International Journal of Agricultural
Science and Research (IJASR)
ISSN(P): 2250-0057; ISSN(E): 2321-0087
Vol. 7, Issue 4, Aug 2017, 719-730

TRANS STELLAR
•Journal Publications •Research Consultancy

CLIMATE CHANGE CHALLENGES AND KNOWLEDGE GAPS IN SMALLHOLDER POTATO PRODUCTION: THE CASE OF MAUCHE WARD IN NAKURU COUNTY, KENYA

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ABSTRACT

This paper explores the climate change challenges, adaptation strategies and knowledge gaps in smallholder potato production in Mauche Ward of Nakuru County, Kenya. Understanding climate change challenges is important in the efforts to build resilience and enhance adaptation among smallholder farmers. Simple random sampling was used to select 150 smallholder potato farmers to participate in a household survey and data analyzed using SPSS. To triangulate the findings, purposive sampling was used to select 76 potato value chain (VC) stakeholders to participate in a brainstorming session in a workshop. Results showed that ncreasing rainfall is reported but the onset is unpredictable.Excess water runoff damages the road network and transportation of potatoes to the market is expensive. Increasing rainfall also causes severe soil erosion on the farms hence reduced soil fertility as well as rampant incidence of potato pests and diseases which calls for further investment on pesticides and fungicides. Results further indicate that flood increase affects quality of water sources which has a negative impact on human health and expected returns to agriculture. However, the household survey respondents lacked a clear perception of the indicators of climate change. They exhibited inability to obtain climate change information from available sources. There was evidence of lack of training and unclear knowledge acquisition on climate change given that a majority of the respondents (50.7 %) reported not having received any training. The study recommends involvement of farmers in collective learning processes to develop and integrate crop, soil and water management intensification strategies. This ensures sustainability of climate change adaptation efforts in smallholder potato production. Any efforts to address climate change challenges in smallholder potato production must be complemented by investments in rural transportation infrastructure and storage facilities.

***KEYWORDS:** Climate Change Adaptation, Knowledge, Potato & Smallholder*

Received: Jul 10, 2017; **Accepted:** Aug 03, 2017; **Published:** Aug 12, 2017; **Paper Id.:** IJASRAUG201795

Original Article

INTRODUCTION

The global mean air and ocean temperatures have been rising over the last century due to increasing concentrations of heat trapping greenhouse gases (GHC) in the atmosphere, especially carbon dioxide, methane and nitrous oxide (IPPC, 2013). This global warming has led to intensity of extreme events such as increased rains, floods, frost, droughts and heat waves, which profoundly impact on the conditions in which agricultural activities are conducted (Bett et al, 2016) and the whole value chain of crop production (Shibabaw et al, 2014). In every region of the world, plants, animals and the ecosystem are adapted to the prevailing climatic conditions (FAO, 2016a). When these conditions change, the result can be an increase or decrease in productivity depending on remedial agricultural practices; with potentially higher negative impacts. Secondary consequences of climate

change include increased vulnerability to diseases, susceptibility to nutritional disorders, deprivation of educational opportunities and ultimately, a serious challenge to all biodiversity (Katelyn, 2016). Adaptation to climate change takes place through adjustments to reduce vulnerability or enhance resilience (Chesterman and Neely [Eds] (2015).

The climate of Africa is warmer than it was 100 years ago and model-based predictions of future GHG induced climate change for the continent clearly suggest that this warming will continue and, in most scenarios, accelerate (Thompson, 2016). Sub-Saharan Africa (SSA) is predicted to be particularly hard hit by global warming because it already experiences high temperatures and low (and highly variable) precipitation. The economies are highly dependent on agriculture, and adoption of modern technology is low (FAO, 2016a). In SSA small-holder farmers are the primary producers of agricultural outputs and account for 80% of all the farms. The smallholder farmers in SSA cultivate small parcels of land which are often degraded and have no access to irrigation. They do not have sufficient labour, little access to financial credits and do not practice commercial market. The effect of climate change challenges facing SSA smallholder farmers is producing enough food for the region (AGRA, 2014).

