

Improving the Decision Making Capacity of Small-scale Farmers in Response to Future Climate Impact in the Flood Prone Bunyala Plains of Western Kenya.



LITERATURE STUDY

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1.1 Introduction

Climate change is the most persistent threat to global stability today and in the coming century. Consequently, all societies need to learn to cope with the changes that are foreseen. Some of the expected changes include, warmer temperatures, drier soils, unpredictable changes in weather and rising sea levels, (Adger et al, 2003). The debate on climate change seems to be increasingly focused on how people from all corners of the world will have to adapt to the changes as a result of impact thereof. With low predictability, uncertain distribution as well as uncertain magnitude of these changes, actions to mitigate the human contribution to climate change seems too few and too limited to make a significant improvement, (Lemos et al, 2007). It is as a result of the above that adaptation to climate change is important in formulating appropriate policies and intervention practices at the local context

In addition, Agder et al, 2003 argues that the impacts of climate change are not evenly distributed; the people most exposed to the worst impacts are the ones least able to cope with the associated risks. This study therefore focuses on how to help build adaptive capacities for those likely to be exposed to negative climate impact and poverty related vulnerabilities especially in rural areas whereby agriculture is the major constituent to the mainstay of their rural economy.

Variation in climate has for a long time impacted on agricultural production and with increased climatic threat, such impacts are likely to manifest themselves in ways that the locals are not conversant with. Bunyala area in western Kenya is one of the places where such impacts have manifest. Attention is focused on Bunyala because in the past 40 years, the area has experienced 13 counts of significant flooding followed by periods of drought. These threats are bound to re-occur thereby disrupting livelihoods if sustained efforts are not taken. It is assumed in this study that the resilience and the adaptive capacity of the people in Bunyala have been greatly molded by such impacts. This literature survey is therefore interested in finding out the adaptive mechanisms that this population has since utilized to cope with such extremes. Much attention is given to agricultural practices and water management system due to the fact that agriculture especially flooded agriculture has been the most important economic activity in the area for many years. It is worth noting that persistent exposure to flooding and drought has weakened the adaptive capacity of the local population to cope with the risk of eminent climate impact. Such exposures inhibit long term investments, this is likely to threaten the fight against food insecurity, poverty and disease burden; accounts of such threats are also presented in this literature survey.

With increased uncertainty and low predictability of the climatic impacts, there is need for an integrated approach where local knowledge and scientific expertise are integrated for improved decision making. Such an intervention could bring together key stakeholders in a forum whereby different knowledge systems can learn from each other. Consequently, possible local scenarios for generating future climate change planning could be initiated. This entire study is aimed at indentifying and gathering key determining factors which when summed up could help develop strategies for improved resilience to climate threats and risks in Bunyala.

This literature survey is divided into two parts. Part one contains a general discussion on climate change and adaptation in developing countries. In this part, definitions of key concepts are given; Examples and illustrations of relevant trends and phenomena from different context are also given.

Part two constitutes an in-depth study of how the local population in Western Kenya-Bunyala is coping with increased negative impact of climate change. An attempt is made to link the people's current socio-economic activities to their social history in an attempt to study their resilience and their adaptation strategies to climate change.

Methodology employed in this study involved; a study of literature on adaptation to climate change and also literature on Bunyala rice irrigation scheme. Grey literature on Bunyala is utilized where possible. General literature on livelihood and market access has also been utilized. Farm visits and observation of the activities carried out in the area together with a checklist on farmers' perception on climate change literature their farming practices and their response to flooding and drought is consulted. A focus group discussion is held with a committee member of an out-growers rice scheme and interviews conducted with a microfinance institution, a KEMRI researcher, a retired politician, experienced farmers and elderly informants. A semi structured questionnaire capturing 307 small scale rice farmers was used for a baseline survey complementing this literature study on Bunyala.

1.2 Adaptation to Climate Change in Developing Countries

Adaptation is not a new concept in development literature. It has been used alongside the term 'coping' to help conceptualize how people bounce back to a past state of normality or an equivalent after vulnerability has stricken. Adaptation to climate change is widely defined as the adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and Impact. Lemos et al, 2007 operationalises the above definition as follows; Actions taken to adjust to the consequences of climate change, either before or after impacts are experienced. It is not new that people have always adjusted to climatic impacts in the past, what is new and especially with increased climate temperatures and variability in rainfall is the incorporation of new measures or perspectives to the already existing adaptive strategies. This demands understanding by the affected communities that change is now inevitable and as such responsiveness is important. On the other hand, top down or technological determinism approach whereby recipes and prescriptions are handed over to the local intervention schemes or from policy and scientific communities are unlikely to succeed without due recognition to continuity (i.e. what has gone before, what impact it has done, what are local drivers for change and who and what was previously adapted, (Mertz et al, 2009). A well tailored integrated participatory approach may be very instrumental in encouraging learning of the different knowledge systems on board.

Climate change is likely to increase vulnerability and weaken the already existing capacities to fight diseases, poverty and under development. Vulnerability related to climate change in Africa is mostly influenced by changes in temperature and rainfall variability. General climate trend seems to be suggesting increased temperature especially in many parts of Africa. At the same time, variability in rainfall is also being experienced, rainfall amounts are expected to remain the same or reduced while heavy precipitation events are on the increase. Drought and floods are therefore expected to increase, (Adger et al, 2003). This will make it difficult for populations which were struggling to cope with socioeconomic vulnerability to do so if necessary interventions are not taken.

Building the capacity of the local population in Africa to adapt to climatic impact can therefore not work without due appreciation of the on going developmental initiatives targeted at mitigating

poverty or increasing economic growth. Vulnerabilities are in most cases interrelated and at times intervention to mitigate one vulnerability may exacerbate others or even create new vulnerabilities, (Mertz et al, 2009), for instance, a dam may be constructed in an area to increase the accessibility of water for domestic and commercial purposes. This dam may introduce new breeding places for mosquitoes and consequently increasing malaria prevalence in the area. A sick farmer will not be able to work effectively and the expense he will have to incurred on medication could have been channeled to some productive use if the interrelation between vulnerability and decision making processes is keen enough to detect such occurrences and instill appropriate action. The main aim of this entire pilot project is improving decision support to local population in anticipation of future climate change. This work sees it important to in-cooperate vulnerability, local coping strategies and other strategies currently in use to decision making programs in Bunyala by exploring how the natural resource base could be better safeguarded, augmenting human capital and encouraging entrepreneurship.

1.3 Vulnerability Assessment

Building the resilience of local population in Africa to cope with increased vulnerabilities will therefore involve the introduction of appropriate climate strategies and robust risk management strategies that both support general development goals and climate change adaptation, (Adger, 2001). This will therefore help reduce food insecurity, disease burden, poverty as well as reducing the effect of climate change while at the same time encouraging economic growth. In a special feature of the environmental management journal, (Mertz et al, 2009) presents an exhaustive literature account on adaptation to climate change in developing countries. The article argues that the impact due will be more severe in poor developing countries because of the following reasons; (a) weak adaptive capacity in relation to the degree of vulnerability, (b) increased and combined vulnerability experienced by the local population due to social historic damages and risks, (c) impact related to over population and the stress thereof on land and resource base as well. (d) weak linkages between development and climate change policies. Climate change therefore causes direct stress and accentuates indirect stress on already vulnerable people and resources on which they depend, (Lemos et al, 2007). We will explore each of the four vulnerability and capacity assessment determinants for climate change in the following paragraphs.

1.3.1 Intensity of the Vulnerability and Adaptive Capacity

People adapt to a vulnerability which in most cases is a risk, damage, catastrophe or threat. (Mertz et al, 2009), Defines Adaptation to climate change as the adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impact; therefore adaptation strategies are actions to reduce vulnerability or enhance resilience. Mertz (ibid), defines vulnerability as the susceptibility of exposure to harmful stresses and the ability to respond to these stresses. This article however warns that vulnerabilities are highly contextual and must be linked to a particular hazard and therefore vulnerability analysis should focus on a specific variable. They also encourage the need to indentify the drivers of a specific adaptation strategy (this involves answering the following question; *what is it that makes it work now and here?*). This way, ineffective intervention attempts could be minimized and the appreciation of past adaptation strategies made relevant to tackling present vulnerabilities. Adaptive capacity is the range within which communities or

individuals can react to a stress, beyond this; they lack resources and assets through which adaptation actions can be taken (Mertz et al, 2009).

