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MINISTRY OF WATER AND ENVIRONMENT

CLIMATE CHANGE DEPARTMENT

Economic Assessment of the Impacts of Climate Change in Uganda

Case-study on agricultural production in the Karamoja region

October 2015

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LIST OF ACRONYMS

Acronym	Definition
ALREP	Northern Uganda Agricultural Livelihoods Recovery Programme
BAU	Business As Usual
CDKN	Climate and Development Knowledge Network
CO_2	Carbon Dioxide
DDP	District Development Plan
DFID	United Kingdom Department for International Development
DLG	District Local Government
FAO	Food and Agriculture Organization of the United Nations
GEF	Global Environmental Facility
GoU	Government of Uganda
IFPRI	International Food Policy Research Institute
ITCP	Integrate Territorial Climate Plan
KALIP	Karamoja Livelihoods Programme
KIDP	Karamoja Integrated Development Programme
NAPA	National Adaptation Plan of Action
NAADs	National Agricultural Advisory Services
NCCP	National Climate Change Policy
PRDP	Peace Recovery and Development Plan
RCP	Representative Concentration Pathway
UBOS	Uganda Bureau of Statistics
UNEP	United Nations Environment Programme
UNDP	United Nations Development Programme
UWA	Uganda Wildlife Authority
USAID	United States Agency for International Development
WFP	World Food Programme

EXECUTIVE SUMMARY

Insecurity in the Karamoja region has hindered economic development but peace building programmes implemented in the last few years have resulted in a considerably improved current situation with the prospect of making the transition from emergency support to longer-term development. Among current challenges is how best to develop agricultural activities in drought and flood prone areas with the increased uncertainty of climate change. This study has aimed to contribute to the evidence base on the impact of climate change by assessing the recent and possible future economic impacts on agricultural production (crops and livestock) in three village locations in the Karamoja region.

The study collected field data on climate impacts and adaptation responses via questionnaire and semi structured interviews of local officials and a sample of households in the villages of: (i) Oryeotyene North Ward Village in Abim district (representing the Agricultural zone), (ii) Nakayot Village in Napak district (representing the Agro-Pastoralist zone) and (iii) Lopedot Village in Amudat district (representing the Pastoral zone).

Each of the three villages has recently experienced severe drought events and two of the villages have experienced serious flooding recently. In many cases, these events have resulted in losses of 50 to 100% of total expected production for affected households. Total losses from crop and livestock production combined from the droughts of 2014, compared with recent more "normal" years, were estimated at about $ 179 per household in Oryeotyene North ward, in the range $159 to $501 per household in Nakayot and $748 to $1,224 in Lopedot.

The results provide some evidence for the importance of holding livestock to provide greater resilience to climate events and highlight the risks to investment in agriculture in the light of plans for expansion of crop production in the region. While livestock production and income was very badly hit by drought through loss of water supply, losses of pasture and increased disease incidence, the overall impacts were generally not as comprehensive as for crop production.

The study then considered **future economic impacts from extreme climate events** although estimates are only illustrative as detailed projections on changes in their frequency and intensity are not available. For Oryeotyene Northward, projections of losses of **crop value** from future climate events (floods/droughts) up to 2050 produced total losses of potential crop production of around 9% (for a less severe scenario) and 18% (a more severe scenario). For Nakayot, similar projections produced estimates of about 15% in a less severe scenario and 32% in a severe scenario. Similarly the speculative estimates for Lopedot produced losses in crop production value to 2050 of about 19% to 28% for the different scenarios. Illustrative estimates of future impacts from climate change for **livestock value** show total losses up to 2050 of around 11% (less severe scenario) to 16% (more severe scenario) for Lopedot and 12% (less severe scenario) to 26% (more severe scenario) for Nakayot.

Estimates for overall **changes to yields** of some key crops due to climate change (i.e. long term rainfall and temperature trends rather than extreme climate events) up to 2050 were also made for the three locations. Results indicate potentially significant impacts on the value of important current crops such as maize (up to 12% reductions) and beans (up to 20% reductions) depending on the climate model used.

While there are significant uncertainties in the projections of the magnitude of future impacts, the case study indicates the urgent need to develop local responses to existing and future climate variability and change. The study gives an overview of the types of adaptation response that came from stakeholder consultation with an indicative qualitative assessment of costs and benefits, and priorities. The conclusions in this localised case study indicate, however, the need for more research at the district and regional level on climate impacts and appropriate responses that can provide greater resilience through more stable incomes and livelihoods.

SUMMARY

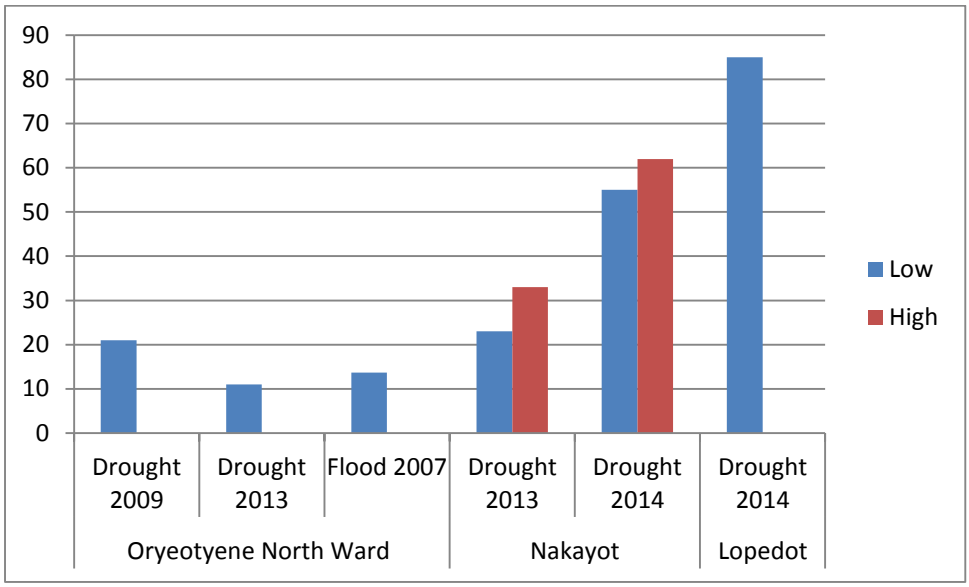
Insecurity in the Karamoja region has hindered economic development but peace building programmes implemented in the last few years have resulted in a considerably improved current situation with the prospect of making the transition from emergency support to longer-term development. Among current challenges is how best to develop agricultural activities in drought-prone areas with the increased uncertainty of climate change. This study has aimed to contribute to the evidence base on the impact of climate change by assessing the recent and possible future economic impacts on agricultural production (crops and livestock production) in three village locations in the Karamoja region. An assessment has also been made of adaptation responses in the villages and priorities for future adaptation.

The study collected field data on climate impacts and adaptation responses via questionnaires and semi structured interviews of local officials and a sample of households in the villages of: (i) Oryeotyene North Ward Village in Abim district (representing the Agricultural zone), (ii) Nakayot Village in Napak district (representing the Agro-Pastoralist zone) and (iii) Lopedot Village in Amudat district (representing the Pastoral zone).

The key findings from the assessment of climate impacts in the three villages are summarised as follows:

- **Each of the three villages has experienced severe climate events recently**. All had experienced recent **droughts** with both Oryeotyene North Ward in the agricultural zone and Nakayot in the Agro-Pastoralist zone having a consistent change in rainfall patterns in the last few years with shorter rainfall seasons which had caused uncertainty for farmers on when to plant and harvest crops. Lopedot in the Pastoralist zone has always experienced instances of drought, however, a very severe drought occurred in 2014 causing significant destruction of crop production. Both Oryeotyene North Ward and Nakayot have also experienced serious **flooding** events over the last 10 years causing destruction of production for those in the flood prone areas.
- **The results showed consistency in the stated high percentage of impact on agricultural production and income for recent climate events within each village sample.** In many cases climate events resulted in losses of 50 to 100 percent of total expected production for affected households. There were, however, some cases of inconsistency in the stated years of past climate events occurring (this is due to differing recall of past events by different respondents) which may have resulted in an underestimation of our estimates of total impacts for a given event.
- **Estimates show significant total impacts on crop production value from recent severe climate events in all three villages.** Examples of percentage losses in crop production value are given in Chart ES.1 which shows in Oryeotyene North Ward estimated losses of about 21 percent of expected crop production (for drought in 2009), 11 percent of expected production (for drought of 2013) and 13.7 per cent of expected production (for floods of 2007). This compares to estimated losses in Nakayot of about 55 to 62 percent of a normal year's value for the 2014 drought and 23 to 33 percent for the 2013 drought. The 2014 severe drought in Lopedot is estimated to have reduced crop production value in the village by around 85 percent compared to the value in 2012. This should be seen in the context of Lopedot being traditionally a livestock zone with only recent introduction of crops.

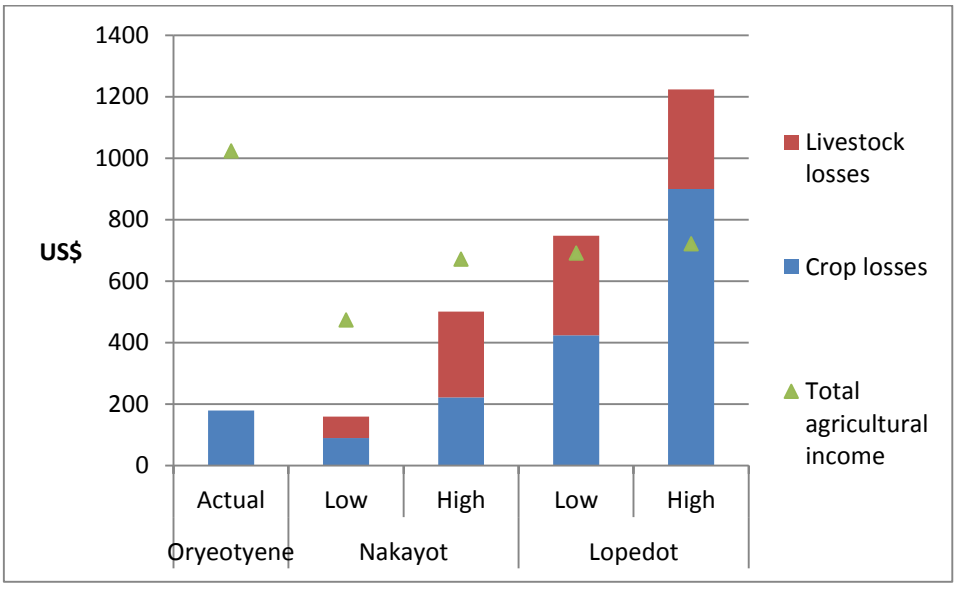
Chart ES1: Impacts on Crop Production Value of Recent Climate Events (% losses)



- **Estimates of total impacts on livestock product income from recent climate events were also significant for the two villages in the pastoral and agro-pastoral zones.** In Nakayot the lower estimate of losses (which may be more realistic) for the drought of 2014 represents about 22 percent of total average income from livestock product sales and the equivalent figure for the 2013 drought is about 20 percent. In Lopedot the 2014 drought is estimated to have reduced livestock production income by around 50 percent.

- **Total losses from crop and livestock production combined from the droughts of 2014 translated into significant average losses per household** as shown in chart ES2. Compared with recent more "normal" years, these losses range from about $ 179 per household in Oryeotyene North ward, in the range $159 to $501 per household in Nakayot and $748 to $1,224 in Lopedot. The higher figure in Lopedot is due to the near complete failure of the crops and 50 per cent losses of livestock income. The significance of these losses for households is also demonstrated by comparison to the total agricultural income in 2014 shown in the chart.

Chart ES2: Estimated Total Losses per Household from Agricultural Production from the Droughts of 2014



- **The study demonstrates the likely magnitude of future impacts on agricultural production from climate change without adaptation** although these are only illustrative in the case of extreme climate events as we do not have projections for changes in frequency and intensity. For Oryeotyene Northward projections of losses of crop value from future climate events up to 2050 (based on the estimated losses from recent events in this study) produced total losses of potential crop production of about 9 per cent (for a less severe scenario) and 18 percent (a more severe scenario). For Nakayot similar projections for losses in crop production value to 2050 produced estimates of about 15 per cent in a less severe scenario and 32 percent in a severe scenario. Similarly the speculative estimates for Lopedot produced losses in crop production value to 2050 of about 19 to 28 percent for the different scenarios.
- **Estimates for overall changes to yields of some key crops due to climate change up to 2050 are also potentially significant in the three locations.** These were based on IFPRI modelling of percentage impacts on yield from long term rainfall and temperature trends and are therefore different from the analysis of sudden impacts of floods and droughts which are not informed by this long term yield analysis. The modelling indicates impacts on the value of important current crops such as maize (up to 12 percent reductions) and beans (up to 20 percent reductions) depending on the climate model used. While these conclusions are highly uncertain they have implications for adaptation in terms of the possible need for crop diversification, improving water availability, capacity building and other resilience strategies in the medium and long term.

Key insights from the analysis of recent climate impacts are as follows:

- **Consistent changes in rainfall patterns and frequency and intensity of severe climate events** in recent years has severely impacted on agricultural production in all three villages. This has clear implications for sustainability of livelihoods in a region where production is already precarious even without a changing climate.
- While other reasons for insecurity of production have been reduced in recent years, in particular the local and cross-border conflicts, the **impacts of climate variability have increased**. All villages had evidence of large percentage decreases in **crop production,** including for staple crops, resulting from recent severe climate events and this has increased reliance on other sources of food and income. In some cases there has been a near complete failure of crops (e.g. Lopedot, 2014).
- **Future impacts from climate variability and change on agricultural production are highly uncertain** due to lack of projections for future frequency and intensity of extreme climate events. However, a continuation of recent trends will result in significant losses of crop and livestock value up to 2050.
- Given projections of country level growth in per capita income it is **likely that the gap between living standards in this region and the rest of the country will widen** in coming decades. Furthermore, in the absence of measures to address climatic variations fluctuations of incomes in the region will make livelihoods here more unattractive.
- Although it is not valid to make direct comparisons between these loss figures for climate events between crop production and livestock product sales, the study does provide some **evidence for the importance of holding livestock** to provide greater resilience to climate events. In Lopedot, it could be concluded that while livestock production and income were very badly hit by the drought in 2014 through loss of water supply, losses of pasture and increased disease incidence, the overall impacts were not as comprehensive as for crop production as it was at least possible to take livestock to graze in other regions and retain some limited household consumption of milk and meat, and also to retain remaining livestock assets for future years. It is also interesting that in the mixed farming village of Nakayot it was suggested among priority adaptation actions there should be long term investment in livestock since "they are not adversely affected by climate change". Even though the survey showed

some significant impacts on livestock production from climate events in the village, livestock was still perceived as a more resilient type of agriculture than the crop production.

- **Further information on future impacts of climate variability and change on agricultural production is needed**, both for future frequency and intensity impacts of extreme events (drought and flood) and long term impacts on agricultural yields of changes in rainfall and temperature (as also noted in the national agricultural study). However, it is clear that a continuation of recent trends in extreme events will result in significant losses of crop and livestock value up to 2050. As this study has been necessarily based on rather a limited set of villages it will be essential for more comprehensive studies to give much more detailed regional assessment of such local vulnerabilities in order to inform the process of devising targeted adaptation responses.
- The type of data provided in this case study, if further developed at district and regional level, and in conjunction with other community data (such as the Food Security and Nutrition Assessment (WFP & UNICEF 2014) and FAO Household Economic Assessment (FAO, 2014)) can provide a key input to adaptation planning and monitoring. It can be used to estimate potential losses due to extreme climate events and thus inform emergency preparedness and responses, and long term planning and development of effective response mechanisms.

In terms of adaptation to climate change one has to look at the question in the wider context of agriculture in the region relative to development in the rest of the country. The region has high levels of poverty now and even without climate change the future looks bleak. There is some prospect for growth; for crop production about 2.4% per year to 2030 and 1.9% per year after that is being projected by FAO for agriculture in sub-Saharan Africa as a whole and Karamoja should benefit from something similar. But with the rest of the country growing faster the gap between living standards in this region and the rest of the country will widen. Hence we expect not only to see growing gaps in per capita income but, in the absence of measures to address climatic variations, the fluctuations of incomes in the region will make livelihoods here unattractive. One must expect therefore some migration to urban areas and an increase in productivity (output per head) for agriculture to emerge. The continued practice of agriculture in all areas of the region under the national growth scenarios is of course not guaranteed: there are examples in other countries (e.g. post-war Italy, post-communist Russia) of marginal areas for agriculture being abandoned as new opportunities arise elsewhere in the country.

The overall message from the above analysis is that we can expect significant autonomous adaptation in the region as individuals respond to the differences in opportunities in Karamoja versus the rest of the country. Yet this will not be enough to improve livelihoods for the people of these villages, some of whom appear to have a strong preference to continue their current agricultural and/or pastoral lifestyle. Moreover there is an urgent need to address the climate variability that exists and a programme to do that is essential.

Table ES1 gives an overview of the types of adaptation response that came from the stakeholder consultation of this case study with an indicative assessment of costs and benefits and priorities.

Table ES1 Indicative Costs and Benefits of Types of Adaptation Responses

	Type of Response	Costs	Benefits	Priority
1	Capacity building	Moderate	High	High
2	Improvement of crop storage	Medium/High	High	To Determine
3	Resettlement plan	High	Unclear	To Determine
4	Crop diversification	Medium/High	Moderate/High	High
5	Household income diversification	High	High	Medium Term
6	Improving water availability	High	High	Very High
7	Pasture for animals	Moderate	High	High
8	Flood control	High	High	To Determine
9	Rehabilitating on degraded land	High	High	Medium Term
10	Improvement of transportation	High	High	To Determine

Key insights from the analysis of adaptation responses are as follows:

- Improvements in stable income are urgently needed for the people of these villages. So there is, *prima facie*, a strong case to include programmes that **diversify household incomes** (item 5) in the programme. However data on costs and benefits for such programmes are not available and should be prepared.
- Consequences of extreme events for farmers need to be mitigated, given the huge losses they cause. Activities that improve **water availability** during periods of drought (item 6) and that **control flood impacts** (item 8) are of critical importance. Data indicate the net benefits from proposed water conservation and collection are high relative to costs but similar information is not available for flood control measures and needs to be collected. At the same time we see both as a matter of high priority.
- Farmers would benefit from **better information and knowledge** about which crops are best suited to the changing climatic conditions (many options exist, including tree plantations) and items 1 (capacity building), 4 (crop diversification) address that aspect. Both of these have high net benefits and are a high priority.
- The surveys carried out also show **some farmers are operating on highly marginal land** and probably need to be relocated if they are to survive. Items 3 (resettlement plan) is a costly and complex process and needs further consideration. Item 7 (improved pasture for animals) emerges as having a high net benefit. Item 9 (rehabilitating degraded land) has high costs and benefits and should be a medium term priority. Measures that aim to **increase the efficiency of agriculture** in the area (items 2 (improvements of crop storage) and 10 (improvements in transportation) come in this category) need to be evaluated. We lack enough data for this at present.

The evidence indicates that many of these actions are of high value in the current situation and many are urgently needed, especially those addressing extreme events. Climate change will make the need even greater.

1. INTRODUCTION

1.1. Context

This case study of the Karamoja region is part of the support to the Government of Uganda (GoU) in implementing the National Climate Change Policy (NCCP) being provided by Baastel and its partners[1], and funded by the Climate and Development Knowledge Network (CDKN) and DFID. The support is focused on filling gaps in evidence of the cost of climate change through an Economic Assessment of the Impacts of Climate Change in Uganda. It aims to provide estimates in monetary terms of the current and potential future costs of climate change in the country, considering both the cost of residual damage and of the adaptation efforts that are currently conducted and need to be conducted in the future. Importantly, the information generated in the study aims to help the GoU and local institutions to prioritize their interventions.

As part of this nation-wide study, case-studies provide an opportunity to assess the impacts of climate change at the local level, through consultation of various stakeholders, including local authorities, development partners, private sector operators and local communities. In particular, stakeholders' perception of the impacts of climate change has been given due consideration, as well as the adaptation strategies they implement as a reaction to extreme events or new climatic patterns. This bottom-up approach will then feed into the national level assessment, providing concrete examples of the cost of climate change at the local level and possible benefits of a range of adaptation strategies implemented locally. This case study aims to make such a contribution to this evidence in the context of the national level study for the Agricultural Sector (Metroeconomica, 2015).

This constitutes one of five case-studies in the overall study, the other four being:

- Infrastructure: Economic assessment of the impacts of climate change in the Kampala urban area, in close collaboration with the Kampala City Council Authority (KCCA)
- Export/agriculture sector: Economic assessment of the impacts of climate change on the coffee sector in Bududa district in the region of Mt. Elgon
- Health sector: Economic assessment of the impacts of climate change on malaria prevalence in the districts of Tororo and Kabale;
- Water and hydropower sectors: Economic assessment of the impacts of climate change in the Mpanga river catchment.

The Karamoja region was chosen as a case study because it faces a number of development challenges in the light of historical marginalization, local and cross-border conflicts and lack of capacity development and investment. Insecurity has hindered economic development in recent decades but peace building programmes implemented in the last few years have resulted in a considerably improved current situation with the prospect of making the transition from emergency support to longer-term development (FAO/EU, 2009). Among current challenges is how best to develop agricultural activities in drought-prone areas with the increased uncertainty of climate change.

