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Gender Differences in Experiencing Diverse Shocks, Coping Strategies and Reliance Mechanisms for Achieving Food Security in KwaZulu Natal Province, South Africa

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Abstract

A cross sectional study was conducted in the year 2010 to assess gender differences on the status and factors influencing household food security among 390 beneficiaries of the Empowerment for Food Security Programme (EFSP) in KwaZulu Natal province (KZN), South Africa. The study used Household Food Insecurity Access Scale (HFIAS) to measure food access. The study findings revealed significant difference in the food security status between male and female-headed households. Almost 63% of female-headed households were severely food insecure compared to 49% of their male counterparts. Among the main shocks encountered, significant difference was noted on serious injury or chronic illness of a household member whereby female-headed households were highly affected compared to their male counterparts. Male-headed households significantly relied on livestock sales while their female counterparts relied more on receiving gifts or money in coping against income or food shortage. These findings indicate a poor situation of food security status among the respondents. Hence, policy priorities related to food security in KwaZulu Natal area should be gender oriented and focus on improving access to livestock ownership, adequate health care provision and support for child care to reduce the problem of food insecurity among the EFSP beneficiaries.

Keywords: Gender, coping mechanisms, food security, KwaZulu Natal

Introduction

Food security is a widely known phenomenon, which historically started to make serious impact on the development debate during the 1970s and has continued to do so for the last three decades (Hart, 2009). Principally, food security assessments were done at macro level by assessing national food

production and supply. This aggregated means of assessing food security often however masks major disparities at the micro level. To help policy planning and effective allocation of resources, food security must also be considered at the household as well as at the individual level (Becquey *et al*., 2010). The main goal of food security is for individuals to be able to obtain adequate food at all times and to be able to utilize the food to meet the body's needs (Olarinde and Kuponiyi, 2005).

The concept of gender came up during the 1990s and is linked to food security in a fundamental way (World Bank, 2009). Gender refers to socially constructed roles and relationships between men and women, which can vary widely across cultures. These socially constructed roles are usually unequal in terms of power and decision making as well as in terms of having control over assets, freedom of action, and ownership of resources, among others (Ellis, 2000). The concept of gender has also been considered in agriculture and development where agricultural opportunities are recognised to be different for men and women (Omwoha, 2007). Gender-based inequalities all along the food production chain "from farm to plate" hinder the attainment of food and nutritional security (World Bank, 2009).

The target of the first Millennium Development Goal is to halve the proportion of people who suffer from hunger. This goal is extremely important in Southern Africa, where food security has become increasingly problematic over the last 20 years (Love *et al*., 2006). In South Africa, food security has increasingly become a central focus of many government and non-government programmes. Various interventions not directly under the ambit of food security, but which impact on food security such as food gardening, exists (Lima, 2008). South Africa's Integrated Food Security Strategy (IFSS) declares its primary objective to overcome rural food insecurity by increasing the participation of food insecure households in productive agricultural sector activities (De Klerk *et al*., 2004). In this regard, joint collaboration between the KwaZulu Natal Provincial Department of Agriculture and the Government of Belgium established the KZN Empowerment for Food Security Programme (EFSP). This five years programme that began on 1st April 2006 aimed at improving the livelihoods of poor households by providing access to food for consumption and sale. Food access problems are serious in KwaZulu Natal, which ranks the second province in South Africa in terms of food insecurity

with 23.1 % of the households having inadequate or severely inadequate food access (Stats SA, 2010).

A gender based comparison study on food security status and resource endowment is necessary because men and women are important members of the society and each play different roles. It is also important because as previously shown in the literature; women are more prominently affected than men within the population. Vulnerability assessments have identified that female-headed households are more food insecure and resource poor than male-headed households (Mtshali, 2002). Since men and women experience the problems of food security differently, their response might also be different indicating that the causes and consequences of food insecurity and resource access constraints are gender related. Limited access to productive resources (be it capital, credit, water, land, and support systems) have consequences for agricultural productivity and environmental sustainability, making households prone to food insecurity.

In a South African rural situation, most reproductive and productive activities take place in the domestic sphere or the household domain (Mtshali, 2002). This study focuses on comparing benefits accruing to male and female beneficiaries of the EFSP to explore if household headship by gender significantly influences their food security status.