1.3.2 Underlying Socio- historic Challenges and Risks

Since historic times, human settlement has led to clearing land i.e. cutting down trees, shrubs and exposing bare soil to erosion and other agents. Human settlement and especially the growth of metropolitans and poor drainage planning is making it impossible for rain water to drain into streams and rivers. Settlement and over population in some areas is pushing some people to marginal lands with unreliable rains and other adverse effects. Rice growing for instance introduces flooding in an area thereby increasing Bilharzia and malaria incidences. Inappropriate augmentation of social capital likewise makes people who could be self_ sufficient vulnerable and thus dependant to external help. Lack of capital, improper planning and coordination is a disincentive to entrepreneurship and this is a key constraint to economic growth at the grassroots. Finally, some practices passed over from generation to generation are either none functional and/or ineffective at the moment. Adaptation thus involves change as well as continuity but the challenge is how to facilitate such a process without disrupting the social order of events and harmony, (Barber, 2003).

1.3.3 Stress to the Natural Resource Base

A study conducted in Morogoro-Tanzania on climate change adaptation, (Paavola, 2004) describes charcoal burning, dependence on risky agricultural practices and deforestation as some of the activities contributing towards reducing the ability of the natural resource base to perform its safety net function. Paavola further illustrates the importance of safeguarding the resource base as it supports both the rural and urban population. In Morogoro, almost all urban dwellers use charcoal for fuel due to the nature of their choice of food, and the way they are used to preparing it. This is despite the fact that 40% of the region is connected to electricity supply (ibid) which, when properly utilized could be a cheaper and environmental friendly energy source. Charcoal burning is a great contributor to deforestation, urban fires and carbon monoxide poisoning. Deforestation has been promoted by growth of towns and modern lifestyles which demand more forest resources. Risky agricultural practices include poor agronomic practices like cultivating down hill, over stocking of livestock and use of toxic chemicals which farmers claim to be effective pesticides but are detrimental to ground water and the conservation of biodiversity. Unchecked exploitation of the resource base is not only damaging but also a main contributor to anthropogenic climate change.

1.3.4 Institutional Linkages on Poverty, Economic Growth and Future Climate Impact

Adaptation to climate change involves moderating harm associated with climatic impacts and at the same time exploiting benefits that have either been neglected, under utilized or have appreciated in value. Such kind of intervention will involve the working and collaboration of different players with distinct norms, values and contribution. Proper incorporation of rural population in such efforts will help build their resource base in order to be well prepared, equipped and more knowledgeable to face future challenges.

1.4 Climate Impact on Water and Agriculture

Climatic change impact cuts across different sectors of national and global economy. In developing countries, agriculture is the backbone of the economy in terms of food supply and income

generation. Thus, any slight change in climate directly affects this sector, specifically the rural areas where majority of the population is found (Mertz, et al, 2009)... Occurrence of drought spells as well as excessive floods are both detrimental. A remarkable incidence was experienced in Kenya in 1961 and 1997 where extensive flooding occurred resulting to loss of homes and lives, damage to crops, evacuations and increased vulnerability to ill health, (Conway et al, 2004). The total damage of these two flooding incidence cost Kenya at that time an estimated 5 million pounds, (Conway, *ibid*); However, according to **Russell, 2004**. the real loss of such vulnerabilities cannot be precisely estimated in economic terms as indirect costs are complicated to quantify.

Generally, climate change has profound negative effects on agriculture, food security, human settlement, biodiversity, health, forests and water sources. The IPCC 2007 has projected that in Africa, between 75 and 250 million people will be exposed to increased water stress due to climate change by 2020. Moreover, increased temperatures and climate variability will most likely confuse the existing cropping calendars leading to failed crop. In the long run, this results to serious implications on employment opportunities in the rural areas, food security and agricultural sustainability.

1.4.1 Impact on Agricultural Practices

Specific impacts include reduced soil moisture, changes in cropping calendars and reduced crop quality (both nutritional and visual due to water/temperature stress, and increased CO₂ concentrations) (DCC, 2008). Others are possible increase (and change) of pests, diseases and weeds, tendencies for cereal productivity to decrease in low latitudes, increased soil erosion and nutrient movement into waterways and reduced productivity in low latitudes due to reduced water availability (IPCC, 2007). The livestock sector too will experience increased heat stress on stock, increased maintenance cost of animal health, reduced supply of pasture and grain and consequently less carrying capacity, reduced availability of reliable and quality water supply to stock as well as reduced herbage quality (DCC, 2008).

1.4.2 Impact on Water Systems

Water availability is expected to fall as drought increases in mid-latitudes and semi-arid low latitudes (IPCC, 2007). Hundreds of millions of people will be exposed to increased water stress as water resources in some dry regions at mid-latitudes and in the dry tropics decline due to changes in precipitation and evapo-transpiration.

Some of the obvious effects of climate change on water resources include reduced inflows to water storages, reduced stream flows in major catchments, reduced recharge of groundwater which ultimately reduces available water for various uses including agriculture and industrial use. This has the effect of increasing the intensity of droughts (DCC, 2008). Inundation of coastal freshwater wetlands and lowlands is expected to increase and so is flooding.

1.5 Adaptive Strategies/Mechanisms

There are a number of adaptation measures that can be taken to cope with the vagaries of climate change and take advantage of opportunities arising. One is variety selection and use of appropriate varieties such as New Rice for Africa (NERICA) or Drought Tolerant Maize for Africa (DTMA) and alteration of production cycle to avoid extremes. Livestock breeds could also be improved.

Development, monitoring and early intervention of disease incidences as well as adoption of integrated pest and crop management practices should be encouraged and supported. Other adaptation measures to be embraced include improved rainwater harvesting, storage and conservation techniques; water use and re-use, irrigation efficiency, use of appropriate crop variety, crop relocation and improved land management.

With changes in cropping patterns, there are various indigenous methods of weather forecasting in Africa that can go a long way to aid the locals in adapting to new weather patterns. These methods have been developed over a long period of time to intricate systems of gathering, predicting, interpreting and decision-making in relation to weather. For example, in Burkina Faso farmers do it by formulating hypotheses on seasonal rainfall by observing natural phenomena and draw predictions from divination, visions or dreams. Indicators used include timing of fruiting of certain local trees, intensity and duration of cold temperatures and insect behavior in rubbish heaps outside compound walls among others (IPCC, 2007). Proper and timely altering of planting dates in response to weather variability could be likewise a reliable adaptive mechanism. Importantly, adaptation measures require improved decision making. Effective decision-making involves the management of risks and uncertainties to reduce their impacts (Harwood et al, 1999).

Water supply, its effective use and management need to be improved as an adaptive measure. Increased water sources also need to be checked to ensure that they don't become mosquito breeding grounds. Besides improving water management systems and agricultural practices, there is need to also boost infrastructure and health facilities to connect rural areas to help in service provision. Such efforts should be capitalized in a positive way such as opening up trade links and reducing transportation costs of the traded goods. However, it is for caution that such improvement in infrastructure could promote risk-related activities. For example Jassanoff, 2002 reported that a well structured transport system could led to increased deforestation through increased illegal logging owing to better roads. Burning of biomass for fuel should be reduced and alternatives sourced while at the same time encouraging re-afforestation (WHO, 2008). This pilot study will evaluate in details some of the above mentioned adaptation strategies.

Part two of this study will focus on vulnerabilities, adaptive capacity and impacts of climate change in Bunyala flood plains –Western Kenya. A detailed account on rice cultivation in the flooded fields will also be documented in details.