This case study seeks to contribute to the evidence base on the impact of climate change by assessing the existing recent and future economic impacts on agricultural production in three specific village locations of the Karamoja region. It then evaluates a range of current and possible future adaptation options. Section 2 of this report presents contextual information for the region. Sections 3, 4 and 5 present the findings of the

[1]Namely Makerere University, Metroeconomica and the University of Wolverhampton

assessments for the three village locations in the Abim district, Napak district and Amudat district. Unless otherwise stated the information given in these sections is from the survey interviews undertaken in the three locations. This is followed by general conclusions in Section 6.

Figure 1.1: Focus group discussion in Oryeotyene village

1.2. Methodology

The study selected three villages for collection of field data on the basis of three criteria: (i) that they represented three main livelihood zones of the region, (ii) additional source information on farming livelihoods was available at the village level from other studies[2] and (iii) they met practical considerations of accessibility within the timeframe of the field work. The locations selected were as follows:

- Oryeotyene Northward Village in Abim district in the Agricultural zone (namely 'Western mixed crop farming zone').
- Nakayot Village in Napak district in the Agro-Pastoralist zone (namely 'Central sorghum and livestock zone')
- Lopedot Village in Amudat district in the Pastoral zone ('South eastern cattle maize zone')

Summary details of the three villages are given in Table 1.1.The livelihood zones of Karamoja (FAO, 2014) and locations of the three selected villages are shown in Figure 1.2. These definitions have been developed by FAO on behalf of the Ministry of Agriculture of GoU and funded by DFID.

[2] The key sources reviewed for data of most relevance to the study were: WFP & UNICEF (2014) Food Security and Nutrition Assessment (FSNA), FAO (2014) Household Economy Assessment, Mercy Corps (2013) Livelihood Dynamics in Northern Karamoja and (UBOS, 2005-11) Uganda National Panel Survey.

A field mission was conducted in March 2015 to collect local data via questionnaire and semi structured interviews of local officials and a sample of village households for each location. The questions included themes on village demographics, agricultural production and livestock production/holdings and the economics of farming at household level. It then covered local impacts of climate events on farming production over recent years, exiting adaptation responses and planned adaptation responses. The questionnaire is attached to the report as an annex.

For each village ten households were randomly chosen for interviews based on the questionnaire after focus group discussions. While there is a possibility that the households selected were not fully representative of income groups, crop production and livestock holdings within the villages, the general consensus in consultations with village officials and in the focus groups was that most village members were generally in the same income group and that agricultural production and livestock holdings for the interviewed households was representative. Thus our general conclusion was that the household samples were largely representative of the villages.

Table 1.1: Summary of Villages in Field Mission

District	Village	FAO Zone	Current Number of Households	Households Interviewed
Abim	Oryeotyene North ward	Western mixed crop farming	83	10
Napak	Nakayot	Central sorghum and livestock	862	10
Amudat	Lopedot	South eastern cattle maize	41	10

Quantitative information collected via the survey and other sources was used to estimate the economic costs of recent climate event impacts in the three village locations[3]. This formed the basis for estimating possible future economic impacts of climate change and variability under different climate scenarios. It should be noted that the village of Nakayot has a much greater population than both Oryeotyene Northward and Lopedot villages. Therefore, estimates of production value and climate impacts at village level based on the sample for Nakayot should be treated as much less reliable than those for the other two villages given that the sample represented a much smaller percentage of total population Conversely, the results for Lopedot will be more robust than the others due to the proportionately larger sample size.

The steps in this assessment for each village were as follows[4]:

- The **value of production** (sold and not sold) of crops and livestock products for the surveyed households in recent years was estimated based on questionnaire responses on quantity of production

[3] Data collected from the three villages for production and price in UGX/kg were used to calculate value of production currently and to estimate the costs of lost production due to climate events in recent years. The calculation of value of production included both sold and subsistence production (based on the value at local prices if it had been sold). Where no information was available on local prices of specific crops or livestock products due to all village production being subsistence a price was estimated based on data from other villages in the survey and from local price data given in the Info Trade website (www.infotradeuganda.com), FAO (2014) and Mercy Corps (2013). The review of prices found reasonable consistency for specific products from these different sources with some exceptions, for example maize and groundnuts had quite wide ranges of prices. Therefore, where necessary the study made low and high estimates of value of production and value of climate event impacts based on the range of prices.

[4] In the village assessments of the value of production and climate impacts conversions from UGX into dollars have been made at the purchasing power parity (PPP) exchange rate which is taken as a better guide to the real value of earnings and prices than the market rate.

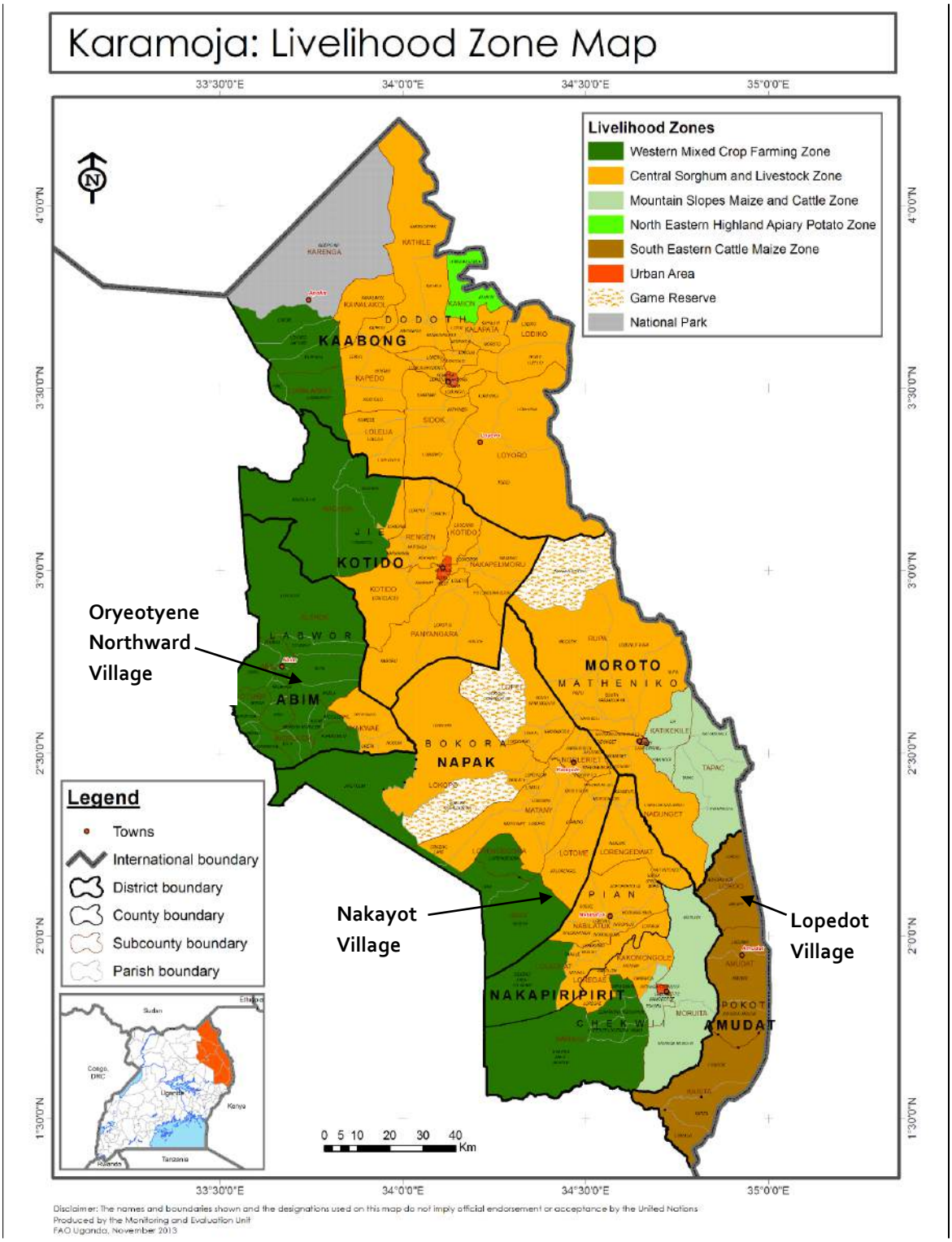
and prices. In cases where there were no or few sales realistic prices were taken from other sources resulting in low and high estimates of values according to the range of prices quoted in sources.

- Based on the estimates for the value of production for the surveyed households, the corresponding **value of production for the whole village** was estimated. This assumed that the households were representative of the village as a whole, as discussed above.
- **Impacts of recent climate events** on crops and livestock production were estimated for the sample households and for the villages as a whole based on questionnaire responses on the percentages of lost production and price data. Thus the study derived values for percentage of losses of production value in the villages due to the climate events and the average losses per household for each village.
- **Total values of future impacts from extreme climate events** up to 2050 were calculated based on assumed future scenarios for frequency and intensity of these events. These values are based on the estimated values of losses from recent events at village level. The future scenarios calculations assumed some production growth based on FAO projections[5] and no population change[6] and there is no discounting of future losses. It is stressed that they are only illustrative of possible scenarios as we do not have projections for changes in frequency and intensity of extreme climate events in the region.
- Overall **changes to value of production of key crops resulting from projected long term changes in temperature and rainfall trends** were also estimated. Regional projections for changes in yields for selected crops by IFPRI[7] were used to estimate changes in the value for each village up to 2050 under business as usual assumptions. It should be noted that the modelling of percentage impacts on yield from long term rainfall and temperature trends and are different from the analysis of sudden impacts of floods and droughts which are not informed by this long term yield analysis.

It should be noted that this study is necessarily focused on climate impacts on crop and livestock production and earnings. This is part of a bigger picture of food security in the region as studied in detail in the region by FAO (2014) and WFP & UNICEF (2014) among others. These studies provide a fuller account of the local economy and livelihoods in terms of production, income from all sources, expenditures and food needs. This study aims to further inform this wider picture by providing quantitative evidence specifically on climate impacts on agricultural production in the case study locations and associated adaptation options.

[5] Assumed growth in production was 2.4% p.a. up to 2030 and 1.9% pa from 2030 to 2050 based on the future projections for sub Saharan Africa from the FAO report World Production Towards 2030/50 report (Alexandratos & Bruinsma, 2012).
[6] The assessment of future impacts has not assumed overall population growth rates in line with overall projections at national or regional level because the recent population trends in the three villages do not match these growth rates. Due to the uncertainties of future population trends in the three villages of the case study (with some decreases in population also possible if there is migration) we have taken an "everything else being equal" approach with an assumption of no population growth. Increases in population in the villages will increase the overall losses. Assuming an increase of 3% per annum (as given in UBOS 2014 for overall population increases) and a corresponding increase in agricultural production the total losses to 2050 would increase by about 5% from the estimates given in this report, with per household losses remaining the same.
[7] Unpublished data from modelling by the International Food Policy Research Institute's (IFPRI).

Figure 1.2: Livelihood Zones of Karamoja



Source: Karamoja HEA Baseline Coverage. FAO (2014)

2. KARAMOJA REGION

2.1. Outline of the Region

The Karamoja region in north-eastern Uganda comprises five administrative districts of Kaabong, Abim, Kotido, Moroto and Nakapiripirit (see Figure 1.2) covering 10,550 square miles with approximately 1.2 million inhabitants, predominately from pastoral and agro-pastoral ethnic groups. Historically, the region has been a pastoral area, although crop production has more recently become an important source of household food and income in some areas. However, few households are self-sufficient in food and most rely on exchange for much of their staple diet (FAO/ FEWSNET, 2013).

The most recent FAO assessment identifies five broad rural livelihood zones in the region as shown in Figure 1.2. These are: (i) Western Mixed Crop Farming, (ii) Southeastern Cattle and Maize, (iii) Mountain Slopes Maize and Cattle, (iv) Central Sorghum and Livestock and (v) Northeastern Highland Apiculture (FAO, 2014). Thus the region comprises a distinct range of livelihoods from Wet-Agricultural (settled), to Agro-Pastoralist (partial household movement-transhumance) and the Pastoral (transhumance). Agro-pastoralism has been adopted by the Karimojong[8] as a specific strategy in response to environmental conditions that make agriculture difficult to sustain reliably. It is the mainstay of their economy that involves extensive livestock rearing combined with growing of crops such as sorghum, maize and millet. Crop and livestock production systems therefore play complementary roles and food security depends on both. Seasonal patterns of grazing are a key element in the flexible response of Karimojong agro-pastoralists to uncertain resources. Herders move livestock frequently to best exploit available pasture and water. The productivity of the pastoral system depends on the ability of herders to move frequently to new areas of grazing in response to unpredictable rainfall. This mobile exploitation of communally held grazing has proved the most optimal use of arid and semi-arid environments. It is also essential for the conservation of resources. Seasonal resource use patterns enable the best watered and lush pastures to be left for grazing well into the dry season while the herds roamed far and wide to feed on short term grass available only at the beginning of the wet season (FAO/EU, 2009).

Karamoja faces a number of development challenges. Historical marginalization, local and cross-border conflicts (most typically in the form of cattle raiding) and a lack of capacity development and investment in the region have contributed to underdevelopment. Insecurity has also hindered economic development, limiting the scope of successful interventions, the region suffering perennial conflicts underpinned by high levels of insecurity, cattle raiding and inter-ethnic violence (DFID, 2013). Disarmaments campaigns and other peace building programmes implemented in the last few years have however resulted in a considerably improved situation today. Whereas emergency aid has been the norm for many years in Karamoja, developing a certain degree of dependence by the recipient population, the challenge is now to make the transition from emergency support to longer-term development (FAO/EU, 2009).

The region suffers from severe environmental degradation, poor infrastructure, lack of social services, and limited marketing opportunities. In recent years, the region has been subject to recurrent drought and sporadic floods. This may be resulting in the erosion of the local people's resilience and coping capacity and changes in the relative importance of different livelihood strategies. The region is also recognized as being the least socially and economically developed part of the country and the majority of the population remains below the poverty line (FAO/ FEWSNET, 2013).

The government of Uganda is very active in the region. Its programme is under the political leadership of First Lady, Hon. Janet Museveni, Minister for Karamoja, who is assisted by Hon. Barbra Nekesa Oundo, Minister of

[8] People of Karamoja

State for Karamoja. In particular, agricultural development in the region is being strongly promoted (ALREP, 2013).

2.2. Regional Programmes

A number of programmes have been and are being undertaken in the region mainly to promote food security and sustainable development. These include:

- UK DFID's programme "Enhancing resilience in Karamoja Uganda" (2013/4 – 2015/6). This is focused on increasing resilience to extreme climate and weather events in Karamoja through strengthening nutrition programmes, livelihoods and food security for the vulnerable communities, and includes supporting the development of early waning and food security information by FAO, WFP and UNICEF in support of the GoU.
- The Karamoja Integrated Development Programme (KIDP), which is the Karamoja component of the Peace Recovery and Development Plan (PRDP), aims to promote human security and promote conditions for development in Karamoja. The GoU is implementing a number of development programmes with development partners under the supervision of the Office of the Prime Minister.
- Key initiatives funded by the EU with a focus on livelihoods and food security are the Northern Uganda Agricultural Livelihoods Recovery Programme (ALREP) and the Karamoja Livelihoods Programme (KALIP). The overall objective of KALIP is to "promote development as an incentive to peace by supporting livelihoods, including agro-pastoral production and alternative income generation opportunities for the people of Karamoja".
- The World Food Programme (WFP) is implementing a strategy for Uganda with a focus on food security and nutrition Agriculture and Market Support, including for Karamoja[9]. :
- USAID is funding development programmes in Karamoja including one implemented by Mercy Corps and ACDI/VOCA (Mercy Corps 2013).
- Several donors and agencies are involved in Local Government capacity building, with particular reference to GIZ and DFID.
- Donor coordination in the livelihoods sector also takes place under the Food Security and Agricultural Livelihoods Cluster (FSAL, led by the MAAIF with technical assistance by the FAO) and the Agricultural Donors Group. Donor coordination on Karamoja occurs under the Karamoja Development Partners Group (KDPG) chaired by DFID.

Key reports of regional surveys have been reviewed for information of specific relevance to this study. In particular, assessments were made of data available in (i) the World Food Programme and UNICEF Food Security and Nutrition Assessment (WFP & UNICEF 2014), (ii) Food and Agriculture Organization Household Economic Assessment (FAO, 2014), (iii) Baseline Study for Livelihood Dynamics in Northern Karamoja (Mercy Corps, 2013) and (iv) Uganda National Panel Survey (UBOS, 2005-11). Of particular use was the survey by the World Food Programme and UNICEF which provided livelihood data at village level and was used to check the plausibility of agricultural data collected via the case study questionnaire[10].

In the next section we present the case of each of the three villages separately. This is followed by a conclusions and recommendations section where we synthesise the findings and compare the three villages to draw a number of recommendations on adaption strategies.

[9] http://www.wfp.org/countries/uganda/operations
[10] The use of assessment study data from the FSNA, and household economy livelihood analysis to inform and cross check community information provides a strong basis for development and adaptation planning and monitoring.

3. ABIM DISTRICT CASE STUDY

Abim district is largely in the Western Mixed Crop Farming Livelihood Zone which has relatively high reliance on crop production. The village surveyed in this district was Oryeotyene North ward village which was formed in 2006 and has currently 83 households. According to village officials all households are involved in growing some crops and none are primarily pastoral (though a few animals are kept, mainly oxen for ploughing). Key crops grown are sorghum, which is the main staple food, in addition to ground nuts, millet, simsim, maize, sweet potatoes and the recently introduced beans and cassava. From the sample the estimated total value of crop production in 2014 was about 57 million UGX or about $55,000. This is about $657 per household.

Officials report that rainfall patterns have been changing over the last 10 years. The village used to have two rainy seasons starting from February to April, then from September to October. However, this has changed and now the rains appear in late March or early April, for short periods of time which does not allow for adequate crop growing preparations. This has resulted in long durations of droughts that have occurred annually since 2010.

Data from the village survey showed that for those households impacted by recent climate events the percentage reduction in crop production and income can be considerable and in some cases up to 100 percent. The sample of households had total production losses of up to 22 percent for drought events and about 14 percent for floods. These estimates should be treated with caution as they are based on a relatively small sample and due to some inconsistency over dates of events reported in the questionnaire.

In the absence of projections for future frequency and intensity of extreme climate events in the village the study has made some illustrative estimates of the possible future scale of impacts under two scenarios:

- Under a more pessimistic scenario total losses of potential crop production to 2050 have been calculated as about 950 million UGX (about $915,000). This represents about 18 percent of total potential production up to 2050 assuming business as usual production with no further adaptation to climate change.
- Under a less pessimistic scenario total losses of potential crop production would be about nearly 460 million UGX (about $443,000) to 2050 or about 9 percent of total potential production.

The study has also considered overall changes to expected yields for different crops due to long term changes in temperature and rainfall. The assessment indicates that for some crops such as sorghum, maize and beans there may be significant impacts on the value of production in the period to 2050 in the village. Although these conclusions are uncertain they have implications for adaptation in terms of the possible need for crop diversification in the medium and long term.

3.1. Abim District Context

Abim is located in the eastern part of Karamoja and is a mountainous district composed of one county, five sub-counties and one town council. The population has been steadily increasing from 58,590 in the 2002 census to 97,273 in 2012 at an average annual rate of 5.2 percent in this period compared to the national annual growth rate of 3.2 per cent. The district covers a total area of about 2,337 km^2 of which 97 percent is available for human settlement and agriculture which is the main land use and economic activity in Abim district. Over 80 percent of the population of the district depends on subsistence farming, and poverty levels are over 50 percent. The land is highly fragmented due to traditional practices of inheritance. Land shortage along with intensive subsistence agriculture has led to soil degradation and poor yields (ADLG, 2014).

The district is largely in the Western Mixed Crop Farming Livelihood Zone according to FAO / Ministry of Agriculture of GoU definitions[11]. This zone has relatively high reliance on crop production. In comparison to other areas of Karamoja, rainfall is more plentiful and soils are productive and households are generally more able to meet their food needs without external assistance. Key crops grown for consumption and sale including sorghum, maize, millet, cowpeas, pigeon peas, groundnuts, beans, sweet potatoes, cassava, sunflower and sesame (*simsim*). The FAO household economy baseline assessment found a high reliance on self-employment in this zone, with activities including firewood and charcoal sales, brick making, building poles, thatching grass, stone quarrying and brewing (FAO 2014).

Abim district has a climate characterized by an intensive hot season from December to February and a rainy season from March to November, with the dry spell in June and July. The downscaled climate analysis[12] in Rautenbach (2015) concluded that the district had an average monthly rainfall of 55.5 mm (standard deviation value of 44.7) based on time series of observations over the period 1951 to 2005. It also found that average near-surface temperature over the period 1979 to 2005 was 23.1 °C (standard deviation value of 1.5). The daily mean temperature ranges from 20°C to 35°C (ADLG, 2014).

The District Development plan notes that the seasons have been unpredictable the last three years, with rains arriving earlier and extending for longer periods into usually dry months. Recent variability of climate conditions have included more extreme dry spells, lightning strikes, floods and storms which have impacted on agricultural production due to heightened problems of low crop yields, declining soil fertility and degraded soils. The most serious consequence for farmers is that the usual planting seasons have become unreliable (ADLG, 2014).

