Incidence of Indigenous and Innovative Climate Change Adaptation Practices for Smallholder Farmers' Livelihood Security in Chikhwawa District, Southern Malawi

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Abstract

Prolonged dry spells or droughts and floods as a result of climate change are a serious problem for smallholder farmers in Malawi, because agriculture is their main livelihood strategy. Food shortages and low income levels due to climate change impacts mean inability of farmers to actively participate in the day to day economic activities. Low income levels can also be translated into lack of access to basic needs of life that are purchased with money. Farmers that have mainly been affected with this problem are those that have land allocations in the Shire River Valley in Chikhwawa and Nsanje Districts. Understanding of the indigenous and innovative climate change adaptation strategies would assist smallholder farmers and policy makers, civil society organisations and the private sector to design programs that can assist farmers to build resilience against climate change impacts for their sustainable livelihoods. This paper therefore assessed the incidence of indigenous, innovative climate change adaptation strategies for smallholder farmers' livelihood security in Chikhwawa district. Factors that affect adoption of such strategies were also analyzed and discussed.

The study revealed that Crop diversification, eating a wild tuber plant called nyika (Nymphaea petersiana), applying organic manure to agriculture fields, mixed crop and livestock farming; small scale irrigation are the main indigenous climate change adaptation strategies being adopted by households in the study area. The study also shows that household size, landholding size, total annual household income level, access to inputs and output markets, months household had no maize or sorghum as a proxy to food insecurity level, and access to agricultural extension services are the major factors or household characteristics that significantly affect adoption of indigenous climate change adaptation strategies in the study area. It was so clear from the analysis that access to agricultural extension services strongly and significantly affects the probability of households adopting most of the identified climate change adaptation strategies.

In terms of policy implications, the identified indigenous climate change adaptation strategies should be promoted by the farming communities, responsible government departments, the donor community, civil society organisations as well as the private sector if farm families in the study area and other areas in Malawi are to build resilience against climate change impacts and have sustainable livelihoods. The government of Malawi through Ministry of Agriculture and Food security should also improve on the agricultural extension services delivery system and develop messages that aim at promoting adoption of climate change adaptation strategies being identified.

Key words: Climate change, indigenous and innovative adaptation strategies, livelihood security

1. Introduction

Climate change and variability (CC&V) is increasingly emerging as one of the most serious global problems affecting many sectors of economic growth in the world. Such sectors widely affected by the impacts of climate-related hazards and calamities include; Agriculture, Water, Fisheries, Forestry and other Land-Use, Wildlife, Energy, Industrial Processes and Product Use, Waste Management, Human Health, and the sustainable livelihoods of both rural and urban communities (Lema M.A and Majule A.E., 2009 and Bie et.al., 2008). Climate change and variability is considered as one of the most serious threats to sustainable development with adverse impacts on food security, economic activities and physical infrastructure (Lema M.A and Majule A.E., 2009 and IPCC, 2007). The impacts are so rampant in Africa, which is considered to be one of the most vulnerable regions to climate change in the world.

Africa is subject to widespread poverty, recurrent droughts, and inequitable land distribution and over dependence on rain-fed agriculture (Lema M.A and Majule A.E., 2009). As such, the majority of farming households in Africa have struggled to sustain their livelihoods and this has been as a result of numerous social, economical and environmental degradation problems which have been exacerbated by adverse impacts of climate change and climate variability. Climate change and variability has created uncertainties in temperature patterns, intensities of received ultraviolet radiation, and rainfall and wind patterns. As a result, rural people in countries like Malawi whose main economic activity is agriculture are faced with so many challenges in decision making with respect to their agricultural activities (Bie et.al, 2008).

Over the last few decades, Malawi has experienced extreme weather events, ranging from droughts (1991/92) to floods (1996/97) and flush floods (2000/01). During the 1996/97 crop season, when there were floods in the southern region, some parts of the northern region along the Karonga Lakeshore plain experienced drought conditions. These extreme weather events clearly show that there are large temporal and spatial variations in the occurrence of climate-related disasters and calamities. In the affected areas, these events have had irreversible and damaging effects on crop and livestock production, especially the droughts that occurred during the 1978/79, 1981/82, 1991/92 and 1993/94 crop growing seasons.

Prolonged dry spells or droughts and floods are a serious problem for smallholder farmers in Malawi, because agriculture is their main livelihood strategy. Food shortages and low income levels mean inability of farmers to actively participate in the day to day economic activities. Low income levels can also be translated into lack of access to basic needs of life that require to be purchased with money. Farmers that have mainly been affected with this problem are those that have land allocations in the Shire River Valley in Chikhwawa and Nsanje Districts.