PART TWO: AN EMPIRICAL SURVEY ON BUNYALA FLOOD PLAINS

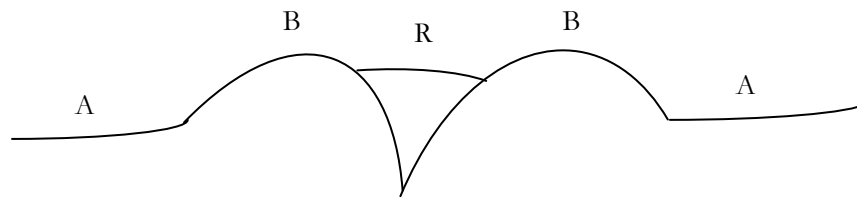
2.1 Introduction

The Bunyala Flood Plain is found in the recently curved Bunyala district. The district is found in Western Kenya and covers an area of 185.6 km². It has an estimated population of 66, 568 (Bunyala District, 2008). Bunyala is an alluvial flood plain with low terrain and has a high potential for rice production. Soils are alluvial sediments from various sources (Jaetzold and Schmidt, 1982). The flood plains and river terraces are almost flat to gently undulating with slopes of between 0 and 5%. The AEZ is LM4, a marginal cotton zone. Altitude ranges between 1135-1200m above sea level with mean temperatures of 22.7-22.3^oc. Annual rainfall average is 750-1015mm and bimodal with much of it falling in the first season (Bunyala District, 2008).

2.2 Floods and Livelihood in Bunyala

Residents of Bunyala have experienced flood incidences since 1940's. As a result, many lives have been lost due to flooding and associated vulnerabilities i.e. ill health, loss of assets, crop loss, and frustrated income generating activities have been experienced. Normally, long rains are expected in the month of April and May and the short rains expected in the month of August and September. During these months the residents of Bunyala are alert over the occurrence of floods. recently, rains as well as flooding shifted from the expected. For instance Elnino floods experienced in 1997, occurred in December, whereas flooding in South Bunyala in 2006 occurred in late November; 2 months after the peak of the short rains. Flooding has also influenced human settlement in that the once uninhabited surrounding hills are now occupied. Homesteads, schools and other social amenities have been constructed to support the growing human population in the district. The area where the current Bunyala district headquarters office is located is one of the areas currently inhabited by migrants from the flood plains.

The Banyala people being typically a fishing community live along the Nzoia river and the shores of Lake Victoria. They build their houses at the peak of the river banks (see point B in the figure below) thereby reducing vulnerability from moderate and low floods. To further protect their dwellings from floods, the residents constructed small dykes around their homesteads. In principle, a homestead is comprised of several mud-walled and grass thatched huts. Currently however, such homesteads are fewer as brick houses roofed with iron sheets have come up.



The area marked R is the river flow. Points marked A are agricultural fields where crops such as sweet potatoes, millet, cowpeas and maize were cultivated. Cassava, being a drought resistance crop is not a priority for cultivation. However, its cultivation is dominant among the neighboring Samia community living far away from the river.

–In the past, the construction of mud walled and grass thatched huts factored the possibility of flooding. Therefore, a slab approximately half a meter had to be built with its top section used to form the floor of the house. On this floor, the entire wall of the hut was erected...The huts were therefore accessed by a stair case which pointed away from the direction of the river. With the huts being round in shape, incoming rain water or moderate flood water was easily channeled away to the low laying grounds, and had to soak the slab before destroying any household assets. Chickens and goats were also safely confined in to this homestead. Currently, due to shortage of construction materials and labour difficulties, huts are mainly erected without the slab thus endangering homesteads when floods strike. The photo below is an example of typical Bunyala homestead. With the collapse of the homesteads, the people in the area are threatened by floods as illustrated in the Magdalene Nakwayo case below:

Magdalene Nakwayo comes from Ikula village and there she had a mud, grass thatched hut for shelter which she constructed with the help of her neighbors. During the short rains of 2008, flooding came and destroyed her house which had been constructed on point A in the diagram above. The flooding happened at night and the whole village had to be moved to camps in Mudembi, Mudere and Buremia. Magdalene did not lose a lot from the floods as she did not have much due to previous similar disruptions. In this flood, she lost 10 chickens, clothing, and crops. At the camp in Mudembi, she was given a tent and provided with relief food. In September 2009, the camp was closed to ensure that the locals utilized the short rains. Now she is back to the village and while her neighbors are busy reconstructing new houses, she has erected her tent in an open field as shown in the photo below. Magdalene lives with the fear of another flood but she claims that she has nowhere else to go. She lives with her grand son and hopes that with a good harvest she will be able to sell some of her produce to construct a better shelter.



Pic. 1, a typical Banyala homestead. Pic.2 Magdalene Nakwayo in front of her tent

Water harvesting

Water harvesting is not a common practice in Bunyala. Despite the change of roofing from grass thatched to iron-sheet, rain water harvesting is hardly done. It is not surprising to see women going to fetch water in the shallow wells immediately after the rains while their houses are ideal for rainwater harvesting. The shallow wells are however numerous in the area and women don't have to walk for long distances to fetch water. The water is also free or costs less than one dollar per month per household. Below is an illustration of a water well and one of the few rain water harvesting structures in the area.



Pic. 3, a shallow water well. Pic.4 water harvesting in an administration block of a local primary school Pic. 5 water harvesting in a local rice milling structure

Farm planning

Farm design was also done in a way to allow water movement. as a result the boundary of each plot of farming ground was a V shaped furrow created by the two neighboring farmers to allow water to flow. Today these furrows are non-existent and with the current population pressure in the area, residents who have not migrated uphill have now settled in the low laying plain (area marked A above) and as a result increased their vulnerability to floods. Terraces are hardly constructed by the migrants who move uphill as well as those who choose to stay in the flood plains. Water canals are found along the flooded rice irrigation schemes which also traverse areas a few kilometers away from the river. These canals have created an artificial river which has provided opportunities for novel horticultural practices such as kale and tomato production and hook fishing along the canal banks.

Over time, the duration flood water takes to drain has changed. When it flooded, the water did not stand still on the fields for a long time. In the past, floods water created its own water ways whereby it could flow back to the river once the water levels started reducing.

Among cultivated crops, millet was thought by many respondents interviewed to withstand moderate floods unlike maize., Cowpeas and sweet potatoes are fast maturing crops and as the flood water ,drained, the two crops were planted in the 'reclaimed land' and provided emergency supply of food during periods of crop failure. Flooding is also associated with increased fish along the river banks. When it floods, most men turn in to fishing, catching as much fish as possible for direct sale; the fish is preserved through drying for future use and also for barter trade which up to a decade ago has been a common practice alongside the currency system. There are fish traps still in the ground between the river and the dykes (See illustration below).

The staple food for the Banyala was and still is millet flour baked to a thick porridge (ugali) and at times mixed with small portions of maize and cassava. The more food insecure the Banyala were, the more the cassava proportions were in the ugali. The ugali is served with fish and at times with greens i.e. cowpeas leaves. Chicken is a delicacy in the Banyala community. It also serves as a quick source of household revenue especially after floods where the household needed to invest in new seeds if the floods had destroyed their fields.

New settlement and migration

Flooding is responsible for migration within Bunyala district and the neighboring region. After the famous 1961 floods, mass migration occurred from the flood plains to the surrounding raised grounds (hills). With every subsequent flooding, more people are forced to migrate mostly to higher grounds. There exists an interesting migration-remigration pattern in the area as the flood plain Banyala's are not accustomed to a hilly livelihood. This is because water is comparatively scarce away from river Nzoia, there is also threat of tsetse fly attacks on livestock and hill-side agriculture is relatively different from what the Banyala are accustomed. Water harvesting is not a practice that the Banyala are accustomed to but at the higher grounds this is inevitable since the proximity to River Nzoia is not a privilege any more. In the late 1990's, the catholic diocese of Bungoma helped the migrants by constructing cement tanks for water harvesting. The chairman of CODMI, a local NGO regretted that migration is not well planned and coordinated. As a result of ill-preparedness; soil erosion and deforestation came into play. It is evident that though many migrants dwell in the raised grounds, they still farm in the flood plains. Despite consequences associated with flooding, a lot more people still live in the flood plains due to increased population pressure.

Population and water drainage

Increased population and unplanned settlement in the flood plains has now tampered with the water drainage system that once existed. Now flood water takes longer to drain since water-ways which directed the water back to river Nzoia are blocked due to human activity i.e. houses and farms which now block water flow once it floods. Though dykes have since been constructed along the flood plain, it is as if the residents' self responsibility to protect themselves from floods and drought have dwindled since the construction of the dykes. This is due to the fact that since its construction, it has flooded at least nine times (see the years in bold letters below). Since 1937, floods in Bunyala were experienced in the following years; 1937, 1947, 1951, 1957/58, **1961/62, 1963, 1975, 1977/78, 1997, 2002, 2003, 2006 and 2007** (Bunyala District, 2008).

