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Perceived Effects of Climate Change on Agricultural Production: A Gendered Analysis Done in Bahi and Kondoa Districts, Dodoma Region, Tanzania

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Abstract

Climate change literature has revealed that the effects of climate change on women and men are not the same and that women are more likely to be severely affected by climate change. However, data to indicate the way men and women are affected by climate change are missing. A study to examine effects of climate change on agricultural production by sex was done in Bahi and Kondoa Districts, Dodoma region, Tanzania. Specifically the study analyzed perception of climate change and effects of climate change on agricultural production. A sample of 360 respondents, 12 focus groups of discussants and 78 key informants were consulted. Analysis of quantitative data involved descriptive statistics and qualitative data were analyzed by content analysis. Results showed that men and women perceived and were affected differently by climate change. Women were severely affect by effect of climate change that caused hunger/food shortage, that caused them to be subjected to bad food debts and effects that caused them to waste productive time in less productive activities; whereas men were severely affected by the effects of climate change that involved wasting of resources; that associated with out-migration and effects that reduced status of respondents. Using their knowledge, respondents managed to perceive and identify climate change effects. The study recommends Tanzania and other Less Developed Countries to use available knowledge system to learn and manage climate change effects.

Key words: Effects of climate change, Men and women, Perception, Agricultural production

1.0 Introduction

Climate change effects are location specific and disproportionately distributed among different countries, income groups, occupations and between gender (IPCC, 2007). In Africa, climate change is already having serious negative effects where much of the population is suffering from direct result of increased temperatures, changed rainfall patterns and rise in sea level. The impacts of climate change are more severe in sub-Saharan Africa where agriculture is the most important economic activity and source of food and income (Boko *et al.* 2007). Climate change has been the major constraint to agriculture productivity (crop and livestock production) in Tanzania because in addition to other deficiencies that exist in the sector, the nature of agriculture practiced depends solely on rainfall. In Tanzania, Dodoma Region is among the regions severely affected by failing agriculture due to climate change (FAO, 2008), as the region is situated in semi-arid areas. Various studies including Ribeiro and Chaúque (2010), UNFPA (2009) and Osman-Elasha (2008) have revealed that the effects of climate change on women and men is not the same and that women are more likely to be severely affected by climate change. However, data to indicate the way men and women are affected by climate change are missing. Most of documented information on climate change effects including Mark (2010), Levira (2009) and Morton (2007) are not disaggregated by gender.

Lack of disaggregated data has meant that climate change policy makers in Tanzania such as the National Adaptation Programme of Action (NAPA) cannot come up with gender specific policies (URT, 2007). According to UNFPA (2009), gender blind interventions will be less effective in addressing aspects of climate change, as they may exacerbate the problems associated with climate change by widening inequalities between the sexes. Therefore, this

paper, examines the effect of climate change by gender in Bahi and Kondoa Districts of Dodoma Region, in order to contribute relevant data that can be used to develop efficient interventions to adapt to or reduce climate change effects. The rest of the paper is structured as follows: the next section covers methodology including study area, research design and the way data were collected and analyzed; results and discussions; and finally conclusion and recommendations.

2.0 Methodology

2.1 Study area

The study was conducted in three villages of Bahi District, Dodoma Region, namely Nagulobahi, Chipanga B and Msisi; and three villages of Kondoa District that is Puhi, Isusumya and Kurio. Administratively Bahi District has four divisions, 21 wards and 56 villages whereas Kondoa District has eight divisions, 35 wards and 160 villages. Both Districts are situated in semi-arid areas and have a dry savannah type of climate which is characterized by long dry season, unimodal and erratic rainfall that falls between November/December and April. Bahi District has an annual average rainfall of about 500 to 700 mm and annual average temperature of about 22.6^0C. Kondoa District has an annual average rainfall of about 500 to 800 mm and an annual temperature of about 21^0C. The economies of Bahi and Kondoa Districts depend on agriculture (crops and livestock production). The main crops grown in Bahi District are pearl millet, sorghum, paddy and ground nuts; and for Kondoa District the main crops are maize, finger millet, oil seeds, pearl millet and sorghum (URT, 2003).

