of manure, thinning crops, weeding crops twice and applying approved post harvest handling techniques. These strategies will help increase production, productivity and quality which will improve both food and income security for the households.

There is need for improved dissemination of knowledge and for capacity building to help farmers and other land users in Otuke to develop farming practices and systems that conserve soil and water resources, ensure sustained fertility and, where possible, reverse chemical, structural and biological degradation of the soil

3.2.1.2 Rain water harvesting

As many households are not harvesting water for agricultural practices, it would be good to initiate manageable household-based irrigation systems that farmer households would use in a field as a pilot (contract farmers) and the following could be considered; where loans are given to individual farmers within a group, both men and women would be benefited highly. Most farmer groups may receive the money as loans through the village savings and loans associations (VSLAs) or on a 50:50 grant that can be stipulated in the agreements. Most of the grant money could be used to buy irrigation equipment/inputs. Women would be more committed to saving than men therefore are more reliable to be use in case of any pilot project

The GWI EA's strategy of using champion/model farmers to promote improved food security, land and water management in Otuke district would yield commendable achievements. However, care should be taken so that only committed and willing farmers are targeted, not just anybody. They will show that land degradation and food insecurity can be reduced and

[21] www.fao.org/ag/ca

livelihoods improved through water for agriculture. Concerted efforts from all stakeholders – central government, Otuke DLG, civil society and communities, are needed to invest in this type of practice and scale up the successes created by this pilot water for agriculture project.

3.2.1.3 Introduction of fast-maturing crop varieties

Since the first rains last less than two months and the second rains last longer but cause water logging, fast maturing crops should be introduced and promoted by GWI EA in collaboration with the Production Directorate of Otuke District Local Government. This could include yellow beans which mature in 60 days, and needs rain only for the first month. Seremi I and II millet varieties from NaSARRI Serere mature in 65 to 70 days also needs only one month of good rainfall. Sesame I and II simsim varieties from NaSARRI Serere mature in 110 days. There are a host of other drought-resistant and fast maturing ground nuts and other crops which the project can introduce to farmers in the three project sub counties.

3.2.1.4 Introducing irrigation

In introducing irrigation technologies, considering the additional labour requirements, only willing and eager farmers should be recruited, on an incremental basis. Manual irrigation should be piloted with individual households, while petrol-powered irrigation technologies should be piloted at community levels.

These investments GWI EA will pilot, should be given to farmers on a cost-recovery basis i.e. as a loan. This has the double effect of fostering ownership as a result of the value attached to them, but also paves the way for sustainability of the interventions.

3.2.2 Otuke District Local Government

Investment in land and water management

In implementing central government plans, ODLG should increase investment in land and water management at the community and district levels must be a priority to sustain the resource base that produces food and livelihoods. Local people can neither invest nor bear the burden by themselves. The government must provide incentives for communities to improve their management of natural resources, so benefiting the nation and the global environment.

Knowledge generation, management and innovation

Farmer households should be encouraged to experiment and innovate. This should be in the specific areas of new fast-maturing crops, water for agriculture (irrigation) technologies, etc. Farmers should be motivated to learn how to build on and use their own knowledge. In the beginning, model/champion farmers/technology adapters should be rewarded by ODLG with GWI EA facilitation, to consolidate learning, and become reference/learning points in their communities. This will make extension services become more demand-driven, and farmers can tell if they are getting value for money. Innovators**,** under Farmer field schools involve many people within a watershed area, so speeding up adoption of improved land management techniques.

Build long-term resilience

Extension efforts should focus more on practices that build long-term soil fertility and the efficient use of every drop of water –rather than focusing only on commercial enterprises. This

will help farmers benefit from sustained provision of ecosystem goods and services, and cope better with poor soils, dry spells, water logging and other challenges.

Bye-laws and regulations

Bye-laws relating to farming, food security and water for agriculture must be formulated and enforced effectively to promote appropriate land and water management practices. Byelaws to conserve and make more productive use of land and water must be developed and enforced, with the full participation of local stakeholders.