Residents of Bunyala are concerned over the increase in the incidences of flooding in the last 7 years with a record time of at least twice in a year. The most vulnerable months to floods are February-April and September - December. To farmers in the region, 1981 floods were the most memorable as were most devastating to the cultivation of rice and other livelihood support mechanisms.

Diseases and floods Malaria¹ incidents in the area are also on the increase, this is partly because the longer the flood water stagnates on the farm plots, the more mosquitoes are likely to breed in them. Other water borne diseases like bilharzia are reported to be prevalent in the area. Moreover, there are hundreds of acres of land along the Ruambua mdembi potential for rice cultivation but are un-

¹ *Information on Malaria obtained from KEMRI-Kisumu, specifically from Steve Muga*

utilized. Instead, the land is surrounded by homesteads, shrubs and little ponds with stagnant water that create favourable breeding grounds for mosquitoes. Although about 75% of the residents own bed nets, their usage is estimated to be less than 40%. Unfortunately, with the low level usage of bed nets, malaria cases will be on the increase since the three most devastating mosquito species namely *Anopheles gambiae*, *Anopheles arabiensis* and *Anopheles funestus* in malaria transmission co-exist in the area. This Mosquito species have different characteristics and feeding habits that makes it difficult to tame them using only bed nets.

2.3 Drought and Livelihood in Bunyala

Unlike the arid and semiarid regions in Kenya which experience drought for 2-5 years consecutively, Bunyala falls in a high productive area that experiences occasional drought for a period of 1-2 seasons (each year has two seasons). Currently there are incidences where drought has extended to a period of 2 years raising concerns of change.

Many communities in Kenya define drought in relation to the impact it causes, (new standpoint, 2006). The 1953 drought in Bunyala is much remembered by the elderly respondents that we contacted. This drought was nicknamed *maumau* as it coincided with the movement for Kenya's independence. This drought resulted to the movement of youth from rural farming communities to the emerging town centre's to look for alternative sources of livelihood. an example of these alternative livelihoods included prostitution in exchange for food in Port Victoria. There was occasional supply of relief maize. Later, the maize was ground into flour that was used to make porridge locally known as *obando* and this substituted sorghum in drought spells. The relief maize also came through the Port Victoria by then an important trading water route between Uganda and Kenya. Since the maize supply was inconsistent, cases of ambush on the way home from the collection point were rampant.

To further curb famine, intermarriages that existed between Kenyans and Ugandans enhanced exchange of food between in-laws on either side of the borders. For remembrance of the years when drought struck, children born within these periods were named *Nanjala* (girl) or *Wanjala* (boy) to mean drought.

Drought in most cases is linked to famine, the latter also occurred in the area affecting the crops. In 1961, a **mould** locally known as *Ituvungu* affected most of the stored grains and caused a major post harvest loss. Several locust invasions. have also been experienced. Such incidences are remembered through names such as *Asike* and *Nyerere*(the local name for locust). Both names symbolise the locust invasion. In the 2006-2007 rice planting season farmers suffered total crop failure due to rice blast attack.

The Banyala's are not very much accustomed to forest fruits but during periods of drought, wild fruits such as *Itunduri* (tomato like fruit), *Ochonge* (thorny fruit tree) and *Osongola* (also thorny) were consumed by children and adults alike. Domesticated fruit trees such as mango, pawpaw and passion fruit were recently introduced in the area. Few homesteads have 1-5 fruit trees. Although the climate is definitely suitable for fruit production, this practice has not been sufficiently promoted in the area. Fruits like pawpaws are important sources of vitamins throughout the year especially to

young and infant babies and their supplement during the dry, spell is also very crucial given that cassava is not easily digestible pawpaw's act as roughages.

Bananas however is a crop that is well cultivated in the area and especially along the river Nzoia (see picture below) since it's a crop that requires a lot of water for optimum growth and yield, (personal communication with a banana farmer). Besides farming, sand harvesting is also an activity that is carried out along the banks of River Nzoia to provides additional income during the dry periods.



Pic. 8, Banana planted along the banks of River Nzoia . Pic. 9, Sand harvesting along the banks of River Nzoia

Once it rained, traditional vegetables such as *Mrenda, Isunga and Mchicha* grew in the wild.. These vegetables are known locally to be highly nutritious. To date they still grow in the wild and in abandoned parcels of land as shown in the photograph below. During drought, the Banyala embark on basketry where they weave mats and baskets using papyrus and palm leaves. Fishing is also another option taken by the residents during drought. Majority of them resume farming during good rainy seasons. Hunting for wild pigs and other wildlife was a practice executed by the youth in the area. With a ban on hunting for game meat in Kenya, such practices are rare. Although the population of wild pigs has declined over time, these animals are known to destroy crops in the Maumau region. This is facilitated by the fact that the area is hardly inhabited by people and only used as a distant farming ground.. The existence of a natural forest which the wild pigs inhabit and connected to a source of water (the Yala swamp) provides a suitable hiding place for the pigs.

Cereals are important food security providers if proper storage and preservation methods are used.. Different storage facilities for different cereals have been used in the area. The stores are constructed using local materials and tailored to provide ideal storage conditions for specific harvested crops. Below is a photo of an abandoned millet and sorghum facility which was constructed to keep the cereals cool and dry. The doorway was just below the roof to ensure that chickens did not gain access to the store. It was also thought that the cereals at the top were drier due to sufficient air flow circulating at the top of the store. Such was most suitable for grinding into flour. This also explains why the door was placed higher as dumbness could result to aflatoxin poisoning (locally known as *sikukhu*). Currently these, storage facilities are hardly used or have already been rendered obsolete by majority of the farmers. Increased grain theft, high population and low production are some of the explanations given for the disappearance of such storage facilities.



Pic. 10, wild vegetables (with the red stem) growing in an abandoned piece of land.

Pic. 11, a traditional storage facility for millet or sorghum

Food preservation is a practice still being utilized by the Banyala's. Drying and salting are the most common practices. Some of the dried foods include sweet potatoes, cassava, pumpkins, groundnuts fish, vegetables, bananas, milk and blood.. Drying of milk and blood used to be a common practice but due to commoditization of milk and reduced animal stock, such practices have been abandoned.. A special delicacy made of fresh blood known as *apruu* was consumed during moderate drought and dried blood stored to make a dish known as *amariki*. Drying and salting is now very common to fish, cassava and sweet potato. Currently, the fish stock in the Kenyan side of Lake Victoria is very low. In a night, a fisherman could return home with only 3-7 fish. In most retail outlets, dried fish is in supply from the old stock. Traders have also started importing dried fish from Uganda to Bunyala(see adjacent photo). If drought was to strike, protein availability would be much compromised as fish is the only available reliable source of protein.



Pic. 12, Dried fish transported from Busia border town to Bunyala (a reversed Role)

Storage and packaging of dried food is an art very well developed in Bunyala whereby cylindrical airtight containers were used to store food. The containers were placed on top of each other so that the one on top acted as a tight lid to the one below it. The sides of the containers (where the one below and the one above met) was smeared with cow dug as a sealing and protective agent. The preserved food had to be well dried and stored in compartments inside the container so as not to contaminate each other. This practice is hardly practiced at the moment. Once the stored food was needed for consumption, it was cooked slowly under slow cow dug fire to utilize energy and for proper cooking. Barter trade in exchange of livestock and stored food products has been practiced against the money system since the 1960's but dwindled in the 1980's. In this trade ,milk and meat were traded for sorghum and cassava and the exchange was accompanied by a communal festivity.

The residents of Bunyala have been vulnerable to flooding. With the increased climate uncertainty, flooding may increase. Every occurrence of floods makes people more vulnerable since they frustrate their effort to engage in long term planning and investment.. Flooding is also associated with other vulnerabilities such as ill health, i.e. diarrhea and malaria and a possible contamination of wells. Wells are the most common sources of water for drinking and for domestic use. Drought was not a major threat in the area until deforestation, poor land management practices and under

utilization of rain water struck due to lack of proper planning and preparation while migrating to higher grounds.. Preservation technologies used in the past to enhance food storage .have either been abandoned or replaced with commoditization. With increased threat of climate change in the future, such technologies will have to be reviewed or blended with new ones to enable the residents cope with increased vulnerability. Social ties especially among relatives on either side of the border are a very important livelihood strategy to survive uncertainties such as famine, drought, loss of crops and floods. Finally there are additional diversification options that could be utilized in addition to utilizing wild vegetables. This could be rewarding if proper marketing channels are identified.