2.2 Research design and methods of data collection

A cross-sectional research design was used in this study. Both primary and secondary data were collected and analyzed. Primary data involved qualitative and quantitative data. The study sample was obtained by using simple random sampling technique, from a sampling frame of farmers who were dealing with crop production and livestock keeping. Moreover, key informants including ward and village leaders, crops and livestock extension workers, religious leaders, members of village government committees, head teachers and elderly farmers (two men and two women) were selected purposively. Qualitative data were collected through key informant interviews and focus group discussions; and quantitative data were collected by using a structured questionnaire. To collect qualitative data, a checklist of items for in-depth interviews with key informants was used to gather information from 78 key informants (13 individuals from each village); and a focus group interview guide was used in discussion to gather information from 12 focus groups of discussants (one group of men and one of women from each village). To collect quantitative data, a structured questionnaire was administered to a sample of 360 respondents (30 men and 30 women from each village) to verify and quantify some of the findings from qualitative data. Secondary data were gathered from various reports relevant to the study and the web.

2.3 Data analysis

Analysis of qualitative data was done by using content analysis in which the data were broken down into smallest meaningful units of information and/or themes and summarized to supplement important information with respect to the objectives of the study. Quantitative data analysis was based mainly on descriptive statistics including frequencies, means, percentages and cross-tabulations. Perception on climate change was measured through indices of four climate change indicators (increase in rainfall variation, temperature, strong wind and drought. Inferential analysis was done by using chi-square test at $p < 0.05$ level of significance to determine association between the variables; and corrected Rao-Scott chi-square (χ_c^2) was used to determine association between variables for the multiple response answers (Lavassani *et al.* 2009).

3.0 Results and discussions

3.1 Perception of climate change by sex

Using indices from Likert scale statements, it is revealed in Table 1 that 87.2% of men perceived changes in rainfall variation compared to 76.7% of women. The findings further showed that more than 95.0% of the respondents

perceived increase in temperature, strong wind and drought; and that drought was highly perceived by both men and women. The findings attest that the majority of men and women perceived changes in climate. Using the chi-square test, the findings showed that there was significant association between perception of respondents on increase in rainfall variation and sex ($\chi2 = 11.588$; $p \leq 0.05$); increase in strong wind and location (village) of respondents ($\chi2 = 42.792$; $p \leq 0.01$); increase in drought and marital status ($\chi2 = 73.536$; $p \leq 0.001$) and also increase in drought and ethnic group ($\chi2 = 193.098$; $p \leq 0.001$). This indicates that perception of climate change in the study area varied by sex, village of respondent, marital status and ethnic group of respondents.

Table 1: Perception of respondents on climate change by sex

Scale for perception	Men (n=180)		Women (n=180)	
	n	%	n	%
Perception on increase in rainfall variation				
Perceiving	157	87.2	138	76.7
Not perceiving	23	12.8	42	23.3
Total	**180**	**100.0**	**180**	**100.0**
Perception on increase in temperature				
Perceiving	177	98.3	175	97.2
Not perceiving	3	1.7	5	2.8
Total	**180**	**100.0**	**180**	**100.0**
Perception on increase in strong wind				
Perceiving	175	97.2	172	95.6
Not perceiving	5	2.8	8	4.4
Total	**180**	**100.0**	**180**	**100.0**
Perception on increase in drought				
Perceiving	180	100.0	178	98.9
Not perceiving	0	0.0	2	1.1
Total	**180**	**100.0**	**180**	**100.0**

Source: Survey data (2011)

It was revealed during the key informant interviews and focus group discussions that rainfall used to begin in November or December and end in late May in the 1970s, but in the 1990s variation in rainfall onset and also distribution of rainfall had increased. Rainfall could start in December or January and end in March or early April, causing rain season to be short. It could fall too heavy for example, during El Niño in 1997/98; or too heavy and very little within the same season. Moreover, rainfall could fall in one side of the village and leave another side of the same village dry; and sometimes could fall for one or two weeks and stop for a month and start to fall again after crops have been damaged by drought.