Although there has not been monitoring of climate change at the level of Abim district, field observations from the recent State of the Environment Monitoring show changes of perennial rivers to seasonal rivers, formally productive wells in boreholes drying up and becoming seasonal and reduced crop production (ADLG, 2014).

3.2. Case Study Village: Oryeotyene North ward

3.2.1. Village context

Abim district was formed from the larger Kotido district in 2006. Oryeotyene North ward village was formed immediately thereafter. From the onset, this village was not a livestock area but a farming village, partly because of the fear that rearing animals would be of no benefit because they were being raided and taken away by their neighbours from Kotido, Moroto and Nakapiripirit. They instead grew crops which comprised of sorghum, which is the main stable food, and grown by all households in addition to ground nuts, millet, simsim, maize, sweet potatoes and the recently introduced beans and cassava. However, even then, household production of such foods was hampered by the cattle rustling insurgency which affected harvesting quantities negatively. Fortunately, the situation started to improve around 2006, with the prevailing peace after the Karamojong disarmament process, and the production quantities have increased supported by optimal land usage and expansion. Also, about the same time, village homesteads started buying animals, mainly focused on oxen which are used for ploughing farmland in addition to a few cattle, goats, pigs and chicken. These are kept at home and taken out to graze every day. The numbers of these are not documented and it was difficult

[11] FAO have recently updated the livelihood zone map of Karamoja (Figure 1.2) and defined five livelihood zones: Western Mixed Crop Farming Livelihood Zone, Central Sorghum and Livestock Livelihood Zone, Mountain Slopes Maize and Cattle Livelihood Zone, Southeastern Cattle and Maize Livelihood Zone, and Northeastern Highland Apiculture Livelihood Zone (FAO, 2014).

[12] The assessment by Rautenbach has included both regional-scale climate change projections of near-surface temperatures and rainfall in Uganda and a number of downscaled scenarios focusing on specific districts where the case-studies were conducted.

to estimate how many there are in the village (the survey only reported one cow for milk, two oxen for ploughing and one pig with no reported production)[13]. However, despite these developments the village has not been achieving its potential of food production in recent years mainly due to droughts and changes in rains patterns that have affected the crop growing seasons.

Table 3.1 gives household data on the village. Kotido district was excluded from the published national census data in 2002 and, therefore the information on households before 2011 was derived from local officials. In 2011, Abim district carried out a community information survey to estimate number of households in the villages, while the 2014 data was obtained from the Uganda Bureau of Statistics (UBOS) 2014 census mapping exercise. The rise in total number of households since 2006 shown in the table is attributable to the prevailing peace after the long periods of insurgencies and the neighbouring Karamojong cattle raids. In addition to the increasing population on existing village land this stability has encouraged people to repossess previously abandoned land for their households.

The table shows that all households practice some form of agriculture and none are pure pastoralists. The number of households in active crop and livestock production is not documented, however, the assumption is that some households have one or more types of livestock (cattle, oxen, pigs, goats and chicken) in small numbers in addition to crop cultivation. The official consulted estimated up to 10 per cent of households have some livestock, mostly oxen for ploughing.

Table 3.1: Households in Oryeotyene North ward

	Number of households in village		
Category	**2014**	**2011**	**2006**
Total # of households in Oryeotyene North ward Village	83	43	37
# of households in agriculture	83	43	37
# of households in pastoral	0	0	0
# of households active in both crop and livestock production	not documented		
# of households in non-farming economic activities	not documented		
# of households not economically active	0	0	0

3.2.2. Agricultural Production and Value

Data on agricultural production was collected from a sample of 10 households and is summarised in Table 3.2[14] and Chart 3.1. This shows the main crops over the period since 2000 were sorghum, groundnuts and beans in terms of numbers of households with sweet potatoes and maize also of importance in terms of total production tonnage. Average cultivated area in the sample has increased from about 2.4 acres in 2000 to 3.8 acres in 2014. Respondents reported a number of reasons for increases in output (including a shift to more fertile land due to prevailing peace), and for declines in output (delayed rains and drought (5), pests (2), age and sickness (3) and land disputes (1)).

[13] The data for the WFP & UNICEF (2014) study included this village and indicated that about 45 percent of the sample had at least one head of cattle and other livestock in small numbers.
[14] Households did not give answers on questions about agricultural yield as this concept was not clearly understood. The unit of area was changed from hectares to acres as this is more commonly used and easily understood.

Chart 3.1: Summary of Crop Production in Oryeotyene North ward

Left: kg of production. Right: acreage planted.

Table 3.3 gives estimates of the value of crop production in the sample and for the whole village based on stated prices[15] and total production data given in the survey for 2014, 2010, 2005, and 2000[16]. The values include both sold production and unsold production retained for household or other consumption. As there are no official statistics for agricultural production in the village, estimates for the total village value of production per crop were made based on the survey data assuming that production by the 10 households in the survey is representative of all 83 households producing crops in the village[17]. Results show total value in 2014 of about 57 million UGX which converts to about $55,000 using the purchasing power parity exchange rate[18].

Table 3.3 and Chart 3.2 show that, when calculated at 2014 prices, the estimated value of total production in 2000, 2005 and 2010 was actually higher than in 2014. This seems to be because although in 2014 more area was cultivated and there was greater production of some crops (such as sorghum and sweet potato), the total production of crops with higher value (such as beans, groundnuts and simsim) was lower than in some previous years of the sample. The part played by climate change and variability in this reduction in value of production is discussed further in the next section.

The estimates of value of crop production translate to about $657 per household in 2014 or about $82 per person[19]. The equivalent per household estimates were slightly higher in 2010 ($890), 2005 ($830) and 2000 ($1158). However, all of these estimates represent gross incomes from crops alone of below the extreme poverty rate of $1.25 per day, as defined by the World Bank.

[15] There was some variation between respondents in price per tonne for the same crop. The range of prices given was checked with prices given in the other village surveys and with other sources and found to be in a consistent range.
[16] Unlike the assessment for Nakayot village low and high estimates have not been made for crop production values as there were more crop sales in Oryeotyene North ward village and therefore more complete information on price per kg on which to base the analysis.
[17] This assumption is supported by consultations of village members and local officials which confirmed that average farm size were in the same range as for those households interviewed.
[18] Estimates of total village crop production value based on value of crop sales and percentages of sales in total production (in Q3 of the questionnaire) give somewhat higher estimates than for 2014 in Table 3.3. This is likely to be due to generalisations and rounding of percentages of sales in total production given in answer to Q3 of the questionnaire.
[19] Based on average of 8 persons per household (FAO/WFP, 2014).

Chart 3.2: Estimated total value for Oryeotyene North ward village (sold not sold) (UGX at 2014 prices)

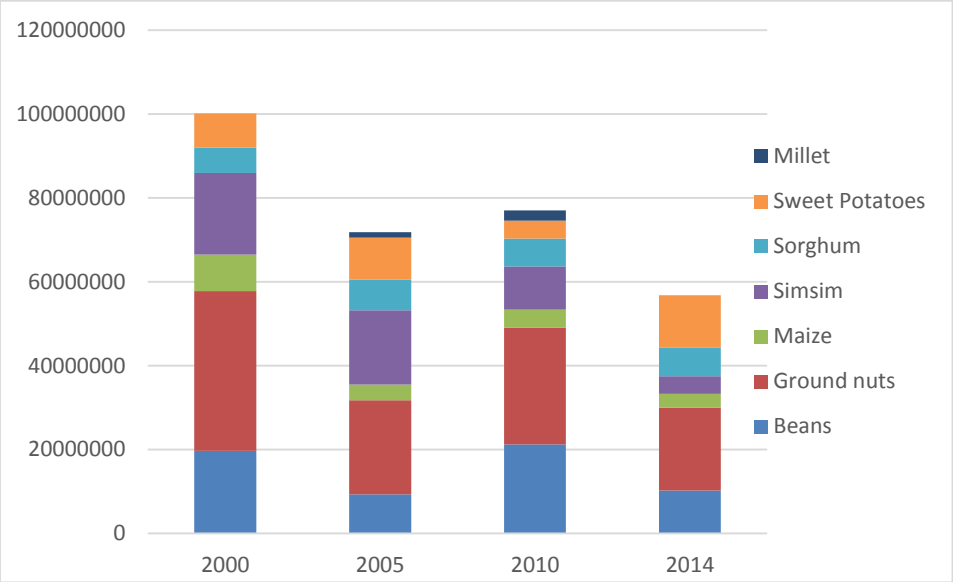


Table 3.2: Summary of Crop Production in Oryeotyene North ward

	2014			2010			2005			2000		
Main Crops	Number of Households20	Kg	acres	Number of Households	Kg	acres	Number of Households	Kg	Acres	Number of Households	Kg	acres
Beans	7	730	6.5	7	1550	9	3	630	3.5	3	1200	3.5
Ground nuts	9	1370	8	8	1560	8.5	6	930	6	6	1400	5.75
Maize	2	925	2	2	1000	2	1	300	1	1	700	1
Simsim	5	160	4	4	425	4.5	2	615	2.25	3	670	2.25
Sorghum	9	2040	12.5	9	2010	9.5	8	2210	9	6	1815	7
Sweet Potatoes	5	1000	5	3	600	2.5	5	1400	4.25	3	1060	3.25
Millet	0	0	0	1	200	1	1	100	1	1	0	1

[20] Number of households refers to those with at least some production in the given year. Therefore this figure does not include households which had some acreage sown but did not have any production.

Table 3.3: Estimated Value of Crop Production in Oryeotyene North ward over Recent Years (UGX at 2014 prices)

	2014		2010		2005		2000	
	Total value of production in sample (sold and not sold) (UGX)	Estimated total value for village (sold not sold) (UGX)	Total value of production in sample (sold and not sold) (UGX)	Estimated total value for village (sold not sold) (UGX)	Total value of production in sample (sold and not sold) (UGX)	Estimated total value for village (sold not sold) (UGX)	Total value of production in sample (sold and not sold) (UGX)	Estimated total value for village (sold not sold) (UGX)
Beans	1,236,000	10,258,800	2,556,000	21,214,800	1,125,000	9,337,500	2,370,000	19,671,000
Ground nuts	2,377,500	19,733,250	3,360,000	27,888,000	2,700,000	22,410,000	4,590,000	38,097,000
Maize	397,500	3,299,250	510,000	4,233,000	450,000	3,735,000	1,050,000	8,715,000
Simsim	506,000	4,199,800	1,245,000	10,333,500	2,139,000	17,753,700	2,352,000	19,521,600
Sorghum	816,000	6,772,800	804,000	6,673,200	884,000	7,337,200	726,000	6,025,800
Sweet Potatoes	1,515,000	12,574,500	510,000	4,233,000	1,205,000	10,001,500	979,000	8,125,700
Millet	-	-	300,000	2,490,000	150,000	1,245,000	-	-
Total (UGX)	**6,848,000**	**56,838,400**	**9,285,000**	**77,065,500**	**8,653,000**	**71,819,900**	**12,067,000**	**100,156,100**
Total (USD)	**6,571**	**54,535**	**8,909**	**73,943**	**8,302**	**68,910**	**11,578**	**96,098**

Table 3.4 gives the gross income from sales of crops in the village and indicates that a much higher proportion of the total value of production (about 59 percent in 2014) is sold to provide households with income than the other two villages covered in this report. The overall percentage does, however, include a wide range in the percentage of production sold by the different households consulted. For example, percentages of beans sold ranged from 25 to 80 percent. Data collected on input costs of crop production was rather too variable between households to draw clear overall conclusions but indicated that costs were relatively low allowing for margins of about 70 to 80 percent for beans and 65 to 90 percent for sorghum. This is in line with the KALIP Baseline Survey Report which reports that in Karamoja smallholder crop producers are not used to incurring any costs beyond paying for inputs and labour (FAO, 2008).

Table 3.4: Value of Sales of Crop Production in Oryeotyene North ward 2014 (UGX)

Main Crops	Total income from sales in sample (UGX)	Estimated income from sales for village (UGX)
Beans	984,000	8,167,200
Ground nuts	1,435,000	11,910,500
Maize	310,000	2,573,000
Simsim	423,000	3,510,900
Sorghum	405,000	3,361,500
Sweet Potatoes	330,000	2,739,000
Millet	150,000	1,245,000
Total (UGX)	**4,037,000**	**33,507,100**
TotaL (USD)	**3,873**	**32,149**

3.2.3. Other Income

As noted above, the survey found very few livestock holdings and no income from livestock products. However, there is evidence of some income from other non-farming activities such as bricklaying, stone quarrying and labouring. We do not have sufficient data to make an estimate of non-agricultural income for the village but the evidence suggests that these activities can be important sources of income for some households; for example, one respondent earned UGX108,000 per year ($104 per year) from cutting and selling poles from the mountains and UGX145,000 per year ($139 per year) from labouring. Another respondent earned as much as 2 million UGX per year ($1920 per year) from selling fish in the market. This level of potential earnings for some households is backed up by the baseline study by FAO (2014) which gives a range of average per household annual income for Abim district of between about UGX750,000 for the poorest to UGX3,100,000 for the better off (about $720 to $2974).

3.3. Impacts of Climate Change

3.3.1. Current Impacts

A summary of recent climate change events in the village is given in Table 3.5. Officials report that rainfall patterns have been changing over the last 10 years. The village used to have two rainy seasons that would start from February to April, then from September to October. However, this has changed and now the rains appear in late March or early April, for short periods of time which does not allow for adequate crop growing preparations. This has resulted in long durations of droughts and increased temperatures and accounts for the response given in the table that droughts have occurred annually since 2010.

The impacts of the changes in rainfall patterns for farmers is that the shorter rain periods in late March or early April has made it difficult for farmers to easily tell the planting and harvesting seasons (and this is noted as a general issue for Abim District in the District Development Plan (ADLG, 2014)). This has led to lower food production and therefore greater food insecurity in some households, especially those that have lost a large part of their crops during these events.

The worst floods occurred in 2008, following heavy rains in May and June. Oryetyene village is in the lower belt of the district and was therefore most affected by these floods. The floods of 2008 destroyed roads which were swept away with the running water, many homes were soaked and washed away, and Oryeotyene primary school and village properties were also destroyed. People could not move easily to trade in their commodities or for social activities. There was also an increase of malaria cases and an outbreak of foot and mouth disease following these floods.

Table 3.5: Climate Change Events in Oryeotyene North ward Since 2000

Event	Date of event
Drought	Annually from 2010
Flooding	2008
Change in rainfall patterns	2005 onwards
Increased temp	2005 onwards

Source: Local Village Officials

There were some significant differences between the dates of climate events given by local officials in Table 3.5 and those given by households in the interviews. There was also no clear consistency on the dates of climate events between households in the survey. In estimating losses from climate events for the village we have therefore focused on those events for which there was most agreement and omitted events that were reported by less than three households as these did not provide sufficient data on which to make reliable village level estimates of impacts. Table 3.6 summarises losses from recent climate events reported by 30 percent or more of the households in the survey. These are largely in agreement with the information from village officials in Table 3.5 (although there is discrepancy in the date of the key flooding event of 2007/2008).

The table shows that for those households impacted by climate events the percentage reduction in production and income can be considerable and in some cases up to 100 percent. Based on the percentages of lost crop production and price data, estimates have been made for losses of crop production value for the sample and for the whole village. These show percentage losses of total production of up to 22 percent for drought events and about 14 percent for the floods of 2007. These estimates should be treated with caution as they are based on a relatively small sample and due to the inconsistency over dates of events explained above. Actual damages will be higher than reported here if the collected data underestimates the proportion of households affected by any given climate event, which is possible given the spread of different dates stated by households.

Table 3.6: Summary of Impacts of Climate Events on Crop Production in Oryeotyene North ward (2014 prices)

Event	Year	No of households impacted in survey	Reduced area (%)	Reduced Production (%)	Reduced income (%)	Estimated loss of value for sample (UGX)	Estimated loss of value for village (UGX)	Estimated loss of value for village (% of production)
Flood	2007	3	25 - 50	40 - 90	30 - 50	1,467,214	12,177,879	13.7
Drought	2009	3	40 - 100	60 - 90	30 - 90	2,295,200	19,050,160	21.5
Drought	2013	3	10 - 50	50	25 - 50	1,241,310	10,302,869	11.6
Drought	2014	4	10 - 50	10 - 65	10 - 60	1,868,193	15,506,001	17.5

3.3.2. Future Impacts

The regional scale climate change projections for Uganda given in Rautenbach (2014) have been downscaled to the specific locations for this case-study, in order to provide scenarios for temperature and rainfall patterns over the next 50 to 80 years. Rautenbach (2015) used daily rainfall and near-surface temperature data for Abim District to calculate projected percentage changes in the number of daily events. This has been done over the period 2041-2095 (under a high CO_2 Representative Concentration Pathway (RCP 8.5) and a medium-to-low CO_2 Representative Concentration Pathway[21] (RCP 4.5)), relative to the number of daily events in historical deciles (10% percentile categories) over the period 1951-2005.

The study found that more days with rainfall in the lower rainfall categories (0%-40% deciles) and less days with rainfall in the higher rainfall categories (40%-100% deciles) are projected in future. Also a small, but increasing fraction (RCP 4.5 = +0.38% ; RCP 8.5 = +0.38%) of days might receive more daily rain than ever recorded before (>100% percentile). It also found that it is 100% unlikely that near-surface temperatures in the 0% to 60% range will appear again in future, but very likely that daily near-surface temperatures will exceed the most extreme decile category (>100%). It concluded that these findings were an obvious global warming signal [22] (Rautenbach, 2015).

It should be noted that the results of the Rautenbach study, while highlighting the significance of global warming projections in the region, have not been used directly in the assessment of future climate impacts in this case study. This is because (i) it does not include projections for future changes in frequency and intensity of extreme climate events and (ii) the IFPRI modelling results for climate change impacts on agricultural yields allowed a much more detailed analysis for different agricultural products than would otherwise have been possible. The IFPRI modelling, however, uses the IPCC fourth assessment report (AR4) SRES emissions scenarios rather than the Representative Concentration Pathways (RCPs) of the fifth Assessment report (AR5) as used in the Rautenbach (2014) study. Thus, there may be some differences in the results given in this study for climate impacts on agricultural yields compared to results using RCP scenarios. This can be further assessed as and when analysis of impacts on agricultural yields using RCP scenarios becomes available in the IFPRI

[21] Representative Concentration Pathways (RCPs) are four greenhouse gas concentration (not emissions) trajectories adopted by the IPCC for its fifth Assessment Report (AR5) in 2014
[22] Signal refers to the long-term warming trend as opposed to year-to-year variations which are often referred to as noise.

modelling. However, the results using AR4 emissions scenarios can be used to approximate the RCP scenarios and this does not alter the overall conclusions of this study.[23]

Impacts of climate change on agricultural production will very much depend on trends in frequency and intensity of drought and flood events in the village. Although we know that Karamoja is one of the main areas in Uganda facing higher variation of rainfall associated with increased risks of droughts and floods, we do not have projections for future changes in frequency and intensity of these events.

Based on estimates given above for impacts on agricultural production of recent drought and flood events in Oryeotyene Northward we can indicate the future scale of impacts given assumptions about future frequency of such events. Assuming a more pessimistic scenario where a drought on the scale of 2014, a drought on the scale of 2009 and a flood on the scale of 2007 occur in three year cycles continuously until 2050 total losses of potential crop production have been calculated as about **950 million UGX** [24] (about $915,000) . This represents about 18 percent of total potential production up to 2050 assuming business as usual in terms of crop production with no further adaptation to climate change and no growth in production due to increasing farming population in the village.

Assuming a less pessimistic scenario where a drought on the scale of 2014, a drought on the scale of 2009 and a flood on the scale of 2007 occur in six year cycles continuously until 2050 total losses of potential crop production would be nearly **460 million UGX** (about $443,000). This represents about 9 percent of total potential production up to 2050 under the same business as usual assumptions.

The study has also considered overall changes to expected yields for different crops due to long term changes in temperature and rainfall trends as analyzed in the Agricultural Sector report for this project (Metroeconomica, 2015). Regional projections for changes in yields from selected crops for Uganda obtained from IFPRI[25] (which takes into account growth in productivity over time) indicate a wide range of results for different crops according to the various climate models used as shown in Table 3.7. While all models show projected reductions in yields for sorghum and soybeans there is disagreement between models on whether maize yields will increase or decrease.

[23] The AR4 lower emissions scenario B1 used in IFPRI modelling is closest to RCP4.5 scenario used in Rautenbach (2014) and the AR4 higher emissions scenarios A1B used in IFPRI modelling is closest to RCP6 which is not used by Rautenbach. The more extreme higher emissions scenario RCP8.5 used in Rautenbach is closest to the AR4 emissions scenarios A1FI which has not been used in the IFPRI modelling.

[24] This is with assumed growth in production of 2.4% p.a. up to 2030 and 1.9% pa from 2030 to 2050 based on the future projections sub Saharan Africa from the FAO report World Production Towards 2030/50 report (Alexandratos & Bruinsma, 2012).

[25] Unpublished data from modelling by the International Food Policy Research Institute's (IFPRI).