Methodology

This study was conducted in KwaZulu Natal, which is among nine provinces in South Africa. The province is formed by the former Zulu homeland and Natal Province. KwaZulu Natal is now South Africa's largest province, containing more than 10 million people. The province is located on the eastern side of South Africa occupying an area of 92,100 km². It lies between latitude 28° 40' and 0''South of the Equator and Longitude 30° 40' and 0'' to the East of Greenwich. The principal language spoken is IsiZulu, followed by English and Afrikaans. According to the 2000 National Census, the population of KwaZulu Natal constitutes mainly of Blacks (85%), followed by Indians (9%) and Whites (5%). KwaZulu Natal ranks second as a major contributor to the economy, accounting for 16.7% of South Africa's GDP (www.info.gov.za).

Study design

This was a cross sectional comparative study involving beneficiaries of the (EFSP) in KwaZulu Natal province. The study was conducted in 2010 involving four purposively selected Districts (Zululand, Ugu, Umkhanyakhude and Umgungundlovu) in Eight (8) Municipalities (eDumbe, Pongola, Vulamehlo, Umuziwabantu, Big 5 False Bay, Umhlabuyalingana, Richmond and Umsunduzi/ Umgeni). KwaZulu Natal Province was purposively selected out of the nine provinces in South Africa based on its vulnerability to food insecurity. The baseline survey was conducted between April 2007 and July 2008 in which the sample size of 646 respondents was used. In this study, a total of 390 households comprised of 215 Male Headed Households (MHH) and 175 Female Headed Households (FHH) involved in small scale vegetable production and livestock keeping in the project were purposively selected from the list provided by the KwaZulu Natal Provincial Department of Agriculture initially used in the 2007-2008 Baseline Study.

Data collection and analysis

The study used Household Food Insecurity Access Scale (HFIAS) to measure food access. The HFIAS score is a continuous measure of the degree of food insecurity (access) in the household during the past four weeks (30 days). The maximum score for a household is 27. The higher the score, the more food insecurity (less access) the household experienced and vice versa (Coates *et al*., 2007). The standardized HFIAS questionnaire constituting of nine specific questions about worry as well as availability of and accessibility of food for the household during the previous 30 days was used. The standard procedure for scoring was used whereby zero was attributed if the event described by the question never occurred, 1 point if it occurred once or two times during the previous 30 days (rarely), 2 points if it occurred 3–10 times (sometimes), and 3 points if it occurred more than 10 times (often).

The collected data such as socio-economic characteristics, type of shocks, choice of coping strategies and reliance mechanisms were analysed using the Statistical Product and Service Solutions (SPSS) for windows version 18.0. The purpose was to obtain both descriptive and inferential statistical results. Measures of central tendency such as means, frequency tables, and standard deviations were computed. Inferential statistics using the Chi squared test and Analysis of Variance (ANOVA) were performed to assess the significance of

association between different variables. These tests were undertaken with the assumption that the household food security variables had a relationship with household headship by gender.

Ethical issues

For ethical purposes, this study was introduced to participants before data collection. Those who did not voluntarily consent to participate were not forced to do so. This was also stated clearly on the front page of the questionnaire. Confidentiality of participant was ensured by assigning identification number for each participant.

Results and discussion

Household food security status

Based on HFIAS, the food security status was obtained for each household. The HFIAS score corresponded to the sum of the points and could range from 0 (food security) to 27 (maximum food insecurity). Higher score values indicate that the household experienced more food insecurity while lower HFIAS scores indicate a household faced less food insecurity. Results for the classification are shown in Figure 1 where almost two thirds (63%) of female-headed households were severely food insecure. Statistical tests were performed to examine if the differences for various variables between female and male household heads was significantly different from zero. The results of this analysis are presented in Table 1.

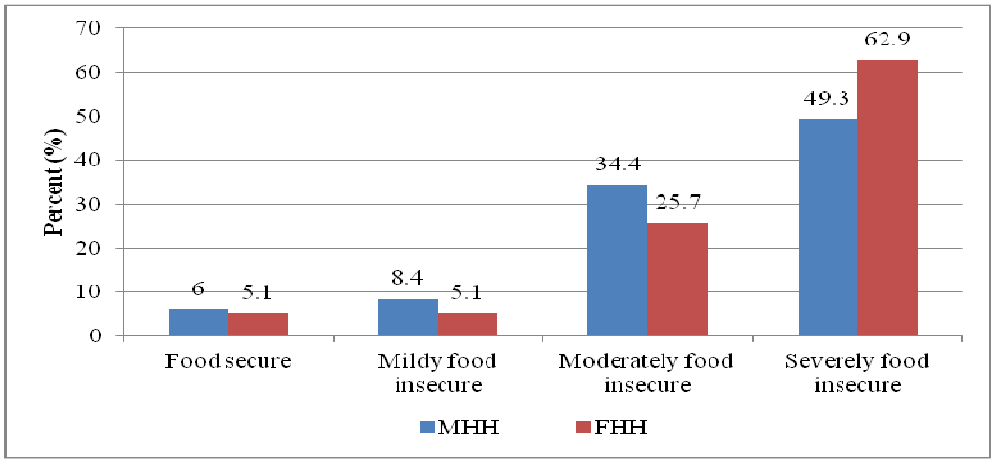

Figure 1: Food security status by gender of the household head (%)