In addition, high temperature was felt much in November and cooled down when rainfall started; and it was an indicator that rainfall was about to fall. But, according to discussants, in the 1990s temperature had notably increased and in some seasons increased temperature extended from August to February. The cold season that used to be experienced mainly from late May to September in the1970s was experienced only in mid June throughout July in the 1990s, and the rest of the cold season becomes warm and sometimes very hot during the day. Furthermore, in the 1970s the dry spell used to take one to two weeks in late January or February and it was an important period required during crops establishment. Nevertheless, in the 1990s dry spell takes four to six weeks between January and March, causing strong sunshine that damages crops. For example, during the survey, in the study area rainfall had stopped in December and started to fall again at the end of March. Crops, especially maize were badly damaged by drought such that farmers in Kurio village ploughed maize plots to plant sweet potatoes and cassava. Traditional indicators that were used to indicate rainfall onset (for example, when baobab trees sprout) could indicate signs for rainfall

onset but rainfall delays. Other changes mentioned during focus group discussions were increase in human diseases such as malaria, cholera and typhoid; crop pests; and livestock diseases. It was also revealed that bad years had increased and good years decreased in the 1990s compared to the 1970s. Rainfall variation including erratic distribution and amount together with variation in rainfall onset; increased temperature; and also strong wind were the main causes of increase in drought. Strong wind blew away rainfall clouds causing rainfall to delay or fall in patches. Climate change had caused various physical effects on agricultural production activities of men and women in the study area as it is shown in section 3.2.

3.2 Perceived physical effects of climate change on production activities by sex

Table 2 depicts perceived physical effects of climate change on production activities of respondents in the study area. It is shown from the Table that climate change was the cause of crops to be damaged and also the cause of persistent low yields, the effect which was perceived equally by men and women. Moreover, more women were likely to perceive effects of climate on reduction of water sources and shrinkage of wetland areas; reduction in crop varieties; non-farm production activities; and increased crops insect pests and vermin compared to men. Likewise, men were more likely to perceive effect of climate change on reduction in pastures, number of livestock and milk yield; and increased livestock diseases compared to women. This indicates that men and women perceived physical effects of climate change on their production activities differently. The corrected Rao-Scott chi-square (χ_c^2) test showed significant association between the perceived physical effects of climate change on production activities and sex ($\chi_c^2 = 250.171$; $p \leq 0.001$) indicating that perception of the physical effects of climate change on production activities depend on the sex of respondents.

Table 2: Perceived physical effects of climate change on production activities by sex

Description	Men (n=180)		Women (n=180)	
	n	% of responses	n	% of responses
Physical effects of climate change on production activities				
Damaging crops and persistent low yield	180	16.1	180	15.8
Reduction in pastures, number of livestock and milk yield	179	16.0	165	14.5
Increased livestock diseases	177	15.8	118	10.4
Reduction in water sources and shrinkage of wetland areas	175	15.7	180	15.8
Increased crops insect pest and vermin	160	14.3	177	15.5
Reduction in crop varieties	127	11.4	163	14.3
Reduction in non-farm production activities	120	10.7	157	13.8
Total	**1118**	**100.0**	**1140**	**100.0**

NB: Multiple responses
Source: Survey data (2011)

In the study area, drought was the cause of frequent wilting and in severe case most of crops to dry, the effect that resulted into persistent low crop yields. Droughts reduced pastures, causing high mortality rates in livestock and reduction in milk yield due to inadequate feeding and increased incidence of diseases. Drought had also encouraged emergency and increase of insect pests and vermin including stalk borers and birds that attacked maize, sorghum, paddy and pearl millet. It was revealed during focus group discussions and key informant interviews that birds especially quelea quelea occurred often in the study area and for the past five consecutive years (2005 – 2010) quelea quelea was a threat to sorghum and pearl millet grains in villages of Nagulobahi, Puhi and Kurio. In addition, elegant grasshoppers had been a threat to cassava, sunflower and pigeon peas crops, attacking leaves and cutting seedlings in Isusumya village. Those insect pests had discouraged sorghum, pearl millet and cassava farming such that 6.7% of men and 5.8% of women (responses) had abandoned sorghum farming; 7.7% of men and 3.2% of women

