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PERCEPTIONS AND ADAPTATION TO CLIMATE CHANGE AND VARIABILITY BY IMMIGRANT FARMERS IN SEMI-ARID REGIONS OF KENYA

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ABSTRACT

Kenya comprises of 83% arid and semi-arid land mainly suited to extensive livestock production. Communities living in the semi-arid areas have been affected by serious effects of climate change and variability. A study was carried out to evaluate farmer perceptions and adaptation to climate change in Naro Moru and Nairutia areas (both in Nyeri North District) and Matanya in Lamuria Division in Laikipia East District, areas that are typically semi-arid in nature. The farmers identified environmental destruction as the major contributor to the visible effects of climate change and variability in the region. The main indicators are erratic and low rainfalls, frequent droughts and dust storms, low crop yields and high day and low night time temperatures. The effects of climate change resulted into increased levels of poverty, food insecurity, change in biodiversity and scarcity of resources such as water and indigenous trees which are sources of medicine, nectar, fuel wood, timber and fodder. Changes in biodiversity entail disappearance of wild animals and insects such as safari ants and an upsurge of pests (e.g. centipedes, millipedes and birds). The reduced availability of resources has changed the people's attitudes towards the need to conserve the natural resources and enhance food security through self and group initiatives. The biggest efforts have been towards tree planting and husbandry and adoption of appropriate technologies and farming methods.

Key Words: Biodiversity, drought, food security, tree planting

RÉSUMÉ

Le Kenya comprend 83% de terres arides et semi arides utilisées principalement à l'élevage extensif. Les communautés vivant dans ces régions ont été affectées par de sérieux effets de la variabilité et du changement climatique. Une étude était menée pour évaluer les perceptions paysannes et l'adaptation au changement climatique dans les milieux de NaoMoru et Nairutia (tous dans le district du Nyeru au Nord) et dans la Division de Lamuria à Matanyu dans le District Est à Laikipia, milieux typiquement à nature semi aride. Les fermiers ont identifié la destruction environnementale comme étant la cause majeure aux effets visibles du changement et la variabilité climatique dans la région. Les indicateurs principaux sont des précipitations erratiques et faibles, de sécheresses fréquentes et pluies orageuses, faibles rendements des cultures et des températures nocturnes élevées et basses. Des effets du changement climatique a résulté une augmentation élevé du niveau de la pauvreté, l'insécurité alimentaire, le changement dans la biodiversité et le manque des ressources comme l'eau et les arbres indigènes à usage comme matériel de médecine, nectar, bois de chauffe, planches et alimentation du bétail. Le changement dans la biodiversité signifie la disparition de la faune et insectes tels que les termites et l'apparition des pestes (centipèdes, millipèdes et oiseaux). La disponibilité réduite des ressources a changé les attitudes de la population en rapport avec le besoin dans la conservation des ressources naturelles et l'amélioration de la sécurité alimentaire à travers des initiatives personnelles et privées. De plus grands efforts ont été faits pour la plantation d'arbres et l'élevage ainsi que l'adoption appropriée des technologies et des méthodes d'exploitation agricoles.

Mots Clés: Biodiversité, sécheresse, sécurité alimentaire, plantation d'arbres

INTRODUCTION

In Kenya, the arid and semi-arid lands (ASAL) occupy about 455,408 km^2 which is about 83% of the total land mass of the country, with indications that the ASAL is increasing (GoK, 2010a). These ASAL support over 25% of the total human population and are mainly suited to extensive livestock production (Sombroek *et al*., 1982; Ottichilo *et al*., 2000). However, climate change now threatens to eradicate the country's rich biodiversity (GoK, 2010a). In the dryland areas of Kieni East Division, Nyeri District, Sijali *et al*. (2007), found that destruction of the natural resources (particularly indigenous trees) is a major contributor to climate change in the region. The most affected plant species are those of important cultural values such as sources of medicines, fuel wood (firewood and charcoal), fodder and building materials. Just like in other areas of Kenya, the tree cover has been declining (GoK, 2010b), thereby, leading to environmental degradation and the now visible effects of climatic change and variability

Data from the Kenya Meteorological Department (KMD) show evidence and impacts of climate change in Kenya over the last 50 years (GoK, 2010a). With reference to the Central Kenya region, the trend of minimum temperature from 1960 has been increasing by 0.8-2.0 °C; while the maximum temperature has been increasing by 0.1-0.7 °C. With regard to rainfall patterns, there has been a general decline with time in the main rainfall season of March-May (the 'Long Rains') and a tendency for the October-December (the 'Short Rains') to extend into the normally hot and dry period of January and February (GoK, 2010a).

