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Coping Strategies toward Food Security: A Case of Morogoro Region

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Abstract
This paper discusses the adequacy of off-farm coping strategies in enhancing food security for rural communities and support climate change adaptation. Using data from 2010 household cross-sectional survey in Morogoro, principle components and wealth index were performed to ascertain farmers' characteristics and ability of the off-farm activities to meet food requirement for each individual household for the whole agricultural season. The findings revealed however, that, the ability of coping strategies from off-farming activities was limited in meeting food requirements throughout the year, hence rendering food insecurity to majority of farmers in the rural areas. Climate variability coping strategies are vital in increasing small holder farmers' resilience to climate change and weather variability. With appropriate support from governments and development partners, farmers are encouraged to diversify to more viable farming and non-farming strategies so as to increase the chances of non-farm activities in decreasing the problem of food inadequacy.
Keywords: Food security, Off-farm, Climate Variability, Coping strategies, Tanzania

1.0 Introduction

Effects of climate change such as rising temperature and changes in precipitation are undeniably clear as well as their impacts on ecosystems, biodiversity and people in the world (Case, 2006). Africa is particularly vulnerable to climate variability as its economies are largely based on weather-sensitive agricultural production systems (Stige *et al.*, 2006). This vulnerability has been demonstrated by the devastating effects of the various prolonged droughts in the 20th century and recent flooding (Boko *et al*., 2007). Because of lack of economic development, and institutional capacity to cope with these changes, poorest countries and people are most vulnerable to the impact of climate change and therefore will suffer earliest and most (IPCC, 2001; Stern, 2007).

Just as agricultural productivity gains have always been closely linked to poverty reduction, productivity decline in tropical and subtropical agriculture that is resulting from climate change can be expected to increase the depth and severity of poverty (Arnade, 1998). Despite the fact that, agricultural sector is the mainstay for more than 415-million people in sub-Saharan Africa (Boko *et al*., 2007), African governments have largely not met their budgetary commitments to this sector (FAO, 2012). And since development partners continue to support the continent with food aid rather than sustainable investment in the sector, this has resulted into underperformance in the agricultural sector that is characterised by low agricultural productivity (McMillan & Rodrik, 2011). This underperformance both in terms of agricultural GDP growth and rate of productivity can be traced to among other things, limited availability and low usage of agricultural inputs such as fertilisers, improved seeds, extension services, rural infrastructure, agricultural machinery and agro-ecological conditions (Daberkow & Reichelderfer, 1988; Morris, 2007). Lack of these services by most farmers in Sub-Saharan Africa has exacerbated the impact of climate change on crop production hence reducing the ability of farmers to cope with the unreliable rains and prolonged droughts (Boko *et al*., 2007).

It is known from extensive field trials across the region that rising temperatures and increasing aridity reduce crop yields, particularly of maize (Oxfam, 2011). Due to climate change and variability, famers have been experiencing unpredicted harvests that have greatly threatened food security. As an alternative to food shortage caused by prolonged droughts and unpredicted weather, small scale farmers in rural areas engage on off-farm activities as alternative means to increase household incomes that would absorb the shocks caused by climate change (Cooper *et al*., 2008). Several studies have been done to show how farmer employ different strategies so as to adapt to the climate change effects. For example, a study by Akyoo *et al*. (2013) revealed that to cope with climate variability effects, famers employ variety of farming strategies to increase food availability such as diversification to off-farm activities, agro forestry, spatial separation of farm plots, diversification into other crops, temporary wage employment and others. Deressa *et al.* (2008) showed large family households may be compelled to use part of the labor force to off farm activities so as to ease the imposed consumption pressure.

Derressa *et al.* further found out that farmers' non-farm incomes determine choice of adaptation strategies.

Hence farmers embark on various activities out of farm so as to ensure food security during climate related food shocks. However, little is known from the literature whether the off-farm activities undertaken by most smallholder farmers in bad years work or not in helping them cope with climate change and weather variability. Bad year is considered to be a year that farmers fail or get yields below average, usually due to sparse rains (Slegers, 2008). The year 2009 was expressed by respondents to be a bad year and therefore was adopted in this study as a baseline for a bad year since it complies with Munishi *et al.* (2010) who showed that 2008/2009 was years prolonged with drought that imposed big impacts both on crop and livestock production. This paper aimed to assess the adequacy of these off-farm coping strategies in the study area. To fill the gap, the research question that this paper sought to answer was: Are the non-farm coping strategies sufficient to off-set the risks of poor yield during bad year as a result of climate change and variations?