(responses) pearl millet farming and 9.6% of men and 7.4% of women (responses) had abandoned cassava farming. The merit of sorghum, pearl millet and cassava is that they are hunger buffering crops, grown purposively for food security and are produced more by women. Abandoning or reducing production of these crops, will have great effect on food security within the household and income of women.

Table 2 show also that drought had caused decline in water sources and shrinkage of wetland areas in the study area. This reduced the amount of domestic water and lessened non-farm production activities by reducing garden crops, fishes; salt production and basket making materials (*milala*). Additionally, crops like beans and sweet potatoes that were grown in late February to early March had been very much reduced and were no longer grown every season because of rainfall variation that had caused growing season to be shortened, especially in Bahi District. Similar findings were reported by various studies including Maharjan *et al.* (2011), Mengistu (2011) and Mongi *et al.* (2010). The consequences of perceived physical effects of climate change were the socio-economic effects discussed in section 3.3.

3.3 Perceived socio-economic effects of climate change by sex

The main reported socio-economic effects of climate change were waste of resources; increased hunger and weakness; farmers being subjected to bad food debts; increased family conflict; out-migration; decreased sanitation, hygiene and domestic water; waste of productive time in less productive activities; and loss of status and failure of respondents to improve family well-being (Figure 1).

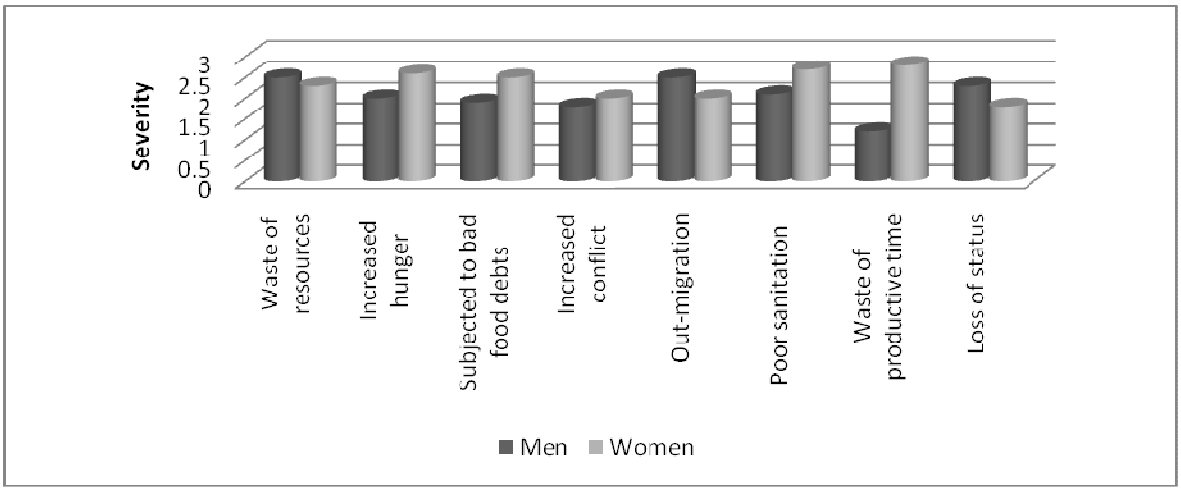

Figure 1: Ranking of perceptions on severity of socio-economic effects of climate change by sex. Perception of severity of the effect of climate change increases as scale increases from
0 – 1 = Low/moderately affected; 1.1 - 2 = Highly affected; 2.1 - 3 = Severely affected.
Source: Survey data (2011)