Source: Field survey KwaZulu Natal, July-August 2010

Table 1: Food security level compared by gender of the household head

	MHH (n=215)	FHH (n=175)	F-stat	p-value
HFIAS score	18.1±5.3	19.8±5.6	9.168	0.003

Source: Field survey KwaZulu Natal July-August 2010

Results in Table 1 show significant differences in food security levels between male and female-headed households (p=0.003). The mean HFIAS score were higher in both gender categories. Male heads of household had a lower mean HFIAS score (18.1±5.3) compared to their female counterparts (19.8±5.6). The poor situation in food security status among FHH is supported by Rose and Charlton (2002) in a study conducted in South Africa and Kapungwe (2005) in a study conducted in Zambia. The authors reported that food insecurity rates were higher among households headed by females. Literally, the main reason that explains this situation is unequal access to livelihood assets by female heads thus making their households prone to food insecurity.

Common shocks faced by household heads

The adverse events which may lead to a loss of income, a reduction in consumption and/or a loss of productive assets are considered as shocks or stress to the household. Such events may be due to various factors that are beyond the control of the households. This could be associated with the economic situation, health conditions as well as the environment and climate on which the households' reside. Occurrence of shocks in the households headed by males and females was assessed and compared as shown in Table 2.

More than 75% of household heads in both gender reported to be affected by the rise in food prices. This is also supported by Hart (2009) who reported that a year-on-year food price increase for 2008 was 16.7%, being significantly higher than a year-on-year increase of 6.7% in 2006. In addition, Jacobs (2010) pointed out that the impact of intersecting livelihood shocks; rapid food price inflation and economic downturn, virtually affected all South Africans in 2008. Other important shocks that were mentioned by the respondents include the rise in food production cost (about 50%), drought (more than 40%), theft (more than 20%) and death of livestock mentioned by more than 25%.

Table 2: Percentage distribution of household heads by types of shocks faced

Shocks	% Response MHH (N=215)	FHH (N=175)	Comparison χ^2 value	p-value
Number of people increased	33.5	34.3	0.168	0.682
Increased food production costs	49.3	51.4	0.037	0.847
Cut-off/decrease of government grant	13.0	14.9	0.132	0.716
Flood	12.1	12.0	0.066	0.797
Tornado/Storm/Cyclones	11.6	18.3	2.513	0.113
Droughts	42.8	41.1	0.202	0.653
Serious injury or chronic illness	41.9	50.9	4.298	0.038
Loss of a job of the main breadwinner	17.2	13.7	0.360	0.548
Loss of remittances	13.5	16.6	0.703	0.402
Loss of possessions/theft	28.4	21.7	0.300	0.584
Death of many livestock	31.6	25.7	0.934	0.334
Food prices increases	77.2	76.6	0.255	0.613

Source: Field survey KwaZulu Natal July-August 2010

About half (50.9%) of the female heads of households were significantly (p=0,038) affected by the serious injury or chronic illness of a household member than their male counterparts (Table 2). Similar findings were reported by Kerr (2005) who stated that illness of a family member or the women head herself jeopardised food security of majority of the smallholders in northern Malawi because her labour was drawn away from food production. However, this was contrary to Dercon *et al*. (2005) who reported that incidence of illness shock was higher among male-headed households in Ethiopia.

Households coping strategies during income shortage

Coping strategies adopted by household heads are short term and immediate response that may be taken by an individual or household against changes of context due to various shocks or adverse effects that threaten their livelihoods. In this study, coping mechanisms against income and food shortage were assessed and compared by gender.

Results in Table 3 show that male heads of household (41.9%) were more (p=0,004) likely to sell livestock compared to their female counterparts. There was a significant (p=0,011) difference in receiving gifts or money for female heads of household (24%) compared to MHHs. These findings show that the

choice of coping against the effects of shocks may differ depending on gender. Differences in the coping strategies could be due to the level of assets the household heads have in possession. Similar findings were reported by Bob (2002) who stated that livestock ownership within a household and community in Ekhuthuleni, South Africa are highly gendered such that households that are female-headed rarely owned cattle which is viewed as a significant source of wealth in rural areas.