Although the Kenyan agriculture sector supports the livelihood of over 70 percent of the rural population (Government of Kenya [GOK], 2011a), it is mainly rain fed and hence vulnerable to climate-induced risk and uncertainty. Many of the land management and water-use efficiency initiatives intended to strengthen the climate change adaptive capacity of communities in Kenya have failed partly due to lack of awareness of their availability (Ojwang, Agatsiva & Situma, 2010)

A changing climate is associated with increased threats to food safety, post-harvest losses and pressure from invasive species, pests and diseases (Beddington et al, 2012). Crop yields could be reduced mainly as a result of erratic rains, floods; droughts and soil infertility (Bie, Mkwambisi & Gomani, 2008). Households that depend mostly on agriculture stand to lose food production due to climate change since falling harvests undermine household and national food security. Adverse climate effects can influence farming outputs at any stage from cultivation through the final harvest (Ayanwuyi, Kuponiyi, Ogunlade & Oyetoro, 2010). Even if there is sufficient rain, its irregularity can affect yields adversely if rains fail to arrive during the crucial growing stage of the crops.

Potato is the world’s fourth most important food crop after wheat, rice and maize and the leading non grain food commodity. World potato production is steadily increasing with a total of 385 million metric tons recorded in 2014 (FAO, 2015a). Approximately two thirds of production is consumed as food with the balance being used for animal feed, potato starch in pharmaceuticals, textiles and adhesives. Potato is a staple food and cash crop in the tropical highland regions of sub-Saharan Africa, where it is grown both as a horticultural crop due to its high value, and a food security crop (Okello et al, 2016). Potato yields in sub-Saharan Africa are very low, averaging 7.8 tons per hectare (FAO, 2015a).

Small-scale farmers in the region attain low yields due to inadequate supply of clean seed, pest and diseases associated with climate change. In Kenya, potato ranks second after maize as a most important staple food (Muthoni & Nyamongo, 2009). This study focused on potato which in addition to calories and protein is a vital source of vitamins, potassium and fibre. The International Potato Center (CIP) has partnered with the Government of Kenya to promote the potato as a strategic food security crop due to its high productivity per unit area (Sullivan, 2010). There are approximately 25000 to 30000 hectares grown annually**.** Average yield achieved by the small-scale farmer is approximately 7.8 tons per hectare against a potential 50 tons per hectare (FAO, 2015a). The low yields have been attributed to poor agronomic practices, limited access to clean seed and diseases associated with climate change (Beddington et al, 2012).

Potato farming is an important food as well as cash crop in Mauche Ward of Njoro Sub-County, where this study was carried out. Mauche lies in the Mau escarpment where there has been massive environmental degradation mainly caused by human activity such as deforestation and poor agronomic practices on the hilly terrain. Use of firewood by a majority of the households, charcoal burning and timber harvesting have contributed to depletion of the forest cover.

Understanding climate change effects and challenges is important in the efforts to build resilience and enhance adaptation among smallholder farmers. Integrating crop intensification, soil fertility and water management in potato production, as adaptation strategies to climate change and variability are concrete and sustainable options. These include crop rotation which increases the rate of accumulation of soil organic content as different crop species have different rooting forms and depths. This enhances distribution of organic matter in the soil profile (Wood fine, 2009).

Tied ridging as a water management strategy is known to improve crop performance (Kabanza & Rwehumbiza, 2007). Organic farming is a systematic approach for sustained biological diversity and has the potential to gradually reverse the effects of climate change and build resilience (UNFCCC, 2007). Recycling wastes of plant and animal origin in order to return nutrients to the land minimizes the use of non-renewable resources. Organic farming which is a low-risk farming strategy with reduced input costs, therefore presents lower risks with partial or total crop failure due to extreme weather events or changed conditions in the wake of climate change and variability (Wani, Chand, Najar &Teli, 2013).

