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Farmers' Awareness on Climate Change and Adaptation Practices in Mpwapwa District, Dodoma-Tanzania

Immaculate O. Gillo
Assistant Lecturer, Institute of Rural Development Planning, Dodoma, Tanzania
Jeremiah Mkomage
Assistant Lecturer, Institute of Rural Development Planning, Dodoma, Tanzania
Hozen Mayaya
Associate Professor, Institute of Rural Development Planning, Dodoma, Tanzania

Abstract:
Climate change has serious impacts on human livelihood, particularly rural farmers whose livelihoods depend on agriculture. The extent to which these impacts are felt depends in large part on the level of farmer's awareness and adaptation in response to climate change. This study examined farmers' awareness on climate change in Mbori and Makutupa villages, in Mpwapwa district. The study determined farmers perceived causes of climate change and assessed adaptation practices in coping with climate change. Data were collected through participant observation, interview and Focus Group Discussion from 100 respondents. Factor analysis was used to analyze the awareness of the farmers on climate change and effectiveness of adaptation strategies. Results show farmers awareness on the impact of climate change was very high with 86% of respondents being aware that, climate change is caused by deforestation (80%), charcoal burning (69%), overstocking (60%), and farm activities (46%). The study further revealed that farmers have some knowledge to change their farming practices to cope with the impact of climate change. The Adaptation measures include planting of drought tolerant crops and engaging in irrigation schemes.
The study further recommends formulation of effective policies that will help farmer's adaption to climate change by investing on appropriate adaptation technologies, increase access to information, extension services and more involvement of Non-Governmental Organizations (NGOs), media, and private sector.

Keywords: *Climate change, awareness, adaptation practices, livelihood, small holder farmers*

1. Introduction

The literature on the climate change indicates that effects of climate change such as changes in rainfall and temperature, floods, drought, typhoons, and hurricanes have already touched every corner of the world and every aspect of people's lives (Chaudhary & Aryal, 2009). The effects of climate impact upon the livelihoods of the rich and poor in whatever part of the globe they live (IPCC, 2007). For many years, scientists and climatologists have raised concern on climatic change and its effects to human being and environment; as it affects agriculture, forestry, food, and water resources that are critical for livelihoods (CEEPA, 2006). In Asia and Sub Saharan Africa, Climate change has already led to the reduction in the yields of several crops that are important for food security to the populations (Tin, 2008). Agriculture remains the main source of livelihoods for rural communities in Tanzania; as it is a source of food and raw materials for industries; it provides employment to 66.9% of the population, accounts for about 23 percent of GDP, generates 30% of exports and 65 percent of inputs to the industrial sector, and contribute to 23% of Gross Domestic Product (URT, 2016).

Agriculture is inherently sensitive to climate conditions and is one of the most vulnerable sectors to the risks and impact of climate change. As it has been argued, "droughts, floods and changes to growing seasons have significant effects on agricultural productivity" (Tin, 2008). The degree to which climatic change affect agricultural system depends on a wide variety of factors, including the type of crops produced, the availability of necessary resources (financial, natural and institutional), technical capability, and human knowledge. In Tanzania, agriculture is seasonal and farmers mainly depend on rained agriculture. This makes them vulnerable to the adverse impact of climate change. Long-term changes in rainfall patterns and shifting temperature zones are significantly affecting agricultural production, food security, and economic growth (Hassan and Nhemachena 2007). Adaptation to climatic changes is widely recognized as a vital component of any response effort to climate change (Baethgen et al., 2003). Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damage, to take advantage of opportunities, or to cope with the consequences. Thus, the adaptive capacity of a society describes its ability to modify its characteristics or behavior so as to cope better with changes in external conditions. Agricultural adaptation to climate change is the manner in which farmers update their expectations of the climate in response to (unusual) changing weather (Kulindwa, 2002).