3.3.1 Waste of resources

It is shown in Figure 1 that men were more likely to perceive severity in wasting resources compared to women. In the study area wasting of resources occurred when farmers were forced to replant several times because of crop failure or when crops were destroyed by drought such that they were forced to plough again the same plot to plant other crops. In addition, waste of resources occurred when floods carried away top fertile soils including manure hence destroying farms. It was revealed during focus group discussions that replanting has become a common exercise from the 1990s due to climate change. For example, in 2006/07 farmers from Isusumya village replanted

four times. Similarly, in Kurio village farmers were forced to plough maize plots to plant other crops including sweet potatoes and cassava after maize crop had been damaged by dry spell. Moreover, floods carried away fertile top soil including manure from the farms in Chipanga B village; and some plots in Isusumya village were no longer used for production because of erosion that had caused deep gullies and water ways. These effects had wasted resources including seeds, land, labour, money and time and also increased cost of production. Men were more likely to perceive severity in wasting resources compared to women probably because of the variation in cost of production between them, which is more felt when money is involved. Women use more of their labour or family labour and are good at keeping seeds.

3.3.2 Increased hunger and food shortage

It is also depicted in Figure 1 that women were more likely to perceive severity of hunger compared to men, probably because it was their role to assure food security in the household. Climate change was the main cause of increased hunger and food shortage due to persistent low yield. Hunger caused weakness and reduced work performance of respondents. For example, it was found during focus group discussions that a number of women had gone without food for three days in Kurio village, but they were continuing with field operations including weeding. With such hunger situation, it was not easy for the respondents to be efficient in production activities. In addition, hunger had also reduced school attendance and class participation of pupils and students. It was impossible for children to go to school when there was nothing to eat at home or hope to get food after classes. Related findings are also reported by Shepherd *et al.* (2011) from a study done to analyze hidden hunger in rural Tanzania.

3.3.3 Respondents being subjected to bad food debts

The results in Figure 1 show further that women were more likely to perceive effects of being subjected to bad food debts compared to men. In the study area persistent low yield for both cash and food crops due to climate change caused demand of food to increase and price of crops including food items to be inflated. During such periods one of the measures undertaken by the respondents to protect the family from hunger was to borrow from traditional food credit (*songoleda*[2]) but during such period the interest rate of food was very high (150 to 300%). This is because the rich compared price of a particular food item during transaction and its price during harvesting period. Moreover, borrowing food from traditional credit was a risk practice in the 1990s compared to the 1970s because yield was unpredictable and persistent low yield reduced the possibility of the respondents to repay loan in time. However, more women opted for borrowing from traditional food credit in order to save their families from food shortage. This action subjected more of them to bad food debts as they failed to repay the food loan in time. Food debts were bad because even if borrowers got food next season, most of it was taken by lenders because of the high interest rate which they were required to pay. This practice locked borrowers in the cycle of food shortage and bad food debts.

3.3.4 Increased family conflict

It is also revealed in Figure 1 that women were likely to perceive severity in increased family conflict compared to men**.** Although there were various sources of family conflict in the study area, conflict associated with climate change occurred when after the family was stricken by hunger, men became devastated. Instead of accepting the reality and cooperate with their spouses to confront the situation, they opted for gathering with other men to eat and drink and left the struggle to search for food to their wives. Such actions caused conflict in the family and women and children were more affected by the conflicts.