Results in Table 3 show that male heads of household were significantly more likely to sell livestock compared to their female counterparts ($\chi 2$ 8.08; p=0,004). Female headed households were significantly more likely to receive gifts and money ($\chi 2$ 6.469; p=0,011). There was no significant difference in the responses with respect to the remaining coping strategies, except for taking loans from money lenders, where female headed households were slightly more likely ($\chi 2$ 2.625; p=0.105) to take such loans.

Table 3: Distribution of household heads by coping strategies

Coping strategy	% Response		Comparison	
	MHH (N=215)	FHH (N=175)	χ^2 value	p-value
Sell livestock	41.9	28.0	8.080	0.004
Sell land, tools, or other assets	2.3	2.3	0.001	0.979
Use own savings	15.3	13.7	0.207	0.649
Borrow money from relatives or friends	60.9	62.3	0.075	0.784
Take out a loan from mashonisa*	15.3	21.7	2.625	0.105
Take out a loan from a formal institution	3.3	2.3	0.331	0.565
Borrow food from relatives or friends	46.0	53.7	2.269	0.132
Take on additional work	19.1	14.3	1.571	0.210
Reduce spending	52.1	47.4	0.840	0.360
Reduce food consumption	44.7	41.7	0.339	0.560
Reduce or stop dept/loan repayments	7.9	9.1	0.190	0.663
Receive gifts or money	14.0	24.0	6.469	0.011
Receive professional counselling	8.8	13.1	1.861	0.172

Source: Field survey KwaZulu Natal July-August 2010

* A township moneylender who lends out his/her own money for profit

The coping strategies employed by households during income shortage are presented in Table 3 show that male heads of household (35.3%) were more (p=0,011) likely to sell livestock as compared to their female counterparts. Gender of the household head was independent in the choice of other coping strategies (p> 0.05). Food intake reduction (44.7 and 41.7% for male and female respondents respectively) and receiving help from neighbours or relatives were the most common options for 46% and above 53.7% of the male and female respondents respectively. This indicates remarkable degrees of food insecurity and reliance on social capital endowments by the respondents.

Reliance mechanisms adopted by household heads

Reliance of household heads on different kinds of social networks of their choice during difficulties depends on their degree of trust, reliability and adaptability. This represents access to social capital endowments. The relationship of reliance choices and gender was analysed by cross tabulations using Chi squared test. Female heads of household (68%) were more significantly (p=0.045) likely to rely on neighbours during difficulties as compared to their male counterparts (Table 4). Reliance on relatives or family within an area was the option for more than 66% of the respondents though differences were not significant between MHH and FHH.

Table 4: Distribution of household heads by reliance choices

	% Response		Comparison χ^2 value	p-value
	MHH (N=215)	FHH (N=175)		
Neighbours	58.1	68.0	4.005	0.045
Relatives/ family in area	66.0	66.3	0.002	0.960
Relatives/ family elsewhere	30.7	39.4	3.249	0.071
Church	14.4	14.9	0.015	0.903
Other	3.3	2.9	0.051	0.821

Source: Field survey KwaZulu Natal July-August 2010

Support types provided to household heads

When households are affected by various shocks or stress, support from social networks is important, to avoid detrimental effects on their livelihoods. In most cases, individuals or households seek for social assistance in order to meet the most basic needs for their survival. Food and money were the most

important claims made on their social networks, stated by almost 70% and above of the respondents. A small portion of female household heads (12.6%) significantly (p=0.015) benefited from childcare compared to their male counterparts (Table 5).

Support for child care to female heads of household is important due to their multiple roles. Thus, female heads of household play both productive and reproductive roles. Such support enables them to access other livelihood opportunities including earning income for their households. This argument is supported by Mtshali (2002) who reported that, women have less access to wage employment, less job security and lower wages than men due to their restricted mobility caused by their reproductive role. Support in the form of food and money received by majority (above 69 %) of the respondents indicates the prevalence of low financial capital and food insecurity in the studied population (Table 5).