Without adaptation, climate change is generally detrimental to the agriculture sector, but with adaptation such vulnerability can largely be reduced. According to Gbetibouo (2009), the degree to which an agricultural system is affected by climate change depends on its adaptive capacity. It is known that people in drought and flood-affected communities have evolved their own adaptation strategies to protect their families, assets, and secure food security (Agrawal *et al,* 2008; Odjugo, 2010). Local-level capacity to adapt to climate change differ among households, social groups, and communities depending on the type of economic activities, availability of resources, their knowledge, access to extension services, level of development, and climate change information; and adaptation to climatic changes is important in reducing its impact to agricultural cultivation (Hassan and Nhemachena (2007). Farmers' awareness of climate change is an important determinant of adaptation to prevent decrease of crop production as the study done by Nast (2001) indicates that climate change adaptation has a potential to increase food production and reduce food deficits from 50 to 20 percent in Africa.

Dodoma which is situated in semi-arid areas is one of the region badly affected with climatic change, farmers have been suffering from a varied problem associated with climatic change including drought, changes to growing seasons, high temperature and water shortage that pose agricultural production challenges (FAO, 2008). It is not known yet whether farmers are aware of climatic change, and how they cope with the problem. Therefore, this study examined farmers' awareness about climatic change, perceived causes and assesses adaptation strategies to cope with the effects of climatic change.

2. Study Area and Methodology

The current study was conducted at Mbori and Makutupa villages, in Mpwapwa district. The two villages are situated in semi-arid areas and have a dry savannah type of climate. The area is characterized by long dry seasons, unimodal and erratic rainfall that falls between November, December, and April. Average annual rainfall is about 500 to 800mm and annual average temperature is about 23°C (REF). The villagers depend mainly on agriculture; the primary crops grown being maize, sorghum, and millet as staples while groundnuts and sunflower as cash crops (URT, 2003).

The study employed a cross-sectional research design and both secondary and primary data were collected. The study sample was obtained by using stratified sampling and simple random sampling technique to obtain a total of 100 respondents from a sampling frame of smallholder farmers from villages of Mbori (50 respondents) and Makutupa (50 respondents). These two villages were selected because is among the area highly affected by climate change in the region. Moreover, purposive sampling was used to select 20 key informants such as District Agricultural Officer, Ward and village leaders, agriculture extension workers, and members of village government committees.

The data collected from this study were obtained from both primary and secondary sources. Primary data collection methods included key informants' interviews, Focus group discussion, and observations. A checklist for an in-depth interview to collect qualitative data from key informants was used and a focus group interview guide was used in discussion to gather information from two focus groups conducted. A structured questionnaire was administered to farmers to collect quantitative data and the observation was made to verify some of the findings obtained from the respondents. Secondary data on the awareness and adaptation practices of farmers towards climate change were collected through review of relevant information. Qualitative data was analyzed by using content analysis where data were broken into small meaningful information in relation to the objectives of the study. Quantitative data was analyzed through descriptive statistics including frequencies, means, percentages, and cross-tabulations. The results obtained were presented by using figures, tables, charts, and text.

3. Results and Discussion

3.1. Respondents Characteristics

The main characteristics of respondents considered in this study are sex, age, level of education and marital status. The results are here under presented and discussed.

3.1.1. Sex of the Respondents

Results on sex of respondents show that more than half of respondents (69%) were males and
31% were females (Table 1). Analysis of the results by village also indicates that the proportion of male headed households is above halt (68-70%). Even though this study involved both sexes in equal probability as they were selected randomly, the possible explanation for this is that a large number of household heads within these communities are men who are more likely to be exposed or has more knowledge of climate change.

Variable	Description	Respondents (%)		
		Mbori (n = 50)	Makutupa (n = 50)	Total
Sex	Male	70	68	69
	Female	30	32	31
Age (years)	18 – 25	6	4	5.0
	26 – 35	20	14	17.0
	36 – 45	36	42	39.0
	46 – 55	34	32	33.0
	>55	4	8	6.0
Level of Education	Informal Education	42	40	41.0
	Primary Education	46	34	40.0
	Secondary Education	6	22	14.0
	College Education	6	4	5.0
Marital Status	Single	22	28	25.0
	Married	48	42	45.0
	Divorced	8	6	7.0
	Separated	14	16	15.0
	Widow	8	8	8.0

Table 1: Person characteristics of respondents'
Source: Fieldwork Survey, 2012

3.1.2. Age of the Respondents

Results on the age of respondents show that on average large proportion (72%) of respondent's ranges between 36 and 55 years old. The results also show that very few respondents were in the age of category o 18 to 25 (25%) and greater than 55 (6%). Similar proportion of age groups is observed in all villages. These results imply that the large number of respondents were adult with the responsibilities of caring for their families also could imply they had adequate experience of climate change and know different coping strategies they adopt in their life style. From this point of view, it can be concluded that age group of people determines understanding level of climate change and coping strategies used within the community. This fact also suggests that there is the presence of labour forces for various coping strategies and interventions as there are more energetic young and middle age people.