2.4 Water Management Technologies in Use

In an area threatened by floods and drought like Bunyala, it is important to outline the major water management technologies that are already in place to support agricultural activities and livelihoods. An overview description of the forces resulting to the introduction of such technologies is presented.. From such descriptions, we could understand the involvement and the role of different institutions in helping reduce vulnerability. Technological investment is key when trying to understand planning and decision making in a given geographical area.. They also show how the locals appreciate and tap the benefits associated with these technologies to improve their income generation and build resilience to eliminate risks and threats.

2.4.1 The Dyke in Budalangi

As already hinted in the previous section, residence of Bunyala protected their homesteads using a technology similar to dyke. They did so by hedging their homesteads with a ²band to prevent flood water from entrenching into their homestead. This technology was also continued during the imperial rule under a communal system of labour known as *silavalava*. Since the famous 1961 floods, there was pressure for the government to act in finding a permanent solution to flooding. As a result the current dyke stretching all the way from Ruambua to Musoma was constructed around the mid 1960s in anticipation of the pilot rice irrigation scheme which was initiated in 1969. Flooding was a threat to the pilot scheme given the investment involved and given the vulnerability and unpredictability of flooding in the area.. Bunyala may flood because it has rained heavily at the Chereangani hills which is the catchment area for River Nzoia. Due to poor drainage in Bunyala, flooding may as well occur as a result of heavy rain in the flood plain. The area may as well flood because the Yala River has also deposited a lot of water in the Yala Swamp causing flooding in the area around *Mauman*.

The current dyke constructed in the 1960s was initially constructed with communal help whereby the residents of Bunyala had to work every Tuesday through communal labour to construct the dyke. Failure to attend to the dyke construction activities was punishable as the village elder (*Mkurui*) and the sub-chief (*Mlango*) would come to your compound to confiscate your working tools like hoes and take away your chickens as a punishment.. Later the communal labour was replaced with the invitation of the ministry of public works to carry out the work on dyke construction and repair. After completion, the topping-up work has been done on the low and weak points where flood water overpowers the walls of the dyke. There are 13 identified weak points along the dyke and

² A raised ground preventing water to flood or to flow in to undesired portions of land.

many residents in this area believe that the dyke has outlived its purpose and thus a new one is needed.

With dwindling government support to public initiatives in the 1990s, the Kenya Armed Forces and the National Youth Service have been called upon to help in the rehabilitation exercises. The villagers recall their involvement in the famous 1997 El Niño floods and the 2001 floods where they had erected their tents at Lugare and Mhoma respectively. More stakeholders have intervened in the floods that followed. At the time of this study, the Ministry of Special Programs and other partners are working together to increase the heights of weak and vulnerable spots along the dyke following the 2007 and 2008 floods. The picture below shows constructors' work in progress



Pic. 13, 14, 15, showing the ongoing work of topping up the dyke at its weak point in Makunda. The first track brings in soil for topping, the second spreads it and the third compresses it.

The villagers of Bunyala- Budalangi have much hope that better dykes are a permanent solution to constant flooding in the area. A retired politician interviewed believed that a permanent solution to flooding and better dyke protection has been hampered by the fact that the problem has been too much politicised. As a result residents, have been waiting for too long for politicians to honour their pledge of a permanent solution to flooding. “By so doing they, the residents, fail to take action of protecting themselves from floods”, added the politician.

2.4.2 The Main Feeder Canal to the Irrigation Scheme

Water from River Nzoia is pumped through a pump station in Ruambua and channeled to the main feeder canal in the irrigation scheme.. With the expansion of rice fields to the out growers scheme, one arm of the canal branches goes to Mulua and Mnemari while the other goes straight to the main irrigation scheme (nucleus). The two arms meet at a point where the canal further traverses through farms and homesteads to the Yala swamp region and later to Lake Victoria. This canal has since 1969 supported rice farming in Bunyala and is being relied upon by the ongoing expansion of irrigated rice fields initiated by the government to increase food security. This canal supplies water for other purposes i.e. domestic use , for drinking by cattle, for small_ scale fishing using hooks and also for some_ small scale horticultural activities(see photo below). Water is pumped by two pump stations; one with 4 pumps each 150 l/s, of which two are in use. The other station has two functional pumps. Currently there are initiatives by World Vision and other independent rice growers to provide their own pumps and reduce the dependency on the NIB pumps.



Pic. 16,15,16 shows livelihood activities as a result of the main rice irrigation canal. The first picture shows a strip of kale production, the second a tomato field and the third, a young girl preparing a bait to fish along the canal while she looks after the parents cattle Dried fish transported from Busia border town to Bunyala (a reversed Role)

In the period 1999 to 2005 when the NIB was not functioning, the pumps were also not running and likewise all operations supported by the canal had come to a halt.. This canal supports the livelihood of many residents of Bunyala. Since rice is the only reliable cash crop in the area at present, rural revenue in Bunyala is highly dependent on the canal. For example, If the out grower farmers in Bunyala fail to produce rice for just a season, the productivity will drop by_ 2,100 tones in grain yield (generally, rice is grown once in a year by most of the farmers, although twice is possible).

At the main irrigation scheme (nucleus), plots of rice cultivation are divided equally to the identified tenants. Each tenant gets a 4 acre piece of land divided into four portions of one acre each. A tenant (farmer) can allocate some portion of the land to his heir or rent it under a special arrangement but cannot sell the plots. Irrigation water is allocated by the Water User Association (WUA) and water inflow is regulated by water guards who control the inflow of water to the sub-feeders and the outflow of the water from the scheme. Each feeder has between 5-8 tenants (each with a 4 acre irrigated land) and these tenants have their own allocated days for irrigation. With this kind of arrangement, the neighboring out grower farmers and members of Munaka CBO are also incorporated in the water use arrangement. The main visible difference of the nucleus tenants and the out-grower farmers is the proper design and construction of the sub-feeders and their bands (the raised ground to ensure flooding). Poor construction of bands allows unwanted water in and out of the rice fields and this eventually affects yield. The out-growers plots are not evenly apportioned; and this might have consequences in harmonizing quality of the out-growers produce. Finally WUA association does not use metric systems to determine how much water should flood a plot of rice since the water guards have developed experience over time to use their tacit knowledge and 'effectively' control the water levels. The water guards have also identified how much water a plot should take using the height of the rice crop in different growing stages. This method works because some farmers are 2-7 days later or earlier with planting as compared with their colleagues in the same feeder . In such respect, water levy is standardized to every acre of rice plot.

2.4.3 Water Trench at Makunda

Makunda area in Bunyala is highly vulnerable to flooding. The occurrence of major floods in the area has greatly affected people by displacing them. The floods further, disrupt schooling programs at both Makunda primary and mixed secondary school. Much damage to the houses, furniture and school materials is believed to occur when flood water takes too long to drain out thereby weakening the foundations of the buildings. For instance, few months before the 2007 general elections, floods occurred. At this period, the intervention to curb the menace became a reserve for politicians contesting for a parliamentary seat. The then member of parliament brought in government engineers and a waterway to direct the flooded water back to River Nzoia was constructed. The waterway was built in such a way that some water can be retained in shallow dams for irrigation or for domestic use(see picture below). In addition, there is a drainage system installed to ensure transportation is not disrupted due to the existence of trench.



Pic. 17,18,19, shows different sections of the trench in Makunda. The first showing the drainage system to allow flood water not to disrupt transportation, the second showing the structure of the trench with water compartments and the third, a zoomed in water compartment which could potentially be used for irrigation

2.4.4 Afforestation

There was evidence of Afforestation in the 1980s when the then President encouraged Kenyans to plant two trees when for some reason one tree had to be cut down. As a result, blue gum and Cyprus trees are common in most homesteads. Some leguminous trees introduced by ICRAF and ministry of agriculture are also grown in the area. Hardly are there natural trees in the area apart from the ones at the Naphuka forest and the heritage site. Naphuka forest is reserved mainly for traditional rituals like; rain making rituals and is a demarcated heritage site..