Increased poverty, food insecurity, lack of alternative on-farm enterprises and continued fragmentation of arable land have additionally led to over-exploitation of natural resources for short-term financial gains (Caritas, 2008). The objective of this research was to evaluate the perceptions about climate change and the adaptations by rural communities to cope with its deleterious effects.

MATERIALS AND METHODS

The study was carried out in April, 2009 in Kieni West and East Divisions, both in Nyeri North District; and Lamuria Division in Laikipia East District in semi-arid regions of Kenya. The three divisions are characterised by an ecological and climatic gradient running from cool humid, sub-humid to semi-arid conditions. According to Jaetzold *et al*. (2006), the study sites lie between Mt. Kenya and Aberdare Mountains and are densely populated with farm sizes of about 1-2 hectares in the medium rainfall areas of Kieni West and East Divisions and 8-40 hectares in the semi-arid areas of Lamuria Division. The people living in the drier parts of agro-ecological zones (AEZ) 4 and 5 are largely recent immigrants from the high and medium rainfall areas of the surrounding districts and other parts of central Kenya (Jaetzold *et al.*, 2006). For example, the results of population census in 1979 and 1999 shows that the population density of Kieni West Division increased from 75 to 109 persons per km^2 between 1979 and 1999 while that of Kieni East Division increased from 79 to 120 persons per km^2 during the same period. The people have largely destroyed the original vegetation in the farmlands and in addition have contributed to destruction of forests fringing their farms (Sijali *et al.*, 2007).

To capture baseline information on the major changes related to climate, biodiversity and the environment, questionnaire interviews were administered to three selected farmer groups in Nairutia and Naro Moru (in Kieni West and East Divisions, respectively) and Matanya (in Lamuria Division). The criteria for selection of these farmer groups was that they were engaged in environmental conservation activities. The interviews were conducted on the active members from each group through a questionnaire with structured and un-structured questions. In total, 64 active members from the three farmer groups were interviewed. The questions were meant to collect data on perceptions of climate change, biodiversity and environmental change with a focus on the start, trend, indicators and causes.

On land use, the focus of the interviews was on trend and causes of change of the main crops and livestock types. Other interview questions were on the individual and group initiatives that the farmers conducted towards coping with the effects of climate change and variability. The information gathered were analysed using the Statistical Package for Social Scientists (SPSS) Version 15.0 for Windows (Miller *et al.*, 2006).

RESULTS AND DISCUSSION

Settlement patterns in the study sites. The results revealed that majority (78%) of the farmer groups members in the area were aged over 40 years and their migration into the semi-arid areas began immediately after Kenya attained her independence in 1963. However, it was not until 1980 to 1999 that there was an influx of settlers from the surrounding medium and high potential districts (Fig. 1).

The 1980 to 1999 period coincided with a general migration of people from medium and high potential areas to marginal areas in the country, due to increased population pressure. Purchasing of farms through buying shares in land buying companies enabled many immigrants to settle in these regions. It was also a time that the government shifted its development focus to the semi-arid lands (KLA, 2000). As a result, the respondents stated that increased populations and demand for resources was one of the major causes of land degradation through massive deforestation, intensification of cultivation along river valleys and expansion of cultivated land into more marginal areas. Other causes of land degradation were overgrazing, loss of biodiversity, salinisation of crop lands, after irrigation with salty borehole water, and soil erosion after exposure of the saline/sodic soils. According to UNEP (2009), land degradation in marginal areas is a source of greenhouse gases which is a major cause of climate change, and proper land management in these areas can lead to greater carbon sequestration due to their spatial extent and their low carbon content and, thereby, contribute to mitigation against climate change. According to Kenya's Agricultural Sector Development Strategy, 2010-2020 (GoK, 2010b), the Government is promoting measures such as adoption of agro-forestry, on-farm forestry, conservation of natural environment and introduction of commercial tree species in the ASAL to control desertification and mitigate against climate change.