3.1.3. Education Level of the Respondents

Education Level of the respondents show that on average large portion (42%) of the respondents had informal education (never attended the formal school), followed nearly by respondents who had primary school education which accounts for 40% of total of the respondents. Also, the results indicate that very few had attained secondary and college education accounting for only 12% and 6% respectively. The level of education is an important factor in coping with risks and uncertainties related to climate change, as education equip people with skills in various opportunities and determines the performance of individuals in their respective development activities (Orindi et al., 2005).

3.1.4. Marital Status of respondents

The results on marital status of the respondents show that on average a relative large number of respondents (42-48%) were married as presented in Table 1. This implies that many had family responsibilities. This also indicates a relative stable community. This may necessitate them to engage in economic activities and find different coping strategies to meet the family needs.

3.2. General Awareness of Farmers on Climatic Change

The findings reveal that 89 percent of the farmers are aware on the causes of climate changes and their impacts to the environment, agriculture and livelihood. Only 11 percent of the farmers said they were not aware of the factors that contribute to the incidence of climate change. In the same vein the majority (88%) of participants of Focus Group Discussion, were aware of the changes in climate.

3.3. Farmers Perceived Causes of Climate Change

As in this regard, farmers interviewed were able to point out different causes of climate change according to their perception. Study results in Figure 1 indicate that the most prominent cause of climate change was cutting of trees (deforestation) that accounts for 80% of all respondents. For example, the Focus Group Discussion participants pointed out the reasons for widespread of trees cutting as meeting human necessities such as charcoal, settlement area, farm expansion and for building materials.