2.4.5 An Early Warning System

There is an early warning system that is installed at the main bridge to Bunyala the entire system comprise an automatic river gauge among other devices. The gauge records the water level of River Nzoia and communicates the message to relevant authorities. Any data gathered that is relevant to the community is then transmitted as an “alert” to a local FM station (Bulala FM) which broadcasts it in the local language. Bulala FM was licensed to broadcast in 2008. Though still new, it enjoys a huge fan base. Besides the gauge, there is also an automatic weather station at the Bunyala district headquarters grounds which facilitates weather prediction of the area.

. Summing up, Technologies such as the trench in Makunda help reduce disruption of schooling should flooding occur. Disrupted schooling and the destruction of assets and school records will

impact on future development brought about by unregulated discontinuities and the frustration of having to build the ones destroyed over and over again.

Generally, water management technologies are important in rice cultivation and in providing security for future investment and planning. In rice schemes, water supply is through a main water canal that is protected by a dyke. After construction of the dyke, flooding has affected the rice scheme only once, (Personal communication with the elderly farmers). This has encouraged the expansion of the out growers' scheme in Bunyala and in turn increasing the acreage for rice cultivation. However, the infrastructural set-up serving the out growers requires some urgent renovation for easy market access although this again will pose demand for harmonized quality rice. Afforestation attempts in the area are few with trees planted around homesteads and in schools, with high population demanding tree resources for settlement, energy, basketry and furniture making, trees which could provide steady additional income like mangoes, are cut down for a one time energy use without due appreciation of other functions the tree plays. Such deforestation is not followed up by re-afforestation and horticulture which is a high value earner in Eastern and Central provinces of Kenya is not quite well advanced and promoted in the area despite a ready infrastructural development like the traversing of the main irrigation canal. Bulala FM's and the early warning systems should be utilized not only for alerts but also for education on mitigation and adaptation options for awareness creation. .

2.5 Income Diversification for improved wellbeing and enhanced Adaptive capacity

Rice production is the main income generating activity for most households in the area and the acreage is now being expanded to include more farmers. Though highly dependable, rice cultivation is complemented by other activities cattle rearing, basketry and fishing carried out in the area. This section explores the on-farm, off-farm and non-farm activities present in Bunyala as well as unveiling other emerging issues.

2.5.1 On-Farm Activities

Food crops like maize, beans, cassava, millet and sorghum are grown in plots of land mainly adjacent to the *boma* (homestead). Mixed cropping is the common cropping pattern utilized by majority of the farmers. The advantage of this farming system is that it helps maximize sunlight and other essential nutrients for plant growth (per meter square) resulting to high productivity or high yields at harvest. Few farmers practice intercropping especially when they have larger portions of cassava and sweet potato. These two crops will need their own space for the proper development of their tubers. Cassava is also known for its nutrients uptake capability thus likely to compete with other food crops in a mixed cropping set-up. Very few farmers are practicing alley cropping whereby they have a few fruit and non-fruit trees alongside their other food crops.

Farmers hardly apply fertilizer to their food crops and much of the cultivation is done using simple tools such as hoes, and machetes. In an entire planting season, much of the time is spent on weeding and. Depending on the size of farm, weeding is either performed by members of the household or through hired labour. Such labour investment ought to bring the cost of production low but will rarely optimize intensification due to shortage or unreliability of unskilled labour. Quantity of produce in favour of quality (few clients demand for quality) is more rewarding to these farmers practicing subsistence farming. Producing just enough to feed the household is their goal

although any surplus (common with maize produce) is traded in the local and regional markets to generate income.

Most farmers in Bunyala also have farms in *Mauman* and *Migigo* (a reclaimed land from the Yala swamp) which are cultivated when the soils in farms around their homesteads get depleted (exhausted). Besides farming, chickens, pigs and goats are reared in most homes and are often sold for quick income to cover expenses such as direct cost of ill-health, school levies and farming expenses. Rice production is not debatable as it is the main cash crop. There is potential to practice horticulture by cultivating vegetables and fruits but agronomic practices for quality produce and identification of viable markets for the produce have to be developed first.

s2.5.2 Off-Farm Activities

Culturally, the Banyala's are known for weaving papyrus and palm reeds into, mats, hats, baskets, flower baskets and storage drums (for cereals and other uses). Papyrus reeds are harvested in the neighboring Yala swamp and the palm trees are found scattered randomly in the region. The palm trees are said to be propagated by birds. Basketry is practiced in periods of low labour demands and is a substitute to fishing. Other trees used for basketry include *magungi* and *midari* which are used for making handles and edge finishing. *Ukindo* (the palm) is the main tree for weaving baskets while for the mats, it is the papyrus reed. Most mats are used locally to provide a resting surface and also as bedding.

The 3 sided stem of the palm branch is entirely used in basketry with each performing different functions. The baskets are marketed by a cooperative:- Bunyala Handcraft Cooperative and sold to supermarkets in Nairobi among other outlets. Basketry supports many farmers who are aging and cannot engage in the intensive rice farming activities. Basketry could thus be termed as a 'social security venture during old age.' Due to increased unemployment, crop failure (even for the rice crop) and dwindling fish catch, many young people are now engaged in the business as weavers, transporters, middlemen and also retailers. It is unfortunate that with increased entry into the business, initiatives are not put in place to plant new papyrus and palm trees. For instance, handcraft in the Eastern province of Kenya by the Kamba people is almost brought to a stand still because the sculptors cut down all the tree species used for carving without due recognition that they needed to replace them, (FAO, 2001).

Charcoal burning is an exercise carried out in Bunyala. By the time this study was being conducted, it was difficult for charcoal burners to find suitable trees to burn charcoal. Desperate to supply charcoal to the neighboring Siaya, Busia and Kisumu towns, they opted to cut down aged mango trees to burn charcoal. Sadly, such trees do not provide quality charcoal but the market is responsive regardless of the quality. Besides, cutting down trees for charcoal burning, deforestation activities have impacted the Cherang'ani hills:- (the source of River Nzoia). To salvage the hills, a World Bank program has intervened and is currently attempting to encourage tree planting in the area.

Other off-farm income generating activities include brick making and fish farming. Brick making is a new technology in the area but is commonly practiced in the Eastern province of Kenya. The new trend of houses are now built with bricks. Brick making requires kilning, a process that contributes to deforestation. A few wealthy farmers in the area are now owning fish ponds for fish farming.

With scarcity of fish in Lake Victoria and the culture of feeding on fish by the local population, fish farming may be a worthwhile venture.

2.5.3 Non-Farm Activities

The irrigated rice scheme provides casual labour to many women and men. Work such as weeding in the flooded rice plantation is especially done by women and so is thrashing of rice after harvesting. Land preparation is mainly done by men and planting exercise requires sufficient labour to ensure uniformity in growth. The existence of a few companies like ³Dominion Limited Company(DLC) in Siaya, the National Irrigation Board(NIB), schools, health centers and fish firms provide extra revenue to residence of the area. Most of the staff members of these institutions hold key responsibilities in the running of community based organizations and self_ help groups. They are also consulted for opinion in matters related to boosting development in the area.