Also food security granary system (*dero kec*) should be reintroduced and enforced in the district. This is will not only improve food and income security but also soil and water resources.

3.2.3 Farmer households/groups

Stronger leadership and voice

Farmer field schools strengthen the farmers' "voice" for advocacy and enable strong leaders to emerge. The farmer field school approach in general, and its use for improving soil, land and water management, should be scaled up so it can reach a larger number of farmers in Otuke. It should be incorporated into the district extension system rather than implemented on a project-by-project basis. Extension staff (from NGOs, NAADs and local government) can play a key role to initiate and backstop farmer field schools. Close collaboration between government and NGOs will assure success.

Better planning through farmer field schools could enable efficient community action planning. This is because farmers become more aware of their farming environment, so can plan better for drought, pests and other problems. These can be used to locate sites for irrigation investments,

Networking

Farmers should arrange exchange visits to be able to further benefit through exchange of information with each other and with research and extension agencies. The farmers in the project sub counties could organize and visit farmers in Adwari where Welt Hunger Hilfe is promoting double-dug trenches and within the district where NCBA Clusa Uganda is promoting conservation agriculture, etc.

Funding

Adequate funding support is needed if farmers are to succeed. For individual groups to be sustainable, they need to develop their own sources of funding – through revolving funds, group-owned businesses and other self-financing mechanisms. Strong farmer organizations can reduce costs because they can buy inputs at lower prices, and can sell their output for more. Farmers must manage (and contribute to) their farmer grants if avails to them so that they can demand good facilitation and make their own decisions.

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10. Senior Agricultural Officer Ministry of Agriculture Animal Industry and Fisheries, PO Box 102, Entebbe, Uganda, charlesrusoke@yahoo.co.uk
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Appendices

Appendix I: Summary of Water for Agriculture Technologies

Technology	Cost (UGX)	Yield	Comments
Super Money Maker Hip Pump	200,600 (+ 300,000 excavation costs)	$0.6m^3$/hr	The technology needs a reservoir of water. It labour intensive and insensitive to women. It is suitable for drip irrigation in household gardens with horticultural crops.
Super Money Maker Treadle Pump	370,000 (+ 300,000 excavation costs)	$0.6m^3$/hr	The technology needs a reservoir of water. It very labour intensive and insensitive to women. It could also cause accidents if the foot slips during pumping. It is suitable for drip irrigation in household gardens with horticultural crops.
Rope Pump	300,000 (+ 300,000 excavation costs)	$1m^3$/hr	The technology needs a reservoir or water hole. It less labour intensive and sensitive to women. It is suitable for drip irrigation in household gardens with horticultural crops.
Davey 5165/5265H Petrol-powered pumps	3,500,000	$20m^3$/hr	The technology requires a big water body like a dam or perennial swamp. There could also be need for large reservoirs into which water can be pumped. It has a 1.8 litre-tank. It uses petrol, hence additional O&M costs. It is suitable for sprinkler irrigation in group farms with leafy crops
Dayliff DC80P Petrol-powered Pump	800,000	$20m^3$/hr	The technology requires a big water body like a dam or perennial swamp. There could also be need for large reservoirs into which water can be pumped. It has a 1.8 litre-tank. It uses petrol, hence additional O&M costs. It is suitable for sprinkler irrigation in group farms with leafy crops
Dayliff DC50H Petrol-powered Pump	1,500,000	$20m^3$/hr	The technology requires a big water body like a dam or perennial swamp. There could also be need for large reservoirs into which water can be pumped. It has a 1.8 litre-tank. It uses petrol, hence additional O&M costs. It is suitable for sprinkler irrigation in group farms with leafy crops