Perceptions on climate change. One hundred percent of the farmer group members were aware of climate change. The farmers in Matanya (14%) and Nairutia (13%) were closely in agreement that

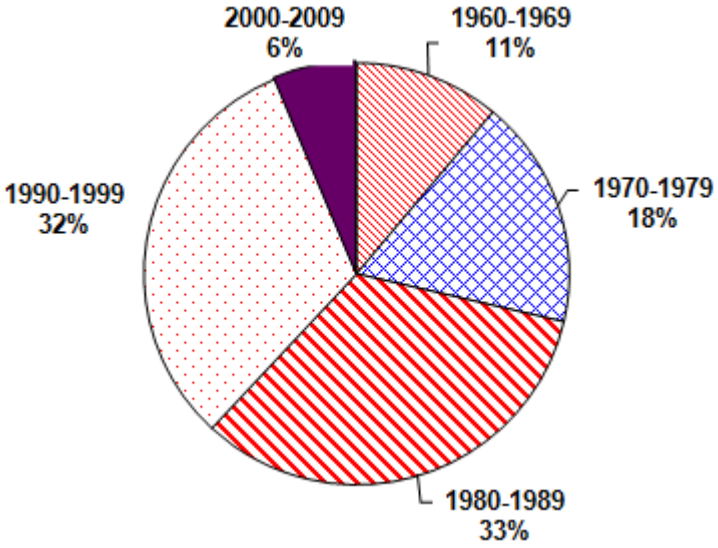

Figure 1. Population migration patterns to the semi-arid areas in the study area.

most changes began during the last 10 years (Fig. 2). However, in Naro Moru an equal number (11%) was of the opinion that the changes occurred during the last 5 and 10 years. These differences may be attributed to the type of agricultural practices that the farmers practiced. The farmers living in Matanya and Nairutia depended more on rain-fed agriculture and, therefore, may have quickly noticed changes in rainfall patterns and increased droughts. On the other hand, farmers in Naro Moru had reliable irrigation schemes until the serious drought periods started when irrigation was curtailed. Therefore, it may have been for this reason that farmers in Naro Moru stated that climate change started during the last 5-10 years.

According to the three farmer groups, the main indicators of climate change were changes in rainfall patterns, temperatures, low crop yields and increase of droughts (Fig. 3). Due to the semi-arid conditions in Matanya (AEZ 5), the farmers identified increase in drought conditions (8.2%) and low crop yields (7.7%) as the main indicators of climate change. In Nairutia (AEZ 3) the main indicators were identified as change in rainfall pattern (8.2%) and low crop yields (7.1%),

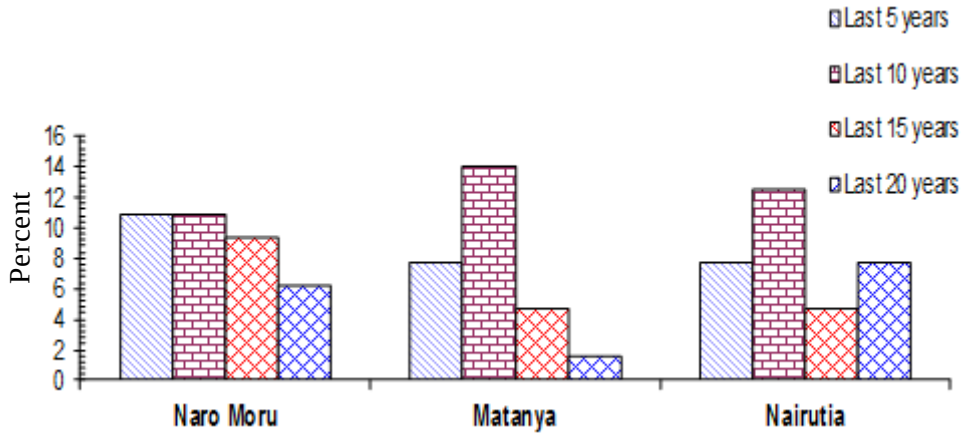

Figure 2. Perceptions on beginning of climate change.