In order to solve this problem the Government of Malawi in collaboration with other development partners, has tried to assist farmers in the valley and even those in the highlands by sensitizing them on the impacts of climate change and by engaging farmers in the decision making process to come up with appropriate solutions that could reduce the negative impacts of climate change. Most of the proposed solutions or strategies have been assisting farmers to cope up with the effects of climate change impacts and not necessarily to adapt to the impacts themselves. However, some communities have been using their indigenous knowledge or technologies to adapt to climate change impacts even though these technologies have not been documented so that they can be reinforced and scaled up to other communities. Thus, some research and development partners are still asking a lot of questions around climate change adaptation practices. Such questions include the following: 1. what are the effective indigenous, emerging and innovative technologies for climate change adaptation? 2. What are the individual and institutional behaviors towards climate change adaptation measures? 3. What are the factors that affect adoption of various adaptation strategies? 4. What are the capacity building needs of the farming communities that can assist to adapt to climate change? Understanding of the links among incidence of climate change, indigenous, emerging and innovative adaptation technologies and livelihood security in Malawi is very key if these questions are to be answered.

This paper analyses the different identified indigenous, innovative climate change adaptation strategies for smallholder farmers' livelihood security in Chikhwawa district. Factors that affect adoption of such strategies are also analyzed and discussed. The paper also discusses the policy interventions that can assist farmers to build resilience against climate change impacts for their sustainable livelihoods.

2. Review of Indigenous & Innovative Climate Change Adaptation Practices in Chikhwawa District

Lema M.A and Majule A.E., 2009 reported that Climate change is a global phenomenon while adaptation is largely site-specific. This implies that climate change adaptation strategies require site specific knowledge. According to IPCC, (2007) a clear understanding of what is happening at a community level is of paramount importance in order to significantly impact on farmers who are by large the most climate-vulnerable group.

Apparently, indigenous, innovative climate change adaptation practices by smallholder farmers in Chikhwawa district were not found in the literature. This implies that climate change adaptation practices in Chikhwawa were not being documented. However, studies in various countries shows how farmers adapt to various impacts of climate change and variability. For example, in Cameroon, Molua (2008) observed that Cameroon's agricultural sector depend largely on the return of good rains and timely availability of adequate inputs such that years of improved rainfall were associated with improved agricultural output and vice versa. However, farmers in Cameroon are not passively submitting to climate variation. It was revealed that farmer's main strategy for reducing climate risks was to diversify production and livelihood systems. In addition, other farmers acquire more livestock to cushion income, while others engage in various non-farm activities. Overall, Molua (2008) concluded that with semi-extensive farming systems being sensitive to small changes in climate, agricultural-dependent countries like Cameroon are more likely to be vulnerable to these changes. Now the major question is: what are the effective indigenous and emerging technologies and innovations for climate change adaptation in Chikwawa District in Southern Malawi?

3. Conceptual Framework & Theoretical Review

Consider a farmer or a decision maker who has been affected by climate change and is able to compare two climate change adaptation alternatives $a$and $b$in the choice set C using a preference indifference operator$\geq$. Assume that this farmer is rational and would like to maximize utility. Given a set of different climate change adaptation measures, this farmer would opt for an alternative that would maximize his or her utility.

If $a \geq b$, the decision maker either prefers a to b or is indifferent. The preference-indifference operator is supposed to have the following properties:

1. Reflexivity: $a \geq a$, $\forall a \in C$.

2. Transitivity: $a \geq b$ and $b \geq c \Rightarrow a \geq c$, $\forall a, b, c \in C$.

3. Comparability: $a \geq b$ or $b \geq a$, $\forall a, b, \in C$.

Because the choice set C is finite the existence of an adaptation alternative which is preferred to a farmer is guaranteed, that is

$$\exists a^* s.t \ \ a^* \geq a \ , \ \forall a \in C. \qquad (1)$$

More interestingly, and because of the three properties listed above, it can be shown that the existence of a function

$$U : C \rightarrow \Re : a; U(a) \tag{2}$$

Such that

$$a \geq b \Leftrightarrow U(a) \geq U(b), \quad \forall a, b, \in C. \tag{3}$$

is guaranteed. Therefore, the alternative a^* defined in (1) may be identified as

$$a^* = \arg\max_{a \in C} U(a) \tag{4}$$

Using the preference-indifference operator ≥ to make a choice is equivalent to assigning a value, called utility, to each alternative, and selecting the alternative a^* associated with the highest utility.

The concept of utility associated with the alternatives plays an important role in the context of discrete choice models. However, the assumptions of neoclassical economic theory present strong limitations for practical applications. Indeed, the complexity of human behavior suggests that a choice model should explicitly capture some level of uncertainty.