Table 3.7: Average Yield Change 2000 to 2050 for Eastern Region (percent)[26]

	CNRM A1B[27]	CSIRO A1B	ECHAM A1B	MIROC A1B
Maize	-12.0	6.5	5.0	7.4
Sorghum	-15.9	-2.9	-13.3	-4.5
Soybean	-20.7	-4.4	-18.1	-9.0

Source: From IFPRI Data

Table 3.8 gives estimates of changes to value of production according to the predicted percentage changes in yields from the climate models up to 2050. The selected crops of sorghum, maize and beans are those for which we have regional projections from the IFPRI data and represent about 42 per cent of total crop values in the village in 2010. The table indicates potentially significant impacts on the value of production in the period to 2050 in the village, especially for beans, depending on the model used. While these conclusions are highly uncertain they have implications for adaptation in terms of the possible need for crop diversification in the medium and long term

Table 3.8:.Estimated Change of Value of Production in 2050 (UGX) (2014 prices)

	Low Estimated Value 2010	Change in Value by 2050			
		CNRM A1B	CSIRO A1B	ECHAM A1B	MIROC A1B
Maize	4,233,000	-404,897	220,283	171,012	252,080
Sorghum	6,673,200	-851,281	-155,379	-712,427	-240,546
Beans	21,214,800	-3,513,079	-748,144	-3,071,319	-1,526,018

3.4. Adaptation Options

Current actions and programmes undertaken in the village as responses to climate change and variability are summarized in Table 3.9 These demonstrate a range of responses including:

Increasing resilience to climate events:

- Households near flood prone areas have been taught to build restraining trenches that hold the water from flooding their homes and gardens. Digging waterways to hold back the water during heavy rains and the resultant flooding was identified as a priority in the consultation

[26] The models are:
- CNRM-CM3 = National Meteorological Research Center–Climate Model 3;
- CSIRO = climate model developed at the Australia Commonwealth Scientific and Industrial Research Organisation;
- ECHAM 5 = fifth-generation climate model developed at the Max Planck Institute for Meteorology (Hamburg); GCM = general circulation model;
- MIROC = Model for Interdisciplinary Research on Climate, developed by the University of Tokyo Center for Climate System Research.

[27] A1B is a SRES higher emissions scenario assuming fast economic growth, a population that peaks mid-century, and the development of new and efficient technologies, along with a balanced use of energy sources (Waithaka et al.,2012).

- Provision of water storage. In 2014 the Government built 6 valley tanks, one of which is close to Oryeotyene Village. These are meant to capture rain water, and store it for longer durations to be used by the nearby communities, especially for cattle water.
- Resettlement and acquisition of more fertile farmland at the foothills of the village away from the flood paths. Reduced planting on low lying areas and instead open up fertile lands on the hill slopes.
- Environmental control such as reducing deforestation and charcoal making from trees and encouraging afforestation.

Adaptation of farming practices:

- Training in simple irrigation to improve efficiency of available water use.
- Crop diversification through the introduction of other foods such as maize, beans and cassava. Some of these crops are drought resistant, like cassava, while others are early maturing to adapt to drought and shorter rainfall seasons.
- Introduction of drought resistant varieties of the commonly grown crops such as long term sorghum.

Capacity building:

- Training of communities to recognise climate change events and adopt strategies to mitigate their effects. This is mainly carried out by the district officials in addition to other ministries such as the Office of the Prime Minister, NGOs and the Ministries of Karamoja and Agriculture. These are supplemented by efforts from Government entities like NAADs (National Agricultural Advisory Services) and NGOs.

Income diversification:

- Households are taking on other income generating activities that include selling shops in markets, manual labour, and stone quarrying.

The following additional priority adaptation options were proposed in the survey responses along with re-emphasizing the importance of existing options as given above:

- Introduce more drought resistant crops
- Control soil and water loss by digging retention and contour ditches
- Improve early weather change detection warning and therefore early land preparation for planting seasons
- Acquiring Oxen for use during ploughing and as they open up more land for cultivation.
- Planting trees in conjunction with reduced tree cutting
- Identify and bring early maturing crops.
- Reduced planting on low lying areas and instead open up fertile lands on the hill slopes
- Digging water ways and grass to hold back the water during heavy rains and the resultant flooding
- Diversification of livelihoods by introducing other income generating activities

Abim District Local Council has also made a District Contingency Plan on Drought and Epizootics (ADLG, 2010) which has prioritised for actions for the persistent drought over most parts of the district. While this includes actions related to livestock and crop production it is largely focused on action for reacting to drought incidence such as water supply need and mass vaccination of livestock. It does include requirements for crop production such as quick maturing seed/ planting materials, underground water harvesting and cultivation along valleys but does not provide detailed assessment of local provisions or costs (ADLG, 2010).

In summary, the adaptation actions outlined in the section that are already taking place in Oryetyene village, both those with support from government and development agencies and those occurring autonomously, are mostly in line with the key general priorities for adaptation action as assessed in the concluding section of this report and summarized in Table 6.1. This includes, in particular, key actions for capacity building, crop

diversification, improving water availability, rehabilitation/acquisition of more fertile land and income diversification. The study did not make a technical assessment of specific further adaptation action requirements at village level which would necessitate an in-depth study of local conditions using agronomist as well as economist expertise. This would ascertain where there may be specific gaps in the existing range of actions, and the need for further development of existing actions and improvements in their effectiveness.

Table 3.9: Summary of Adaptation Actions and Programmes: Abim district, Oryeotyene village

Type of Response	Action	Programme	Implemented by	Period	Financed	Note
Capacity building	Sensitisation and training of communities on climate change	Karamoja livelihood improvement programme (KALIP)CMDRR and APFS, Ministry of water and environment	Goal/UNFAO	2013-2015 2015	EU DFID	Ministry received funding thru FAO but got funding from DFID
Resettlement plan	Acquisition of more land		Community initiative	2007-2015		Voluntary movement after disarmament
Reducing on land degradation	Afforestation	Action for social change/KITENEP	ADRA Uganda	2009-2011	Denmark	
Crop diversification	Introducing other drought resistant and early maturing crops	NAADS and OPM	Local Government production depart			
Household income diversification	Introduction of new income generating activities	KOICA world vision	World vision	2012-2014	Korean Government	Support to few selected groups
Improving water availability	Construction of valley tanks	KALIP-OPM	Ministry of water and MAAIF	2014-2015	EU	
Improving garden irrigation mechanisms	Introduction of simple irrigation schemes	UN FAO	GOAL	2013-2014	EU	
Flood control	Building of restraining trenches and contour ditches	PMG	Local Government	2007-to date	Central Government	

Improving on agriculture practices	Introduction of oxen for garden ploughing	OPM empowerment project	OPM-Local Government	2014-2015	Source not clearly known	Few selected beneficiaries

4. NAPAK DISTRICT CASE STUDY

Napak District is located in the west central area of Karamoja Region. The village surveyed in this district was Nakayot which has established in 2007 and has currently about 860 households. It is in the Central Sorghum and Livestock Livelihood zone and therefore agro-pastoral but with the majority of households growing crops including sorghum, maize, cassava, sunflower, green grams and cow peas. The livestock is mainly cattle, goats, sheep and free range chicken rearing.

Estimates of total value of crop production for the village in 2014 range from about 80 million UGX to 183 million UGX (about $77,000 and $175,000) or about $89 to $203 per household. This compares to higher estimates of about $108 to $239 per household in 2010 which did not suffer from such severe droughts. The estimated total income from livestock product sales for the village was about 280 million UGX which converts to about $310 per household and $44 per head.

There have been a number of extreme climate events since the formation of the village, principally floods in 2007 and 2012, and droughts in 2009, 2010 and 2014. Rainfall patterns have also changed during the last 3 years with the first rains now appearing in April, instead of in February as previously, and lasting for shorter durations. Climate events have significantly affected crop production in recent years with instances of whole large areas of crop farmland being destroyed by drought or floods. Households consulted reported high percentage impacts on area cultivated, production and income during the floods of 2013 and droughts in 2013 and 2014 with some having 90 to 100 per cent reductions in production.

The study estimates losses of value of crop production from floods in 2013 were between about 25 million UGX and 49 million UGX for the village (about $24,000 to $47,000). The values for losses from droughts were higher, in the range 34 to 107 million UGX in 2013 (about $33,000 to $103,000) and 80 to 200 million UGX in 2014 (about $77,000 to $192,000). Thus the 2014 drought is estimated to have reduced potential production value in the village by around 55 to 62 percent of a normal year's value.

The survey also identified significant impacts of recent climate events on livestock with affected households reporting over 50 percent reductions in production and over 70 percent reductions in income. Estimates indicate total village losses in the range 98 to 195 million UGX for the floods in 2013 (about $94,000 to $187,000), 56 to 223 million UGX for the drought of 2013 (about $53,000 to $214,000) and 63 to 251 million UGX for the drought of 2014 (about $60,000 to $241,000).

In the absence of projections for future frequency and intensity of extreme climate events in the village the study has made some illustrative estimates of the possible future scale of impacts under two scenarios:

- Under a more pessimistic scenario total losses of potential crop production to 2050 have been calculated as about 2.6 billion UGX (about $2.5 million). This represents about 32 percent of total potential production up to 2050 assuming business as usual production with no further adaptation to climate change.
- Under a less pessimistic scenario total losses of potential crop production would be about nearly 1.3 billion UGX (about $1.2 million) to 2050 or about 15 percent of total potential production.

The study has also considered overall changes to expected yields for different crops due to long term changes in temperature and rainfall. The assessment indicates that for some crops especially sorghum, there may be significant impacts on the value of production in the period to 2050 in the village.

The village level estimates for Nakayot should be treated with more caution than the other two villages in the case study due to the much smaller sample in comparison to village size.

4.1. Napak District Context

Napak District is located in the west central area of Karamoja Region. The national census of 2002 estimated the population of the district as 112,700 and this had grown to about 198,000 by 2012. The district has the countries lowest population density of 22.3 persons per km^2. It covers an area of 4,978 km^2 with about 2,000 km^2 available for cultivation (UNDP, 2014).

The main economic activity in Iriiri Sub-county, where this case study is located, is subsistence agriculture, where people grow crops and rear animals for survival and not for sale. In this Sub-county it is estimated that more than 81 percent of the rural population live below the poverty line (NDLG, 2014).

Napak district covers two livelihood zones in the FAO Household Economy Assessment (HEA) Baseline Report (FAO 2014): the western mixed farming zone and the Central Sorghum and Livestock Livelihood Zone (see Figure 1.2). The livelihoods in the Central Sorghum and Livestock Livelihood Zone are agro-pastoral with main crops of maize, sorghum, beans but also an historical dependence on cattle with goats and sheep and some poultry and donkeys also kept. In a good year crops can contribute over 70 per cent of household food and all households grow some crops. Households also engage in other economic activities including firewood, grass, pole and charcoal sales, unskilled agricultural labour and brewing (FAO,2014). The Western Mixed Crop Farming Livelihood Zone has a higher reliance on crop production as well as other non farming activities as described above in the Section on Abim Distirct (FAO 2014).

The climate in Napak is semi-arid with a hot season lasting from November to March and a wet season from April to August. Rainfall is in the range of 300 to 1200mm per year with a mean annual rainfall of 800mm (UNDP, 2014). The downscaled climate analysis in Rautenbach (2015) concluded that Napak district had an average monthly rainfall of 64.5 mm (standard deviation value of 52.4) based on time series of observations over the period 1951 to 2005. It also found that average near-surface temperature over the period 1979 to 2005 was 21.2°C (standard deviation value of 1.3).

4.2. Case Study Village: Nakayot

Nakayot village is situated in Iriiri Sub County in the southern part of Napak District. The village was established in 2007, as a resettlement camp after the insurgency and Karamajong disarmament process. It mainly comprises of people who came from Iotome, Ngoleriet and Nabilatuk counties of Napak and Nakapiripirit districts. Most of these settlers used to be pastoralists but lost their cattle during the raids and theft and instead resorted to growing crops as an alternative livelihood. The area of settlement is part of the Karimojong green belt, and therefore one of the food baskets of Karamoja region. The community is agro- pastoral but the majority are crop growers. Most of the crops grown are sorghum, which is the staple food, as well as maize, cassava, sunflower, green grams (mung beans) and cow peas. The livestock is mainly cattle, goats, sheep and free range chicken rearing. Since its formation, the village has been growing, both in terms of population and households (as shown in Table 4.1) because of the fertile soils, government support through NAADs (which has been giving free planting seedlings and drilling bore holes) and aid from NGOs especially CLIDE and ADRAA. However, Nakayot was carved out of a game reserve and this has led to conflict with the Uganda Wildlife Authority (UWA). Some of these conflicts have led to destruction of boreholes which has prompted some residents to migrate out of the village and back to their original homes or neighbouring villages, thus slowing the village development progress. This reduction is reflected in the reduced number of households for 2014 shown in Table 4.1. Fortunately, this conflict is now being dealt with by government, UWA, and the residents.

The location of the village is on the border between the Western Mixed Farming Zone and the Central Sorghum and Livestock Livelihood Zone (Figure 1.2). It seems to have many characteristics of the latter zone in that

historically the population were pastoralists but has turned to crop production in good years and all households consulted cultivated sorghum. However, it also has some features of Western Mixed Crop Farming zone at least in terms of the range of crops that are being grown. The households consulted did not give much evidence of engaging in the non-farming economic activities which are characteristic of both zones.

Table 4.1: Households in Nakayot

Category	2014	2011	2006
Total # of households in Nakayot village	862	1300	1000
# of households in agriculture	862	1300	1000
# of households in Pastoral	0	0	0
# of households in active crop and livestock production	30	5	0
# of households in non-farming economic activities	20	15	0
# of households not economically active	0	0	0

Source: Local Council Chairman and Sub county Chief

Figure 4.1: Young Karimojong warrior, Nakayot Village

Figure 4.2: Conducting a household interview in Nakayot village

4.3. Agricultural Production

This section summarises information on agricultural production collected in the consultation of village officials and households in Nakayot. It also makes estimates of this production at village level based on the survey sample. It is stressed that the household sample for Nakayot represents a much smaller proportion of the total number of households in the village than the other two villages in this case study. Therefore these estimates should be given a much lower level of confidence than those for the other villages and caution is needed in making direct comparisons with the other villages based on these estimates.

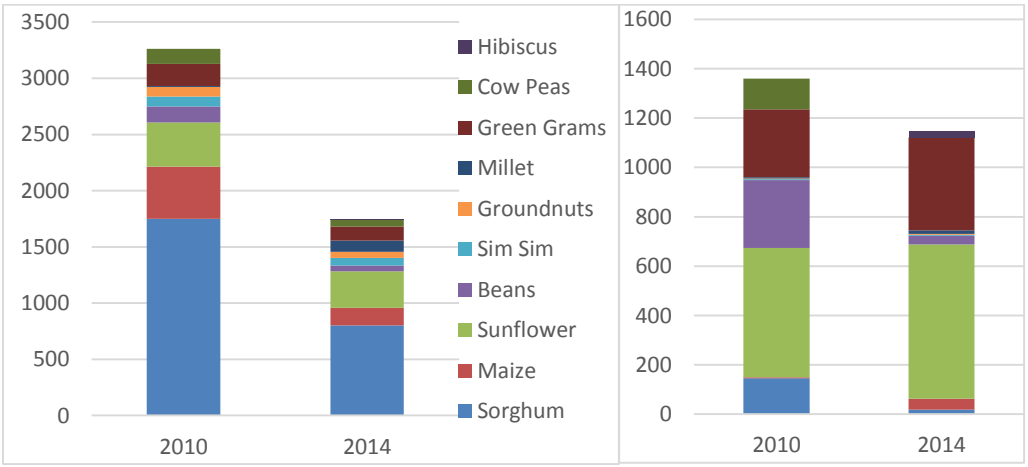
4.3.1. Crop Production

All households questioned in Nakayot cultivated a variety of crops (between 3 and 7 per household) with all producing sorghum in good years and a total of 10 different crops grown. Crop production data are shown in Table 4.2 and Chart 4.1: and indicates a reduction in production of most of the key crops (especially Sorghum and maize) in 2014 compared with 2010 due to the drought. The amount of acres planted for most crops have, however, increased in this period.

Table 4.2: Summary of Crop Production in Nakayot

	2014			2010		
Main Crops	**Number of Households**	**Kg**	**acres**	**Number of Households**	**Kg**	**acres**
Sorghum	7	800	18	10	1750	14.5
Maize	3	157	4.5	5	463	4
Sunflower	5	325	6.25	6	395	5.25
Beans	5	51	3.5	4	140	2.75
SimSim	2	70	4	2	90	3
Groundnuts	2	52	3	2	84	3
Millet	3	100	1.5	1	10	0.5
Green Grams	2	125	3.25	3	195	2.75
Cow Peas	2	60	2	3	135	1.25
Hibiscus	1	4	0.25	0	0	0

Chart 4.1: Summary of Crop Production in Nakayot: left: kg of production. Right: acreage planted.



Estimates for the value of crop production per crop and in total in 2014 are shown in Table 4.3. The table shows there were very few cash sales of crops and almost all production was not sold. Thus estimates were made for

the total value (sold and not sold) of production in 2014. Low and high estimates are derived from prices for the different crops given in the survey as well as a review of prices from other sources[28]. There was found to be quite a large range in stated prices for some crops and this is reflected in the range of production values calculated. Estimates of total value of crop production for the village have been calculated assuming the survey sample values are representative. These show a total production value of about 80 million UGX for the low estimate and 183 million UGX for the high estimate which converts to about $77,000 and $175,000 or about $89 to $203 per household converting UGX at the purchasing power parity exchange rate[29].

Table 4.3: Value of Crop Production in Nakayot (2014)

Main Crops	Total income from sales in sample (UGX)	Total value of production in sample (sold and not sold) (UGX)		Estimated income from sales for village (UGX)		Estimated total value for village (sold not sold) (UGX)	
		Low Estimate	High Estimate	Low Estimate	High Estimate	Low Estimate	High Estimate
Sorghum	0	320,000	640,000			27,584,000	55,168,000
Maize	0	62,800	157,000			5,413,360	13,533,400
Sunflower	4,000	97,500	325,000	4,875	16,250	8,404,500	28,015,000
Beans	0	51,000	112,200			4,396,200	9,671,640
Simsim	900	21,000	280,000	1,050	14,000	1,810,200	24,136,000
Groundnuts	0	62,400	208,000			5,378,880	17,929,600
Millet	0	100,000	150,000			8,620,000	12,930,000
Green Grams	0	97,125	97,125			8,372,175	8,372,175
Cow Peas	0	120,000	150,000			10,344,000	12,930,000
Total (UGX)	**34,000**	**931,825**	**2,119,325**	**5,925**	**30,250**	**80,323,315**	**182,685,815**
Total (USD)	**32.6**	**894**	**2,033**	**6**	**29**	**77,069**	**175,284**

Table 4.4.gives estimates for the value of crop production in the village in 2010. It indicates higher estimates for total production value in 2010 than in 2014 by about 83 percent for the low estimates and 78 percent for the high estimates. The totals convert to a range of about $108 to $239 per household. While 2010 cannot necessarily be taken as a "normal" crop production year (as some flooding is reported to have occurred) these differences in value give some indication of the severity of impact of the droughts in 2014 compared with production in a more normal year. Chart 4.2 below illustrates those points.

[28] In particular prices given in the survey were checked with those given for regional markets in Uganda in the Info Trade website and found to be reasonably consistent.
http://www.infotradeuganda.com/index.php/market-information/food-prices.html

[29] The market rate for the Ugandan shilling was 2,778 to the US dollar at the end of 2014. The PPP rate was 1,042 to the dollar is a better guide to the real value of earnings and prices.

Chart 4.2: Estimated total value for village (sold not sold) (UGX)

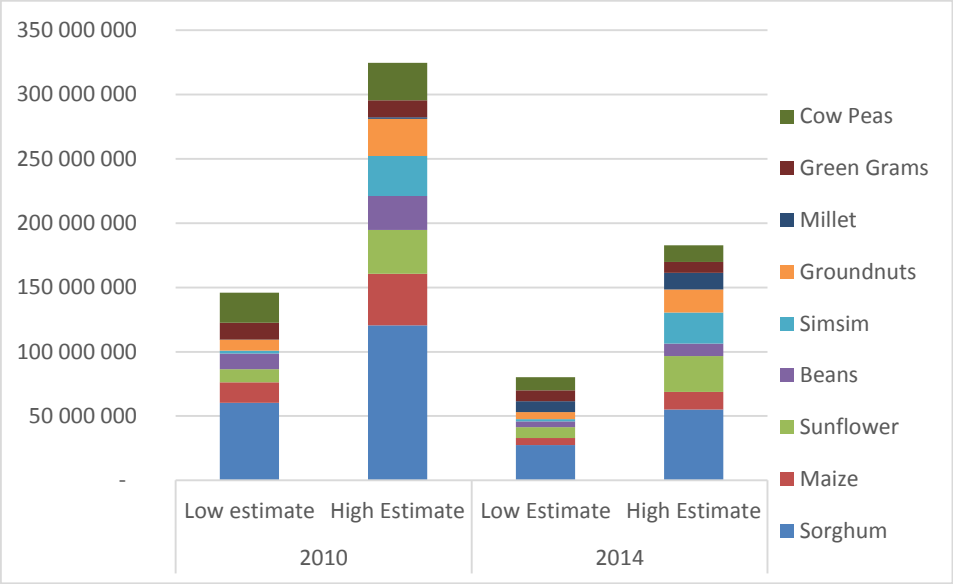


Table 4.4: Value of Crop Production in Nakayot (2010) at 2014 prices.