Integrating climate change adaptation strategies in potato production is better achieved through participatory innovation in which smallholder farmers become central in the design of research processes as partners in planning and implementation. As noted by Nederlof, Wongtschowski and Van Lee (2011), participatory innovation in agriculture provides an important contribution towards improving agricultural development and food security in Africa. Farmers and other actors become experts instead of simply users or receivers of information from specialists (Krasny & Lee, 2002).

MATERIALS AND METHODS

The Study Area

The study was carried out in Mauche Ward of Nakuru County, Kenya. Mauche is one of the nine Wards in Njoro Sub-County. Others are Njoro, Lare, Makungugu, Nessuit, Kihingo, Naishi, Sururu and Mau Narok. Mauche Ward was chosen because of climate change vulnerability and presence of farmers engaging in potato growing. It covers an area of 166 square kilometers. Its altitude is 2100-2800m above sea level and receives an annual rainfall of 1600-2200 mm. Agro-ecological zones are Upper Highlands and Lower Highlands. Mauche Ward has a population of 25,088 comprising of 4994 households and 5590 farm families (GOK, 2014). The main crops grown in Mauche are maize, potato, wheat, beans and vegetables. Livestock kept include cattle, sheep and local chicken. The main challenges to agricultural productivity in the Ward include inadequate certified or clean potato seed, high cost of farm inputs, poor road network, crop pests and diseases as well as decreasing soil fertility levels which hamper farmers' realization of potential yields (GOK, 2014).

During the time of this study, there was shortage of extension services as the Ward was served by only three agricultural extension workers with expertise in crops, livestock and home economics. Due to inadequate transport and facilitation, extension messages were delivered mainly through demand driven and group approach - hence farm visits by extension workers were limited and out of reach to many farmers.

Mauche farmers are mainly smallholders with farm holdings below 2 hectares. Maize is the staple food crop in the area whereas potato is grown as a cash crop. The main commercial market is Mauche, where farmers sell their farm

produce and purchase farm inputs. Mauche Ward lies on the Mau escarpment and is highly vulnerable to soil erosion due to the sloppy terrain. Increased human population and demand for more agricultural land for food production has resulted in destruction of the vegetation cover and subsequently rampant environmental degradation. There has been increasing deforestation and cultivation of water catchment areas and river banks, which have contributed to pollution of water sources as well as changes in climatic conditions. Figure 1presents the location of the study area.