Appendix II: Seasonal Analysis of selected aspects

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall	∘		∘∘ ∘∘∘	∘∘∘ ∘∘∘	∘∘∘ ∘∘∘∘	∘∘	∘∘∘	∘∘ ∘∘∘∘ ∘∘∘∘	∘∘ ∘∘∘∘ ∘∘∘∘	∘∘ ∘∘∘	∘∘∘	∘
Food	∘∘∘∘ ∘∘∘∘	∘∘∘ ∘∘∘∘ -School fees -Seeds	∘∘∘ ∘∘∘	∘∘∘	∘∘	∘	∘∘∘	∘ ∘∘∘	∘∘∘ ∘∘∘	∘∘∘ ∘∘∘∘	∘∘∘∘ ∘∘∘∘	∘∘ ∘∘∘∘ ∘∘∘∘ Full harvest
Income	∘∘∘ ∘∘∘	∘∘∘	∘∘	∘			∘	∘∘∘ Millet 1	∘ ∘∘∘ C/peas P/peas G/grams Soya	∘∘∘ ∘∘∘∘ **Beans** **Soya**	∘∘∘∘ ∘∘∘∘ **S/flower** **Soya**	∘∘ ∘∘∘∘ ∘∘∘∘ Rice Simsim Millet 2
Labour needs	∘∘ Swamp	∘∘ Swamp	∘ ∘∘∘ Garden Prep.	∘∘∘ ∘∘∘∘ Weeding	∘∘∘∘ ∘∘∘∘ Weeding	∘∘∘ ∘∘∘ Weeding	∘∘∘ ∘∘∘∘ Planting sim[2] Weeding Millet harvest Planting rice	∘∘∘ ∘∘∘∘	∘∘∘ ∘∘∘∘	∘∘∘∘ ∘∘∘∘	∘∘ ∘∘∘∘ ∘∘∘∘	∘∘∘ ∘∘∘
Harvests	***Toke*** ***Alodi***						Greens **C/peas** **G/grams**	**Millet** **C/peas** **G/grams**	**Millet** **G/nuts** **Maize** **Beans**	**Millet** **Beans**	**S/flower** **Soya** **Simsim** **Rice**	**Sorghum** **P/peas** **Rice**
Number of meals	∘∘	∘∘	∘∘	∘	∘	∘	∘	∘∘	∘∘	∘∘	∘∘	∘∘

Appendix III: Key Informant Respondents

No.	Name	Title	Institution
1	Mr. Tobias OKER	Water and Irrigation Research Officer	Namalere Agricultural Engineering Institute
2	Dr. Martin NYEKO	Deputy Dean	Faculty of Agriculture -Gulu University
3	Mr. Okaasai OPOLOT	Director Crop Production	MAAIF
4	Mr. James Sunday MUTABAAZI	Commissioner Farm Development	MAAIF
5	Eng. Andrew KATO	Water Engineer	MAAIF
6	Eng. CHONG	Commissioner Water for Production	DWD, MWE
7	Dr. GAMAL	Irrigation Consultant	DWD, MWE
8	Ms. Christine KENEEMA	Irrigation Officer	DWD, MWE
9	Ms. Josephine MUGALA	Coordinator	UWASNET
10	Mr. George William OMONY	Meteorologist	Department Meteorology MWE
11	Mr. John ELEM	Field Coordinator-Lira	NCBA Clusa-Uganda
12	Eng. Josephat MUSINGUZI	Sales Engineer	DAVIS & SHIRTLIFF
13	Ms. Phoebe ARINGO	Partnership Coordinator	Bead for Life
14	Mr. EBONGA Samuel	Senior Agricultural Officer	Otuke DLG
15	Dr. ANYURU Thomas	Production Coordinator/DVO	Otuke DLG
16	Mr. Michael NKANUBO	Commissioner	Ngetta ZARDI
17	Mr. ERAYU Emmanuel	Senior Meteorological Supervisor	Ngetta ZARDI
18	Mr. OTUDE Anthony	Deputy Project Manager	Welt Hunger Hilfe – Lira
19	Julian Kobusinge	Sales	Multiple Industries Ltd