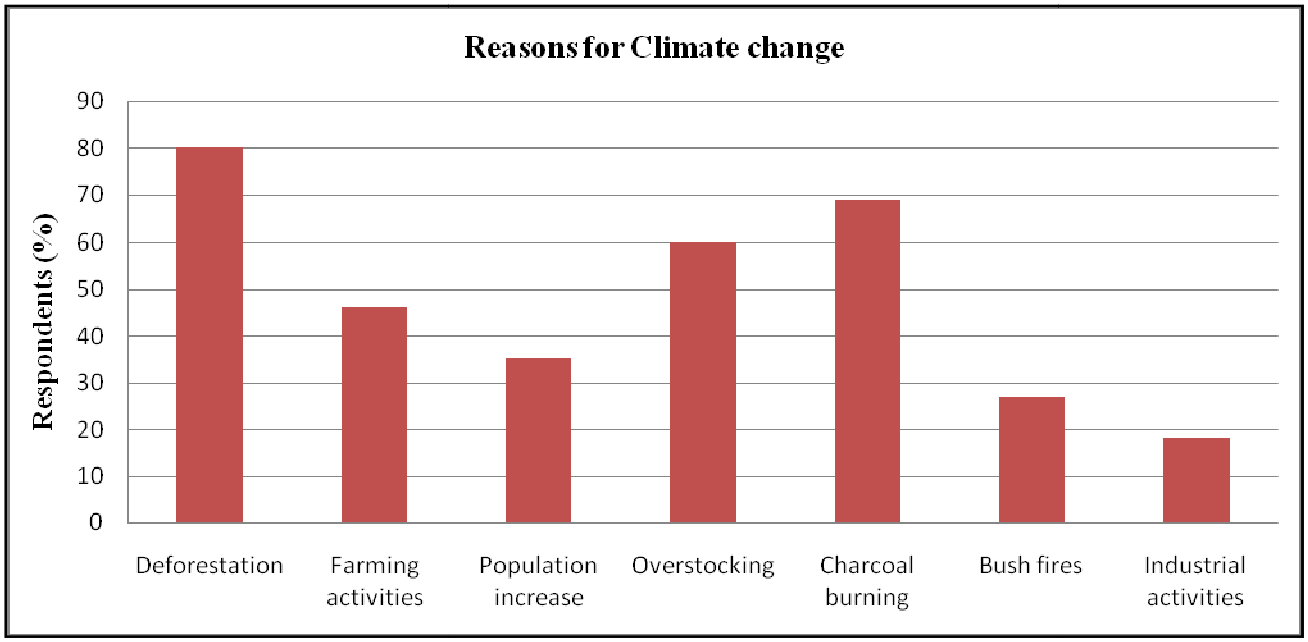

Figure 1: Farmers mentioned causes of Climate change

Sixty nine percent of the farmers voiced their concern that charcoal burning which is highly practiced in the area is due to lack of electricity or gas for cooking, is another major cause. Other causes mentioned by respondents as contributing factors for climate change were: overstocking 60 percent, poor farming activities (46 per cent), increase in population (35 per cent), bush fires (27 per cent), and industrial activities (18 per cent). These findings imply that climate change is mainly caused by human (anthropogenic) activities an argument supported by Ehrhart et al, (2006) that climate change is mainly caused by anthropogenic activities such as burning of fossil fuels from industrial activities, bushfires, deforestation, and also bad agricultural practices.

3.4. Famers Perceived Indicators of Climatic Change

Study results in Table 2 indicate that a change in precipitation is the most indicator known by 95% respondents. Possible reasons for noting changes in precipitation could be the fact that rainfall is important to the survival of farmers' crops, something that makes them to observe the trend of weather changes over time. The other indicators mentioned are temperature increase (81%), increase in crop pests and diseases (56%), drying of water sources (78%), drying of animal pasture (72%), and increase of families under food insecurity (36%) as a result of persistent drought.

Variable	Description	Respondents (%) (N=100)
Indicator	Changes in precipitation	95
	Temperature increase	81
	Drying of water sources	78
	Drying of animal pasture	62
	Increase of crop pest and diseases	56
	Low yield and food insecurity	36

Table 2: Indicators of climate change known by farmers

3.4.1. Precipitation Changes

In total, 95% of the respondents observed changes in rainfall patterns. The changes included remarkable decrease in the amount of rainfall, rainfall coming late, and rainfall coming in short periods. As a result, the area is getting drier and drier. Similar observations were noted by the key informants that there was a change not only on the total amount of rainfall but also in the timing of the rains. The patterns indicated that rains often come either earlier or later than expected. The findings as regard to changes in precipitation pattern is supported by Lavira (2009), which indicated that rainfall pattern has been decreasing at different places in Tanzania; affect farming and animal keeping activities. The same was also found by Gbetibouo (2009), who reported a change in the timing of rainfall with the main rainfall season coming late. The same author, further noted that rainfall was short-lived making water that is responsible for farming activities to be inadequate, hence, failure in production.

Secondary data from the Tanzania Meteorological Agency from 1985 to 2011 period showed a significantly decrease in rainfall amount as depicted clearly in Figure 2. Based on these findings, it is clear that the changes in precipitation pattern have been sweeping across the country for decades and its impact on agriculture production is inevitable.

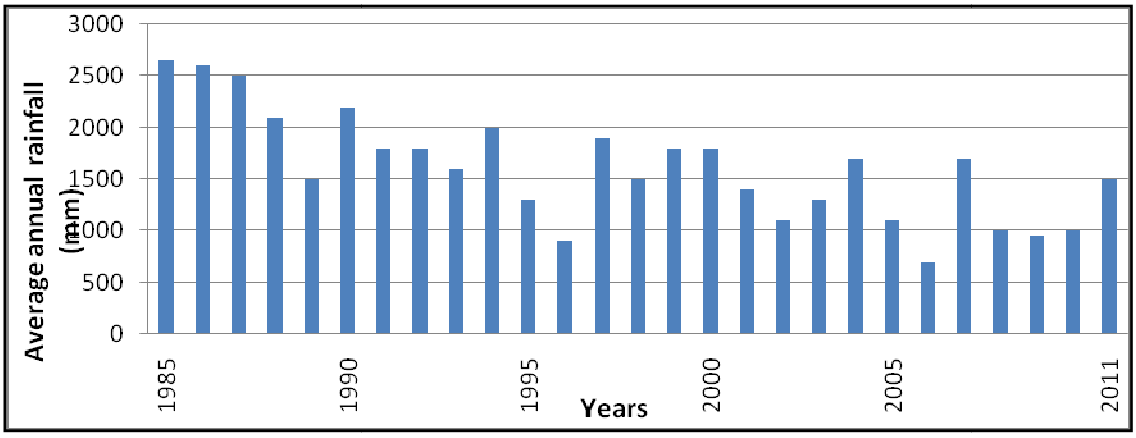

Figure 2: Mean Annual Rainfall variations, 1985 - 2011
Source: Tanzania Meteorological Agency, 2012