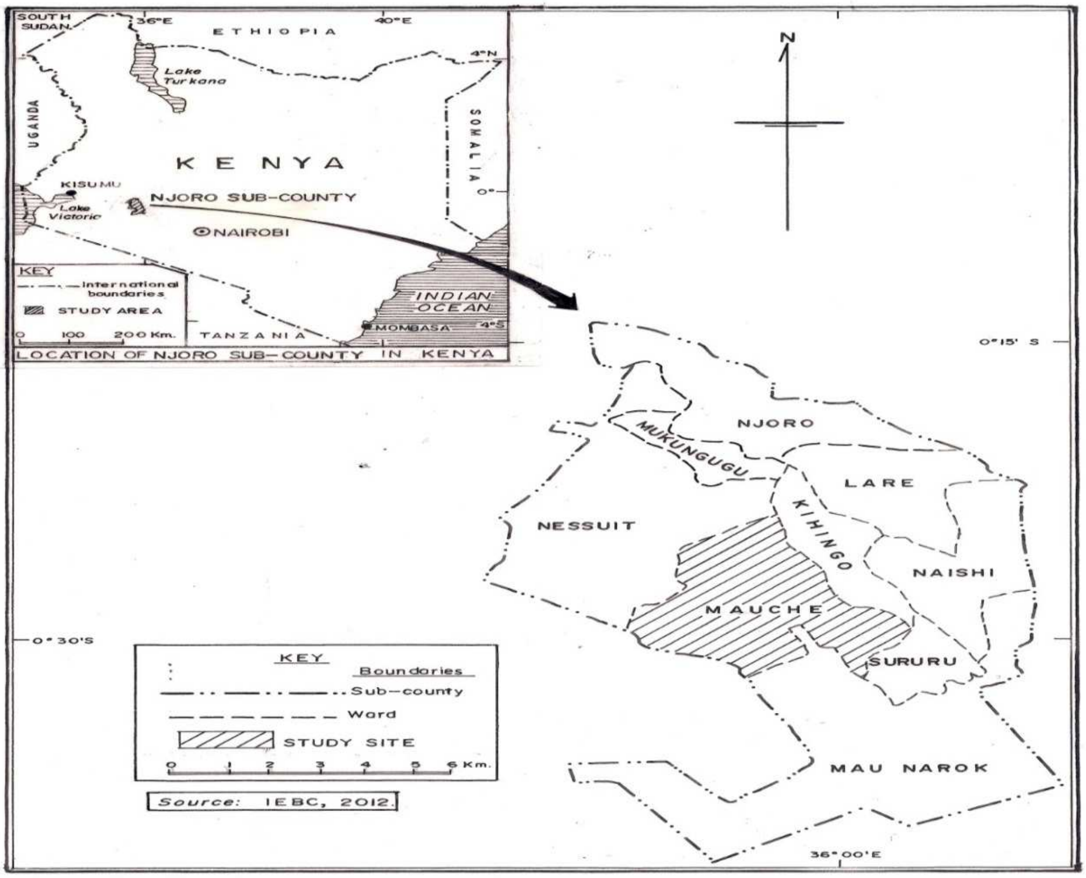

Figure 1: Location of the Study Area

Data Collection Methods

The study employed Simple Random Sampling to select 150 farmers to participate in the household survey. A pre-tested semi-structured questionnaire was used to collect primary data from sampled smallholder farmers in the study area to elicit information on Farmers' Perceptions on Occurrence of Climate Change Indicators, Farmer Strategies to Cope with Climate Change, Sources of information on climate change, Organizations training farmers on climate change, Key areas covered in climate change training and level of knowledge acquired on selected climate change adaptation strategies. Collected data was edited, coded and analyzed using SPSS. The results were presented descriptively using frequency and percentages.

To triangulate the household survey findings, purposive sampling was applied to select 76 potato value chain actors to participate in a workshop. These included Chomosa farmer group with 31 members, a representative of agricultural institutions (Egerton University); potato seed multiplier(Agricultural Development Corporation, Molo); faith based organization (African Gospel Church); processor (Njoro canning factory); Researcher (KALRO Njoro); Three

extension service providers from the Nakuru County Department of Agriculture; local Administration (Chief Mauche Location); department of social services (Mauche Community Development Assistant); a Non-Governmental Organization (East African Grain Council); twenty eight officials of 14 other farmer groups in the study area. Simple random sampling was used to select 2 agro-input suppliers, 2 potato traders and 2 transporters to participate in the workshop. The 76 participating potato value chain stakeholders were guided through a brainstorming session. Brainstorming is a participatory process in which participants in a forum discuss an issue and arrive at a consensus. The workshop facilitators started by introducing the climate change agenda to the participants. The group was then divided into eight mixed groups. Each group deliberated on a particular thematic area and recorded their findings on a flip chart. During the plenary session, the leader of each group made presentations with input from the group members for validation and adoption by the workshop participants. The thematic areas were:

- Local awareness of climate variability and trends and associated impacts on natural resources
- Consequences and impacts of climate related changes on livelihoods
- Expectations of future changes and perceptions of vulnerability
- Observations on Responses and Adaptation
- Observations about barriers to Climate Change adaptation
- Main Options (alternatives) during climate change pressure
- Main Impact of Climate Change on Women
- Possible Solutions as Suggested by Farmers for Climate Change Pressure

RESULTS AND DISCUSSIONS

Farmers' Perceptions on Occurrence of Climate Change Indicators

Respondents were asked to give their perception on occourance of selected climate change indicators. The respondents were asked to rate the incidence of occurrence of eleven climate change indicators using a 5-point Likert scale ranging from 'Very low' indicating a very minor occurrence to Very high indicating a common occurrence. The results of the ratings are given in Table 1.