The exact source of uncertainty is an open question. Some models assume that the decision rules are intrinsically stochastic, and even a complete knowledge of the problem would not overcome the uncertainty. Others consider that the decision rules are deterministic, and motivate the uncertainty from the impossibility of the analyst to observe and capture all dimensions of the problem, due to its high complexity. Simon P. et al. (1992) compare this debate with the one between Einstein and Bohr, about the uncertainty principle in theoretical physics. Bohr argued for the intrinsic stochasticity of nature and Einstein claimed that “Nature does not play dice”.

The Luce Model

An important characteristic of models dealing with uncertainty is that, instead of identifying one alternative as the chosen option, they assign to each alternative a *probability* to be chosen.

Luce (1959) proposed the choice axiom to characterize a choice probability law. The choice axiom can be stated as follow.

Denoting $Pc(a)$ the probability of choosing a in the choice set C, and $Pc(s)$the probability of choosing one element of the subset S within C, the two following properties hold for any choice set U, C and S, such that $S \subseteq C \subseteq U$.

1. If an alternative $a \in C$ is dominated, that is if there exists $b \in C$ such that b is always preferred to a or, equivalently, $P_{\{ab\}}(a) = 0$, then removing a from c does not modify the probability of any other alternative to be chosen, that is

$$Pc(S) = Pc \setminus \{a\}(S \setminus \{a\}) \quad (5)$$

2. If no alternative is dominated, that is if $0 \prec P_{\{ab\}}(a) \prec 1a$ for all $a,b \in C$ then the choice probability is independent from the sequence of decisions, that is

$$Pc(a) = Pc(S)Ps(a) \quad (6)$$

Random Utility Models

Random utility models assume, as neoclassical economic theory, that the decision-maker has a perfect discrimination capability. In this context, however, the analyst is supposed to have incomplete information and, therefore, uncertainty must be taken into account. Manski (1997) identifies four different sources of uncertainty: unobserved alternative attributes, unobserved individual attributes (called “unobserved taste variations” by Manski, 1997), measurement errors and proxy, or instrumental, variables.

The utility is modeled as a random variable in order to reflect this uncertainty. More specifically, the utility that individual i is associating with alternative a is given by

$$U_a^i = V_a^i + \varepsilon_a^i \quad (7)$$

where V_a^i is the deterministic part of the utility, and ε_a^i is the stochastic part, capturing the uncertainty. Similarly to the neoclassical economic theory, the alternative with the highest utility is supposed to be chosen. Therefore, the probability that alternative a is chosen by decision-maker i within choice set C is

$$P^i c(a) = P\left[U_a^i = \max_{b \in C} U_b^i\right] \qquad (8)$$

The Logit Model

The logit model is derived from the assumption that the error terms of the utility functions are independent and identically Gumbel distributed. These models were first introduced in the context of binary choice models, where the logistic distribution is used to derive the probability. Their generalization to more than two alternatives is referred to as multinomial logit models.

3.1 Determining factors affecting adoption of various adaptation strategies smallholder farmers in the study area

Consider a farm family which is affected by climate change and has a set of different adaptation measures. We assume that each farmer faces a set of discrete, mutually exclusive choices of adaptation measures amidst risks and uncertainties. These measures are assumed to be dependent on a number of climate attributes, socioeconomic characteristics and other factors X. Let A_i be a random variable representing the adaptation measure chosen by any farm family.

According to Greene, (2003) the MNL model for adaptation choice specifies the relationship between the probability of choosing option and the set of explanatory variables X as follows:

$$\mathrm{Prob}(A_i = j) = \frac{e^{\beta_j' x_i}}{\sum_{k=0}^{j} e^{\beta_j' x_i}}, j = 0,1,2....j \qquad (1)$$

where β_j is a vector of coefficients on each of the independent variables X. Equation (1) can be normalized to remove indeterminacy in the model by assuming that $\beta_0 = 0$ and the probabilities can be estimated as:

$$\mathrm{Prob}(A_i = j) = \frac{e^{\beta_j' x_i}}{1 + \sum_{k=0}^{j} e^{\beta_j' x_i}}, j = 0,2....j, \beta_0 = 0 \qquad (2)$$

Estimating equation (2) yields the J log-odds ratios

$$\ln\left(\frac{P_{ij}}{P_{ik}}\right) = x_i^{'}\left(\beta_j - \beta_k\right) = x_i^{'}\beta_k \text{, if } k = 0 \tag{3}$$

The dependent variable is therefore the log of one alternative relative to the base alternative.