3.4.2. Temperature Changes

Increase in temperature was one of the main indicators for climate change mentioned by 85%of farmers interviewed. This finding shows that majority of farmers are aware of changing temperatures, as it is easily detected. Further inquiry from primary respondents on the type of change of temperature indicated that more than two thirds of respondents (80%) perceived that temperature is increasing. As noted by Levira (2009), temperature has been dramatically increasing, and this is responsible for increased evapo-transpiration in the soil. The proportion of respondents who held that there was no any major change in temperature was 11% while only 5% argued that the temperature is decreasing, as indicated in Figure 3.

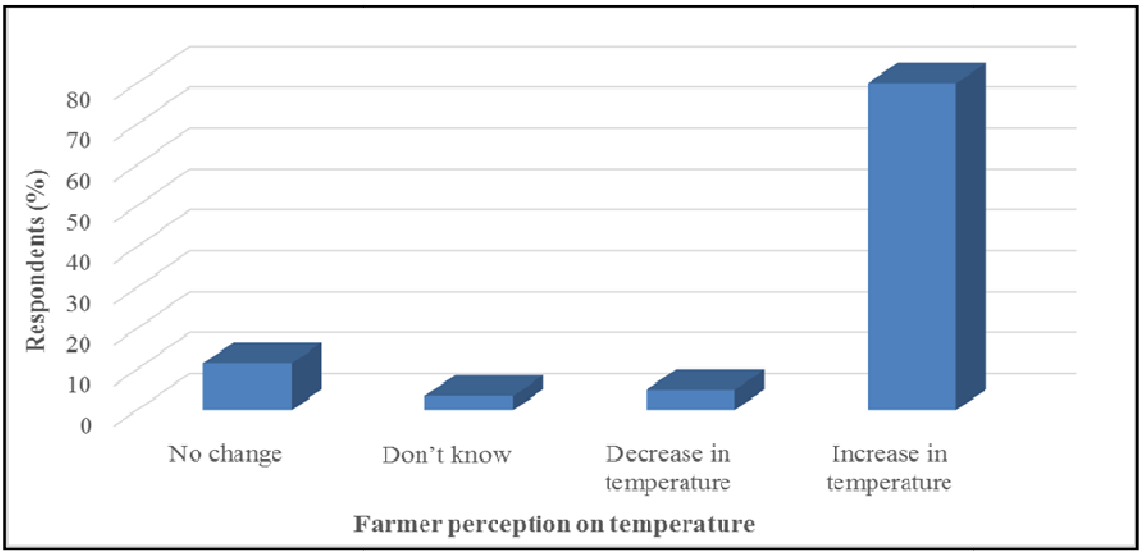

Figure 3: Farmer perceptions on temperature changes

3.4.3. Increase of Crop Pest and Diseases

Other mentioned indicators of climate change included eruption of crop pests and diseases (56%) such as stolk borers, maize weevils, elegant grasshopper, and large grain borers which in most cases occurs in serious drought situation. Failure of crops creates food insecurity as supported by District Agriculture Department that there is a decrease in crop production although this situation may be attributed by many factors that include reduced soil fertility and poor agricultural practices.