Appendix IV: Questionnaire Respondents

No.	Name	Village	Sub county
1	AKELLO Grace	Abongodero	Orum
2	OKELLO Gucabio	Akulla Owalla	Ogor
3	AKELLO Susan	Oyuo	Orum
4	AWIO Otim Charles	Ocoko imaki	Orum
5	KOLI Maria	Oyuo	Orum
6	Gloria OPENE	Ocoko imaki	Orum
7	Beatrice	Amwa	Orum
8	AWERA Joseph	Oyuo	Orum
9	ODONG Johnson	Abongodero	Orum
10	ALABA Josphine	Angeta	Olilim
11	OGWANG Eronastina	Amaro-lel	Ogor
12	Grace OPIO	Amaro-lel	Ogor
13	Lilly OGWOK	Awee	Olilim
14	Scovia OPIO	Angeta	Olilim
15	OWUNI James	Awee	Olilim
16	OBWOR Carolina	Amaro-lel	Ogor
17	ANYUTE Charles	Olilim TC	Olilim
18	Dorcus EPILA	Angeta	Olilim
19	OGENA Francis	Angeta	Olilim
20	OKORI David	Ocoko imaki	Orum
21	Bonny OTIM	Ocoko imaki	Orum
22	OTIM Moses	Oyuo	Orum
23	Michael EYEN	Oyuo	Orum
24	KOLE Beatrice	Oyuo	Orum
25	APIO Jenty	Abongodero	Orum
26	ONAPA Francis	Amwa	Orum
27	Jasinta	Oyuo	Orum
28	OBUA Geoffrey	Olilim TC	Olilim
29	OBURA Wilson	Angeta	Olilim
30	ATAI Christopher	Amwa	Orum
31	Evelyn	Ocoko imaki	Orum
32	Gloria APORO	Amwa	Orum
33	OKULLO Richard	Amwa	Orum
34	AKULLO Lilly	Amwa	Orum
35	Joyce ADONGO	Ocoko imaki	Orum
36	ADONG Florence okaka	Amwa	Orum
37	AKELLO Hellen	Amwa	Orum
38	ACULA Flo	Te-dam	Olilim
39	OKULLO Jimmy	Ocoko imaki	Orum
40	Alfred AKWECH	Amaro-lel	Ogor
41	OKELLO Luciano	Amaro-lel	Ogor
42	Beatrice	Ocoko imaki	Orum
43	AKOLI Janet	Abongodero	Orum
44	ACUMA John	Te-dam	Olilim
45	Jago NGAI	Te-dam	Olilim
46	AKETCH Betty	Te-dam	Olilim