2.5.4 Emerging Issues

In summary, there is evidence of knowledge utilization and by taking a transient walk along the farms, it is not difficult to recognize the different cropping systems. Such cropping systems might be a result of extensive extension education now perfected in practice. This is an indication that the farmers are teachable and once a technology has saturated in them, it is then likely to survive as a regime. Technology transfer is also evident in the induction of youth in basketry, once known to be a domain for the elderly. Specialization is also taking effect with some of the youth being weavers, others transporters and retailers. It is nonetheless worrying that due attention is not given to the propagation of new palm and papyrus reed even with an influx in the number of weavers. Fish farming, basketry, small scale horticulture are some of the diversification options that could be developed to potential income generating activities. This is the case with conventional alternatives such as charcoal burning and brick making which are on the decline due to lack of raw materials. With increasing population in the area, demand for energy and shelter is on the rise. Therefore, a change in energy use or cooking techniques will be expected. Viable options would be to invest in alternative environmental friendly innovations such as recycling of charcoal powder or use of low energy demanding brick kiln. Prolonged effect of a vulnerability i.e. crop failure due to disease or drought may stress the need to switch to other income generating options i.e. basketry and fishing

2.6 The Potential of Rice for Enhanced Adaptive Capacity

Since the introduction of rice production in Bunyala in 1969, the crop has been generally regarded as a cash crop by most of the farmers. The system in which it was introduced has a lot to do with its perception as a cash crop. Ruigu, 1988 argues that most of the large_ scale irrigation schemes in the country including Bunyala are under the National Irrigation Board (NIB). He further argues that, these irrigation schemes were initiated for settling the landless people as well as boosting food production in the country. As a result, the government's strategy was to supply the basic external inputs and also help in the development and the maintenance of the irrigated fields. The main role of the farmers was to provide labour to pieces of land they were allocated though owned by the government. After farmers harvested the rice, drying, storage and market sourcing remained the task of NIB. Most of the time, the produce was sold to the National Cereals and Produce Board(NCBD)

³ *Dominion is a company owned by a foreign investor in the neighboring Siaya district as is specializing in rice breeding and also rice production for the domestic and export market, Francis Mambala, 2007*

which is a government parastatal. In this arrangement, the government deducted the cost of maintenance and development of the scheme as well as the cost of external input from the total sales of produce and the difference was given to the farmers.

In Kenya, irrigation uses over 69 percent of the limited water resource. Despite this high usage, the performance of irrigation systems and the output thereof is not equally rewarding. In general, most of the agricultural activities across the country rely on water from rain and that from irrigation. Moreover, of the total land area of Kenya estimated at 582,646 km² only 17 percent is classified as medium to high potential agricultural area for both irrigated and rain-fed farming, Ngigi, (ibid). Such a small area to have its produce feed over 35 million is hefty. Besides, with population expected to increase over time, there is need to call for further intensive and extensive exploration of agriculture using modern technologies for sustainable production..

With rice production, the activities of the NIB came to a halt between 1999 to 2005..During this period, farmers who were accustomed to marketing arrangements of NIB could not grow rice any more since water supply to their rice scheme that was regulated by the NIB had been stopped. Other activities such as Research and development of improved varieties were also stopped by the NIB. Nevertheless, farmers sourced for alternatives and they bought their own small water pumps to flood rice plots. In addition, farmers also started small-scale irrigated rice fields near River Nzoia. The box below is a typical illustration of such an attempt by farmers in Nyandikinya self- help group.

Rice farming in Nyandikinya was started in 1999 by Mr. John Osonga who used his retirement benefits after working for the firestone company in Nairobi to buy a small water pump. With the pump he flooded a half an acre land and planted rice. He did all the land preparations, development of the bands, procuring seeds and investing labour all by himself. After a successive harvest, he expanded his farm to one acre and later to 3 acres. His extended family (the Vinaki clan) was interested in his initiative, he brought them onboard and together they are growing rice in a 25 acre piece of land. The group believes firmly in providing its own capital and will hardly borrow from microfinance institutions. 'Farming is risky and if you borrow and experience failed crop, they will come and pick your hard earned assets as repayment', said Mr. Osonga. Due to their self sufficiency, they could regulate their activities to go against that of the farmers at the main rice irrigation scheme, for instance, in 2008 they planted their rice in February while the main scheme had planted in September 2007, by so doing they utilized the long rains and therefore did not have to use their engine water pump thus cutting down on costs. In addition to that, their rice crop was harvested when no one else had rice in the area thereby able to influence the price of their rice produce.

With the return of NIB, more small_ scale rice farming self_ help groups have cropped up and some have consolidated themselves into community based organizations sourcing funds for the farmers groups to meet the cost of production. Such Groupings like Munaka CBO are relatively autonomous in operation but rely considerably to the services offered by the NIB. Munaka issue will

be revisited in the next section of this report to assess how rice farming by small_ scale farmers could be used to improve the resilience of the Bunyala community.

Climate change is already thought to be influencing cropping seasons and this translates to unpredictability and uncertainty; such a risk will also result to lost yield and increased production cost. Drought especially in the arid and semiarid regions and many other problems i.e. food distribution are likely to worsen the food security situation in the country and at the same time donor intervention in relief is also thought to be dwindling, Dabisa, 2009. On realization of the above, the government together with her partners is now investing in intensive irrigated agriculture especially for maize and rice. Bunyala is one of the targeted schemes for this undertaking. Food security could thus be improved through initiatives that aim at narrowing the gap between food availability and food sovereignty. Such attempts could even add more meaning to rural life especially in the era of increased climatic impacts by encouraging production of high yielding crop. This could be facilitated through improved husbandry and at the same time looking at options to rewarding quality produce and encouraging competition. In such a set up, rural communities could be empowered through market induced returns to plan and prepare for the uncertainties ahead responsibly.

3. Discussion: Revisiting the Vulnerability Capacity Assessment Determinants

In part one of this documentary which was on literature review cum exploratory survey on Bunyala, 4 determinants of vulnerability and adaptive capacity analysis adopted from Mertz et al, 2009 were introduced.. these determinants will be re-introduced to help in analyzing the preparedness of Bunyala in response to increased future climatic impacts. The determinants are described below.

3.1 Intensity of the Vulnerability and Adaptive Capacity

Since 1961, Bunyala has experienced 13 counts of registered floods. Such flood incidences have weakened the ability of the locals to cope with future vulnerabilities as well as providing new adaptive measures to cope with such extremes. The evidence gathered seems to suggest that most of the adaptive measures passed on through generations are either lost or non-functional at the moment due to changing trends and modernization. Water management technologies such as dykes have been installed to cushion the villagers from floods but the frequency of the flood water overpowering the dykes seems to suggest increased danger to household assets, crops in the fields, stored food and infrastructure such as schools, roads and houses. Flooding has its blessings too as it is related to increased fish catch which serves as emergency food supply and the excess smoked or dried for future use. Change in trends in housing from mud grass huts to bricks and with iron sheet roofing could provide opportunities for rain water harvesting but this is not quite well explored in the area. Residents are accustomed to fetching water in the nearby shallow wells which could potentially be contaminated by flooding. Increased population is pushing for increased shelter and exploitation of natural resources. The homestead arrangement which consolidated buildings together for ease of common protection mechanism are on the decline. Unplanned constructions are also blocking water ways for flood water making it to stagnate thus increasing the chances of mosquito breeding. With 3 types of mosquito species in the area each with unique characteristics, susceptibility to malaria becomes an issue worthy of necessary attention, Diarrhea and bilharzia, are other illnesses associated with flooding in the area. A sick farmer cannot produce optimally. Similarly a farmer scared of flooding cannot invest appropriately.

Drought though not regarded as severe as the floods is also a threat in the area. Its occurrence in the past resulted to famine and food insecurity but no major incidents have been recorded in the recent past. It is however feared that the frequency of short drought spells are on the increase. Famine on the other hand is caused by an outbreak of pests and disease as well as flooding that destroys food crops in the field and harvested ones in storage facilities. Food storage and preservation techniques used in the past are now under-utilized as the staple food of the locals remains generally the same. Fast maturing crops and wild vegetables are immediately planted in the fields freed from flood water. It is evident that both cultivated and wild fruits are not well appreciated in the area. Due to inexperience of coping with floods, migrants from the flood plain to higher ground (the hills) find it hard to cope without the proximity of River Nzoia. Cultivation practiced in the higher grounds hardly employs soil conservation techniques like terracing thus resulting to poor quality soils due to erosion. It is thought that proper co-ordination and preparation of the migrants should be done to ensure their acclimatization to the new environs.

3.2 Underlying Socio-historic Challenges

Rice production is a capital intensive venture and with economies of scale, returns from such an investment are not only profitable but also reliable. For this to happen, yields and quality will need to be improved. Rice from Bunyala is already thought to be of the same yield with that from Mwea irrigation scheme (the most successful rice scheme in Kenya). In this respect, difference in marketing and value adding make the distinction between farmers of the two irrigation schemes. Better market to a great extent is influenced by proper crop husbandry and good co-ordination of farmers that will allow uniformity of quality, operations and increased accountability. In most cases, the more the farmers the harder the task of proper co-ordination due to dynamics in backgrounds, perceptions, intentions and behavior, (Vellema, 2006). Below is a presentation on points of interest observed when interacting and with the farmers believed to be linked with socio-historic issues.