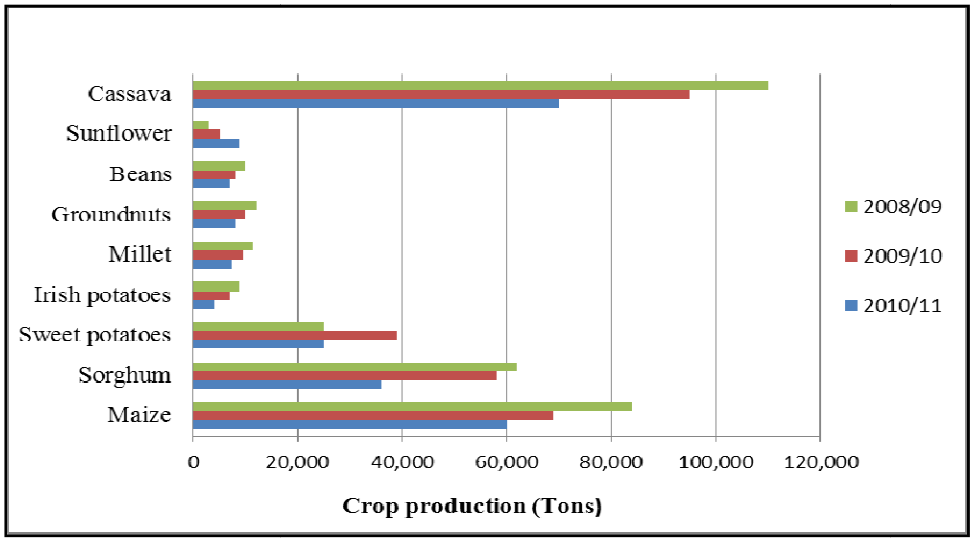

Figure 4: Crop Production trends from 2008/09-2010/11
Source: Mpwapwa District Agricultural Department, 2012

The trend of harvest for most crops such as maize, millet, sorghum, and millet that are the common crops grown in the area have progressively decreased over the past four years i.e. from 2008 to 2011.

3.5. Adaptation Strategies Undertaken by Farmers against Climate change

This study revealed different adaptation efforts made by farmers in Mpwapwa district to reduce the negative effects of climate change, indicating that farmers knew that the climate has changed and will go on changing. The study results in Table 3 on adaptation strategies indicate that close to all respondents (98%) reported planting drought resistant crops, 91% planting early maturing crops, 88%, change planting season, 82% practice irrigation farming, 80% engage in off farm activities, 76% practice mixed farming, 66% use certified seeds which have been tested to grow under hash situation, and 46% of respondents use manure and pesticides as strategy to adapt or reduce negative effects of climate change. Generally, it indicates that farmers have diversified strategies to cope with the changes in climate.

Variable	Description	Respondents (%) (N=100)
Adaptation measures	Planting of drought resistant crops	98
	Planting early maturing crops	91
	Changing planting season	88
	Engaging in Irrigation	82
	Engaging in off farm activities	80
	Practicing mixed farming system	76
	Use of certified seeds	66
	Use of manure and pesticides	46

Table 3: Adaptation strategies used by farmers to cope with climate change
Source: Fieldwork Survey, 2012
(Percentages are in multiple responses)

3.5.1. Changing Planting Season

The study (Table 3) revealed that 88% of respondents have changed their planting season to ensure that the critical crop growth stages do not coincide with very harsh climatic conditions such as mid-season droughts. Many respondents argued that the timing of rains has changed due to the rain coming late and unpredictably in frequency and amount. Before the on-going changes, rainfall used to start from early November and reached its peak in December or January. Because of unpredictability of the rainfall, farmers cultivate and plant in successive periods; at first, from January, then in late January, and finally in late February. Such changes in planning seasons show that farmers have modified their planting seasons to cope with climate changes. The findings on changes in the planting season is supported by Orindi and Eriksen (2005) who noted that farmers have modified the length of the crops growing period and, changed the planting and harvesting dates as crop management practices against changes in climate.

3.5.2. Practicing Mixed Farming System

The change from a monoculture farming system to a mixed farming system was identified by 76% of the respondents (please refer to Table 3 above) as one of the strategy adopted when farmers are faced with climate risk. Farmers grow a number of different crops in

the same plot of land to reduce the risk of complete crop failure. The practice of mixed farming subject to changes in climate is also documented by Orindi and Eriksen (2005) who reported that crop mixing serves as assurance to farmers because different crops are affected differently by changes in climate. The same authors further reported that farmers also practice intercropping cultivation whereas they grow more than two crops in the same field and deal with soil management techniques to retain water and reduce runoff.