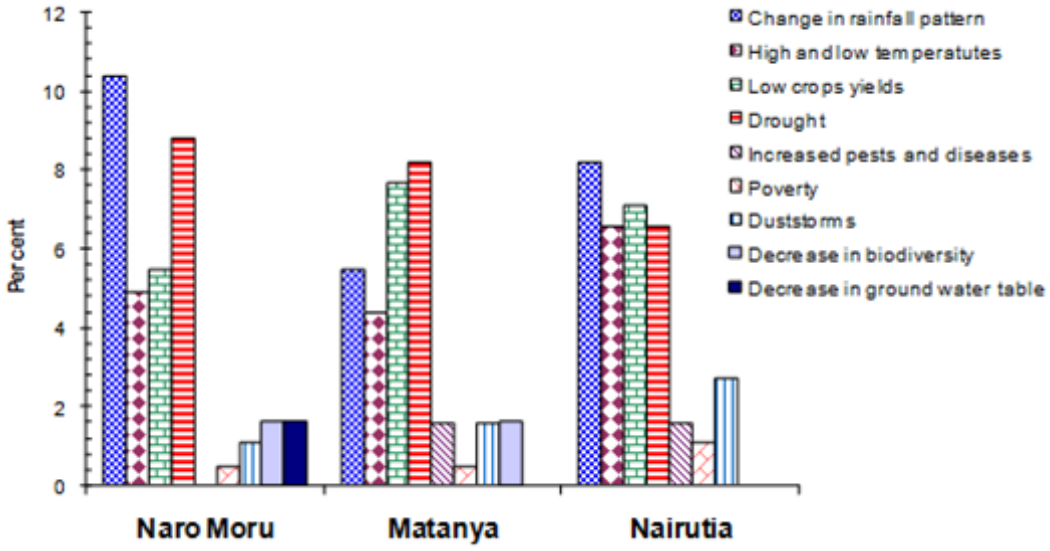

Figure 3. Indicators of climate change in the study area.

while farmers in Naro Moru (AEZ 4) identified change in rainfall pattern (10.4%) and frequent droughts (8.8%) as the main indicators of climate change. The results of a study carried out by Kuria (2009) on a community living near the Kikuyu escarpment forest, revealed results closely in agreement with the current study. The farmers in Kikuyu identified key indicators of climate change as a rise in temperature, low rainfall, drying of rivers, increased diseases, low crop yields and an increase of frost due to the low temperatures. The surge in occurrence of pests and diseases in the study site of Kuria (2009) and the current study sites may have been as a result of the rise in temperature.

All three farmer groups in the current study identified deforestation as the main cause of climate change through destruction of trees on farms and near forest edges as a result of poor forest management. Fifteen per cent of farmers in Naro Moru were of the opinion that deforestation was the main cause of climate change in the area; while in Nairutia; it was 14% (Fig. 4). In Matanya, 13% of the members considered deforestation as the main cause of climate change. These differences may be attributed to the fact that, the farmers living in Naro Moru and Nairutia lived next to the Mt. Kenya and Aberdares Mountain forest edges, respectively, and were aware of the type of destruction that occurred in the forests; while there were no forests in Matanya. Data collected revealed that in Nairutia and Naro Moru, some of the most threatened tree species due to deforestation were *Juniperus procera* Endl., *Warbughia ugandensis* Sprague, *Olea europia* L., *Prunus africana* (Hook.f.) Kalkm., *Cupressus lusitanica* Mill and *Pinus patula* Scheide. ex Schltdl.& Cham. In Matanya area, the most threatened tree species were *Podocarups falcatus* Mirb., *Acacia xanthophloea* Benth., *Acacia tortilis* (Forssk.) Hayne and *Prunus africana* (Hook.f.) Kalkm (species found growing mainly along river valleys). Regarding causes of climate change, the community living near the Kikuyu escarpment forest also identified causes of climate change as deforestation, pollution and introduction of foreign species, particularly Eucalyptus species (Kuria, 2009).