Main Crops	Total value of production in sample (sold and not sold) (UGX)		Estimated total value for village (sold and not sold) (UGX)	
	Low estimate	High Estimate	Low estimate	High Estimate
Sorghum	700,000	1,400,000	60,340,000	120,680,000
Maize	185,200	463,000	15,964,240	39,910,600
Sunflower	118,500	395,000	10,214,700	34,049,000
Beans	140,000	308,000	12,068,000	26,549,600
Simsim	27,000	360,000	2,327,400	31,032,000
Groundnuts	100,800	336,000	8,688,960	28,963,200
Millet	10,000	15,000	862,000	1,293,000
Green Grams	151,515	151,515	13,060,593	13,060,593
Cow Peas	270,000	337,500	23,274,000	29,092,500
Total (UGX)	1,703,015	3,766,015	146,799,893	324,630,493
Total (USD)	1,634	3,613	140,852	311,477

4.3.2. Livestock Production

Estimates of livestock holdings in the village are given in Table 4.5 and show that about 40 percent of the households consulted held some livestock. Estimates of total village numbers of livestock given by the Veterinary Officer for Nakayot Village, who kept good records, are also shown in the table and indicate reasonable agreement between estimates for cattle and goats, though the survey estimate for sheep is significantly lower than the official estimate and is likely to reflect that only one sheep holder was captured in the survey. Total grazing area was difficult to estimate because the animals were grazed on any free land that had grass on it, sometimes taking them out of Nakayot especially during the drought seasons.

Table 4.5: Livestock Holdings in Nakayot (2014)

Livestock	Number of Households with livestock in survey	Number of livestock in survey	Estimated numbers for Village from Survey data	Official estimates of numbers for Village
Cattle	4	29	2500	2000
Goats	4	66	5689	5,000
Sheep	1	12	1034	10,000
Poultry	1	5	431	n/a

Table 4.6 gives estimates of income for the village per livestock product. These are based on data for average sales per month and sales values per animal from the Veterinary Officer except for poultry and milk values which were estimated from the survey data. Caution is needed in the case of village estimates from the survey data (poultry and milk) as this is based on a relatively small number of household that sold livestock products. In the survey only three households had income from milk, one household had sold one cow, one household had sold one goat and one household had sold one chicken in 2014. The estimated total income for all households in the village was about 280 million UGX (about $268,000) which converts to about $310 per household and $44 per head. This does not include the value of any own production consumed by households, which would mainly be milk (which we estimate as having a sales value of about 250 million UGX based on limited survey data) and a small amount of meat[30]. This total also does not include any other livestock production related income. One respondent earned 20,000 UGX per year from farm labouring which would equate to about 1.7 million UGX (or $1,631) for the whole village if we were to assume the survey is representative. The small sample size means that we cannot confidently assume this from the survey data; however such income would seem to account for only a small amount of total agriculture related income.

It was difficult to estimate net income from livestock production from the survey as the only stated cost was for treatment of animals (on average about 5,000 shillings per year or about $5) and most inputs (water, feed, etc.) would not have been bought on the market.

Table 4.6 Estimated Total Annual Income in Village from Livestock Products (UGX) (2014 prices)

	Average sales per month	Sales per year	Value per animal	Value of sales per year
Cattle	5	60	500,000	30,000,000
Goats	15	180	80,000	14,400,000
Sheep	10	120	60,000	7,200,000
Poultry			8,500	732,700
Milk				226,533,600
Total Income (UGX)				278,866,300
Total Income (USD)				267,567
Total Income per Household (USD)				**310.4**
Total Income per Person (USD)[31]				**44.34**

[30] The Central Sorghum and Livestock Livelihood Zone profile in the FAO Household Economy Assessment states that livestock are rarely slaughtered in this zone except for special events and meat consumption at household level is mainly from animals that die naturally (FAO,2014)

[31] Based on average household size in Napak of 7 people (from FAO/WFP, 2014).

The estimated total current value of livestock assets held in the village, based on current prices if they were sold, is given in Table 4.7. This indicates that taken together the village holds considerable value in its livestock assets.

Table 4.7: Total Value of Livestock Assets in Village (2014 prices)

	Number in village	Total Value (UGX)	USD
Cattle	2000	1,000,000,000	959,482
Goats	5,000	400,000,000	383,793
Sheep	10,000	600,000,000	575,689
Poultry[32]	431	3,663,500	3,515
Total Asset Value		2,003,663,500	1,922,478
Total Asset per Household		**2,324,436**	**2,230**
Total Asset per Person		**332,062**	**319**

4.3.3. Total Agricultural Production

The study has combined the total estimates of crop and livestock production values for the village given above to calculate an approximate range of the annual value of agricultural production of 426 to 603 million UGX or $409,000 to $579,000. The survey crop data for 2010 have been used as being a more "normal" year than 2014 which suffered a severe drought while the livestock data used are the average value of sales based on data provided by local veterinary officials. Thus the total includes crop production value (sold and not sold) and livestock sales value (not own consumption or asset value). The rationale is that all (or most) crops produced will be consumed or sold in the year of production whereas livestock assets will mostly not be consumed in the given year unless sold.

These totals for agricultural production values convert to an annual value of about $474 to $671 per household or $68 to $96 per person. Although there may be some other non-agricultural income not picked up in the survey this is unlikely to change the totals by very much as only about 2.5 percent of households in the village were said to be involved in non-farming economic activities. Clearly, these figures represent extremely low average incomes even in non-drought years and indicates that the local population are part of the total of 94.3 percent of the population in Karamoja region that is currently living in extreme poverty (less than $1.25 USD per day) given in USAID (2013)[33]. They are also consistent with poverty rates of 81 percent in rural areas for In Iriiri Sub-county (NDLG, 2014).

4.4. Impacts of Climate Change

Village officials stated that there had been a number of extreme climate events since the formation of the village, principally floods in 2007 and 2012 (when almost all of Nakayot village was submerged and cut off from neighbouring communities) and droughts in 2009, 2010 and 2014. It was also noted that rainfall patterns have changed during the last 3 years. The first rains now appear in April, instead of in February as previously, and are now for shorter durations. This has exacerbated the now frequent and prolonged dry seasons every year since 2012.

[32] Estimate is based on survey but caution is advised as only one respondent had poultry.
[33] In making the comparisons with the poverty line later we use the equivalency scales set out by OECD, in which the 2nd adult member of a household is counted as 0.7 and each child is counted as 0.5 of an adult.

Impacts from climate events reported in the survey of households do not fully coincide with the climate events reported by officials. It was agreed that there were floods in 2007 and 2012 and droughts in 2014. However, households report impacts from floods and droughts also in 2013. This may be due to different interpretations of the meaning of drought during the changing rain patterns since 2012.

As well as the effects on agricultural production outlined below there have been other socio economic effects from climate events. The floods have led to massive destruction of transport, households, school facilities, food storage granaries and latrines. This created unhygienic conditions which in the 2012 floods led to an Hepatitis E outbreak in this village, although there was no noted increase in other diseases such as malaria. Animals have also been affected, with goats contracting the contagious complicated pleural pneumonia. During this time, it became difficult for people to move or trade as most parts of the village were cut off from the neighbouring communities.

4.4.1. Impacts on Crop Production

The climate change events have significantly affected crop production in recent years with instances of whole large areas of crop farmland being destroyed by either drought or floods. Households consulted reported high percentage impacts on area cultivated, production and income during the floods of 2013 and droughts in 2013 and 2014 with some having 90 to 100 per cent reductions in expected production, as illustrated in Table 4.8. However, not all households reported that their production was affected by all these events and there was rather a low level of reported impacts for events before 2013.

Estimates have been made in Table 4.8 for loss of value of crop production (sold and not sold) for the surveyed households due to climate events. These calculations are based on the survey results for value of production and for percentage of reduced production reported by households due to the climate events[34]. Estimates for losses of value for the whole village assume the sample losses are representative of the village. They are also given in the table. These estimates show that the total value for the village of losses to crop production from floods in 2013 were between about 25 million UGX (low estimate) and 49 million UGX (high estimate) which converts to about $24,000 to $47,000. The total village values for losses from droughts were higher at the high end, being in the range 34 to 107 million UGX in 2013 (about $33,000 to $103,000) and 80 to 200 million UGX in 2014 (about $77,000 to $192,000). Thus the 2014 drought is estimated to have reduced potential production value in the village by around 55 to 62 percent of a normal year's value. It is stressed that these loss estimates are much less reliable than for the other two villages in this case study due to the much lower proportion of household in the sample compared to total number of households in the village.

4.4.2. Impacts on Livestock Production

The survey also identified significant impacts of recent climate events on households holding livestock with affected households reporting over 50 percent reductions in production and over 70 percent reductions in income, as indicated in Table 4.9. However, it seems that not all livestock holders reported being impacted by the same events, for example only half of the households holding livestock reported impacts from the floods of 2013 and one respondent reported no impact of the drought of 2014 on his livestock production. The table gives estimates of loss of income per year from recent climate events based on applying the percentage impact on income derived from the survey to the estimate of total village income from livestock sales (in Table 4.6). The low estimates assume that the percentage impacts on income at village level only applies to the proportion of

[34] For most households it was possible to estimate the value of total potential production (without the event occurring) and production losses from responses on the percentage of production lost. In case where all production was lost we had to estimate total potential production from 2010 production data. We did not have production data for 2012 and 2013 and therefore the estimated losses for Drought and Flood events in those years assumed the same potential production as for 2014.

livestock holding households that reported impacts in the survey. The high estimates assume that all livestock production is affected in the same percentage as the affected households in the survey. The large range between low and high estimates is a result of the uncertainty about the number of households impacted when only a relatively small number of livestock holding households were captured in the survey. On the other hand, there is more certainty about the significance of impacts on affected households in terms of the high percentage reductions in income for both floods and droughts.

The results indicate total village losses in the range 98 to 195 million UGX for the floods in 2013 (about $94,000 to $187,000), 56 to 223 million UGX for the drought of 2013 (about $53,000 to $214,000) and 63 to 253 million UGX for the drought of 2014 (about $60,000 to $241,000). The lower estimate of losses for the drought of 2014 represents about 22per cent of total average income from livestock product sales and the higher estimate about 90 per cent.

Table 4.8: Summary of Impacts of Climate Events on Crop Production in Nakayot

Event	Year	No of households impacted	Reduced area (%)	Reduced Production (%)	Reduced income (%)	Estimated loss of value for sample (UGX)		Estimated loss of value for village (UGX)	
						Low Estimate	High Estimate	Low Price	High Price
Flood	2007	1	70	90	90	57,780	176,400	4,980,636	15,205,680
	2012	1	10	30	30	24,047	49,997	2,072,808	4,309,698
	2013	5	10 to 100	4 to 100	5 to 100	291,086	569,476	25,091,648	49,088,866
Drought	2013	4	30 to 90	60 to 90	5 to 95	394,761	1,244,926	34,028,377	107,312,600
	2014	7	40 to 90	50 to 90	20 to 90	929,687	2,318,297	80,138,976	199,837,158

Table 4.9: Impacts of Climate Events on Livestock Production in Nakayot (2014 prices)

Event	No of households impacted	Impact on grazing area (%)	Impact on Production (%)	Impact on Income (%)	Loss of income for village (UGX)	
					Low Estimate	High Estimate
Flood 2007	1	60	70	70	48,801,603	195,206,410
Flood 2012	0					
Flood 2013	2	40-50	50	70	97,603,205	195,206,410
Drought 2013	1	65	75	80	55,773,260	223,093,040
Drought 2014	1	90	90	90	62,744,918	250,979,670

4.4.3. Total Agricultural Impacts

Taken together, the impacts of the recent climate events on production of crops and livestock products in Nakayot are considerable. Table 4.10 summarises the estimates given in the analysis above and calculates total losses from crops and livestock. We estimate that the total value of losses from the 2013 drought was about 90 million UGX (lower estimate) or about $86,000 and for the 2014 drought it was about 143 million UGX (lower estimate) or about $137,000 which converts to about $159 per household. .

Caution is needed in interpreting Table 4.10, as it is combing crop production (sold and not sold) with livestock income (sales only). It is also difficult to make a direct comparison between total economic impacts on crops and livestock of these events in the village due to the small number of livestock holders captured in the sample which makes estimating total impacts on livestock values unreliable. Nevertheless, since livestock production is a significant income generator for some households compared to income from crop sales (which are very low in the survey) any impacts of climate events on livestock sales can have a significant effect on monetary earnings in the village. Livestock holding may also provide additional resilience to climate events especially as most respondents holding livestock reported sometimes taking them out of Nakayot especially during the drought periods.

Table 4.10: Summary of Estimated Total Impact of Climate Events on Crops and Livestock in Nakayot

		Crops		Livestock		Total Losses (UGX Million)	
Event	Year	Estimated loss of value due to climate event for village (UGX Million)		Estimated loss of sales value for village (UGX Million)			
		Low Estimate	High Estimate	Low Estimate	High Estimate	Low Estimate	High Estimate
Flood	2013	25.09	49.09	97.60	195.21	122.69	244.30
Drought	2013	34.03	107.31	55.77	223.09	89.80	330.41
Drought	2014	80.14	199.84	62.74	250.98	142.88	450.82

4.4.4. Future Impacts on Agriculture

Impacts of climate change on agricultural production will very much depend on trends in the frequency and intensity of drought and flood events in the village. The Rautenbach study (2014) indicates that Karamoja is one of the main areas in Uganda facing higher variation of rainfall associated with increased risks of droughts and floods, although we do not have projections for future changes in frequency and intensity for these events.

Rautenbach (2015) used daily rainfall and near-surface temperature data for Napak District to calculate projected percentage changes in the number of daily events. This has been done over the 55-year period 2041-2095 (under conditions of both RCP 4.5 and RCP 8.5), relative to the number of daily events in historical deciles (10% percentile categories) over the 55-year period 1951-2005. The study projected more days with rainfall in the lower rainfall categories (0%-40% deciles) and less days with rainfall in the higher rainfall categories (40%-100% deciles). Also a small, but increasing fraction (RCP 4.5 = +0.38% ; RCP 8.5 = +0.38%) of days might receive more daily rain than ever recorded before (>100% percentile). It also concluded it was 100% unlikely that near-

surface temperatures in the 0% to 60% range will appear again in future, but very likely that daily near-surface temperatures will exceed the most extreme decile category (>100%). This is an obvious global warming signal.

Based on estimates given above for agricultural production under recent drought and flood events in Nakayot we can indicate the future scale of impacts given projections about frequency of such events. Assuming a scenario where a drought on the scale of 2014, a drought on the scale of 2013 and a flood on the scale of 2013 occur in three year cycles continuously until 2050 total losses of potential crop production have been calculated as nearly 2.6 billion UGX (about $2.5 million) based on the low price estimates [35]. This represents about 32 percent of total potential production up to 2050 assuming business as usual in crop production and no adaptation to climate change and no growth in production due to increasing farming population in the village. Such a scenario is plausible given recent sustained shifts in seasonal rainfall patterns over the last three years. On the other hand it may be on the high side as such a sequence of events is rare. Therefore we also consider a scenario where a drought on the scale of 2014, a drought on the scale of 2013 and a flood on the scale of 2013 occur in six year cycles continuously until 2050 total losses of potential crop production would be about nearly 1.3 billion UGX (about $1.2 million) on the low price estimates representing about 15 per cent of total potential production up to 2050.

Illustrative estimates of impacts on **livestock income** of future droughts and floods have also been made using the same scenarios as used for crops. Under the less severe scenario, total losses of potential livestock income up to 2050 have been calculated as about 2.2 billion UGX (about $2.1 million)[36]. This represents a loss of about 12 percent of potential livestock production income without the droughts. Under a scenario where a drought on the scale of 2014 and a drought on half the scale of 2014 occur every five years until 2050 total losses of potential livestock production income are estimated at about 4.5 billion UGX (about $4.4 million) or about 26 percent of potential crop production without the droughts.As well as sudden and significant impacts on agricultural production from droughts and floods, climate change is also projected to bring about long term overall changes to expected yields for different crops in Uganda as analyzed in the Agricultural Sector report. Regional projections for changes in yields from selected crops for Uganda obtained from IFPRI[37] indicate a wide range of results for different crops according to the various climate models used as shown in Table 3.7. While all models show projected reductions in yields for sorghum and soybeans there is disagreement between models on whether maize yields will increase or decrease.

Table 4.11 gives estimates of changes to value of production for this village according to the predicted percentage changes in yields from the climate models up to 2050. The selected crops of sorghum, maize and beans are those for which we have regional projections from the IFPRI data and represent about 60 per cent of total crop values in the village in 2010. The table indicates potentially significant impacts on the value of production in the period to 2050 in the village especially for sorghum depending on the model used. While these conclusions are highly uncertain they have implications for adaptation in terms of the possible need for crop diversification in the medium and long term.

[35] This is with assumed growth in production of 2.4% p.a. up to 2030 and 1.9% pa from 2030 to 2050 based on the future projections sub Saharan Africa from the FAO report World Production Towards 2030/50 report (Alexandratos & Bruinsma, 2012).

[36] This is with assumed growth in all livestock production of 2.9% p.a. up to 2050 based on the future projections for livestock production in sub Saharan Africa from the FAO report World Production Towards 2030/50 report (Alexandratos & Bruinsma, 2012).

[37] Unpublished data from modelling by the International Food Policy Research Institute's (IFPRI).

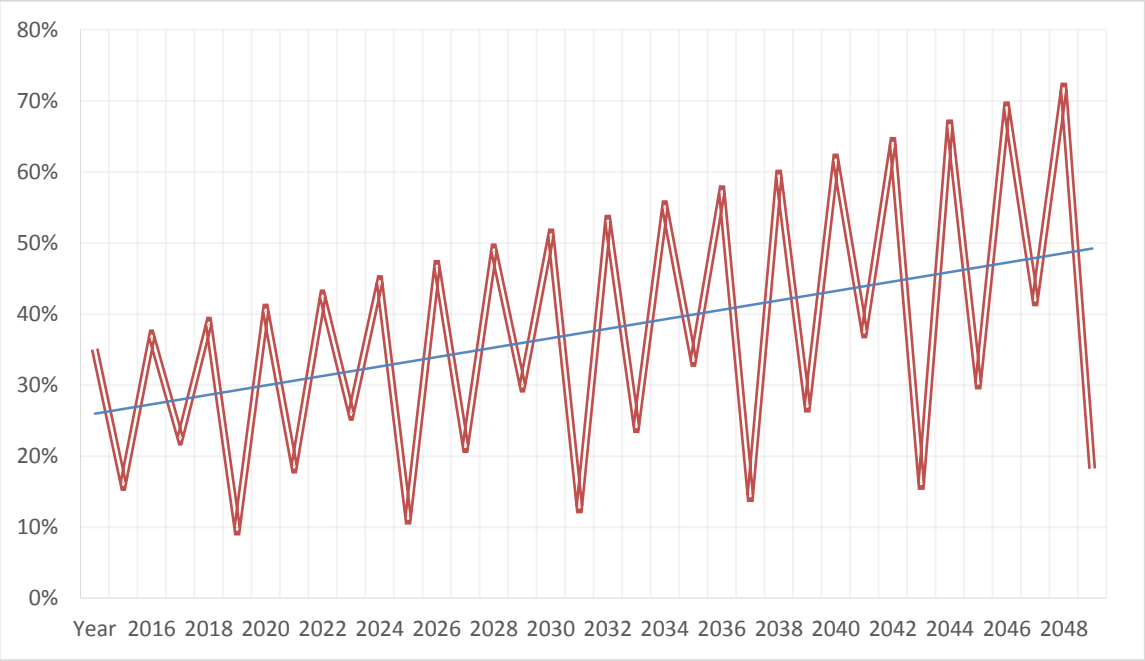
Table 4.11.Estimated Change of Value of Production in 2050 (UGX) (2014 prices) in Nakayot

		Change in Value by 2050			
	Low Estimated Value 2010	CNRM A1B	CSIRO A1	ECHAM A1	MIROC A1
Maize	15,964,240	-1,527,021	830,771	644,952	950,690
Sorghum	60,340,000	-7,697,405	-1,404,958	-6,441,859	-2,175,048
Beans	12,068,000	-1,998,408	-425,580	-1,747,114	-868,073
	High Estimated Value 2010	Change in Value by 2050			
Maize	39,910,600	-3,817,553	2,076,926	1,612,379	2,376,726
Sorghum	120,680,000	-15,394,810	-2,809,917	-12,883,719	-4,350,095
Beans	26,549,600	-4,396,498	-936,276	-3,843,651	-1,909,760

The present situation in the village of Nakayot and similar villages in the region provides a basis for seeing how livelihoods may evolve in the future and what actions will be needed for them to remain sustainable as the rest of the country grows. Even without climate change the future looks bleak. There is some prospect for growth; about 2.4% to 2030 and 1.9% after that is being projected by FAO for agriculture in sub-Saharan Africa as a whole and Karamoja should benefit from something similar. But with the rest of the country growing faster the gap between living standards in this region and the rest of the country will widen. Figures 4.1 and 4.2 show a likely evolution to 2050 for the percentage of average per capita income in Nakayot in comparison to the poverty line of $1.25 per day and to GDP per capita, assuming Uganda follows the moderately optimistic scenario (SSP1) where per capita income grows at 5.6 percent to 2050. The projections are the most favourable to Karamoja as we have taken the high value estimates for incomes in the villages and assumed the frequency of floods and droughts follows a six year cycle rather than the three year one we have just observed. Yet, even in this case not only do we see growing gaps in per capita income but, in the absence of measures to address climatic variations,[38] the fluctuations of incomes in the region will make livelihoods here unattractive. One must expect therefore some migration to urban areas and an increase in productivity (output per head) for agriculture to continue. The continued practice of agriculture in the region under the national growth scenarios is of course not guaranteed: there are examples in other countries of marginal areas for agriculture being abandoned as new opportunities arise elsewhere in the country.