Table 5: Distribution of household heads by support provided

	% Response		Comparison χ^2 value	p-value
	MHH (N=215)	FHH (N=175)		
Food	69.3	73.1	0.691	0.406
Money	74.0	73.1	0.033	0.857
Counselling	27.0	29.1	0.225	0.635
Childcare	5.6	12.6	5.923	0.015
Other	0.9	4.6	1.636	0.201

Source: Field survey KwaZulu Natal July-August 2010

The findings in Table 5 confirm similar findings by Mtshali (2002) who reported that claims of food, loans, gifts or work in KwaZulu Natal are frequently made at the time of stress or shock. Such claims imply that people can call upon moral, material, and practical assistance or support when responding to stress or shock.

Conclusion

The overall situation of food security status among the respondents is quite poor. Female-headed households were more severely food insecure compared

to their male counterparts. The effects of shocks such as serious injury or chronic illness of a household member, increase in food price, drought and higher food production cost had an important influence on the respondents' food security status.

Some coping strategies against income and food shortage such as reducing food intake or overall consumption that were employed by respondents could be detrimental to their health and food security status. Based on the findings from this study, it is clear that some factors influencing household food security status are gender specific. Gender differences were also significantly noted regarding support for child care; female-headed households benefited more from this support compared to their male counterparts.

An important contribution of this study to food security program planners is the findings that relate to the effects of shocks and child care support for female-headed households. Meanwhile, male respondents benefited more from livestock ownership since they were more likely to have access to this resource. Since food security is determined by multiple factors, it is important to investigate within each gender category the specific constraints faced by men and women because lack of gender disaggregated analysis can mask the most important gender specific issues that are worthy to be addressed in order to reduce the impact of food insecurity in any population. The nutritional status of target communities should be part of food security assessments in order to address the component of food utilization which is important for targeting specific intervention related to health aspects of food security.

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Influence of Farmer Field Schools on Adoption of Agricultural Farm Innovations in Mbinga and Mbeya Rural Districts, Tanzania

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Abstract

The Farmer Field Schools (FFS) extension approach was piloted in Mbinga and Mbeya Rural Districts for over 10 years, after which it was out-scaled to the rest of the country. However, this decision was not based on empirical evidence regarding the effectiveness of the approach in facilitating farmers to adopt better farm practices. This study was conducted in Mbinga and Mbeya Rural Districts to determine how the FFS approach influenced the adoption of farm innovations including intensification, diversification and extensification of production. Innovations considered include timely operations, improved maize and bean varieties, new livestock breeds as a measure of intensification, new economic activities as a measure of diversification and expansion of land under cultivation as a measure of extensification. A structured questionnaire was used to collect primary data from 270 randomly selected respondents consisting of 180 FFS participating and 90 non-FFS participating farmers. The data were supplemented with focus group discussions and key informant interviews. Results show that there was a statistically significant difference between FFS and non-FFS farmers in adopting farm innovations and crop productivity. The FFS approach influenced the adoption of farm innovations including intensification, diversification and extensification of production and resulted into increased agricultural productivity. However, sustained adoption and successful out-scaling will depend on the availability of resources.

Keywords: Farmer Field School, intensification, diversification, adoption, intensification.

Introduction

Agricultural extension and advisory services are a critical means of addressing rural poverty (Godtland *et al*., 2003) by improving the productivity of agricultural systems, raising the income levels of farm families and improving the quality of life of rural farm households (URT,

2000). In addition, extension services aim at maintaining and conserving the natural resource base for sustained agricultural development and enhanced food security. The design of agricultural extension programmes in developing countries has been the subject of heated debate (Byerlee, 1982). Guided by these debates, extension services have undergone several transformations in the past few decades. The main transformation, until recently, was the shift from the transfer-of-technology approach to more participatory approaches including the Farmer Field Schools approach.

The term Farmer Field Schools (FFS) came from an Indonesian expression *sekolah lapangan* meaning field school. It is defined as a group of extension processes based on adult non-formal educational methods (Gallagher, 1989). It is a participatory agricultural extension approach based on learning by discovery. The aim of FFS is to build farmers' capacity to analyse their production system, identify problems, test possible solutions and eventually adopt the practices most suitable to their farming system. In addition, it aims at increasing production/productivity of crops and livestock; reducing production costs by using less inputs for example pesticides and inorganic fertilizers; reducing unnecessary human exposure to agrochemicals; empowering farmers to make decision on farming activities even in the absence of extension officers; timely field operations and emphasizing participatory and democratic learning approaches (FAO, 1999).