2.0 Materials and Methods

A cross-sectional research design was conducted for this study between January and June 2010, covering six villages in Morogoro rural, Kilosa and Mvomero districts of Morogoro region, Tanzania. According to Bailey (1998), this kind of design allows data to be collected at a single point in time. The targeted population of the study was all the farmers engaged in small scale crop production in the selected districts because their livelihood largely depended on agriculture which is beset with various risks and uncertainties including climate change risks (Horowitz and Lichtenberg, 1993; Clarke, 2011; Long, 2009; FAO, 2011). The sample size from which data was collected consisted of 240 respondents, and according to the nature of the study, time and resource constraints, the sample size was adequate for the study (Babbie, 1990). Sampling strategies involved simple random and purposive sampling. To obtain this sample, six villages, 3 from Kilosa district, 2 from Morogoro rural and one from Mvomero were purposefully selected. From Kilosa district, three villages were taken for the study (120 respondents), two from Morogoro rural (80 respondents) and one from Mvomero (40 respondents). Respondents then were randomly selected for interviews whereby primary data were obtained using questionnaires.

2.1 Analysis

Descriptive statistics was used to describe the general characteristics of respondents in the study area.

2.1.1 Analysis of Adequacy of Off-Farm Coping Strategies in Reducing Livelihood Risks Associated with Climate Variability

In this study, adequacy was considered as sufficiency of off-farm coping strategies to meet household food requirement per season assuming food deficit caused by shortage of food due to climate change and variability risks. Food security is the main livelihood objective of poor household. Therefore, the study considered food shortage to be the major livelihood risk for small scale farmers. To address this objective, the following steps were followed:-

First, food requirement for each individual household for the whole agricultural season was established. According to IFPRI (2013), 1800 Kilocalories is the minimum energy food per person per day that most people require to live a healthy and productive life (Von Grebmer *et al.*, 2010). This study used an average minimum of 2010 kilocalories of carbohydrate (energy food) per day for a normal person, and this means that people in Tanzania must consume at least 0.5025 kilogram of maize per day to meet the nutrition requirement[1]. In this study maize was taken to be food and not other cereals because the crop is the staple food in the area. Therefore, food requirement was mathematically expressed as follows:-

$$QFR_i = HS_i \times APC'_i \quad \text{.....(1)}$$

Where:

QFR= Quantity of Food Required by the household in i^{th} household

HS= Household size in i^{th} household

APC' = Average Personal Consumption per year in i^{th} household，and equals to 0.5025 kg of maize times 365 days.

Second, the food requirements were expressed into cash value by multiplying with market price for maize to have a valued food required as shown in the equation 2 below:

$$VFR_i = QFR_i^{X} Mrkt\,\mathrm{Pr}_{mz} \quad \text{.....(2)}$$

Where:

VFR=Valued Food Required

[1] To determine the level of food consumption, age differences and sex among individuals was not considered, that is, every member in the given household was assumed to consume on average the same amount of food explained above.

QFR=Quantity of Food Required

$MrktPr_{mz}$=Market price of maize (determined by taking the average annual price of 1kg of maize in the study area)

$i=i^{th}$ household

Based on the assumption that households in Morogoro spend 75% of their income on food products and only 25% on non-food products (Schellenberg *et al.*, 2002), therefore 75% of off-farm incomes was deducted from off-farm income and used for consumption as shown on the equation 3 below:

$$Toffinc_i = 0.75X Offinc_i \quad \text{.....(3)}$$

Where:

$TOffinc_i$= Total amount of off-farm income used for consumption

$Offinc_i$=Off-farm income from i^{th} household

The comparison to examine the extent of off-farm strategies to meet food requirement was specified in equation 4:

$$Ablty_i = Toffinc_i - VFR_i \quad \text{.....(4)}$$

Where:

$Ablty_i$=Ability of off-farm incomes to cover food requirement for i^{th} household which must be ≥1.

Ablty ≥1 was then equated to Adequacy of off-farm coping strategies which was then analyzed basing on the wealth of farmers in the study area. To obtain this, the wealth of the respondents was measured using wealth index. This method is used for calculating wealth indices by aggregating the various asset ownerships and housing characteristics variables basing on the method of principal components.