According to Greene (2003), the MNL coefficients are difficult to interpret, and associating the with β_j the jth outcome is tempting and misleading. To interpret the effects of explanatory variables on the probabilities, marginal effects are usually derived as follows:

$$\delta_j = \frac{\partial P_j}{\partial x_i} = P_j\left[\beta_j - \sum_{k=0}^{j} P_k \beta_k\right] = P_j\left(\beta_j - \bar{\beta}\right) \tag{4}$$

The marginal effects measure the expected change in probability of a particular choice being made with respect to a unit change in an explanatory variable (Long, 1997; Greene, 2000). The signs of the marginal effects and respective coefficients may be different, as the former depend on the sign and magnitude of all other coefficients.

4. Data

The data used for analysis in this study were based on a farm household survey administered to a sample of 300 farm families. These farm families were randomly drawn from smallholder farmers that live in five Traditional Authorities and are targeted by Evangelical Lutheran Development Services (ELDS) in Chikhwawa District. From these farmers, information on household characteristics, experience and knowledge of climate change impacts in the area, indigenous and innovative climate change adaptation practices, farming practices that exacerbate climate change impacts etc were collected and used in the analysis.

Some of the explanatory variables that were considered in the analysis of the factors that affect the probability of households to adapt to climate change impacts by adopting different indigenous and innovative climate change adaptation strategies were as outlined in table 1.0 below. The descriptive statistics of the variables were computed using STATA 10 statistical package. Identified indigenous and innovative climate change adaptation practices were also summarized using STATA 10.0 statistical package and have been outlined in table 2.0 below. The different adaptation strategies combinations or options by smallholder farmers were computed using Excel computer package and also summarized using STATA 10.0 statistical package. The summarized adaptation practices options are as outlined in table 3.0 below. Results of the multinomial logit model analysis, where factors affecting the probability of households to adapt to climate change impacts by adopting different adaptation options as compared to households that did not adapt are outlined in table 4.

Table 1: Descriptive Statistics of household characteristics

Variable	Obs	Mean	Std. Dev.	Min	Max
Age of hh head	300	41.96667	15.01901	18	86
Education of hh head[1]	300	5.473333	3.944764	0	16
Household Size	300	6	3	1	15
Farming experience of hh head	300	18.37 333	14.37996	1	68
Value of hh assets[2]	300	75,301.11	237,020.2	0	3,141,200
Land Holding size[3]	300	3.6638	2.260337	0	15.5
Months hh had no maize in 2009	300	1.706667	2.5903	0	12
Months hh had no sorghum in 2009	300	2.91	2.813352	0	12
Distance to market[4]	300	3.809667	2.774431	0	13
Total annual income	300	5,204.65	90,392.73	0	1,000,000

[1] Number of Years spent in school.

[2] Value of household assets and total annual income is in Malawi Kwacha and the exchange rate is US$1:Mk152

[3] Land holding size is in acres, 1 acre=0.4hectare

[4] Distance is measured in Kilometres

[5] This wild tuber plant is scientifically known as *Nymphea petersiana*

Table 2: Identified Indigenous climate change Adaptation Strategies by percentage of households practicing

I.D	Adaptation strategy	Percentage of households practicing
1	Crop diversification	84.00
2	Eating Nyika(a wild tuber plant)[5]	56.67
3	Apply organic manure to fields	53.00
4	Mixed crop and L/stock farming	43.33
5	Small scale irrigation	42.33
6	Nonfarm income generating activities	27.67
	Sample size	300

*Note: **"Practice all"** means a household practices all the five identified strategies as indicated in Table 2. This excludes non farm income generating activities being practiced by a small percentage of households.*

Table 3: Different combinations of indigenous climate change adaptation strategies by percentage of households practicing