3.3.5 Out-migration

Increase in food shortage and hunger due to climate change encouraged out-migration in the study area. Although

[2] *Songoleda* is a Gogo word for a traditional food credit system operating in the study area which involves the rich - livestock keepers and crop producers (*tajiri ng'ombe/chakula*) and the poor (*mochiwa*). The main commodity for transaction is cereals (food), but they are also lending money nowadays.

out-migration is one of the measures of adaptation, it had negative effects to the family. The findings in Figure 1 show that men were likely to perceive severity on the effect of out-migration compared to women. Out-migration was not a pleasure, but respondents emigrated to search for casual labour or exchange various possessions with food away from home whenever opportunities to secure survival of their families in the village were inadequate due to drought. Whether emigrants succeeded to get casual labour or food depended on the situation which they encountered in the new areas where they emigrated to. Some of the emigrants returned home after getting food while others came back after the food shortage was over with nothing in their hands; and others forsook their families and decided to establish new ones. Such actions destroyed family bond and marriage ties; caused children to be discouraged and decided to emigrate to roam in towns (for example, in Kondoa and Dodoma towns) to become street beggars, increasing number of street children and childhood pregnancies for girls. Moreover, emigration had increased chances of spreading or being infected by HIV/AIDs and other sexually transmitted diseases. This is for both emigrated respondents including children; and also women who remained at home.

Emigration was also one of the causes of increased burden of women because in addition to their reproduction and production roles they were required to undertake part of the responsibilities which were to be done by men. The challenge of women was also increased when the family moved to a new place or when they were forced to stay away from home or from their children for a week or more days. It is argued in UNFPA (2009) that population movement is likely to intensify as changing climate leads to the abandonment of flooded or arid and harsh environments including areas with persistent food shortage or hunger, a situation which is happening in the study area.

3.3.6 Decreased sanitation, hygiene and domestic water

It is also shown in Figure 1 that climate change was the cause of poor sanitation, hygiene and had increased domestic water shortage; and that women were likely to perceive severity of decreased sanitation, hygiene and domestic water compared to men. In the study area drought reduced water sources and ground water causing shortages in domestic water in the 1990s compared to the 1970s. In the 1990s most of water sources which had enough water throughout the year, dried just after rain season. For example, Kurio village water source had enough water throughout the year in the 1970s but during El Niño of 1997/98 the source was eroded by floods such that when rain falls, the rain water flowed straight to the low land areas of Bahi District through River Bubu. Furthermore, in the 1970s women drilled shallow wells that kept water throughout the year, but in the 1990s it was difficult for them to drill such shallow wells after rains. For the areas where women managed to drill the wells, for example, Nagulobahi village, the wells dried in July. Decrease in domestic water was the main cause of poor hygiene.

Furthermore, in the study area floods had destroyed buildings including houses and latrines. For example, in 2009/10 season floods destroyed more than 100 houses in Msisi village and more than 15 houses and 20 latrines in Isusumya village. When houses are destroyed some of the families are forced to take sanctuary in school or office buildings which are not affected, places where toilet facilities are inadequate. This increases the possibility of environment to be polluted. Equally, pollution from destroyed latrines and heavy dust in the atmosphere due to whirlwind (especially during dry season) polluted and contaminated environment including water sources, reducing the amount of clean water that could be available for domestic use. Water and environment contamination due to climate change widened chances of farmers to be infected by various diseases including typhoid, diarrhoea and cholera. For example, from 1994 typhoid was a common problem in Isusumya village. Whirlwind was also one of the causes of cough and eye diseases. In addition, domestic water shortage exposed famers especially children to skin diseases due to poor sanitation and hygiene. Women were more affected by poor sanitation and hygiene because they were forced to sacrifice water use for their spouses and children. Improved sanitation, hygiene and safe water are important measures for the community to improve health status and it is among the Millennium Development Goals targets (Target 7C: By 2015, halve the proportion of people without sustainable access to safe drinking water and basic sanitation) (WHO, 2011). However, climate change had undermined the efforts of Tanzania to attain this target in the study area.