Other less ranked causes of climate change were poverty (high population and unemployment), land degradation (soil erosion, overgrazing, mining soil nutrients, etc), pollution (fires), intense farming along river valleys and low knowledge on natural resources management (Fig. 4). The intense farming along river valleys especially in Matanya was ranked as the second main cause of climate change as a result of diminishing water sources after increased abstraction of water from the rivers for irrigation

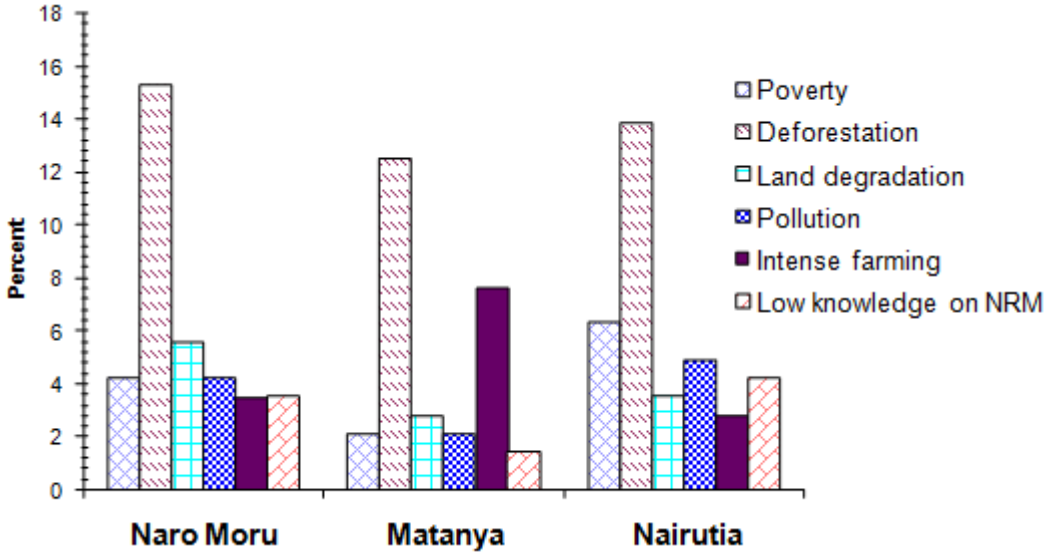

Figure 4. The main causes of climate change in the study area.

which had resulted into conflicts between downstream and upstream river water users. Arnell (2009) stated that water resources and their mismanagement are the causes of the largest impacts of climate change which may cause serious conflicts between the users. Figure 4 shows that intense farming was ranked the least cause of climate change by farmers in Naro Moru and Nairutia; this was attributed to the operational irrigation schemes that existed in both areas. Many farmers in these two areas had also dug individual water pans that they used to harvest and store water runoff, water that they used for farming when piped water was not forthcoming or was not enough.

Perceptions on biodiversity and environmental changes. One hundred per cent of the community members were aware of losses in biodiversity (animals and plants) and changes in the environment. The disappearance of wild animals and insects and loss of plants were the two main indicators of losses in biodiversity (Fig. 5).

According to 39% of the farmers interviewed, the biggest losses in biodiversity occurred between the years 2000 and 2004. This is almost in tandem with their opinion that the climate started changing within the last 10 years. The loss in animals was manifested in form of death and migration of wild animals and disappearance of safari ants, and an upsurge of centipedes and millipedes which destroyed the crops. The loss of plants was manifested in form of reduced vegetation cover due to tree cutting, less grazing areas, disappearance of indigenous plants, etc. A rare phenomenon of an increase in giving birth to human hermaphrodites as an indicator of climate change was given by the Nairutia farmers (though less than 1%), but the data need to be corroborated with medical records from the area.