2.1.2 Differentiation based on Wealth Index

According to Wang (2002), household long run wealth is what causes the most common variation in asset variables. The statistical procedure of principal components was then used to determine the weights (scoring factors) for an index of the asset variables and household main building characteristics. The asset variables considered in the analysis were related to main building quality (roofing, wall, floor, toilet, and extra house), consumable durables, communication means, energy and water sources and transportation means, making a total of 20 variables (table 1). These assets took a value of 1 when the main building or energy or water quality etc. were improved and took 0 if otherwise. The result of principal components was an asset index for each household (A_j) based on equation 5:

$$A_j = f_1(a_{j1} - a_1)/(s_1) + ... + f_N(a_{jN} - a_{jN})/(s_N) \quad \text{.....(5)}$$

Where, f_1 is the eigenvector (scoring factor) for the first asset as determined by procedure, a_{j1} is the j^{th} household's value (1 or 0) for the first asset, a_1 and s_1 are the mean and standard deviation of value on the first asset variable over all households, respectively. This seems to be a better approach in assessing wealth compared to existing procedure based on expenditure and consumption data and hence a better and convenient indicator of wealth.

Table 1: Asset variables

Category	Asset Variables
Main building quality	Roofing, Wall, Floor, Number of rooms, Toilet type,
Consumable durables	Mattress, bed, clock watch, Sofa, Radio, Iron
Implements	Farming tools (eg.Tractor, hoe, plough, power tiller)
Land	Land ownership, Size of land owned
Extra house(s)	House other than main house
Communication means	Mobile phone,
Source of cooking energy	Energy source (eg. Electricity, kerosene, firewood)
Lightening (night)	Night light (lamp, solar, electricity, firewood,)
Water Quality	Source of water (eg.Water tap, Well, River, Dam)
Transportation means	Transport facility (eg car, motor cycle, bicycle)

Source: Author

Kolenikov and Gusavo (2005) assigned 40% of households to the bottom, 40% to the middle and top 20% of the wealth indices. They referred these clusters to as poor, middle and rich respectively. Since data were collected in a year that was perceived to be "bad year", therefore the results from the analysis were used to answer the research question; "Are the non-farm coping strategies sufficient to off-set the risks of poor yield during bad year as a result of climate change and variations?"

3.0 Results and Discussion

3.1 Demographic Characteristics of Respondents

Findings revealed that, 43.4% of respondents were between 31 to 50 years of age, which according to URT (2004), this age groups tend to be active (table 2), whereas, 13.6% were the youths (18 to 30 years) and 28.7% were adults between 51 to 60 years. About 14 per cent of the interviewed respondents were the olds of age above 60. The sex of the household heads in the studied area showed that, majority were males (76.2%) while the rest were females (23.8%). Results on the level of education of the household heads showed that, most of the respondents had between 1 to 7 years of schooling (68.3%) while 17.1 per cent never attended any formal education. About 35 per cent of respondents had post primary education.

Table 2: Demographic characteristics of respondents

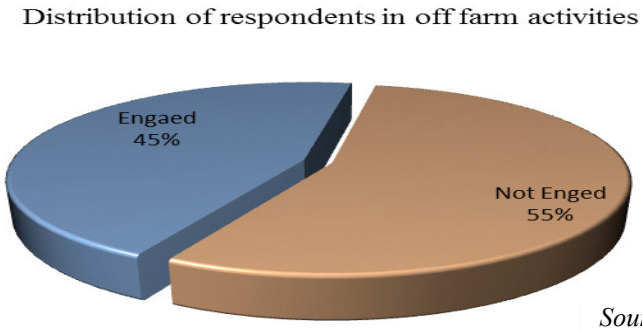
Socio-Economic Characteristics							
Age(yrs)	*%*	*Sex*	*%*	*Educ.level*	*%*	*Family s.*	*%*
18 to 30	13.6	Male	76.2	Non-formal edu.	17.1	1 to 4	18
31 to 50	43.4	Female	23.8	Primary edu.	68.3	5 to 7	55
51 to 60	28.7			Sec. edu.	11.8	7 to 9	20
Above 60	14.3			College/Univ.	2.8	Above 9	7

Source: Author

The survey revealed further that, majority of households had family members between 5 to 7 (45%), whereas, 20 per cent of households had between 7 to 9. Households with few family members (1 to 4) were 18 per cent while the rest (7%) had family members above 9.

3.2 Distribution of Respondents according to Income Generating Activities

Results showed that, fifty five per cent of 240 respondents were not engaged in non-farm activities as an alternative source to increasing food security for the household (Figure.1). These merely depended on the farm activities in their vicinity to earn a living as opposed to the remaining percentage (45%) that had alternative income generating options other than farming to cushion themselves from the impacts of low harvests as a result of droughts caused by climate change. These findings depict that despite farmers wallowing in incidences of recurrent drought in the area, majority remain vulnerable to the calamity as fewer have options to reduce the severity of climate change impacts.