47	Lucy	Te-dam	Olilim
48	Catherine AJALI	Ogweno B	Ogor
49	OMARA Tom	Ogweno B	Ogor
50	APOLLO Esther	Iwit	Olilim
51	AKELLO Evelyn	Iwit	Olilim
52	Faibi ATAI	Abongodero	Orum
53	AMOLLO Pamela	Olilim TC	Olilim
54	Denis ADAR	Abongodero	Orum
55	AJOK Susan	Barkea-lower	Ogor
56	ADONG Betty	Olilim TC	Olilim
57	Janet AKELLO	Ogweno B	Ogor
58	ONGOM Albino	Te-dam	Olilim
59	Catolina	Amaro-lel	Ogor
60	AYO Maria	Amaro-lel	Ogor
61	Ketty EGARO Benson	Camkwoki	Orum
62	ELWOR Lilly	Alapata	Ogor
63	Grace OTIM	Akuda-awala	Ogor
64	ARIO Richard	Abongodero	Ogor
65	OKELLO Fred	Abongodero	Ogor
66	AJWANG Cidonia	Abongodero	Ogor
67	ACHENG Janet	Ocoko imaki	Orum
68	ADWOKI Agnes	Amaro-lel	Ogor
69	OKELLO James	Ocoko imaki	Orum
70	ATOO Milo	Ocoko imaki	Orum
71	Rose OKELLO	Ocoko imaki	Orum
72	OTIM Morris	Amwa	Orum
73	AWIO Lameck	Ocoko imaki	Orum
74	OBAL Justine	Amaro-lel	Ogor
75	AWIO Francis	Amaro-lel	Ogor
76	ACUMA Bosco	Ocoko imaki	Orum
77	ODONGO Dick	Ocoko imaki	Orum
78	AGUM Alfred	Ocoko imaki	Orum
79	Janet OKELLO	Ocoko imaki	Orum
80	Brenda	Ocoko imaki	Orum
81	ATIM Margret	Ocoko imaki	Orum
82	ADONG Betty	Olilim TC	Olilim
83	OKELLO .P	Ocoko imaki	Orum
84	ONGUM Moses	Amaro-lel	Ogor
85	Betty AKULLO	Amaro-lel	Ogor
86	AMOLO Jamila	Ocoko imaki	Orum
87	Hilda	Ocoko imaki	Orum
88	Anna OKOI	Ocoko imaki	Orum
89	Susan ACWERA Patrick	Abongodero	Orum
90	Benjamin	Abil	Olilim
91	Milly AKULLO	Okokowoo	Olilim
92	Molly IJIANG OYUGO	Amwa	Orum
93	ONYUNG Geoffrey	Amaro-lel	Ogor
94	Grace ACAM	Angeta	Olilim
95	Keren OKWEDA	Awee	Olilim

96	Scovia	Angeta	Olilim
97	ANGOM Lucy	Angeta	Olilim
98	Jacinta AWOR	Alapata	Ogor
99	IJANG Lucy	Awitu	Ogor
100	Hellen IGARU	Ocoko imaki	Orum
101	OKELLO Richard	Alapata	Orum
102	AYO Joan	Ocoko imaki	Orum
103	OCERO Bosco	Akany	Ogor
104	OKON Martin	Agweno A	Ogor
105	AKERO scovia	Alapata	Ogor
106	Harriet	Amwa	Orum
107	ODONG Zadock	Alapata	Ogor
108	LAKER Christine	Alapata	Ogor
109	Richard	Abongodero	Orum
110	OCEN sam	Odero	Ogor
111	Sabina AWOR	Akuda awala	Ogor
112	OUNI Emanauel	Akuda awala	Ogor
113	OWERA Francis	Akuda awala	Ogor
114	Harriet OKULLO	Awee	Olilim
115	Grace OKWIR Tonny	Awee	Olilim
116	Harriet	Awee	Olilim
117	AMOT Augustine	Odero	Ogor
118	ADONG Sarah	Abongodero	Orum
119	OCEN Sam	Odero	Ogor
120	Sabina AWOO	Akuda awala	Ogor
121	OKELLO John Bosco	Akuda awala	Ogor
122	Harriet OKULLU	Awee	Olilim
123	AMOT Augustine	Odero	Ogor
124	ADONGO Sarah	Abongodero	Orum
125	Christine ANYONGO	Abongodero	Orum
126	Eunice	Alapatar	Ogor
127	Rebecca OGWAL	Awee	Olilim
128	Mary AYO	Alapatar	Ogor
129	TOKE Ambrose	Akuda awala	Ogor
130	OKULLO Stephen	Akuda awala	Ogor
131	OPIO Oscar	Awitu	Ogor
132	OGWAL Bob Boniface	Alapata	Ogor
133	OKELLO Alfred	Bar kea Lower	Ogor
134	Lucy ANGOM	Olilim TC	Olilim
135	Mary AWIO ELEM	Olilim TC	Olilim
136	Judith	Alapata	Ogor
137	OPIO Bruno	Alapata	Ogor
138	ODONGO jasper	Alingiri	Ogor
139	ACEN Albatina	Anep moroto	Orum
140	OYANGA Benard	Oyuo	Orum
141	OKELLO Bonny	Oyuo	Orum
142	OTIM Jimmy	Alangi	Orum
143	Middy AKELLO	Te-dam	Olilim
144	OMEDO Nickson	Te-dam	Olilim