The main causes of biodiversity and environmental changes were climate change (less rainfall, high temperatures, dry rivers, etc), deforestation (bush burning, tree cutting, etc), change in land use patterns (more irrigated areas and over cultivation) and increased population (Fig. 6). Others were pollution (forest fires and dust storms), increased pests and diseases, poaching and inadequate knowledge in biodiversity and environmental conservation. These causes are similar to those identified in Kikuyu escarpment (Kuria, 2009). The results of Ovuka (2000) in Murang'a and Nyeri Districts also showed that 50% of people interviewed attributed reasons for climate change as human induced, while 30% attributed the changes to global factors. The inevitable consequence of biotic impoverishment is a result of the ways humans have either used or misused the environment (McNeely *et al.*, 1995).

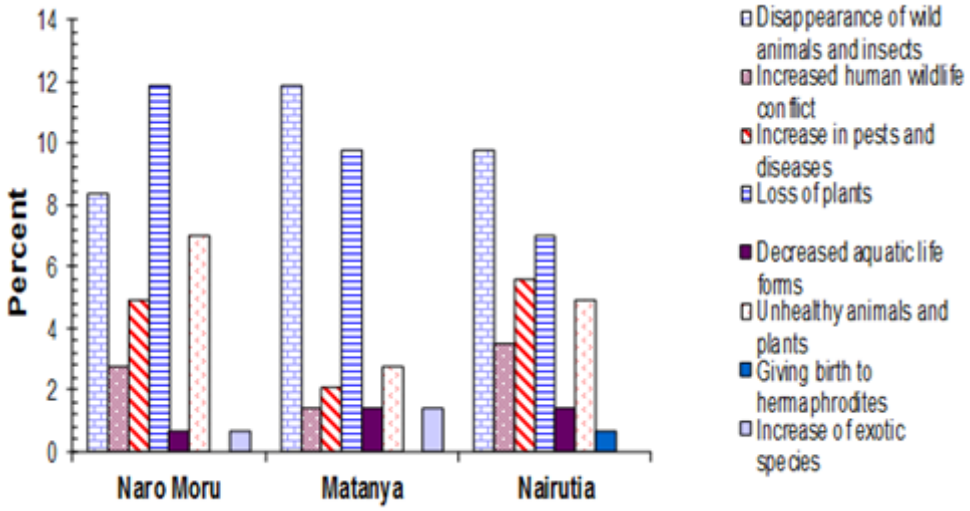

Figure 5. Indicators of biodiversity and environmental changes in the study area.

Actions towards adaptation to climate change The dominant crops for subsistence and cash income for the communities in Naro Moru, Matanya and Nairutia were maize, beans, potatoes and cabbages. Other less dominant crops were peas, wheat, onions and carrots (Fig. 7). In addition, flower farming as a source of income was taken up by the farmers in Naro Moru due to the existence of irrigation water and ready market. However, in the three farmer groups, members stated that crop yields were on the decline trend due to climate change, land degradation, pests and diseases, high cost of inputs, decreasing land sizes, etc. Regarding