Table 1: Rate of Occurrence of Indicators of Climate Change

Indicators of Climate Change	Percent of Respondents				
	Very Low	Low	Moderate	High	Very High
Rainfall seasonality changes	4.5	22.7	57.6	10.6	4.5
Temperature trend changes	9.1	18.2	37.9	30.3	4.5
Water quality and quantity	4.5	25.8	43.9	13.6	12.1
Forest cover change	19.7	21.2	28.8	22.7	7.6
Soil fertility change	7.6	34.8	39.4	12.1	6.1
Natural resources reduced	33.3	19.7	16.7	21.2	9.1
Effect on human health	4.5	15.2	33.3	37.9	9.1
Pest and disease increase	4.5	3.0	16.7	48.5	27.3
Crop yields reduced	6.1	19.7	28.8	30.3	15.2
Fodder reduction	6.1	22.7	37.9	22.7	10.6
Fire incidence increase	60.6	18.2	13.6	3.0	4.5

(N=150)

Although the indicators were there, the farmers exhibited lack of a clear perception of the indicators of climate change. The indicators that were rated highly (high and very high combined) by the farmers in terms of their occurrence included: increase in crop diseases and pests (75.8 %), effect on human health (47 %) and reduction in crop yields (45.5 %). Climate change may increase the impact of pests by allowing their establishment in areas where they could previously not establish (Van Aelst & Holvoet, 2017). Due to climate change, pests and diseases are likely to move into areas less prepared to them, biologically and institutionally, with potentially higher negative impacts. Climate change may also increase the impact of pests by allowing them to appear earlier in the season due to higher temperatures (Connolly-Boutin & Smit, 2015).

The effect of climate change on crop yield depends on temperature, precipitation patterns and atmospheric carbon dioxide. Inadequate precipitation leads to reduced rate of leaf photosynthesis, hence reduced production (Van Aelst & Holvoet, 2017). Indirect effects of climate change on crop yields occour as a result of invasive weeds, scarcity of useful insect species such as pollinators, increasing pests and disease vectors.

During the feedback session with the respondents, it came out clearly that climatic conditions affect human health both directly, through ailments such as malaria and infectious diseases transmitted by vectors and pathogens that thrive with increase in temperature and indirectly, through influences on the levels of pollution in the air and water sources. On the other hand, dry spells led to scarcity of nutritious indigenous African leafy vegetables such as black nightshade (managu), amaranthus (terere), spider plant (saget) and pumkin leaves (malenge) that are also known to be medicinal. This concurs with Darkwa and Darkwa (2013) and Kimiywe et al (2017) that the dietary diversity of indigenous African leafy vegetables provide essential nutrients and in addition, have medicinal value and may be used to treat diseases such as diabetes, gout and gastro-intestinal tract infections among others.

Rainfall seasonality is seen as a challenge as it is manifested in unpredictable onset, which affects timeliness in farm operations. Increase in rainfall causes flooding which affects quality of water sources impacting negatively on human health and expected agricultural productivity. It also causes severe soil erosion on farms hence reduced soil fertility. Climate change in the study area is associated with rampant incidence of potato pests and diseases which lead to reduced crop yields. Due to intermitent rainfall, natural resources have been reducing consistently especially forest cover, pasture and fodder for livestock. Spontaneous fires often occur during the drought period causing massive destruction of flora and fauna. This concurs with Elum, Modise & Marr (2017) that climate change impacts are felt by those whose livelihoods depend on natural resources.