[38] The frequency of extreme events is assumed to occur on a five year cycle, so floods of the 2013 type occur five years and droughts of the 2013 and 2014 type occur with a five year interval.

Figure 4.1: Evolution of Income per Person in Nakayot Village to 2050 as % of Poverty Line

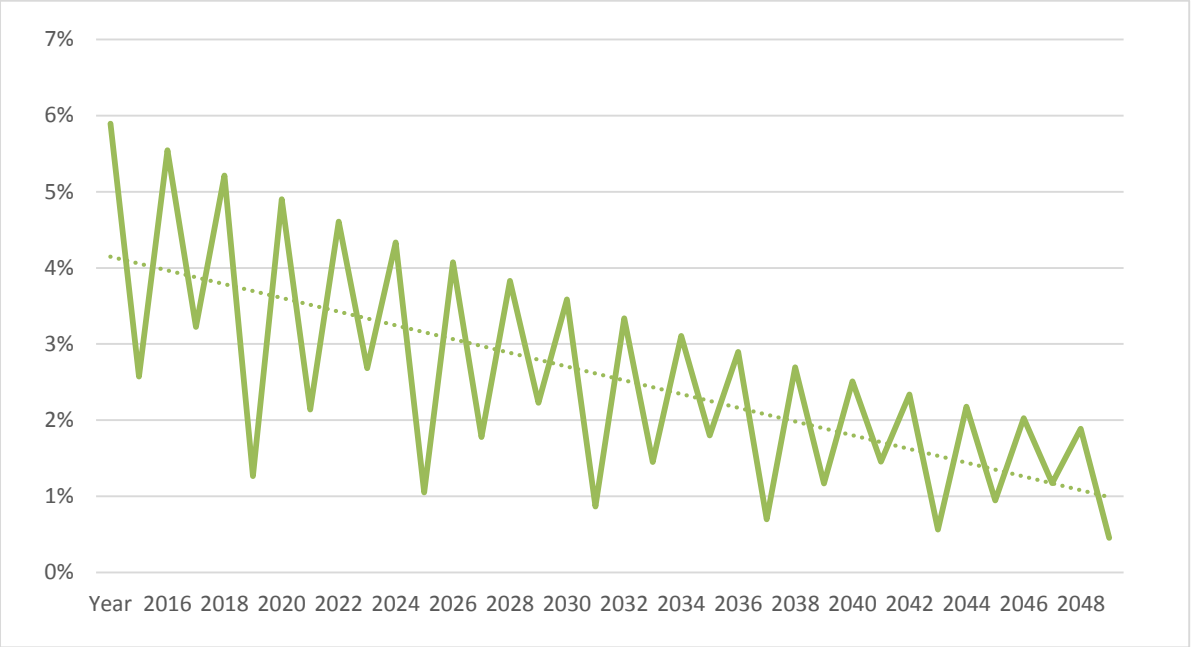


Note: The higher the income is - as a percent of the poverty line - the better off is the household. The oscillations arise from the expected extreme events.

These figures show the likely evolution of incomes in the region in the presence of current climate variability. We should therefore take into account a possible increase in frequency and intensity of extreme events and changes in yields on crops. For extreme events the situation will likely get worse although this is not confirmed in the projections. For changes in yields we see some decline in sorghum and beans and a mixed picture for maize, depending on which model is taken. Farmers will adjust production in the light of these changes to minimize the impact on their livelihoods. The overall expectation is that as a result of both factors average net incomes will decline relative to the non-climate change scenario.

The overall message from the above analysis for Nakayot village on the evolution of income per person against the poverty line and national GDP per capita provides is that we can expect significant autonomous adaptation in the region as individuals respond to the differences in opportunities in Karamoja versus the rest of the country. Yet this will not be enough to improve livelihoods for the people of these villages, some of whom appear to have a strong preference to continue an agro-pastoral lifestyle.

Figure 4.2: Evolution of Income per Person in Nakayot Village to 2050 as % of Per Capita GDP



Source: Own calculations. The poverty comparison is in terms of equivalence scales.

Note: As the rest of Uganda gets richer in the future, the fall in income (expressed here as a percentage of per capita GDP) in Nakayot reflects a growing gap with the rest of the country.

4.5. Adaptation Options

Table 4.12 lists the main programmes and actions relevant for Nakayot village currently being implemented to address climate variation. Actions outlined during stakeholder dialogues demonstrate a range of responses as follows:

Increasing resilience to climate events:

- Households are being relocated from the lower flooding areas to slightly higher altitude areas on the hill slopes.
- Drilling of boreholes that continuously provide water to the households and their livestock
- Construction of bigger granaries standing higher off the ground to enable them store more food and avoid being destroyed by floods.
- Building trenches that will direct water away from the villages during the flooding times
- Planting trees.

Adaptation of farming practices:

- Crop diversification, like the introduction of cassava, sweet potatoes, maize and sunflower
- Pastoralists shifting to other grazing areas whenever there are droughts or floods.
- Introduction of long term varieties of crop which are drought resistant.

Capacity building:

- Sensitisation programmes on the issues of climate change and agriculture in respect to mitigation activities.

Income diversification:

- New income generation sources include beer brewing, brick making and selling shops.

Responses from households when asked for their priority areas for adaptation were as follows:

- Setting up disaster preparedness committees from district to village levels, and supported by the government and meteorological department.
- Assess areas that are climate change disaster prone and prevent catastrophe by acting before they impact.
- Sensitisation of communities regarding climate change and its impacts.
- Improve on support to communities that have been affected to mitigate effects of climate change.
- Government construction of better roads and bridges that are can withstand floods.
- Support for planting more trees by providing them with free seedlings.
- Government investment in creating more water collection dams.
- There should be long term investment in livestock since they are not adversely affected by climate change.
- They should be allowed and supported to open up more land for farming.

Both the Iriiri Sub-County Development Plan (NDLG, 2014) and the Napak District risk assessment (UNDP, 2014) highlight the issues of climate change risks in the area but do not give detailed plans for adaptation. However, the poverty and livelihood analysis of the Iriiri Sub-County Development Plan does include among the issues to be addressed the lack of exposure to improved methods of farming and lack of affordable technologies for better farming practices.

A range of adaptation actions, as outlined in the section, are already taking place in Nakayot village in line with key general priorities for adaptation responses as discussed in the concluding section of this report and summarized in Table 6.1. Thus there are (or have been in the recent past) programmes implemented for supporting capacity building, crop diversification and storage, water availability and greater resilience to flooding. The responses from households, however, indicate that they believe more can be done in terms of specific planning and investments in adaptation for extreme climate events, including capacity building, investments in flood protection and opening up more land for farming. Moreover, according to the information collected for the village, livestock production has not been a key focus of recent programmes with responses to climate events being mainly autonomous through movements of livestock to other grazing grounds. Households have therefore identified long term investment in livestock as being one priority for adaptation. Since this study has not made a technical assessment of specific requirements for further adaptation action at village level the issue of how to support livestock production, as part of the wider picture of support for crops and other income diversification, should be highlighted as a priority for further assessment.

Table 4.12 Summary of Adaptation Actions and Programmes: Napak district, Nakayot Village

Type of Response	Action	Programme	Implemented by	Period	Financed	Note
Capacity building	Sensitisation and training of communities on climate change	CMDRR/DEWS	Production and Environment Department	2013-2014	Central government	This programme is done on piecemeal basis
Improvement of crop storage	Building bigger granaries	Action for social change	ADRA-Uganda	2012-2013	Denmark	
Resettlement plan	Acquisition of land and relocating households to higher altitudes		Community livestock integrated development (CLIDE) programme	2007-2009	EU –NUREP and Christian veterinary mission	Uganda Wildlife Authority tried to limit peoples expansion to other lands
Crop diversification	Introducing other drought resistant and early maturing crops		Community livestock integrated development (CLIDE)consultancy programme	2007-2009	EU –NUREP and Christian veterinary mission	Support to resettling community
Household income diversification	Introduction of new income generating activities		Community livestock integrated development (CLIDE)consultancy programme	2007-2009	EU –NUREP and Christian veterinary mission	
Improving water availability	Construction of bore holes	Action for social change	ADRA- Uganda	2010-2011		
Pasture for animals	Moving to other grazing areas during the drought periods					
Flood control	Building of restraining trenches and contour ditches	NAADs and Production department		2013-2014		Community initiatives after training
Reducing farming on degraded land	A forestation.		Community livestock integrated development (CLIDE) programme	2007-2009	EU –NUREP and Christian veterinary mission	Also gave agricultural tools
Improvement of transportation	Building better roads and bridges		ACF	2013-2014		Only opened community access roads

5. AMUDAT DISTRICT CASE STUDY

Amudat District lies in the South Eastern Cattle and Maize Livelihood Zone which is fundamentally a pastoral zone where households also plant crops (mainly maize and beans) which provide food and income in good years. Therefore, livestock are the mainstay of the local economy, providing milk, meat and income. The district is one of the least developed in the country with high levels of extreme poverty.

The village surveyed in this district was Lopedot which has long been in existence and has currently about 40 households. Previously all the residents were nomadic livestock keepers. Around 5 years ago the government started encouraging the residents to take up crop production and about 50 percent of households have now started to cultivate mainly maize, beans and groundnuts. Estimates of total value of crop production for the village show a dramatic difference between the good year of 2012 when total production value for the village was in the range 21 to 45 million UGX ($20,000 and $43,000) and 2014 when crops failed due to a severe drought and the range was only 1.8 to 3.1 million UGX (about $1,700 to $3,000). This converts to about $500 to $1,000 per household (about $80 to $175 per person) in 2012 and only about $42 to $74 per household (about $7 to $12 per person) in 2014.

Most households that reported impacts of the 2014 drought suffered near 100 percent reductions in crop production and income. It is estimated that the total value of crop losses in 2014 for the whole village were in the range 18.1 to 38.4 million UGX (about $17,000 to $37,000) according to whether low or high price assumptions are used. This is a reduction of about 85 percent compared to the value in 2012.

All consulted households in the village held some cattle and goats, most held sheep, 30 percent had donkeys and camels and 40 percent had poultry, indicating the continuing importance of pastoralism. Normal annual income from livestock product sales in the village was estimated at about 28 million UGX which converts to about $27,000 or $650 per household.

The severe drought of 2014 led most of the village members to take their cattle to graze in other regions further south where there is some grass and water. It is estimated that losses of sales income from livestock products amounted to about 13.9 million UGX in 2014 (about $13.000).

In the absence of projections for future frequency and intensity of extreme climate events in the village the study has made some illustrative estimates of the possible future scale of impacts under two scenarios:

- Under a more pessimistic scenario total losses of potential crop production to 2050 have been calculated as about 322 million UGX ($309,000). This represents about 28 percent of total potential production up to 2050 assuming business as usual production with no further adaptation to climate change.
- Under a less pessimistic scenario total losses of potential crop production would be about nearly 223 million UGX ($214,000) to 2050 or about 19 percent of total potential production.

Changes to value of production of maize and beans due to predicted long term changes in yields from climate models up to 2050 also indicates potentially significant impacts on the value of maize (up to 12 percent reductions) and beans (up to 20 percent reductions) production in the long term in the village depending on the model used.

Using the same more pessimistic future extreme climate events scenarios up to 2050 as for crops, total losses of livestock income were estimated at about 285 million UGX ($274,000) or a loss of about 16 percent of potential livestock production income. Under the less pessimistic scenario these losses were about 198 million UGX ($190,000) or a loss of 16 percent of potential livestock production income.

5.1. Amudat district context

Amudat District was carved out of Nakapiripirit District in 2009. The total area is 1,615.4 km^2 with a population of 131,658 people which had increased from 63,600 since the national census of 2002. The population growth

of Amudat is 5.4 percent per year. The district is one of the least developed in the country with high levels of extreme poverty. The development initiatives in recent years have been greatly hampered by internal and external insecurity (ADLG, 2011).

The district lies in the South Eastern Cattle and Maize Livelihood Zone according to FAO definitions which is fundamentally a pastoral zone where households also plant crops (mainly maize and beans) which provide food and income in good years only. Therefore, livestock are the mainstay of the local economy, providing milk, meat and income. Livestock numbers here are the highest in Karamoja and with better milk yields. Also of importance is cross-border trade with Kenya. The FAO baseline study did not find so much evidence of self-employment activities (selling firewood and charcoal, etc.) and casual labour as in other zones (FAO, 2014).

The Climate is semi-arid and prone to drought. The dry period is for eight months from August to March followed by sparse rainfall for four months (April to July). Due to the long dry period and lack of adequate water for livestock, the people lead a semi nomadic life style including moving to neighbouring districts for water and pasture (ADLG, 2011). The downscaled climate analysis in Rautenbach (2015) concluded that Amudat district had an average monthly rainfall of 63.1 mm (standard deviation value of 53.9) based on time series of observations over the period 1951 to 2005. It also found that average near-surface temperature over the period 1979 to 2005 was 21.1 °C (standard deviation value of 1.3).

5.2. Case Study Village: Lopedot

Lopedot village, in Amudat district, has long been in existence and previously all the residents, mainly the Pokot tribe, were nomadic livestock keepers who moved to other areas in search of grass and water. Their main livestock comprised of cattle, sheep, goats, camels and recently, chicken. In the recent past (late the 1990s and early 2000s), most residents deserted the village and headed across the Kenyan border, mainly due to insecurity and cattle raids conducted by the other Karimojong tribes. However, since the return of peace, there has been a steady return of residents that has ultimately led to an increase in population and households. Because of the increasing drought seasons, most of the returning residents did not have enough food, and to avoid starvation, the World Food Programme used to hand out food rations. Around 5 years ago the government started encouraging the residents to learn how to farm mainly through training workshops. This was done in addition to distributing cattle, oxen (to be used for farming), goats and seedlings (especially maize and cassava) mainly through NAADs, the Office of the Prime Minister and Ministry of Karamaja, however, this has been only slowly taken up. One reason for this is that the Pokot tribe see it as a punishment to the animals to use oxen to plough farming land. About 50 percent of households have now started to practice some form of crop farming, and this uptake has been mainly in the last three years. They mainly farm maize, beans and groundnuts. In order to increase water availability, the government has sunk several boreholes and valley tanks (these are located in the neighbouring villages but supply this village also). One season ago, the farming community in Lopedot village had a bounty harvest of maize, and sold it to their Kenyan neighbours for good returns. This encouraged the other residents to also cultivate maize during the recent season but, unfortunately, they were hit with a prolonged severe drought that destroyed most, and for some households all, of their crops.

Table 5.1 shows that the number of households in the village decreased from 58 in 2006 to 38 in 2011 due to migration as people looked for fertile land elsewhere. After 2006 households slowly changed from being only pastoralists to also growing some crops. According to village officials there are no households in non-farming economic activities or households that are not economically active.

Table 5.1: Households in Lopedot

	Number of households in village			
Category	**2014**	**2011**	**2006**	**2000**
Total # of households in Lopedot Village	41	38	58	28
# of households in agriculture	0	0	0	0
# of households in Pastoral	0	0	58	28
# of households in active crop and livestock production	41	38	0	0
# of households in non-farming economic activities	0	0	0	0
# of households not economically active	0	0	0	0

5.3. Agricultural production

This section summarises information on agricultural production collected in the case study consultation of village officials and households in Lopedot.

5.3.1. Crop Production

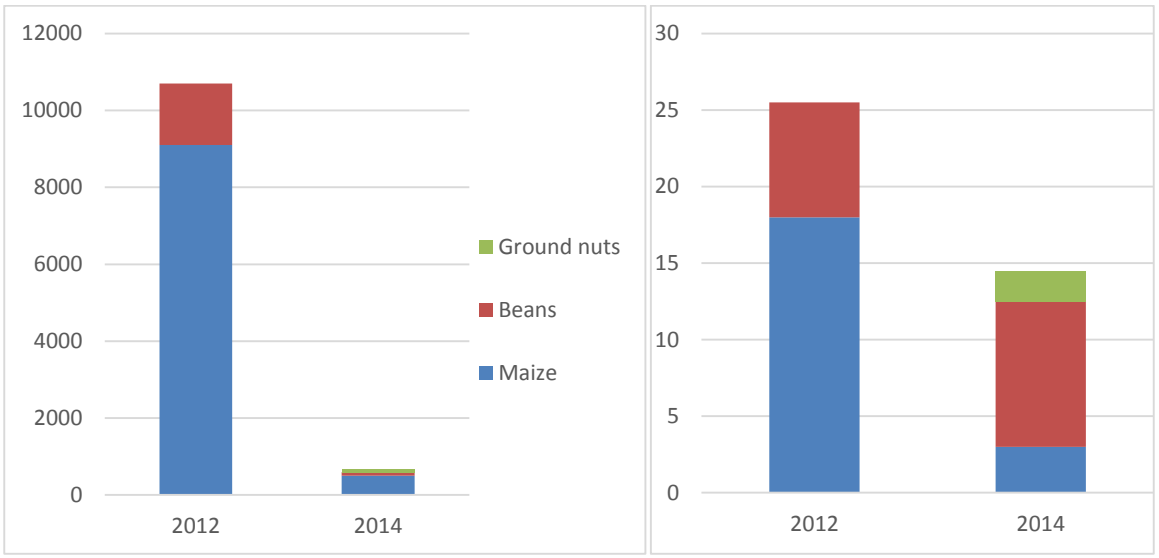
Crop cultivation is a recent development in Lopedot, as explained above, and therefore production data was only available from 2012 when most of the sample started farming. Table 5.2. (and 5.1) indicates that 8 households questioned out of 10 had cultivated maize and beans in 2012 and, with some exceptions, they had been successful in that year but drought in 2014 has caused a total failure of production for all but one household for maize and two households for beans.

Table 5.2: Summary of Crop Production in Lopedot

	2014			2012		
Main Crops	**Number of Households**	**Kg**	**acres**	**Number of Households**	**Kg**	**Acres**
Maize	1	500	3	8	9100	18
Beans	2	90	9.5	8	1600	7.5
Ground nuts	1	90	2	0	0	0

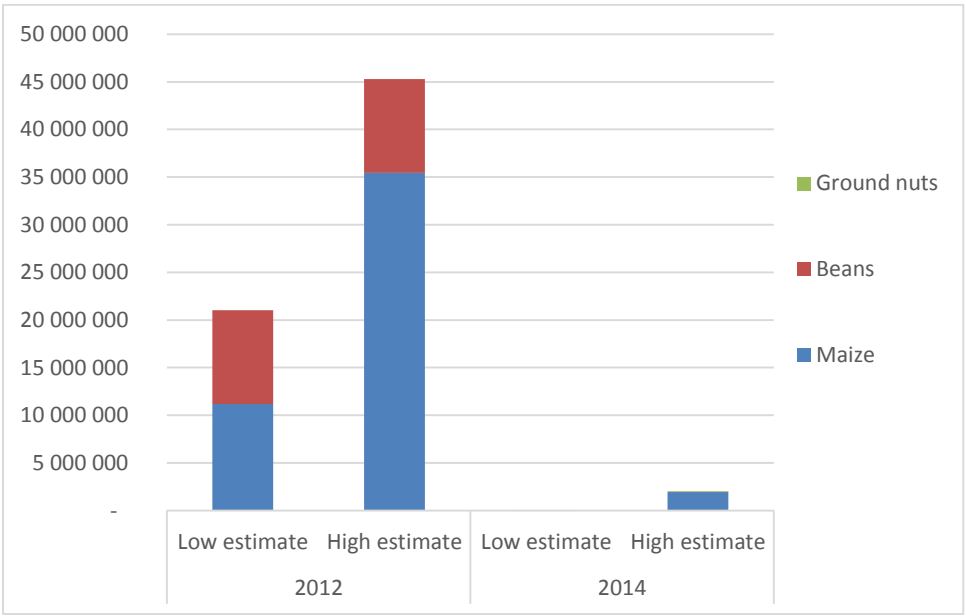
NB: Number of households refers to those with some production.

Chart 5.1: Summary of Crop Production in Lopedot: left: kg of production. Right: acreage planted.



Estimates for the value of crop production per crop and in total are shown in Chart 5.2 and Table 5.3 in 2014 and 2012. Low and high estimates for total value of production (sold and not sold) are derived from the range of prices for the different crops given in the survey. There was found to be quite a large range in stated prices for maize and this is reflected in the range of production values calculated between the low and high estimates. Estimates of total value of crop production for the village have been calculated assuming the survey sample values are representative. These show the dramatic difference between the good year of 2012 when total production value for the village was in the range 21 to 45 million UGX ($20,000 and $43,000 at the purchasing power parity exchange rate[39]) and the drought year of 2014 when the range was only 1.8 to 3.1 million UGX (about $1,700 to $3,000). This converts to about $500 to $1,000 per household (about $80 to $175 per person) in 2012 and only about $42 to $74 per household (about $7 to $12 per person) in 2014[40].