I.D	Adaptation strategy option or combination	Percentage	Cumulative
0	None	6.00	6.00
1	Small Scale irrigation	0.67	6.67
2	Crop diversification	8.00	14.67
3	Mixed Crop and L/stockfarming	1.00	15.67
4	Apply Organic Manure	1.33	17.00
5	Eat nyika	1.67	18.67
6	Practice all except Small scale irrigation	8.67	27.33
7	Practice all except Small scale irrigation and mixed crop& L/stock farming	8.00	35.33
8	practice all except mixed crop&L/stock farming and eating nyika	5.33	40.67
9	Practice all except aeting nyika	3.33	44.00
10	crop diversification and eating nyika	4.00	48.00
11	Practice all except applying organic manure	5.67	53.67
12	Practice all five identified strategies	7.67	61.33
13	Practice all except applying organic manure and eating nyika	2.33	63.67
14	Practice all except crop diversification and mixed crop&L/stock farming	1.00	64.67
15	Practice all except crop diversification and applying organic manure	0.33	65.00
16	Practice all except small scale irrigation and Crop diversification	0.33	65.33
17	Small Scale irrigation and applying organic manure	0.33	65.67
18	mixed Crop and L/stock farming and eating nyika	1.00	66.67
19	Crop diversification and mixed crop& L/stock farming	2.00	68.67
20	Practice all except small scale irrigation and eating nyika	5.33	74.00
21	Crop diversification and applying organic manure	5.00	79.00
22	Small Scale irrigation and crop diversification	2.33	81.33
23	Practice all except small scale irrigation and applying organic manure	5.00	86.33
24	Small scale irrigation and mixed crop & L/stock farming	0.33	86.67
25	Small scale irrigation and eating nyika	1.33	88.00
26	Practice all except mixed crop&L/stock farming and applying organic manure	6.00	94.00
27	Practice all except mixed crop&L/stock farming	5.33	99.33
28	Apply Organic Manure and eating nyika	0.33	99.67
29	Practice all except crop diversification	0.33	100.00
	Total	**100.00**	

5. Discussion of Results

5.1 Identified indigenous and innovative climate change adaptation strategies

Households practicing one or more of the five major identified climate change adaptation strategies were believed to be generally adapting to climate change impacts for their livelihood security. In order to identify the factors affecting adoption of different sets of adaptation strategies by a household, a multinomial logit model was run by using all the 29 different combinations of adaptation strategies against the different household characteristics. Table 4 outlines the combinations of adaptation strategies which proved to be significantly affected by one or more household characteristics. Only household characteristics that were significant at 99%, 95% and 90% confidence intervals were recorded.

The multinomial logit model results above illustrate the indigenous and innovative climate change adaptation strategies adopted by households in the study area. It is so clear from the analysis results that choice of different combinations of practices as compared to not to choose any adaptation strategy by a household was significantly affected by different household characteristics recorded in the table above. Figure 1.0 below illustrates identified indigenous and innovative adaptation practices against percentage of households that practice either one or combination of two or more.

Table 4: Multinomial Logit Model Results

Adapt	Coefficient	Std error	z-statistic	p-value
Practice Crop diversification				
Total annual income**	-0.0000197	0.00000837	-2.35	0.019
Months without maize***	0.3560102	0.1927071	1.85	0.065
Use Organic Manure				
Household size**	0.5190821	0.2639669	1.97	0.049
Acces s to Agri.Ext. Services*	20.92597	2.586447	8.09	0.000
Eat Nyika (a wild tuber plant)				
Distance to the market***	-0.7034511	0.4261017	-1.65	0.099
Access to Agri.Ext. Services*	20.20517	2.220309	9.1	0.000
All *minus* small scale Irrigation				
Age of household head**	0.0567859	0.0279975	2.03	0.043
Household size**	0.3104329	0.1549108	2	0.045
Total annual income*	-0.0000284	0.00000836	-3.4	0.001
Months without sorghum***	0.2531914	0.1468817	1.72	0.085
All *minus* SSI and Mixed crop & L/stock				
Age of household head***	0.0450584	0.0272918	1.65	0.099
Total annual income**	-0.0000274	0.00000944	-2.9	0.004
All *minus* mixed crop&L/stock and nyika				
Total annual income**	-0.0000204	0.00000804	-2.54	0.011
Months without sorghum **	0.408793	0.155529	2.63	0.009
Months without maize***	0.3418234	0.2013342	1.7	0.09
All *minus* eating nyika				
Land holding size**	0.3811462	0.1939771	1.96	0.049
Crop diversification& Eating Nyika				
Access to Agri. Ext Services*	19.71 1	1.74751	11.28	0.000
All *minus* organic manure application				
Months without maize***	0.3683448	0.1944356	1.89	0.058