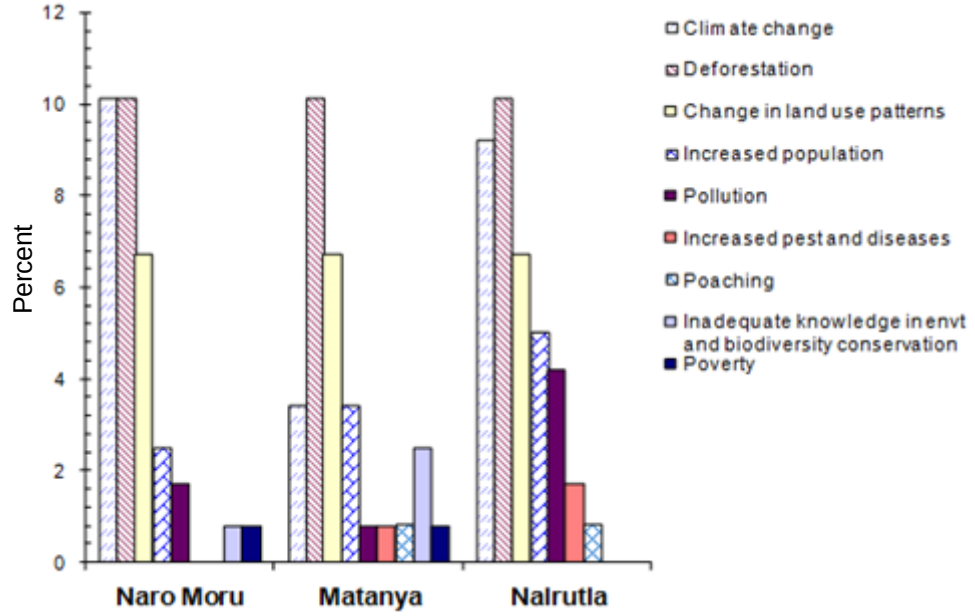

Figure 6. Causes of biodiversity and environmental changes in the study area.

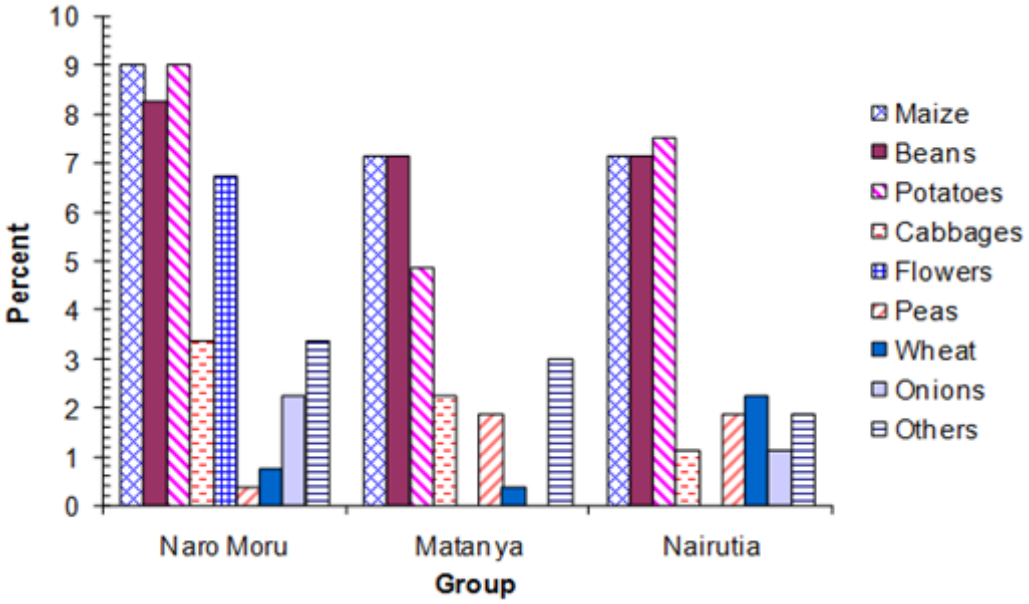

Figure 7. Subsistence and cash crops grown in the study area.

livestock, cattle and sheep dominated, although keeping of many cattle was on a downward trend. However, the farmers added that as an adaptation measure, keeping of chicken, goats and rabbits was on the increase due to their less risks of death during the increasing droughts. In addition, chicken, goats and rabbits had simple management in terms of feeding and were sources of cash, meat and milk.

Experiences on effects of climate change such as scarcity of resources forced the three farmer groups to take up adaptation strategies towards ensuring food security and environmental conservation. The biggest efforts were towards tree planting, which the farmers did without knowing that there would be a positive impact on carbon sequestration. According to Neufeldt *et al*. (2009), carbon sequestered by trees and stored in aboveground biomass and soil contributes to reducing greenhouse gas concentrations in the atmosphere. The highest efforts of tree planting were in the semi-arid Matanya area where 23% of the farmers had planted >200 trees on their farms (Table 1). This was followed by Naro Moru with about 20%, and lastly Nairutia with 8% of the farmers.