3.3.7 Wasting productive time in non-productive activities

The results in Figure 1 reveal also that severity of effect of wasting productive time in non-productive activities was perceived more by women compared to men, probably because it was the role of women to collect water and firewood. In the study area respondents wasted productive time mainly when fetching water and also collecting firewood. Decline in water sources including ground water and increased domestic water shortages forced women to travel a mean distance of 2.0 km to fetch water and also 4.0 km to collect firewood in the 1990s, compared to 0.7 km travelled in the 1970s (for water and also firewood). It was revealed during key informant interviews and focus group discussions that women wasted more time (two to six hours depending on location) because of the long queue and the fact that they had to wait for water to ooze from the ground. In addition, drought encouraged farmers to be engaged more in charcoal and firewood business to earn income. This practice (together with other causes including increased demand for land and material for housing because of increased population) reduced forest and firewood and increased the distance that respondents had to travel to collect firewood.

3.3.8 Loss of status and failure of respondents to improve family well-being

It is also depicted in Figure 1 that men were likely to perceive severity of the effect of loss of status and failure of respondents to improve family well-being compared to women. In the study area respondents varied in status depending on the level of their wealth. According to the findings from key informant interviews livestock ownership was among the criteria used to determine wealth status of respondents. Rich farmers had 20 and above heads of cattle, 10 and above hectares of land, produced enough food and surplus and could pay school fees of children. Additionally, in the 1990s livestock were mainly kept for security purposes, to be sold or exchanged for food during food shortage or hunger. However, climate change had reduced livestock, income and all privileges accrued from production activities, reducing the ability of respondents to meet family development targets and ability to improve their well-being. Although climate change had great negative effects to all farmers, livestock owners who were among 78.9% of men and 50.0% of women were more affected by loss of status. The same observation was reported by Jotoafrica (2011) in a study done in Northern Kenya that loss of animals due to climate change had threatened the pastoralists such that they were forced to shift to low paid jobs like security guards in towns.

It is shown throughout the discussion that men and women were affected differently by climate change. Men were more affected by the effects of climate change that involved wasting of resources; that associated with out-migration and effects that reduced status of respondents. Similarly, women were more affected by the effects of climate change that increased hunger (food insecurity) causing them to be subjected to bad food debts and family conflict; effects that reduced domestic water and forest (trees) causing them to be subjected to poor sanitation and hygiene, and forcing them to waste their productive time that could be allocated in more productive alternatives. The chi-square test revealed that there was significant association between perceived socio-economic effects and sex ($\chi2 = 77.474$; $p \leq 0.001$); location (village) of respondent ($\chi2 = 175.418$; $p \leq 0.001$); ethnic group ($\chi2 = 266.030$; $p \leq 0.001$); main occupation ($\chi2 = 72.839$; $p \leq 0.001$); and size of land of respondent ($\chi2 = 85.\ 254$; $p \leq 0.001$). The findings indicate that perceived socio-economic effects of climate change varied by sex, village, ethnic group, main occupation and land size of respondents.

It is evident from the discussion that although men and women were continuing to work on their farms, crop production and livestock keeping are becoming more risky production activities as climate change intensifies, the observation reported also in Maharjan *et al.* (2011). Climate change has increased poverty level of the farmers, obstructing their effort to meet family development targets; and had undermined effort of Tanzania to reduce poverty and attain Millennium Development Goals, the argument which was also foreseen by UNFPA (2009). However, it was encouraging to realize that respondents were not passive victims of climate change but they were fighting back to assure their survival by undertaking various adaptation practices.

4.0 Conclusion and recommendations

This study analyzed perception of respondents on climate change, and examined effects of climate change by sex. Using available knowledge system majority of men and women managed to perceive climate change (that is increased rainfall variation, temperature, drought and strong winds); identify negative effects associated with climate change; and severity of those effects on their livelihoods. This means that the available knowledge system in the study area can be used to identify climate change and its effects; and use appropriate adaptation practices to adapt to or reduce the effects in Tanzania. The study suggests Tanzania and other Less Developed Countries to build on available knowledge system to learn and manage climate change problems.

Moreover, climate change and its effects were perceived differently by respondents depending on sex, location (village), marital status, ethnic group, main occupation and land size of respondents. This implies that climate change perception varied between men and women; one village and another; among the single and married individuals; and also among various ethnic groups. The study calls for follow up studies to analyze perception of climate change among and between various gender groups.

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