Source: Author

Figure 1: Engagement of farmers in off farm activities

This severity of the vulnerability to climate change impacts emanates from the fact that the livelihoods of a large population in rural areas depend on rain fed agriculture, while using farming technologies and little application of inputs like fertilizers (Morris, 2007). These findings comply with Rockström *et al*. (2003) and (Nyanga *et al.*, 2011) who argued that the livelihoods of a large population in developing economies who are in rural areas depend largely on agriculture that relies mainly on rainfall.

3.3 Factors Influencing Wealth

Results from principle components (equation 5) showed that, three components as shown in the Pattern matrix of factor analysis had factor loadings above 0.30 and explained 58.2% of the total variance (table 3). The three components were named as factors influencing wealth which in this case were the quantity and quality of household assets (table1). The standardized regression coefficients of the quality and quantity of household assets were 0.23, 0.27 and 0.24 and were assigned as High, Moderate and Low respectively (table 4).

Table 3: Pattern matrix of factor analysis for the asset indices using Principle Component analysis extraction method and a direct oblim rotation

	Rotated Factor loadings		
Variables	*1*	*2*	*3*
Roofing	**0.81**	0.17	0.12
floor	**0.79**	-0.15	0.03
Size of land owned	**0.58**	0.27	0.11
Transport facility	**0.39**	-0.12	-0.04
Toilet type	-0.47	**-0.75**	0.05
Mattress	0.53	**-0.53**	0.19
bed	0.36	**-0.44**	-0.17
Clock watch	0.07	**-0.41**	0.13
Sofa	-0.08	-0.28	**0.63**
Radio	0.31	-0.22	**0.71**
Iron	-0.33	0.31	**0.34**
Farming tools	-0.25	-0.18	**0.32**
Land ownership	0.38	0.32	0.03
Size of land owned	0.41	-0.04	-0.04
House other than main house	-0.37	-0.19	0.03
Energy source	0.13	0.27	0.25
Night light	0.06	0.31	-0.16
Quality of water	0.75	-0.05	0.36
Transport facility	-0.01	-0.1	0.25
Mobile phone	0.01	0.04	0.64
Eigenvalues	***2.73***	***1.53***	***1.8***

Source: *Author*

Table 4: Factors influencing wealth

Quantity and Quality of Assets			
	More	moderate	Low
Standardized regression coefficients	0.23	0.27	0.24

Source: Author

3.4 *Farmers' Off-farm Activities and Incomes*

The study results indicated that, the livelihoods activities that farmers engaged outside their farms were selling milk, doing petty business like kiosks and tea rooms (table 5). Others were artisan, selling natural resource products like firewood and charcoal, home gardening, employment and remittance. Majority of farmers that had options for other off farm income activities engaged in doing petty business (51%). Fifteen per cent of these farmers had their off farm incomes as remittance from relatives working in towns and elsewhere. Forty four per cent of famers engaging in off farm activities had their incomes from the rest of livelihood activities such as livestock keeping (8.3%), artisan (10%), home gardening (3.7%) and employment (8.3).

Table 5: Distribution of off farm livelihood activities and income

Non-farm income for 2009 in '000 Tsh[1] (N=108)					
Source	*n*	*%*	*Min*	*Max*	*Mean*
Livestock keeping	9	8.3	40	1500	377.6
Small business	55	51	25	6000	507.3
Artisan	11	10	12	450	214.7
Natural resources(charcoal, mining etc)	4	3.7	140	900	400
Home gardening	4	3.7	100	2000	1062.5
Employment	9	8.3	360	5500	1737.8
Others (remittance,etc.)	16	15	40	730	173.4

Source: *Author*

With regards to incomes generated from off farm activities, petty businesses was the livelihood activity earning farmers more off farm income, followed in descending order by employment, home gardening, livestock keeping, selling natural resources, remittance and artisan in that order. The implication of the revealed off farm

[1] 1 USD = 1674.8053 TZS Thu 09/10/14, 9th October 2014. http://www.currency.me.uk/convert/usd/tzs

livelihood activities is that, majority of farmers in the area depended on doing small businesses because they simply were close to main roads. The large percentage of off farm income from remittance indicated that, majority of household members had left their homes and migrated in towns in such of jobs so as to earn their living. Those earning incomes from selling livestock products like milk are the semi pastoralist farmers that tend to continue earning from livestock during difficult times as they tend to migrate to areas that have pastures to feed their livestock.

3.5 Adequacy of Off-farm Copping Strategies in Reducing Climate Variability Risks

Findings as indicated in Figure 2 revealed that 56.7% of respondents engaged in off-farm activities had their activities not capable of reducing the risks associated with climate variability. On the other hand, 43.3% of respondents had the coping strategies that can reduce the risks of climate variability.