Adapt	Coefficient	Std error	z-statistic	p-value
All practices				
Total annual income**	-0.000012	0.00000473	-2.53	0.011
Months without sorghum **	0.2830155	0.1440 495	1.96	0.049
Access to Agri. Ext Services*	19.85107	1.640641	12.1	0.000
Crop diversification and Mixed crop&L/stock				
Access to agri. Ext. services*	19.14529	2.243486	8.53	0.000
All *minus* SSI& eating nyika				
Access to agri.ext. servi ces*	19.10234	1.701527	11.23	0.000
Crop diversification & organic manure application				
Age of household head***	0.0536928	0.0300059	1.79	0.074
Total annual income***	-0.0000108	0.00000649	-1.66	0.097
SSI and crop diversification				
Month s without sorghum ***	0.3053045	0.17948	1.7	0.089
Months without maize***	0.4013618	0.2095466	1.92	0.055
Access to Agri. Ext. services*	19.45085	2.476866	7.85	0.000
All *minus* SSI & organic manure application				
Months without sorghum***	0.25645 16	0.1537832	1.67	0.095
Months without maize***	0.3296346	0.1967897	1.68	0.094
Small scale Irrigation & Eating nyika				
Months without maize**	0.4734196	0.2307704	2.05	0.04
All *minus* mixed crop& L/stock farming				
Total annual income**	-0.0000249	0.0000104	-2.4	0.016
Months without maize**	0.4208783	0.1919804	2.19	0.028
All *minus* mixed crop &L/stock and Organic manure application				
Landholding size***	0.3669732	0.1893859	1.94	0.053
Months with maize***	0.357373	0.194466	1.84	0.066
Distance to market***	0.2534015	0.1525592	1.66	0.097
Access to Agri. Ext. Services*	19.3434345	1.663863	11.63	0.000

* 99% confidence interval **95% confidence interval, *** 90% confidence interval

Note: The base outcome that was used was that the household did not adapt to climate change as being reflected in a household not practicing any adaptation strategy (none = 0).

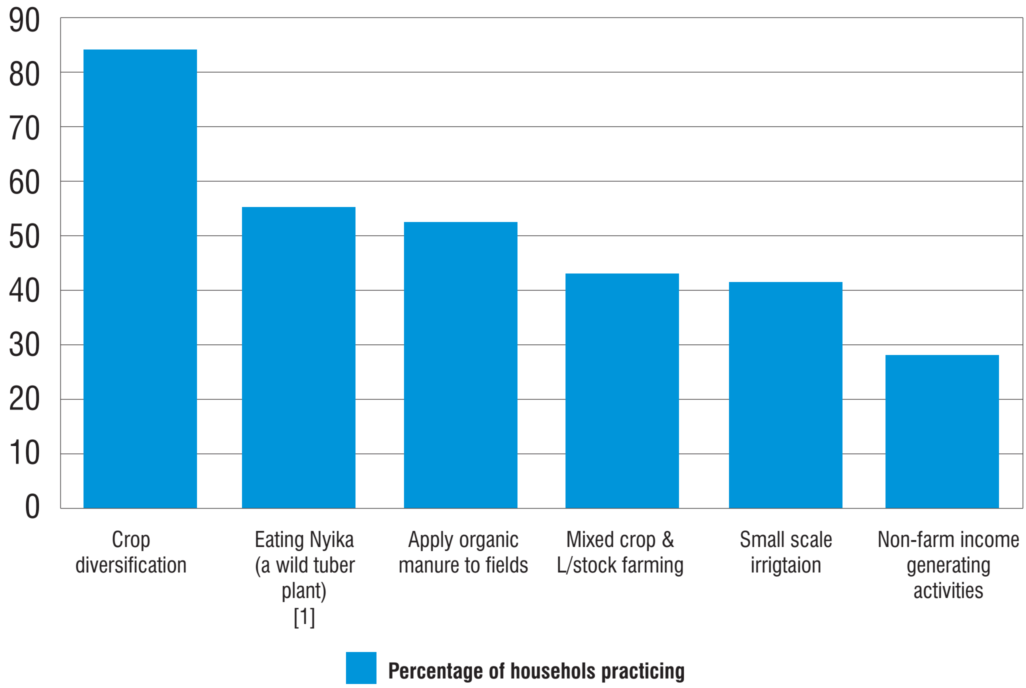

Figure 1: Percentage of households practising indeginous climate change adaptation strategies

Nonfarm income generating activities as a practice was not included in the analysis because a very small percentage (27.67%) of households indicated to have been using the strategy. This implies that agriculture is the main livelihood security strategy in the study area and any agriculture related adaptation practice is of paramount importance and needs to be promoted if farm families are to build resilience against climate change impacts for their sustainable livelihoods. Crop diversification proves to be a major climate change adaptation strategy since about 84% of households indicated to have been practicing it. Another major strategy following crop diversification was eating nyika (a wild tuber plant) scientifically known as Nymphaea petersiana. About 56.67% of households indicated to have been eating nyika when they run short of maize, sorghum and other food crops. Households fetch nyika from Shire River, but those households that stay far away from the Shire river buy nyika from the local market near to their communities. Nyika is a wild plant and it is not yet recognized as a domestic crop but yet it is the plant that has proved to be used as food crop by most households in Chikhwawa in hard times when they have run short of staple food crops. Domesticating nyika and recognizing it as one of the food crops in Chikhwawa and the Shire valley at large can help in building farmers resilience against climate change impacts. About 53%, 43.33% and 42.33% of households indicated to have been applying organic manure to their gardens, practice mixed crop and livestock farming, and small scale irrigation respectively as climate change adaptation strategies.