TABLE 1. Number of farmers (%) who have planted trees in their farms

On-farm trees	Community		
	Naro Moru	Matanya	Nairutia
<50	4.9	0.0	4.9
50-100	11.5	4.9	11.5
101-200	3.3	1.6	6.6
>201	19.7	23.0	8.2

Figure 8 shows the motivating factors for farmers to plant trees. In Matanya area, the community was motivated to plant trees due to the scarcity of fuel wood and protection against dust storms that were common; while in Naro Moru, some farmers enjoyed payments from carbon trade and other tree by-products by companies in the cosmetics and bio-fuel industries. In Nairutia, the existence of many forest remnants and the nearby Aberdares Forest (which served as a ready source of tree products) may have been the reason why the community was not motivated to plant trees as compared to the other two communities. This observation, however, needs further investigation in order to motivate the communities towards contributing to environmental conservation.

In addition to tree planting and husbandry by individual farmers, other individual and community adaptation actions were capacity building, environmental conservation, water harvesting, adoption of appropriate technologies

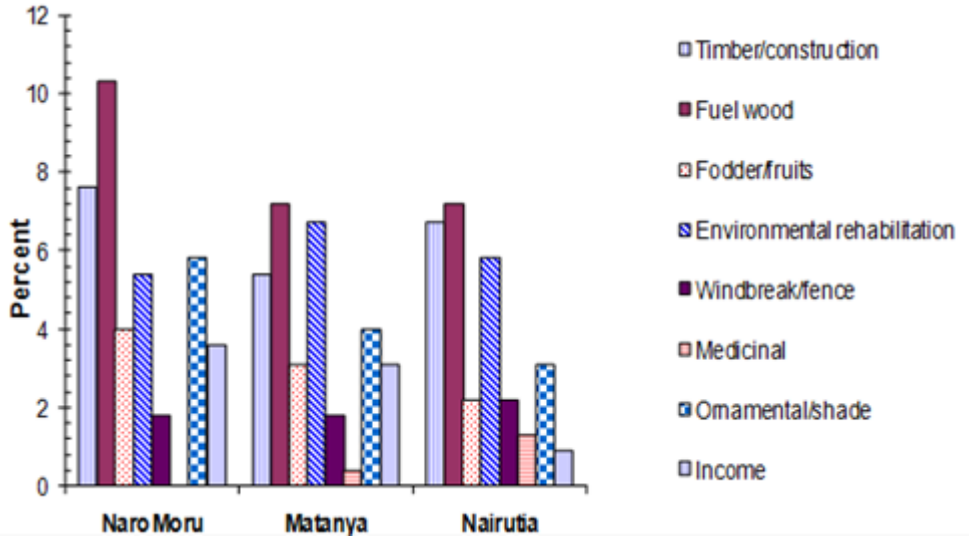

Figure 8. Factors that motivate tree planting by farmers.

and farming methods, enforcement of policy and community mobilisation. Capacity building for the farmers was ranked second by all the groups who stated that new challenges related to impacts of climate change were increasing and, hence, their knowledge on the existing adaptation mechanisms needed to be supplemented with new options and knowledge that was tailored to their local environments. For example, in Naro Moru area, water harvesting for irrigation and domestic purposes by individual farmers was higher than in other areas and the farmers stated that they needed knowledge on fish farming which they could introduce into the water pans for purposes of food security.

CONCLUSION AND RECOMMENDATIONS

The results of this study showed that farmers living in semi-arid regions of Kenya are aware of climate change and its impacts on their livelihoods and the environment in general. However, their perceptions on climate change differed from one farmer group to another and were largely dependent on the conditions of the agro-ecological zone where the respective farmer group is located. Generally, the farmers had observed changes in climatic patterns and scarcity of resources such as indigenous trees and water and a decline in crop yields which had resulted into food insecurity. The scarcity of resources had also resulted into heightened conflicts between people, livestock and wildlife for the little available resources. Due to this realisation, the farmers have started implementing some individual and group actions towards adaptation against effects of climate change. The biggest efforts have been towards tree planting, water harvesting and general environmental rehabilitation. However, it was observed there is very little participation by the youth in community activities due to reasons such as lack of incentives and non-involvement by the adult people.

It is recommended that due to lack of technical expertise of the farmers, there is need for other organisations to complement and enhance the farmer's efforts through capacity building, appropriate technologies, policies and financial support. In addition, for agricultural production, environmental conservation and climate change adaptation and mitigation strategies to succeed, there is need to involve the youth more in the activities, particularly through training and participation in community-based actions.

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