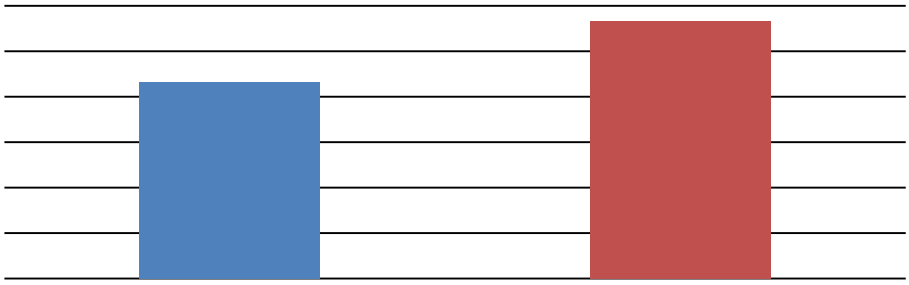


Figure 2: Adequacy of off-farm copping strategies in reducing climate variability risks
Source: Author

Despite the fact that only 45% of respondents engaged in non-farm activities as their alternative to diversify climate change risks, only 43.3% of these respondents had their coping strategies capable of meeting household food requirements in a year. To enable comparison of the farmers' off farm strategies against their wealth groups, weights from principle components were further categorized into wealth indices for the wealth groups in the study area where 20% at the bottom were termed as rich, 40% middle and 40% were poor. Findings revealed that, majority of those poor (61.1%) had coping strategies incapable of meeting household food requirements in a year (Table 6). Consequently about 61 per cent of those in the middle too had off-farm coping strategies inadequate to meet household food requirements. Surprisingly, even the small population of those termed rich in the area, a large percentage of it (about 46%) had their off farm strategies incapable of meeting the household food requirement particularly during the bad year.

Table 6: Per cent Distribution of farmers' ability of off-farm income strategies to meet household food requirement

	No ability	*Have ability*	*Total*
Rich	46.2	53.8	100.0
Middle	60.9	39.1	100.0
Poor	61.1	38.9	100.0
Total	56.7	43.3	100.0

Source: Author

Although results showed that the group of the rich in the area could, to some little extent, survive the shocks of climate change risks using their off farm coping strategies, findings obviously revealed that, the poor and the middle that constituted the majority of the population in the area were highly vulnerable due to inability of their off-farm strategies to meet household food requirements. The implication of this findings on food security is that majority of farmers in the study area did not have coping strategies sufficient to reduce the climate variability shocks. These findings are in line with Boko *et al.* (2007) who asserts that "African farmers have developed several adaptation options to cope with current climate variability, but such adaptations may not be sufficient for future changes of climate (high confidence)" (p. 435).

4.0 Conclusion

This study used data from one geographical area, Morogoro, Tanzania to ascertain the off-farm activities in the study area in meeting food requirement for individual households for the whole agricultural season particularly on a bad season. There is therefore a possibility that for all situations, results may not always entirely generalize all regions of Tanzania. It is obvious however that, climate change has negatively affected small-holder farmers' food security. Due to un reliable rains and prolonged drought, small holder farmers are compelled to engage on income generating activities out of farms such as small business called kiosks, local brews and small shops,

remittances, traditional healing, artisan, livestock keeping, employment, selling of natural resources like charcoal and doing home gardening so as to reduce the impacts of climate change on food security. However important off farm activities are, especially to the rural poor who are highly impacted by climate variability, majority of farmers have strategies insufficient to help them become food secured. This could be due to lack of technical knowledge that is essential in helping them venture into the most appropriate and available resources and innovative skills. Unless small household farmers are supported in enabling them to properly make use of the available off-farm coping strategies, their vulnerability to climate shocks may increase throughout years. As a result, dependency on food aids by these farmers might unnecessarily increase governments' burden especially in developing countries in supporting the rural poor even in times when such aids would not have been necessary.

5.0 Policy Implication

To improve performance in agricultural sector, there must be adequate investment in agriculture by the governments and development partners in entrepreneurial skills, agribusiness, agricultural extension services and better communication of information, advice and forecasts. This could increase food security, reduce hunger and poverty as well as manage the devastating effects of famine and climate change. To increase the chances of non-farm activities in decreasing the problem of food inadequacy, farmers are encouraged to, among other things, diversify farming with livestock keeping and other viable farm and non-farm strategies not only for security purposes during the time of shocks but also as businesses aimed at increasing household income. If well informed and trained by the government and non-government institutions through extension services, crop production and livestock keeping have a mutual relationship since animals use crop residuals as fodder while crops use animal dung as fertilizer. This will help in maximizing household income and increase food security due to full utilization of resources at household level.

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