5.2 Factors that affect adoption of indigenous climate change adaptation strategies

The household characteristics that proved to be significantly be affecting households to adapt to climate change impacts in the study area being reflected in a household practicing one or more adaptation strategies are:- household size, landholding size, total annual household income level, access to inputs and output market, months household had no maize or sorghum, and access to agricultural extension services. It is very clear from table 4 above that as total annual income of the household increases the odds ratio that the household would adopt crop diversification decreases (or moves from 1 towards 0.) (p=0.019). This generally implies that the higher the household income level the lower the probability that the household would adopt crop diversification as a climate change adaptation strategy. Number of months without maize which was used as a proxy for household food insecurity level proved to have a positive effect on the odds ratio that a household would adopt crop diversification as a climate change adaptation strategy (p=0.065).

Household size proved to have a positive effect on the odd ratio that a household would adopt use of organic manure as a climate change adaptation strategy (p=0.049). This implies that the higher the household size the higher the higher the probability that a household would adopt application of organic manure to agricultural field. Access to agricultural extension services also proved to have a positive effect on the odds ratio that a household would adopt application of organic manure to agricultural fields (P=0.000). It is so evident that access to agricultural information on use of organic manure strongly influences households to adopt the practice.

Market access by a household (where distance to the market was used as a proxy) proved to have a positive effect on the odds ratio that a household eat nyika during hard times when a household had run short of staple and other food crops(p=0.099). The shorter the distance to the market the more easier a household have access to the market and the higher the probability that a household would buy nyika from the market and eat where there is no maize, sorghum and other food crops. This also implies that most households get nyika from the market and very few perhaps fetch it from the shire river. It is very possible that very few fetches nyika from the river on their own because it is very risky since there are a lot of crocodiles in the Shire river. However, only courageous few fetches nyika and sell it to majority of risk averse households and those who stay far away from the Shire river.

Access to agricultural extension services proved to have a positive effect on the odds ratio that a household adopt a combination of crop diversification and mixed crop and livestock farming as climate change adaptation strategies(p=0.000)

Number of months without sorghum used as a proxy of food insecurity level proved to have a positive effect on the odds ratio that a household would adopt to practicing a combination of small scale irrigation and crop diversification (p=0.089), so it was with number of months without maize (p=0.055). Access to agricultural extension services also strongly proved to have a positive effect on the odds ratio that a household would adopt a combination of small scale irrigation and crop diversification(p=0.000) as climate change adaptation strategy. Age of household head proved to have a positive effect on the odds ratio that a household would adopt a combination of crop diversification and use of organic manure (p=0.074). Total annual household income proved to have a negative effect on the odds ratio that a household adopt a combination of crop diversification and use of organic manure (p=0.097). This implies that the older the household head the less the amount of annual income the household acquire and the higher the probability that the household would adopt a combination of crop diversification and use of organic manure as climate change adaptation strategies.

5.3 Farming practices that exacerbate the impacts of climate change.

It is so clear in Figure 2 that unnecessary cutting down of trees, cultivating along the river banks and continuous cropping are some of the farming practices that exacerbate the impacts of climate change in the study area.