145	Evaline OGWANG	Alangi	Orum
146	OGWANG Sam	Olilim TC	Olilim
147	Moses	Awee	Olilim
148	Lucy OTIM	Awee	Olilim
149	Agnes OPIO	Alapata	Ogor
150	ODONGO George	Alapata	Ogor
151	AYO Harriet	Awee	Olilim
152	OKELLO sam	Awee	Olilim
153	Elipadia ABUA	Awee	Olilim
154	Kevin AWOR	Te-dam	Olilim
155	ADONG Christine	Apyen pwot	Ogor
156	OJOK Benson	Olilim TC	Olilim
157	Eunice	Angeta	Olilim
158	Molly	Olilim TC	Olilim
159	OKELLO Thomas Okodi	Alapata	Ogor
160	OCEN Lawrence	Ogweno B	Ogor
161	APORO George	Ogweno B	Ogor
162	OCAN Tonny	Alapata	Ogor
163	Florence ALENGO	Erut	Olilim
164	AUMA Concy	Ogweno B	Ogor
165	ANGOM Eunice	Ogweno B	Ogor
166	AKAA Morris	Ogweno B	Ogor
167	OGEL Jenesiu	Awee	Olilim
168	AJWANG Eunice	Akuda awala	Ogor
169	Hilda ODONGO	Akuda awala	Ogor
170	OKULLO Bosco	Akuda awala	Ogor
171	Sarah AGOM	Amwa	Orum
172	ODNGO Emmanuel	Alangi	Orum
173	OCEN Yubentino	Alapata	Ogor
174	OCEN Patrick	Alapata	Ogor
175	ALABA Rose	Alapata	Ogor
176	OJOK Milton	Abongodero	Orum
177	Hellen ATUKE	Alapata	Ogor
178	ACHOLA Sijaria	Ocoko imaki	Orum
179	Cidonia OREE	Odero	Ogor
180	IJANG soffy	Olilim TC	Olilim
181	ATIM Margret	Ocoko imaki	Orum
182	OLUGE Alfred	Angeta	Olilim
183	ATOO Harriet	Iwit	Olilim
184	AKITE Mudulena	Iwit	Olilim
185	OMARA Anthony	Iwit	Olilim
186	ATOOKE Lucy	Iwit	Olilim
187	Semmy AMONGI	Ayiko aola	Olilim
188	Sidona ANGOM	Iwit	Olilim
189	OTIM Jacob	Iwit	Olilim
190	Suzan EYEN	Ayiko Aola	Olilim
191	Ocen David	Ogweno B	Ogor

Appendix V: Focus Group Respondents

Attendance List at Ocoko imaki Village in Orum sub county

No.	Name	Male	Female
1	OKOL Sam	✓	
2	AWIO Lameck	✓	
3	OTIM Julius Peter	✓	
4	EJANG Harriet		✓
5	OKULLU Jimmy	✓	
6	EGARU John	✓	
7	OTIM Bonny	✓	
8	AGOA Milly		✓
9	AYO Joan		✓
10	Atino Josephine		✓
	Total	**6**	**4**

Attendance List at Ogweno B Village in Ogor sub county

No.	Name	Male	Female
1	ECIP Alfred	✓	
2	EYEN Jacob	✓	
3	OYAMA Jenasio	✓	
4	OMARA Tom	✓	
5	OKELLO Alfred	✓	
6	ORON Martin	✓	
7	AKAA Morris	✓	
8	OPIO Felix	✓	
9	OKELLO Geoffrey	✓	
10	ACHOLA Stella		✓
11	AKAO Barar		✓
	Total	**9**	**2**