Dependency on the government and external agents. Any farmer talked to lamented on:- how the government had failed to deliver its promise, how the local MP had failed to honour the pledge on a permanent solution to flooding in the area and how different organizations had failed to help them initiate projects and how the farmers were claiming they were incapable on their own. However, one major issue of concern was own responsibility of the farmers to use locally available resource and knowledge collectively to reduce their vulnerability.. Most farmers asked to comment on the issue, did not know what the community could or have done without external help. From farming point of view, farmers said that they had planted flood tolerant sorghum variety and a few trees around the compound. With such dependency only traces like the case of Nyandikinya self -help group managed to combine their efforts and autonomously grow rice for improved self resilience.

'Farmers are not accustomed to the culture of savings'. A manager of a local micro-credit institution visited said that, the institution faced problems of convincing farmers to take loan since they were used to receiving grants from the government. Moreover, the microfinance has also a saving scheme which very few farmers have been able to utilize. "Farmers spent all the revenue from their rice since to them 'Revenue equals net Profit,' "said the manager. With such kind of culture, planting time often find farmers ill-prepared for the season. A standard fee of Ksh. 12,000 is needed for the out grower farmers before the start of every rice growing season. This money covers the cost of water supply and maintenance of the feeders as well as the cost of seeds and rotavation. In Munaka, farmers

experienced total crop failure in 2006 2006–due to rice blast attack. This made them unable to grow rice the following year(2007) as they lacked the initial standard cost fee of Ksh. 12,000. At the same time, all these farmers had a loan to repay for the failed crop of 2006-2007. Though disastrous, the group managed to gather the required money and this resulted to a successive harvest in 2008/2009. Unfortunately, some of the farmers were reluctant to pay their loan even with a good harvest.

Farmers are not keen to detail, 'sufficient is good enough' is their belief. Fox knowledge is characterized as practical not abstract. Where better quality is involved; it is the small details that makes a difference between a good farmer and a better farmer. Take land preparation and leveling for example, a good rice field which is flat and with loose soil will allow even distribution of water in the plot. In such a plot, uniform growth of rice is expected since each rice plant gets the same treatment. Equally, failing to drain a rice nursery bed on time will result to loss of seedlings and uneven growth. Such small omissions if accumulated will cost the farmer much which is not comparable to the few hours the farmer could have sacrificed to give the crop the attention it deserves. With improved rice husbandry practices, the manager of the NIB thought that the quality of rice and yields would improve considerably. To achieve this, farmers will have to engage in rice production as entrepreneurs but not as tenants of a government scheme like they have been used to.

Ambitious but no clear structure – From a focus group discussion held with the committee of the Munaka Community based organization, it was clear that the group had very good plans including the introduction of upland crops into the irrigated rice fields. Such a venture would be good for crop rotation and would help reduce pest and disease incidences. While the committee articulated future plans very well, they seemed convinced that an external intervention was needed for implementation. There was no clear work plan on how these good plans such as investing in value addition machines for processing and storing the rice until better prices were sought could be effected.

3.3. Stress to Natural Resource Base

Reduced livelihood options are pushing many locals into fishing. Poor fishing technologies are also blamed for lack of fish in lake Victoria (as signs at Port Victoria were warning against such practices). Drought and floods also push many locals into basketry resulting to over harvesting of reeds and palm branches. The problem is not yet severe in the basketry sector but if unchecked it could lead to the extinction of the trees involved. Favorable trees for charcoal burning in the area are literally non-existence due to charcoal demand in the neighboring towns. Overpopulation demands more shelter which demand trees for erecting mud grass huts or for brick making. Migration to higher grounds has resulted to poor agronomic and soil management practices exposing the area to soil erosion and degradation through deforestation exercises. The catchment area of River Nzoia is also deforested threatening the future of a main water in-let to Lake Victoria. Without factoring the environment in personal and regional development decision making for rural development will definitely not yield sustainable outcomes.

3.4 Institutional Linkages on Poverty, Economic Growth and Future Climate Impacts

All the water technologies discussed in this article are externally instigated and in most cases the residents of Bunyala are spectators of what external agents think is appropriate for them. With the

current “Dyke topping up exercise” in progress, some tracks were offloading soil with others leveling it. Such an exercise involved very few workers as most of the community’s watched from a distance. It would be great if such programs involved the locals, in order to increase their responsibility in protecting themselves from eventualities such as floods in future.

The media attention Budalangi gets when floods strike has also resulted to donor response with good intentions. These good intentions when repeated over and over again could be a demoralizing activity for the residents to plan for their own development. Emergency response may not fall in the strategic plan of the development of the area, i.e. keeping people in camps for a long time might be weakening their ability to think of better alternatives to adapt to a disaster. Adequate control of the development and maintenance of the water management technologies by the locals might thus ensure prioritization, continuity and effective use of external funding to the benefit of the area. People involved in the locally controlled programmers should also be knowledgeable, well- versed on the development of the area, trust worthy and tested, otherwise extortion will take heed. Such controls should not dictate the operation of market led initiatives like the cash crop production of rice but should work to ensure that the interests of its growth are protected.

The perception got while interacting with the different farmers was that, they rely on the government for most of activities that involve money . With such mentality, market oriented rice production will be difficult..Collective action in the area is a new concept to many farmers; as observed in one scenario where farmers delayed planting rice for over two weeks because they did not want to join a group to obtain a loan to meet the initial production costs. Despite the fears, these farmers did not have any other source of income to support planting but were still determined to grow rice. Such fears should be addressed and if possible crop insurance introduced to reduce the farmers negative perception on loans.

NIB and the water users association provide needful services like pumping, distribution, monitoring and advice on water use. They research on improved varieties and disease protection as well as organize for trainings. They also decide on the growing schedule and as well source for the market of the rice produced. There lies the dilemma of vital service provision provided by the NIB and the desire to grow entrepreneurs who can compete competitively in the regional market to deliver value rice while optimizing returns. Either way of the dilemma should be carefully calculated to avoid bringing all these important and viable operations to a stand still.

There exists an interdependency of rice and other farm activities. Casual laborers in the rice fields could be paid for weeding one acre of land with 12 Kg of millet. Due to scarcity of labour, many rice farmers prefer growing rice for one season and food crops in the next. This is despite the fact that much of the growing calendar for rice is operated by the NIB. Rice is also sold to buy food crops and to invest in new land clearing and cultivation activities.

Earnings from rice are mainly used for health-seeking, education, investing in small trading activities and for social activities such as preparing for weddings and burial arrangements. Burials are regarded highly in the area thus a lot of the household resources are channeled to the arrangements. improved rice earning would influence the health of the family and also would help invest in improved soil conservation mechanisms, together with new and improved technologies for

maximum productivity which are likely to improve the resilience of the local population to eminent climatic threats.

4. Conclusion

Increased involvement and participation of the local population in the designing and execution of future development plans as well as taking part in the climatic impact adaptation efforts in the area. There is need to encourage local community to engage in novel induced mitigation and adaptation measures i.e. the sprouting of youth groups to plant trees for reforestation and also as an income generating activity(IGA). This is despite the fact that the community's collective action seems not to have been institutionalized but the growth of self-help groups and community based organizations in rice production is a commendable effort.

While external intervention on the plight of Bunyala residents is a noble undertaking, it could increase their dependency on external help and thus fail to take responsibility for their own development. Most of these interventions like that on water management technologies already discussed are beyond the affordability of the locals. A deliberate effort to engage them in the execution of such activities and not just as unskilled man-power providers would help them own the process of searching for solutions to today's and future vulnerabilities. Achieving participation to that level would require a system that is coordinated and consistent.

Rice could be a viable income earner and a reliable option to build the resilience of the locals towards eminent vulnerabilities. Opportunities(efforts) to lower production cost, increase the resistance of rice varieties to pests an diseases, search for better markets and exploration of value adding option will need to be identified, communicated and tested. The next section of this report will seek to identify such opportunities in an effort to help improve decision making of the small-scale rice farmers in Bunyala.

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