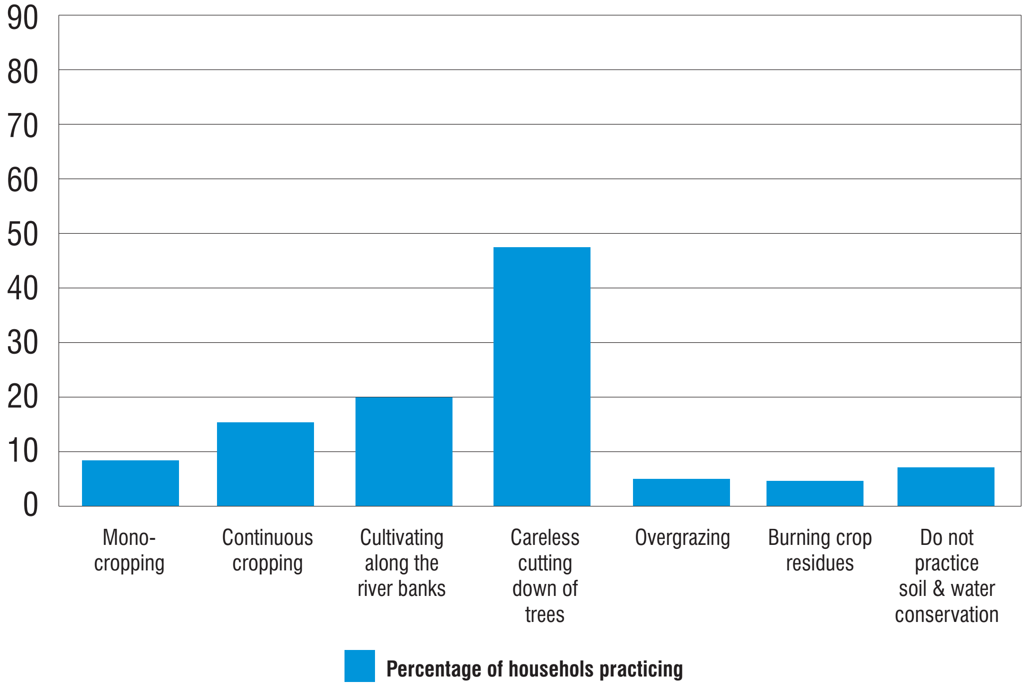

Figure 2: Farming practices that exacerbate the impacts of climate change

Majority of households (47.67%) indicated that unnecessary cutting down of trees is one of the practice in the area that exacerbate climate change impacts. About 20.33% and 15.33% of households indicated that cultivating along river banks and continuous cropping are some of the farming practices in the area that exacerbate climate change impacts.

Continuous cropping degrades the soil structure and fertility. Cultivating along the river banks results in soil erosion and river siltation. Careless cutting down of trees results in increased amounts of carbon dioxide emitted in the atmosphere. Carbon dioxide is one of the green house gases that is considered to be one of the drivers of climate change. Careless cutting down of trees results in increased rain fall water runoff which causes soil erosion. Measures that can be put in place in order to reverse or reduce these malpractices would significantly contribute to climate change impacts mitigation and adaptation in the study area.

6. Conclusions & Policy Implications

The study vindicated that Crop diversification, eating a wild tuber plant called nyika (Nymphea petersiana), applying organic manure to agriculture fields, mixed crop and livestock farming; small scale irrigation and nonfarm income generating activities are the indigenous climate change adaptation strategies being adopted by households in the study area. It was observed, however, that a small percentage of households, practices nonfarm income generating activities. This implies that agriculture, is the main livelihood security strategy in the study area. The five agricultural related adaptation strategies were therefore prioritized to be effective indigenous climate change adaptation strategies in the study area. These results are likely to be more meaningful among smallholder farmers in Chikhwawa who largely depend on agriculture as their main livelihood security strategy. In terms of policy implications, the identified indigenous climate change adaptation strategies should be promoted by the government, the donor community as well as by the civil society organisations if farm families in the study area and other areas in Malawi are to build resilience against climate change impacts.

The study revealed that household size, landholding size, total annual household income level, access to inputs and output market, months household had no maize or sorghum as a proxy to food insecurity level, and access to agricultural extension services are the major factors or household characteristics that significantly affect adoption of indigenous climate change adaptation strategies in the study area. It was so clear from the analysis that access to agricultural extension services strongly and significantly affects the probability of households adopting most of the identified climate change adaptation strategies. In terms of policy implications the government of Malawi through Ministry of Agriculture and Food security should improve on the agricultural extension services delivery system and develop messages that aim at promoting adoption of climate change adaptation strategies being identified.

Since it was observed and it has empirically been proven that majority of households in Chikhwawa eat a wild tuber plant called nyika (Nymphaea petersiana) as a food insecurity coping mechanism, it is recommended that there is need to conduct an action research on domestication of nyika and find ways on how to improve its productivity at the farm level. A study on assessing or understanding the nutrition content and different utilization options of nyika can also be conducted. In terms of policy of implications, domestication of nyika would result in conservation of the indigenous plant genetic resource which is being used as a food crop without any mechanism to replace or conserve it. Nyika can be considered as one of the underutilized food crops which need to be promoted and its genetic resource conserved.

The study also revealed that majority of households (47.67%) indicated that unnecessary cutting down of trees is one of the practice in the study area that exacerbate climate change impacts and about 20.33% and 15.33% of households indicated that cultivating along river banks and continuous cropping are some of the farming practices in the area that exacerbate climate change impacts. In terms of policy implications there is need to intensively promote afforestation programs in Chikhwawa and Malawi at large and conduct intensive civic education programs aimed at sensitizing communities on the danger of unnecessary cutting down of trees, cultivating along river banks and continuous cropping. Innovative collective action institutional set ups can be explored so that they assist in reinforcing adopting of good farming practices and influence communal and household's behavioral change in favor of climate change impacts mitigation and adaptation.

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