Farmer Strategies to Cope with Climate Change

There were a number of possible adaptive responses available to deal with climate change in the study area. These included technological options such crop diversification, use of drought-tolerant and early maturing varieties; as well as behavioral responses such as timely planting. The respondents did not demonstrate adequate application of available climate change adaptation options to reduce vulnerability or enhance resilience. It was only in the areas of disease control (26%) and timely planting (24.7%) where they made an effort. Crop diversification was adopted by 16.7 per cent of the respondents. Although 14 per cent of the respondents indicated undertaking water harvesting, only 5 per cent practiced irrigation. This is in agreement with Michura and Njuguna (2017) that there is low uptake of adoption of climate smart technologies in Nakuru County since adoption of these practices by smallholder farmers remains below expectations.

Smallholder farmers lack resources to adequately protect themselves or adapt rapidly to changing weather conditions (Arumugam et al, 2014). Mitigation and adaptation to climate change are necessary to ensure food security, which is requisite for sustainable economic development (FAO, 2015b). Although the extent to which a system will adapt is a function of its vulnerability to climate change which is in turn influenced by its level of exposure and sensitivity to climate change impacts (Elum, Modise & Marr, 2017), it can be argued that some adaptation interventions require policy and infrastructural support in order to be adopted. For instance, water harvesting and irrigation may not be implemented by farmers in Mauche without the necessary capital investment by the National Government and County Government of Nakuru. On the other hand, use of tolerant and early maturing potato varieties may be adopted if the seeds are adequately availed to the farmers at affordable prices. Beddington et al (2012) asserts that widespread uptake of sustainable practices in agriculture and food supply chains is requisite in meeting current and future threats to food security and environmental resilience.

Sources of Information on Climate Change

The institutions that provided the respondents with information on climate change were recorded. The respondents exhibited inability to obtain information from available sources. Their major sources of climate change information were the Department of Agriculture (42.7 %), followed by the mass media (36.7 %), whereas 13.6 percent did not receive any information on climate change at all. It is necessary to obtain information on the positions of rural farmers and what they know about climate change, in order to integrate this knowledge with available technologies and come up with relevant climate change adaptation practices (Mutekwa, 2009).

Acquisition of information about a new technology determines adoption of technology. Farmers will only adopt the technology they are aware of, and its benefits demonstrated. Access to information reduces the uncertainty about a technology's performance hence may change individual's assessment from purely subjective to objective over time (Caswell et al., 2001; Bonabana- Wabbi 2002). However access to information about a technology does not guarantee its adoption by all farmers. Farmers may perceive the technology and subjectively evaluate it on the basis of its complexity, cost effectiveness and compatibility with the existing practices on the farm.

Access to information may also result to dis-adoption of the technology. For instance, where experience within the general population about a specific technology is limited, more information induces negative attitudes towards its adoption, probably because more information exposes an even bigger information vacuum hence increasing the risk associated with it (Bonabana- Wabbi 2002). It is therefore important to ensure the information is timely, reliable, consistent and accurate. Farmers can only adopt a technology if they are sensitized on how to use it and its benefits.

Organizations Training Farmers on Climate Change

There was evidence of lack of training and unclear knowledge acquisition on climate change given that a majority of the respondents (50.7 %) reported not having received any training. The main institutions that had conducted some climate change training in Mauche Ward were the Department of Agriculture (30.7 %) and Smallholder Farmer Strategies to Cope with Climate Change (SMACC) project (16.6%), which was relatively new in the study area. The respondents cited the Department of Agriculture as a major institution training farmers on climate change due to the close interaction the department has with farmers. The department had carried out some training related to crop diversification (36.7 %), water harvesting (5.3%), timely planting (4.1 %), and planting of drought tolerant varieties (3.3%).Extension workers

usually provide information on crop production technologies and market opportunities.