Chart 5.2: Estimated total value for Lopedot village (sold not sold) (UGX)



[39] The market rate for the Ugandan shilling was 2,778 to the US dollar at the end of 2014. The PPP rate was 1,042 to the dollar is a better guide to the real value of earnings and prices.
[40] Per person estimates based on average household size in Amudat of 6 people (from FAO/WFP, 2014).

Table 5.3: Summary of total production value in Lopedot (2014 prices)

Crop	2014				2012			
	Total value of production in sample (sold and not sold) (UGX)		Estimated total value for village (sold not sold) (UGX)		Total value of production in sample (sold and not sold) (UGX)		Estimated total value for village (sold not sold) (UGX)	
	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate
Maize	150,000	475,000	615,000	1,947,500	2,730,000	8,645,000	11,193,000	35,444,500
Beans	135,000	135,000	553,500	553,500	2,400,000	2,400,000	9,840,000	9,840,000
Ground nuts	157,500	157,500	645,750	645,750	-	-	-	-
Total (UGX)	**442,500**	**767,500**	**1,814,250**	**3,146,750**	**5,130,000**	**11,045,000**	**21,033,000**	**45,284,500**
Total (USD)	**425**	**736**	**1,741**	**3,019**	**4,922**	**10,597**	**20,181**	**43,450**

5.3.2. Livestock Production

Livestock holdings in the village are given in Table 5.4 and show that all consulted households held some cattle and goats, most held sheep, 30 percent had donkeys and camels and 40 percent had poultry. Estimates of total village numbers of livestock are based on the sample and indicate the continuing importance of pastoralism with an average 47 animals per household[41]. In the dry season when the survey took place, most of the cattle had been taken southwards, nearer the Teso region, where there is some grazing land and water sources and would return when the rains start in the village.

Table 5.4: Livestock Holdings in Lopedot (2014)

Livestock	Number of Households	Number of livestock in Survey	Estimated numbers for Village
Cattle	10	125	513
Goats	10	162	664
Sheep	8	123	504
Donkeys	3	13	53
Camels	3	14	57
Poultry	4	36	148

Table 5.5 gives totals for normal annual income from livestock product sales in the survey and estimates of this income for the whole village based on income and price data from the survey. The estimated total income for all households in the village is about 28 million UGX which converts to about $27,000 or $650 per household

[41] Estimates of livestock holdings for the village based on survey data for Lopedot in the FAO/World Food Programme Karamoja Food Security Assessment (FAO/WFP, 2014) was rather lower than estimates from this survey for cattle, goats and sheep by at least 50 percent although there was closer agreed on the proportion of different livestock held.

and $108 per head. As in the case of Nakayot village these estimates do not include the value of milk and meat that is not sold. These estimates are relatively more reliable than those for Nakayot since the sample of households is a much larger proportion of total households in the village.

The survey found that although all households kept cattle and goats only 40 per cent of them gained income from sales of these animals, while 25 percent of sheep holders gained income from their sales and all households with poultry had income from their sales. Interestingly, the proportion of total village livestock holdings that were sold per year were estimated at about three times that of Nakayot in the case of cattle, goats and sheep.

It was difficult to estimate net income from livestock production from the survey as the only stated cost was for treatment of animals which in general represented 5 to 20 percent of total stated revenues for households with livestock sales.

Table 5.5: Estimated Total Annual Income in Village from Livestock Products (2014 prices)

Livestock Product	Total income from sales in sample (UGX)	Estimated income from sales for village (UGX)
Cattle	3,630,000	14,883,000
Goats	1,151,000	4,719,100
Sheep	240,000	984,000
Donkeys	0	0
Camels	840,000	3,444,000
Poultry	900,000	3,690,000
Milk	0	0
Total (UGX)	6,761,000	27,720,100
TotaL (USD)	6487	26,597
Estimated per household income (USD)		**649**
Estimated per household person (USD)		**108**

The estimated total current value of livestock assets held in the village, based on expected revenues if they were sold, is given in Table 5.6. The low estimates assume that all sales are at the lowest prices per animal given in the survey and the high estimates assume all sales are at the highest prices given. The totals in the range 234 to 404 million UGX ($224,000 to $388,000) indicates the considerable value of livestock assets held in the village. The average per household values in the range of about $5,400 to $9,400 can be compared with the average per household values of about $2,200 estimated for Nakayot.

Table 5.6: Total Value of Livestock Assets in Lopedot village

	Number in village	Total Value (UGX)	
		Low Estimate	High Estimate
Cattle	513	128,125,000	256,250,000
Goats	664	33,210,000	59,778,000
Sheep	504	22,693,500	37,822,500
Donkeys	53	n/a	n/a
Camels	57	48,216,000	48,216,000
Poultry	148	1,476,000	2,214,000
Total (UGX)		**233,720,500**	**404,280,500**
Total (USD)		**224,251**	**87,900**

Estimated per household income (USD)	5,470	9,461
Estimated per household person (USD)	912	1,577

5.3.3. Total Agricultural Production

Combining the total estimates of crop and livestock production values for the village given above gives an approximate range for the annual total value of agricultural production in 2012 of about 49 to 73 million UGX or $46,700 to $70,000. This converts to an annual value of about $1141 to $1708 per household or $163 to $244 per person. As in the estimates for Nakayot these totals includes crop production value (sold and not sold) and livestock sales value (but not own consumption or asset value). In the following analysis on climate impacts the 2012 production totals have been taken as representing a good year against which to measure production losses from climate events in particular the drought of 2014.

From these totals it is interesting to note that even in 2012, which represented a very good year for crop production and maize in particular, income from livestock sales was still greater than the total value of crop production (by about 30 percent) assuming the low price estimate for crops, though about 40 percent lower assuming the high price estimate for crops. It should also be noted that the estimates for per household agricultural values are still below the World Bank poverty line of $1.25 per day although greater than the equivalent estimates given for the other two villages.

5.4. Impacts of Climate Change

This village has always experienced periods of drought virtually every year but the most severe drought to hit this village in a long time happened in 2014, destroying most of the crops. As the village has no pasture for their animals most of the village members had to take their cattle to graze in other regions further south where there is some grass and water.

The severe drought impacted the community in a number of ways that included:

- Loss of most of the local farm lands with the farmers incurring huge losses.
- Drying up of water sources leaving only a few boreholes to supply water to the households. This is not adequate to supply animals resulting in reduced milk yield, sales and household consumption.
- The spread of cattle diseases like foot and mouth, which has killed some animals. Additionally, because of the quarantine they could not easily sell their produce which has caused a loss of income.
- Incidence of wild bush fires which can sometimes be very destructive.

5.4.1. Impacts on Crop Production

Among surveyed households there had been six years since 1996 when their crop production had been affected by drought and no years when it had been affected by flooding. However, there was little agreement between the responses on which years the drought impacts had occurred except for 1996 (stated by 3 households) and

2014 for which all crop growing households in the sample were impacted[42]. This assessment has therefore focused on the impacts of the drought of 2014 and has compared crop production with the good crop year of 2012 as we have the best data for these two years. Most households that reported impacts of the 2014 drought said they had suffered 100 percent reduction in crop production and income although one household estimated 40 percent reduction. Based on the survey results for value of crop production and percentage of reduced production due to the drought it is estimated that the total value of losses in 2014 for the whole village were in the range 18.1 to 38.4 million UGX (about $17,000 to $37,000) according to whether low or high price assumptions are used. The 2014 drought is therefore estimated to have reduced production value in the village by around 85 percent compared to the value in 2012. Based on the qualitative information gathered in the village this may indeed be an underestimation of the extent of the impacts.

5.4.2. Impacts on Livestock Production

As in the case of crop production there were a number of years for which impacts of drought were reported in the survey but limited coincidence in dates except for the major droughts occurring in 1996 and 2014. The assessment has therefore focused on the impacts on livestock product sales in 2014. Based on the assumption of 50 percent losses of usual livestock product sales derived from the survey it is estimated that losses amount to about 13.9 million UGX in 2014[43] (about $13.000).

5.4.3. Total Agricultural Impacts

Table 5.7 summarises the estimates given above for losses in production of crops and livestock products sales in the 2014 drought. It is estimated that the total value of losses for the village were about 32 million UGX (low estimate) to about 52 million UGX (high estimate) or about $30,600 to $50,000. This is about 780,000 to 1,275,000 UGX per household or$748 to $1224 per household. This represents between 66 to 72 percent of total crop values and livestock sales combined. As noted above for Nakayot village, caution is needed in interpreting these results as it is combining crop production (sold and not sold) with livestock income (sales only).

It is clear that the 2014 drought had huge impacts on both livestock and crops production. Of those households that reported losses of crops most said this was 100 percent, while households that reported losses of livestock production all said this was about 50 percent. Therefore, it could be concluded that while livestock production and income was very badly hit by the drought through loss of water supply, losses of pasture and increased disease incidence, the overall impacts were not as comprehensive as for crop production as it was at least possible to take livestock to graze in other regions and retain some household consumption of milk and meat, and also to retain remaining livestock assets for future years.

[42] There are some inconsistencies in the answers given to questions 2 and 7 in the questionnaire by two households regarding whether they were impacted by the 2014 drought. Our judgement from reviewing all the data is that all those cultivating crops were hit by the drought of 2014.

[43] The method of deriving losses of livestock production income used for the Nakayot village was not followed exactly in this case because the survey included only one household in the sample (HH8) which stated both income from sales of livestock and being impacted by the 2014 drought. As it would not have been reliable to make village estimates based on only one household an alternative calculation was made applying the 50 percent impact on production results (which was consistent for all households that stated an impact for the 2014 drought) to the total income from livestock sales figure.

Table 5.7: Summary of Impacts on Crop Production Value and Livestock sales in Lopedot of drought in 2014

	Crops		Livestock	Total Losses (UGX Million)	
	Estimated loss of value due to climate event for village (UGX Million)		Estimated loss of sales value for village (UGX Million)		
	Low Estimate	High Estimate		Low Estimate	High Estimate
Losses from drought in 2014	18.12	38.45	13.86	31.98	52.31

5.4.4. Future Impacts

The study by Rautenbach (2015) used daily rainfall and near-surface temperature data for Abim District to calculate projected percentage changes in the number of daily events. This has been done over the 55-year period 2041-2095 (under conditions of both RCP 4.5 and RCP 8.5), relative to the number of daily events in historical deciles (10% percentile categories) over the 55-year period 1951-2005.

The study found that that more days with rainfall in the lower rainfall categories (0%-40% deciles) and less days with rainfall in the higher rainfall categories (40%-100% deciles) are projected in future. Also a small, but increasing fraction (RCP 4.5 = +0.38% ; RCP 8.5 = +0.38%) of days might receive more daily rain than ever recorded before (>100% percentile). It also found that it is 100% unlikely that near-surface temperatures in the 0% to 60% range will appear again in future, but very likely that daily near-surface temperatures will exceed the most extreme decile category (>100%). It was concluded that this is an obvious global warming signal.

Impacts of climate change on agricultural production will very much depend on trends in frequency and intensity of drought and flood events in the village. The Rautenbach study (2014) indicates that Karamoja is one of the main areas in Uganda facing higher variation of rainfall associated with increased risks of droughts and floods, although we do not have projections for future changes in frequency and intensity of these events.

The estimates given above for impacts on agricultural production of recent drought events in Lopedot have been used to calculate illustrative estimates for the future scale of impacts given assumptions about future frequency of such events. Assuming a scenario where a drought on the scale of 2014 occurs every five years until 2050 total losses of potential **crop production** have been calculated as about 223 million UGX ($214,000) based on the low price estimates[44]. This represents a loss of about 19 percent of potential crop production without the droughts. Assuming a scenario where a drought on the scale of 2014 and a drought on half the scale of 2014 occur every five years until 2050 total losses of potential crop production are estimated at about 322 million UGX ($309,000) on the low price estimates or about 28 percent of potential crop production without the droughts. These estimates also assume no further adaptation to climate change and no growth in production due to increasing farming population of the village.

Illustrative estimates of impacts on **livestock income** of future droughts have also been made using the same scenarios as used for crops. Under a scenario where a drought on the scale of 2014 occurs every five years until 2050 total losses of potential livestock income have been calculated as about 198 million UGX[45] ($190,000). This represents a loss of about 11 percent of potential livestock production income without the droughts. Under a

[44] This is with assumed growth in production of 2.4% p.a. up to 2030 and 1.9% pa from 2030 to 2050 based on the future projections sub Saharan Africa from the FAO report World Production Towards 2030/50 report (Alexandratos & Bruinsma, 2012).

[45] This is with assumed growth in all livestock production of 2.9% p.a. up to 2050 based on the future projections for livestock production in sub Saharan Africa from the FAO report World Production Towards 2030/50 report (Alexandratos & Bruinsma, 2012).

scenario where a drought on the scale of 2014 and a drought on half the scale of 2014 occur every five years until 2050, total losses of potential livestock production income are estimated at about 285 million UGX ($274,000) or about 16 percent of potential crop production without the droughts.

Estimates have also been made for overall changes to expected yields of crops due to climate change up to 2050 as has been done for the two other villages in the study. The regional projections for percentage changes in yields for selected crops used in these estimates are the same as the other two villages as shown in Table 3.7.

Table 5.8 gives estimates of changes to value of production of maize and beans[46] according to the predicted percentage changes in yields from a number of climate models up to 2050 and assuming 2012 production levels. The table indicates potentially significant impacts on the value of maize (up to 12 percent reductions) and beans (up to 20 percent reductions) production in the long term in the village depending on the model used. While these conclusions are highly uncertain they have implications for adaptation in terms of the possible need for crop diversification in the medium and long term. Although we do not have regional level projections from IFPRI for changes in yields for livestock products resulting from overall changes in temperature and rainfall to 2050, the national level projections were found to be negligible in the sector report for Agriculture (Metroeconomica, 2015).

Table 5.8: Estimated Change of Value of Production in 2050 (Million UGX) (2014 prices)

		Change in Value by 2050			
	Low Estimated Value 2012	CNRM A1	CSIRO A1	ECHAM A1	MIROC A1
Maize	11.19	-1.53	0.83	0.64	0.95
Bean	9.84	-2.00	-0.43	-1.75	-0.87
	High Estimated Value 2012	Change in Value by 2050			
Maize	35.44	-3.82	2.08	1.61	2.38
Bean	9.84	-4.40	-0.94	-3.84	-1.91

5.5. Adaptation Options

Table 5.9 gives details of the main programmes and actions for Lopedot village currently being implemented to address climate variation by official agencies. The range of adaptation actions outlined during stakeholder dialogues included a range of different types of responses as follows:

Increasing resilience to climate events:

- Sinking of boreholes to access more water for the village households.
- Planting trees instead of cutting and making charcoal.

Adaptation of farming practices such as:

- Agriculture diversification by introducing other farming activities like growing of crops such as maize, beans and cassava.
- Most households are now accumulating goats and camels which are known to be browsers and can withstand dry conditions better than cattle that are grazers. These are now replacing cattle in the supply of milk that is consumed during dry spells.

[46] The only other crop cultivated by sampled households in Lopedot was groundnuts but projections of yield changes at the Uganda regional level were not available from IFPRI sources.

- Movement to other greener areas for pasture and water for animals during the drought seasons.

Responses from households when asked for their priority areas for adaptation responses were as follows:

- Construction of valley dams and boreholes to increase water availability.
- Diversification of livelihoods by introducing other income generating activities.
- Introduction of irrigation schemes to mitigate drought effects on their crops.
- Government to de-gazette the fertile land in the game reserves and give to the residents for agriculture.
- Increase staff to the agriculture team in the villages to improve on training and supervision in addition to equipment to facilitate this process.
- Improving on the weather early warning system. This collects data from 10 households in an area on nutrition status, water shortage, agriculture, security etc. and makes quick recommendations to alleviate any disastrous effects occurring in the village.
- Community sensitization on climate change and its effects with guidance on how best to carry out agricultural activities on their land.
- Encourage farmers to buy early maturing varieties of crops that are not adversely affected by drought.
- Protection of river banks from farming activities to avoid destruction of water bodies

The Amudat District Contingency Plan on Drought (ADLG, 2011) includes assessment of actions for drought scenarios in the district although this is not focused on climate change adaptation actions. The Food Security Agriculture and Livelihoods Sector Preparedness plan outlined within the Contingency Plan includes some agricultural measures such as to improve availability of short maturing crop varieties, education of communities in post-harvest handling and livestock vaccinations but it does not include costing of these actions. The background to development support, including climate change adaptation actions, in Lopedot village is somewhat different from the other two villages in this study. This pastoralist community was largely displaced during the period of insecurity in the region and since returning after the establishment of peace a key development policy has been to support the take up of crop production as a new income generating activity, along with the introduction of browsing animals and increasing water availability. The recent failure of the harvest due to the severe drought of 2014 means that crop production activities are in urgent need of review to ensure there is best possible resilience to climate variability. In this regard, proposals in the survey for adaptation responses given above include a number related to crop production that need further assessment, including for crop diversification, improved water availability and further capacity building.

It is also important to note that, while animal diversification has been supported in the village, the survey did not find support for traditional livestock production among existing programmes and adaptation responses seem to be based on the communities own initiatives. In the light of the impacts of recent drought on livestock production assessed above it is also necessary to further assess ways in which livestock related activities can be best supported in future in the village.

Table 5.9: Summary of Adaptation Actions and Programmes Amudat District, Lopedot village

Type of Response	Action	Programme	Implemented by	Period	Financed	Note
Capacity building	Sensitisation and training of communities on climate change	Karamoja early warning programme	ACTED	2013-2015	DEFID	Thru Government departments and drought bulletins
Resettlement plan	Acquisition of more land especially for crop agriculture					Community initiatives
Crop introduction	Introducing crop agriculture in addition to Pastoralism	Millenium Promise	OPM	2015-2020	EU	Support to groups
Animal diversification	Introduction of browsing animals like goats and Camels instead of the grazers	Karamoja resilience project	ZOA	2014-2015	DEFID thru UN FAO	Agropastoral field schools (APFS) thru group support
Household income diversification	Introduction of new income generating activities like crop agriculture, brick laying	Karamoja resilience project Millenium Project	ZOA POM	2014-2015 2015-20120	DEFID thru UN FAO EU	Started this year
Improving water availability	Construction of bore holes and valley tanks	Rural water supply	UNICEF	2013-2015		
Pasture for animals	Moving to other grazing areas during the drought periods					Community own initiatives
Improving garden irrigation mechanisms	Introduction of simple irrigation schemes	Karamoja resilience project	ZOA	2014-2015	DEFID thru UN FAO	Agropastoral field schools (APFS) thru group support

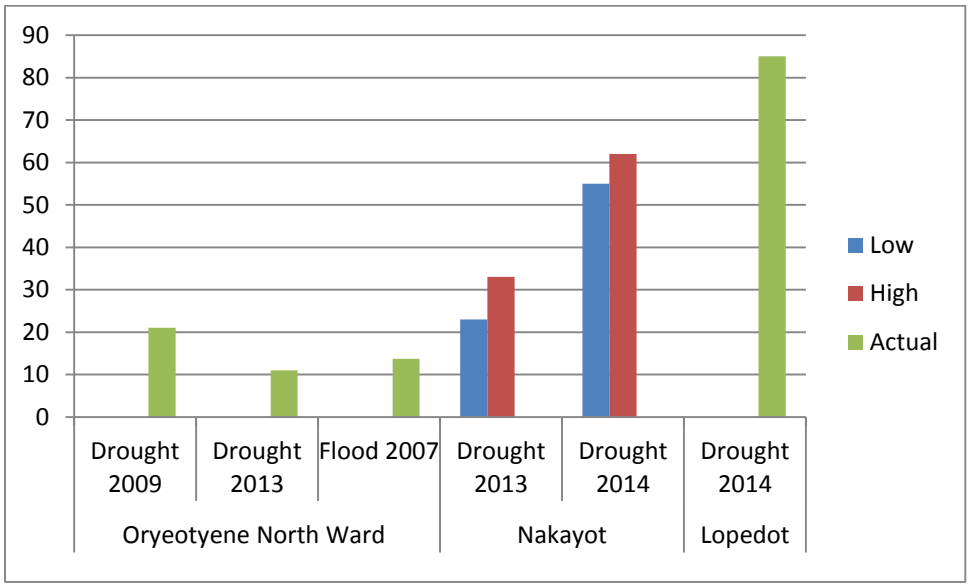
6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Summary of Findings

The key findings on impacts on agriculture from climate change from the assessment in the three villages are summarised as follows:

- Each of the three villages has had very **recent experience of severe climate events**. All had experienced recent **droughts** with both Oryeotyene North ward in the agricultural zone and Nakayot in the Agro-Pastoralist zone having a consistent change in rainfall patterns in the last few years with shorter rainfall seasons which had caused uncertainty for farmers on when to plant and harvest crops. Lopedot in the Pastoralist zone has always experienced instances of drought, however, a very severe drought occurred in 2014 causing significant destruction of crop production. Both Oryeotyene North Ward and Nakayot have also experienced serious flooding events over the last 10 years causing destruction of production for those in the flood prone areas.
- The results showed quite good consistency in the stated **percentage of impact on agricultural production** and income for each climate event within each village sample. In many cases climate events resulted in losses of 50 to 100 percent of total expected production for effected households. There were, however, some cases of inconsistency in the stated years of past climate events occurring (this is likely to have been a recall issue) which may have resulted in an underestimation of our estimates of total impacts for a given event.
- Estimates of total **impacts on crop production** value were made for recent severe climate events in each village. As illustrated in chart 6.1, in Oryeotyene North Ward losses were estimated at about 21 percent of expected crop production (for drought in 2009), 11 percent of expected production (for drought of 2013) and 13.7 per cent of expected production (for floods of 2007). This compares to estimated losses in Nakayot of about 55 to 62 percent of a normal year's value for the 2014 drought and 23 to 33 percent for the 2013 drought. The 2014 severe drought in Lopedot is estimated to have reduced crop production value in the village by around 85 percent compared to the value in 2012. This should be seen in the context of Lopedot being traditionally a livestock zone with only recent introduction of crops.