3.5.3. Engaging in Irrigation

Irrigation farming is one of the common strategies applied by farmers in Mpwapwa district as identified by 82% of the farmers interviewed (please refer to Table 3). This is done more intensively especially during dry seasons by using various traditional irrigation systems such as surface and ground water resources. The common practice to collect water for irrigation was found to be collecting rain water in ponds, digging wells, and using water pumps. Irrigation helps in increasing food production, hence reduces the problem of food insecurity in the area. It also helps to solve water shortage problem, especially in the dry season, when gardening activities are predominantly practised. The common garden crops grown include onions, tomatoes, leafy vegetables, and sugarcane. The potential of irrigation in overcoming effects of climate change is also documented by Baethgen et al., (2003); farmers overcome climate change by investing on irrigation agriculture which has the potential to improve agricultural productivity and lengthening the growing season.

3.5.4. Diversification of Activities

Apart from diversifying farm crops, 80% diversify their activities by engaging themselves in non-agricultural activities (please refer to Table 3). This implies that climate change is a motivating factor for involvement in off farm activities. The activities include wage petty business, selling of charcoal, local beer, firewood, engaging in bee keeping, mining, and fishing. Migration in search of wage employment and resettlement was opted when opportunities to get money or food in the same locality were fading. Previous study by Kulindwa (2002) also reported that there is a gradual shift of activities as the climate continues to change. This signalled that what is happening in Mpwapwa district, and the study area specifically, is not different from what is happening in other parts of the globe.

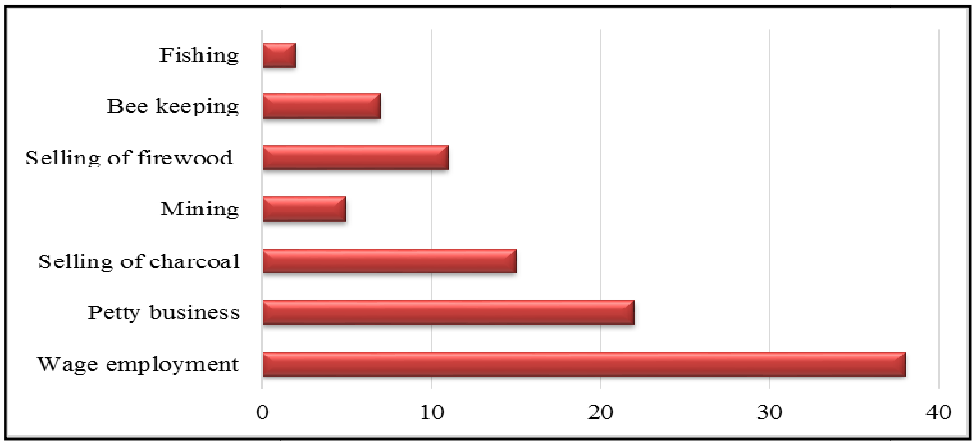

Figure 5: Non-agricultural activities opted for subject to climate change

3.5.5. Planting of Drought Resistant and Early Maturing Crops

Most of all respondents (98%) interviewed (please refer to Table 3) grow crop varieties that are tolerant to drought, to adapt to changes in climate. The crops included sorghum, millet, sunflower, cassava, and cowpea which are more drought tolerant, attain maturity earlier, and grow in a short period of less than 100 days. This is the implication that there is a problem of changes in climate in the study area.

4. Conclusion and Recommendations

This study assessed farmers' awareness on change in climate and the strategies used to cope with the problem of climate change. Based on the study results, it is concluded that the majority of farmers are aware of changing trend of temperature and rainfall patterns as the common indicators of climate change. Farmer's perceived that of climatic changes was noted through increase in temperatures reduction in the amount of rainfall over years. It further concluded that factors for climate change in the study area were deforestation, overstocking, poor farming activities, bush fires, industrial activities and charcoal burning. The current study also found that climate change has affected the agricultural sector in the study area, mainly through declining of crops production. In order to cope with effects of climate change, farmers plant drought resistant crop varieties, practice mixed farming system, plant early maturing crops, change planting season, engage in irrigation, and non-farm activities. In the light of the conclusion drawn, the study recommends formulation of effective policies which will help farmers' adaption to climate change by investing on appropriate climate change adaptation technologies, increase access to information, extension services, credit, and more involvement of NGOs, media and private sector. Policy makers are advised to design and implement appropriate interventions to manage climate change problems, the government to subsidized agriculture, intensify its efforts to promote education, training and public awareness on climate change.

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