Emphasis on crop diversification as a climate change adaptation strategy is essential since it is imperative to protect the livelihoods of communities as well as sustain food security. Studies conducted in several parts of East Africa indicate that women have the lowest access to climate information in general and yet they are the main players in agricultural production (AGRA, 2014). Chesterman and Neely (Eds) (2015) noted that climate-smart agriculture practices are not enough on their own: they need to be delivered in association with climate-related information targeting farmers such as when to plant, crop choice, varieties to plant and management practices. Barriers to adaptation that need to be addressed include lack of access to resources and knowledge needed for adaptation (FAO, 2014).

Level of Knowledge Acquired on the Listed Climate Change Adaptation Strategies for Potato Production

There is need to understand farmers' knowledge of existing climate change adaptation strategies for potato production. Such information is important for designing and implementation of a suitable intervention. The respondents were asked to indicate the level of knowledge acquired on the climate change adaptation strategies for potato production on a five point Likert Scale. Table 2 presents their responses.

Table 2: Level of Knowledge Acquired on Climate Change Adaptation Strategies

	Percent Respondents				
Knowledge Items	**Very Low**	**Low**	**Medium**	**High**	**Very High**
Use of organic fertilizer	21.2	18.2	40.9	15.2	4.5
Use of intercropping	10.6	18.2	43.9	19.7	7.6
Relay cropping	22.7	16.7	42.4	15.2	3.0
Crop rotation	6.1	7.6	42.4	16.7	27.3
Control of potato diseases	1.5	6.1	45.5	21.2	25.8
Post-harvest management	10.6	15.2	40.9	21.2	12.1
Storage of potatoes	12.1	12.1	47.0	15.2	13.6

(N=150)

Climate change adaptation builds on existing efforts to achieve sustainable agriculture intensification for sustainable productivity increases, thereby supporting the achievement of national food security and sustainable development goals (FAO, 2016b). Despite this fact, the respondents generally exhibited inadequate knowledge on the listed climate change adaptation strategies. However, they indicated having acquired relatively high knowledge in control of potato diseases (47%), crop rotation (44%), potato post-harvest management (33.3%) and use of intercropping (27.3%) when high and very high levels of knowledge were combined.

The respondents expressed confidence in their ability to identify and control potato pests and diseases having received training from the local agricultural extension workers. During the feedback session with the farmers, the most common potato diseases in Mauche were bacterial wilt, late blight and viruses; whereas important pests included potato tuber moth and aphids. Farmers controlled potato pests and diseases using pesticides and fungicides purchased from agro-chemical shops in Mauche and Mau-Narok markets. These agro-chemicals are prone to misuse by farmers hence, as suggested by Okonya and Kroschel (2016), there is need to train farmers on more environmentally friendly approaches such as integrated pest management (IPM) and organic soil nutrient management (FAO, 2016a).

Crop rotation entails planting different crops in the same field following a defined order; usually the preceding crop has a positive effect on the succeeding crop in the rotation, leading to higher production overall. Practicing rotation leads to reduced risk of pest and weed infestations; better distribution of water and nutrients through the soil profile;

exploration for nutrients and water of diverse strata of the soil profile by roots of many different plant species, resulting in a greater use of the available nutrients and water; increased nitrogen fixation through certain plant-soil biota; improved balance of nitrogen, phosphorus and potassium (N-P-K) from both organic and mineral sources; and increased formation of organic matter (FAO, 2016b). Better nutrient management through crop rotation can decrease nitrogen fertilizer use by up to 100 kg N per hectare per year, substantially lowering related greenhouse gas (GHG) emissions – hence reducing the costs of production.

Intercropping refers to the cultivation of two or more crops together in time and space, with the aim of maximizing productivity per land area using only few external inputs (FAO, 2013). Intercropping can strengthen the climate change adaptive capacity of households. It increases soil nutrient and protein self-sufficiency as well as conservation and maintenance (Ratnadass, 2012). Reduced pathogen and insect pest infestation levels have been reported in several crop and variety mixtures (Himanen et al, 2016). The main challenges associated with intercropping are related to the lack of information on crop variety performance and optimal yielding in mixtures, crop post-harvest management and the economic risks associated with experimenting with novel mixtures.