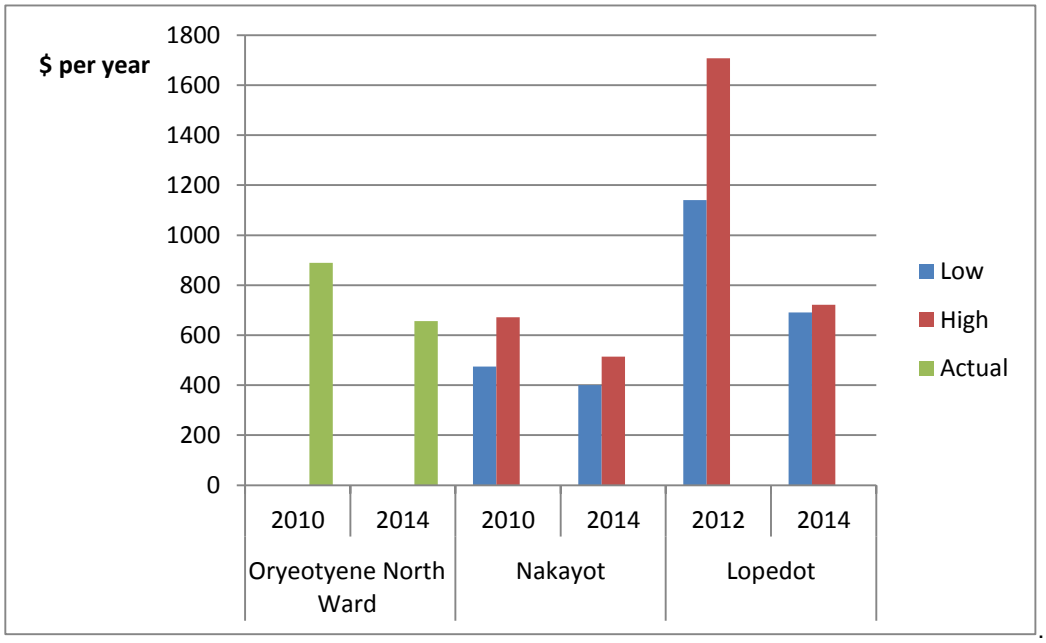
Chart 6.1: Impacts on Crop Production Value of Recent Climate Events (% losses)



- Estimates of total village **impacts on livestock product** income were also made for recent climate events. In Nakayot the lower estimate of losses (which may be more realistic) for the drought of 2014 represents about 22 percent of total average income from livestock product sales and the equivalent figure for the 2013 drought is about 20 percent. In Lopedot the 2014 drought is estimated to have reduced livestock production income by around 50 percent.

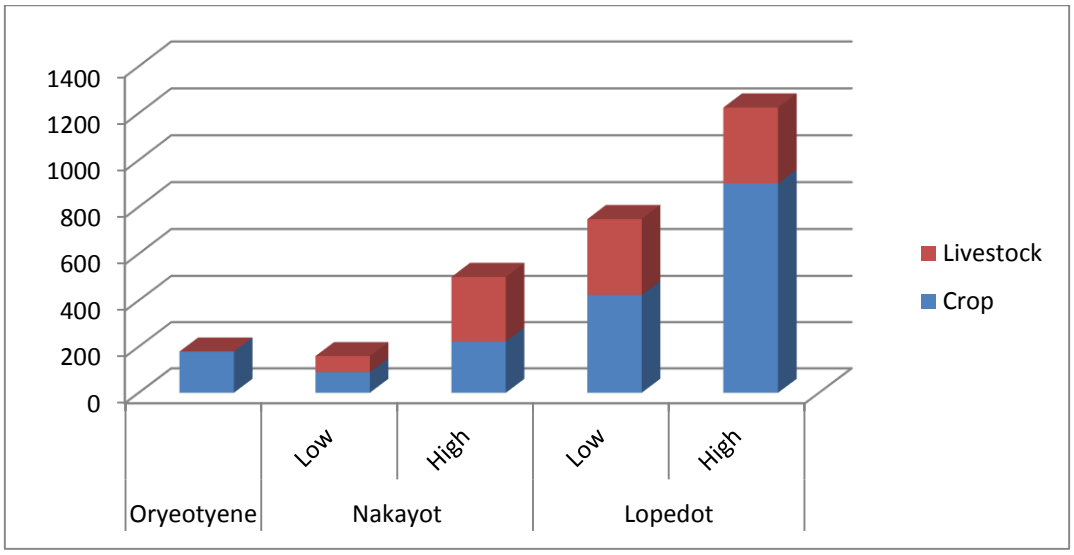
- Estimates of total value of agricultural production (crops and livestock) per household for the three villages are shown in Chart 6.2. As well as estimates for 2014 another recent year where data are available is included (2010 for Oryeotyene North ward and Nakayot, and 2012 for Lopedot) for comparison. It shows the significant drops in average household values in the drought year of 2014 compared with more normal or good years (in the case of Lopedot). This demonstrates that, while there is some variability between villages in average income, in all cases these are below internationally defined extreme poverty rates.

Chart 6.2: Estimated Average Value of Agricultural Production per Household (USD)



- Estimates of total impacts from the droughts of 2014 in terms of **average losses per household** have also been made, as shown in Chart 6.3. These were calculated as about $ 179 per household in Oryeotyene North ward[47] (low estimate), in the range $159 to $501 per household in Nakayot and $748 to $1224 in Lopedot. The higher figure in Lopedot is due to the near complete failure of the crops and 50 per cent losses of livestock income.

Chart 6.3: Estimated Average Losses per Household from the Droughts of 2014 (USD)



- Although it is not valid to make direct comparisons between these loss figures for climate events between crop production and livestock product sales, the study does provide some **evidence for the importance of holding livestock** to provide greater resilience to climate events. In Lopedot, it could be concluded that while livestock production and income were very badly hit by the drought in 2014 through loss of water supply, losses of pasture and increased disease incidence, the overall impacts were not as comprehensive as for crop production as it was at least possible to take livestock to graze in other regions and retain some limited household consumption of milk and meat, and also to retain remaining livestock assets for future years. It is also interesting that in the mixed farming village of Nakayot it was suggested among priority adaptation actions there should be long term investment in livestock since "they are not adversely affected by climate change". Even though the survey showed some significant impacts on livestock production from climate events in the village, livestock was still perceived as a more resilient type of agriculture than the crop production.
- The study also considers **future impacts from climate change** although these are only illustrative in the case of extreme climate events as we do not have projections for changes in frequency and intensity. For Oryeotyene Northward projections of losses of crop value from future climate events up to 2050 (based on the estimated losses from recent events in this study) produced total losses of potential crop production of about 9 per cent (for a less severe scenario) and 18 percent (a more severe scenario). For Nakayot similar projections for losses in crop production value to 2050 produced estimates of about 15 per cent in a less severe scenario and 32 percent in a severe scenario. Similarly

[47] It was possible to estimate more reliable loss values for Oryeotyene North ward village than the other two villages because this village sells crops and could provide actual prices per household in the questionnaire. For the other two villages few crops are sold and so the questionnaire did not provide enough data on prices. Therefore, the estimates of losses for Nagayot and Lopedot are based market prices which, from our review, have quite a wide variation per crop and therefore given a range according to whether the low or high price is taken.

the speculative estimates for Lopedot produced losses in crop production value to 2050 of about 19 to 28 percent for the different scenarios.

- Estimates for overall **changes to yields of crops** due to climate change up to 2050 were also made for the three locations. These indicates potentially significant impacts on the value of important current crops such as maize (up to 12 percent reductions) and beans (up to 20 percent reductions) depending on the climate model used. While these conclusions are highly uncertain they have implications for adaptation in terms of the possible need for crop diversification in the medium and long term.
- The findings given above regarding recent and future losses in crop production due to climate change impacts highlight the question of risks to investment in agriculture in the light of plans for expansion of crop production in the region. The large losses in recently introduced crops (particularly in Lopedot) indicate the high risks that may be attached to such plans. From the information collected in this local case study we are not able to estimate differential risks to returns from these investment at the district level, partly as we cannot assume conditions are the same throughout the district as in the selected villages and also because we do not have quantitative data on costs and returns to crop investment at this level. However, **the conclusions in this localised case study indicate that there should be further more detailed research at the district level to ascertain risks to investment in crops from climate impacts and the level of support that is needed in livestock production in providing resilience in affected villages.**

6.2. Adaptation Options

The report also outlines a range of current and possible future adaptation options for climate change for each village based on stakeholder consultation and other sources. It is difficult to make a quantitative evaluation of the range of adaptation options owing to a lack of locally appropriate data on costs of actions and benefits in terms of likely reduced losses of agricultural production. Nevertheless we have attempted to quantify at least some of the key adaptation options. Table 6.1 gives an overview of the types of adaptation response that came from the stakeholder consultation of this case study with an indicative assessment of costs and benefits and priorities. Notes to each response provide a summary of what can be said about the costs and benefits.

The types of adaptation responses given in Table 6.1 that are common to all three villages are capacity building, income diversification, improving water availability and resettlement. For the two villages where crops have been traditionally grown (Nakayot and Oreyeotyene) the issues of crop diversification, crop storage and flood control are also of high relevance. In Lopedot, which has not been a traditionally crop growing village, the appropriate support for crop production is also a priority issue, in particular through an assessment of the extent to which crop diversification and improved techniques can provide any greater resilience to climate impacts. For the two villages that rear livestock (Lopedot and Nakayot) the availability and quality of pastures for animals is also of high priority.

Table 6.1: Indicative Costs and Benefits of Types of Adaptation Responses

	Type of Response	Costs	Benefits	Priority
1	Capacity building	Moderate*	High*	High
2	Improvement of crop storage	Medium/High	High	To Determine
3	Resettlement plan	High	Unclear	To Determine
4	Crop diversification	Medium/High	Moderate/High	High
5	Household income diversification	High	High	Medium Term
6	Improving water availability	High	High	Very High
7	Pasture for animals	Moderate	High	High
8	Flood control	High	High	To Determine

9	Rehabilitating on degraded land	High	High	Medium Term
10	Improvement of transportation	High	High	To Determine

* These expert judgements are based on a review of literature and experience with agricultural projects in developing countries.

Notes:

1. Costs of capacity building programmes are relatively moderate. Anderson and Robinson (2009) estimates the costs for capacity strengthening and monitoring for Karamoja's livelihoods programme at $275,000 over a 4 year period. Given a population of 1.2 million in the region and approximately 170,000 households it amounts to $1.6 per household. It would be difficult for benefits not to exceed that amount for many years once information on good practice has been passed to the farmers.
2. Mubiru (2010) identifies crop handling as a high priority but does not provide cost data for that component. We could not obtain cost data for this but consider it to be a medium to high cost item for which further work is needed to determine priority.
3. None of the sources reviewed provided data on resettlement but experience from implementation of such a measure suggests that the costs are high and the programme complex to carry out. The programme needs more careful consideration and in any case would be implemented over the medium term
4. Crop diversification is listed in Mubiru as a most urgent priority in the Karamoja region. The only cost figure given is for intercropping, which is out at $90/ha as an upfront outlay and $45/has thereafter. Given an average holding of between 1.5 and 4.5 ha.in our sample villages, this would imply a cost per household in the range of $135-405 upfront and $67.5-$202.5. In the two villages where crops are grown to a significant extent (Nakayot and Oreyeotyene) income from crops in a normal year is around $360-$390. It would need an increase in income of around 15% from a programme at that cost to achieve a positive return. This is possible but should be verified; our judgment is that such a programme is a high priority. Many diversification options are available and should be explored, including tree plantations (e.g. for fruits, oil, forage, wood etc.) that could be more resilient to drought and floods than annual crops. However, those require some security in land tenure in addition to capacity building and market development of the outputs.
5. Income diversification will need to be part of a medium to long term strategy, given the expectation of relatively low productivity growth in agriculture versus the rest of the economy. We have no programmes that could be evaluated at present but some should be over the next few years.
6. Improving water availability is a critical adaptation option. Mubiru indicates a cost of $500 upfront for water storage per household with a capacity of 2,000 – 3,000 litres and $100 per year thereafter for maintenance. In a drought year farmers are losing 50-60% of their crops, and up to 75% in a bad drought with a potential value in 2014 of $200-$280. If the system could prevent 60-65% of the loss resulting from the drought the investment would be socially beneficial. This needs to be confirmed but it is very likely that with some configuration of water storage facilities a saving of that amount could be made.
7. Improved pasture for animals has been costed by Anderson and Robinson (2009) at $572,000 over a four year period. Per household in the Karamoja region this would amount to a meagre $3.3 per household (possibly more as not all households have livestock). Given livestock income at around $310 per household it would take a very small increase in output to justify such an outlay in benefit cost terms.
8. Flood control is seen as a very high priority but its costs are also high. Cost figures for the region are not available in the reviewed literature and so some estimates should be made as a matter of urgency.

9. Mubiru has estimated costs for the rehabilitation of degraded lands: gully rehabilitation by check dams, revegetation of bare hills, filling and revegetation of clay, sand, stone and murrum quarries/mines in the region at $90-500 per ha., depending on the site as upfront and $100 per ha. From some years thereafter. It is hard to value such a programme without a detailed assessment of the likely benefits from that land. If it is at present totally unproductive and if it becomes productive at a 'average' level for the region then the outlays are quite modest and with returns of around $400 per ha., the capital investment will be recouped very quickly. It needs some detailed assessment by site and should be seen as a medium term priority.
10. No data on costs or benefits is available for the region. Experience with other agricultural projects indicates that benefits of improved transportation can be high but then so are the costs. Further work is needed to determine the ranking and priority for this option.

The analysis carried out indicates **improvements in stable income are urgently needed** for the people of these villages. So there is, *prima facie*, a strong case to include programmes that **diversify household incomes** (item 5) in the programme. However data on costs and benefits for such programmes are not available and should be prepared.

At the same time **consequences of extreme events need to be mitigated**, given the huge losses they cause to the farmers. Activities that **improve water availability** during periods of drought (item 6) and that **control flood impacts** (item 8) are of critical importance. Data indicate the net benefits from proposed water conservation and collection are high relative to costs but similar information is not available for flood control measures and needs to be collected. At the same time we see both as a matter of high priority.

Farmers would benefit from **better information and knowledge** about which crops are best suited to the changing climatic conditions and items 1 (capacity building), 4 (crop diversification) address that aspect. Both of these have high net benefits and are a high priority.

The surveys carried out also show some farmers are operating on highly marginal land and probably need to be relocated if they are to survive. Items 3 (resettlement plan) is a costly and complex process and needs further consideration. Item 7 (improved pasture for animals) emerges as having a high net benefit. Item 9 (rehabilitating degraded land) has high costs and benefits and should be a medium term priority.

Lastly there are measures that aim to increase the efficiency of agriculture in the area – items 2 (improvements of crop storage) and 10 (improvements in transportation) come in this category. We lack enough data to evaluate these at present.

The evidence indicates that many of these actions are of high value in the current situation and many are urgently needed, especially those addressing extreme events. Climate change will make the need even greater.

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ANNEX 1: QUESTIONNAIRE FOR CASE-STUDY IN THE KARAMOJA REGION

Economic Assessment of the Impacts of Climate Change in Uganda

Questionnaire for a case-study in the Karamoja region focusing on the Agriculture sector

A. Personnel to interview for each district

Key Informant
Chief Administrative officer
Community Development officer
Sub-count chief
One Focus group
10 household interview

Pre-amble

- Introduce yourself.
- I am Working on a CDKN/DFID project on Economic Assessment of the Impacts of Climate Change in Uganda. This assessment is structured around six work packages and this interview is focusing on the Agriculture sector.
- There is growing concern on the opportunity to develop agricultural activities in drought-prone areas, in particular with the increased uncertainty of climate change. Agricultural development needs to be planned according to the different ecosystems patterns, the availability of renewable water sources at key periods of the year for irrigation and over the long term, and according to the level of investment needed.
- This case study will assess the likely impacts of those climate changes on the current and planned development patterns

Interview guide for officials

1) **Name, position, establishment?**
2) **Describe the general development patterns of the village (for officials mainly)**

Probe:

Area, maps, demographics, land use, water availability and use, types of economic activities, level of Government and aid support.

3) **What adaptation responses to climate change on agriculture have been used in your village up to now?**

Probe:

Coping strategies by households (e.g. changes in agricultural practices for crop and livestock production, investments in soil and water management and diversification of crops, livelihood diversification, migration…)

Actions by others (e.g. Government investment in protection of water supply, support for new farming practices, financial aid, food aid)

Information on costs of these actions and who paid (farmer, community, state aid..etc)

Most effective adaptation(inviewof stakeholders in consultations)

Any trend data (in monetary terms) on Government and Aid support in field sites for years of drought compared to years without drought?

4. **What are the future planned adaptation responses to climate change on Agriculture in your village?**

   Probe: *What is actually planned by households to adapt to future climate change (e.g. changes in agricultural practices for crop and livestock production, investments in soil and water management and diversification of crops, livelihood diversification, migration…)*

   Which do you think should be the priority adaptation responses that should be undertaken for the village?

5. **What are the current and future development investments in Agriculture, livestock, infrastructure, water supply etc (ask for a table)…**

Probe:

1. *entity providing the investment((National and local government investments, private investment)*
2. *Investment costs and expected impacts from investments, e.g. in terms of production and water available for crops.*
3. *Are there any future plans for agricultural land use in your village*
   (kraals, opening up of grasslands, irrigation, changes to crop area/livestock area)

Interview guide for household heads

1. **Regarding households**

	Number			
Category	**2014**	**2010**	**2005**	**2000**
Total # of households in village				
# of households in agriculture				
# of households in Pastoral				
# of households in active crop and livestock production				
# of households in non-farming economic activities				
# of households not economically active				

Also probe: *If there have been significant changes over recent years in numbers given in Question 3 ask why. For example, why declining/increasing number of households or changes in proportions of households in different activities. If there has been migration away ask why people left and where did they go?*

2. **Regarding Crops grown**

Crop	# households				Production(in tonnes)				Area in hectares				Yield (tonnes/ha)			
	2014	2010	2005	2000	2014	2010	2005	2000	2014	2010	2005	2000	2014	2010	2005	2000

Also probe:

Ask for any significant trends in Question 4 variables; e.g. General trends over recent decades in yields (tonnes/hectare) of key specific crops grown in the field sites. For any significant trends ask why? Focus on non-climate change events

3. **Revenues and costs of each crop**

Crop	Rank	What % of total production is sold?	Revenues/incomes (per year for production sold)	Prices/tonne	Costs (per year for total production)	Inputs	
						In-put	Cost
						Water Fertilisers Labor Other inputs (e.g. transport, running machinery)	
						Water Fertilisers Labor Other in-puts	
						Water Fertilisers Labor Other in-puts	

Also probe:

1. Ask about any significant changes in revenue, costs and rank of crop since 2000.

2. How much of total income is from non farming activities? What are these activities?

4. Livestock numbers and area

Livestock type	# households	# of livestock	Farming type (Kraal/traditional)	Total grazing area (hectare)	Livestock production (tonnes, etc)

Also probe: *Ask for any significant changes livestock households, numbers, farming type area, production in recent years. For any significant trends ask why.*

5. **Revenues and costs of livestock**

Livestock product	What % of total production is sold?	Revenues/incomes (per year)	Princes/tonne	Costs (per year)	In-puts	
					In-put	Cost
					Water Labor Other inputs	
					Water Labor Other in-puts	
					Water Labor Other in-puts	
					Water Labor Other in-puts	

6. **Have you experienced any climate change events in this village since 1990?**
   ***Probe**: Climate change event (e.g., flooding, increased rainfall/variability of rainfall, drought, increase/decrease temperature, landslides, mudslides, etc.) with date of climate event (esp. **drought**).*
7. **For each year when you have experienced climate change events what was the impact on agricultural area, production and income?**

Year	Event (Drought, Flood, etc.)	Crops				Livestock			
		# of households	Impact on area	Impact on Production per crop	Impact on Income	# of households	Impact on area	Impact on Production per type of livestock	Impact on Income
			e.g. reduced area by x % or y hectares	e.g. reduced production by x % or y tonnes	e.g. reduced area by x % or y UGX				

Describe any impacts on:

a. *Water/food security issues*
b. *Socioeconomic impacts(mobility, transport), infrastructure and housing damage, health related (vector and waterborne diseases)*

8. What adaptation responses to climate change on agriculture have been used in your village up to now?

Probe: *Coping strategies by households (e.g. changes in agricultural practices for crop and livestock production, investments in soil and water management and diversification of crops, livelihood diversification, migration…)*

9. What are the future planned adaptation response to climate change on Agriculture exist in your village

Probe: *What is actually planned by households to adapt to future climate change (e.g. changes in agricultural practices for crop and livestock production, investments in soil and water management and diversification of crops, livelihood diversification, migration…)*

Which do you think should be the priority adaptation responses that should be undertaken for the village?