Potato value chain stakeholders in Mauche asserted that rainfall has generally been increasing but the onset is unpredictable, which affects timeliness in farm operations. This concurs with the Njoro rainfall data in Figure 2.

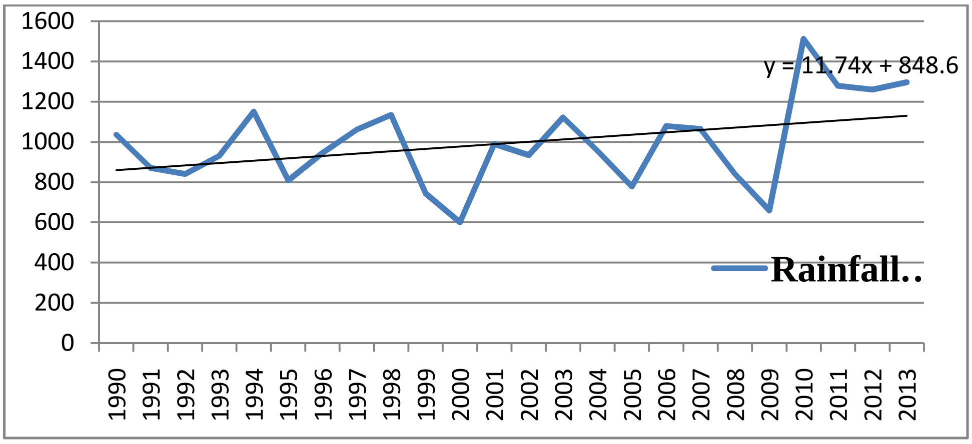

Figure 2: Rainfall Data for Njoro: 1990-2013 – Source, KALRO Njoro

The potato value chain stakeholders complained that excess water runoff damages the road network and transportation of potatoes to the market is expensive due to poor road infrastructure in the producing areas. Increasing rainfall also causes severe soil erosion on the farms hence reduced soil fertility as well as rampant incidence of potato pests and diseases which calls for further investment on pesticides and fungicides. Flood increase affects quality of water sources. This has a negative impact on human health and expected returns to agriculture, which concurs with International Resources Group (2008) and Hoeffler (2005). More intense and frequent precipitation periods also contribute to food insecurity through fluctuations in crop yields and local food supplies, as well as a decline in nutritional intake (FAO, 2008).

To approach the issue of climate change appropriately, one must take into account local communities' understanding of climate change (Apata *et al*, 2009). The assumption is that these communities have an inborn, adaptive knowledge and are able to develop strategies to cope with an erratic climate change, severe pest attack, changing agricultural policies and other natural factors. Vulnerability assessments and resilience analyses done during the research

revealed the need for a range of strategies to enhance regional resilience. Unpredictable rainfall onset calls for adaptation strategies such as planting short season varieties, crop rotation, crop diversification, and varying planting dates (Mutekwa, 2009). Establishing the challenges to smallholder potato production under climate change pressure will highlight "hotspots" of vulnerability in order to facilitate development of strategies by the relevant value chain actors to address them (Morton, 2007).

CONCLUSIONS

The study recommends involvement of farmers in collective learning processes, to develop and integrate crop, soil and water management intensification strategies. This ensures sustainability of climate change adaptation efforts in smallholder potato production.

Any efforts to address climate change challenges in smallholder potato production must be complemented by investments in rural infrastructure such as market access roads, water dams and water pans to facilitate irrigation as well as storage facilities. This can be achieved through collaboration between the National Government, County Governments, partners and stakeholders.

ACKNOWLEDGEMENTS

The authors acknowledge the financial support of Egerton University, Kenya; University of Natural Resources and Life Sciences, Austria and University of Hohenheim, Germany through Smallholder Farmer Strategies to Cope with Climate Change (SMACC) project.

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