The knowledge acquired during the learning process enables farmers to adapt their existing technologies to be more productive, profitable and responsive to changing conditions, or to test and adopt new technologies (FAO, 2003). The first Farmer Field Schools were established in 1989 in Central Java during the pilot phase of the FAO-assisted National IPM Programme (Braun *et al.*, 2000). Subsequently the approach has been extended to several countries in Africa and Latin America. By the 1990s the approach was being used in several African countries such as Burkina Faso, Kenya, Mali, Zambia, Zimbabwe, Uganda, Sudan, Malawi, Ghana and Tanzania.

In Tanzania, the approach was introduced in 1997/98 and tried out in Mbinga and Mbeya Rural Districts on a pilot basis. This study assessed the adoption of agricultural farm innovations including agricultural intensification aimed at increasing the productivity of existing land and water resources in the

production of cash crops and livestock (Dixon *et al.,* 2001). Intensification is associated with increased and more efficient use of production inputs. The study also assessed the extent of agricultural diversification whereby farmers changed into new enterprises such as food processing and marketing of pesticide-free rice (Van den Berg *et al*., 2002) by use of farm resources for commercial gain. It also assessed the extent of extensification whereby farmers were utilizing larger areas of land in order to increase production (Beranga, 1998). Finally, the study assessed the effect of the FFS approach on productivity and income levels of participating farmers.

Methodology

This study was conducted in Mbinga and Mbeya Rural Districts because they are the Districts where the FFS approach was piloted. The main economic activity for both Districts is agriculture, which employs more than 90% of the population. Agriculture comprises of food and cash crop production and livestock keeping. The major food crops for Mbinga District include maize, beans, paddy, cassava and green vegetables. Coffee, cashew nuts (grown around the coastal areas of Mbamba Bay), tobacco, simsim and soya are the major cash crops. Livestock comprise of cattle, pigs, chicken and goats. The food crops grown in Mbeya Rural District include maize, beans, wheat, cassava and green vegetables (tomatoes, onions and cabbage). Irish potatoes, paddy, coffee, pyrethrum, millets and sunflower are the main cash crops. Animal keeping comprise of cattle, pigs, chicken and goats.

Data collection involved administering a structured questionnaire to 270 randomly selected respondents consisting of 180 FFS participating and 90 non-FFS participating farmers for comparison purposes. Also, physical observations such as crop stand, farm size and performance of new enterprises was made to verify the collected information. The primary data were supplemented with focus group discussion and interviews with key informants.

The effectiveness of FFS was determined in terms of the extent to which it influenced the adoption of farm innovations as measured by intensification, extensification and diversification (Scoones, 1998). Intensification is the effective use of agricultural technologies in order to produce enough products per unit of inputs. Some of the technologies examined included the use of improved seeds, recommended seed rate, proper spacing, fertilizer application,

insect/pest control, and improved livestock keeping. Diversification is defined as the entrepreneurial use of farm resources for a non-agricultural purpose for commercial gain. Hence, diversification reflects the reduced dependence of farmers on agriculture as a source of income. Farmers were therefore asked to mention any entrepreneurial activities that they were undertaking using income they obtained from their agricultural activities. Lastly, extensification can be defined as the process or trend of developing a more extensive production system that utilizes large areas of land, so in this study extensification was assessed by asking respondents the extent to which they were able to increase the area of land under cultivation. The data were analyzed using Statistical Product and Service Solutions (SPSS) version 12. A t-test was employed to test whether there was statistically significant difference in the acreage and crop productivity increase before and after joining FFS.

Results and discussion

Intensification

Intensification is the effective use of agricultural technologies in order to produce enough products per unit of inputs (Nindi, 1993). Under this system farmers intensified the small pieces of land by practising the innovations that were learnt during FFS sessions to increase productivity. Intensification involved a number of factors. In relation to the adoption of improved seeds, the study shows that 90.6% of the FFS participating farmers from Mbinga and Mbeya Rural Districts used improved and certified seeds of maize while only 18.9% of the non-FFS participating farmers did so. About 83.9% of the FFS participating farmers and only 15.6% of non-FFS farmers used improved bean seeds. Mukami (2003) reported that the improved seeds are among the critical agricultural inputs required by farmers to improve productivity.

The use of improved seeds has impact on increasing productivit. TARP II SUA Project (2005) reported that the increase in productivity and income was a result of use of improved crop husbandry and improved seeds. Mungisha and Diiro (2010) in a study conducted in Eastern and Central Uganda reported a significantly higher yield (2 941.5 kg/ha) for farmers who used improved maize seeds compared to the yields from local variety (1 694 kg/ha). These findings are in line with Godtland *et al.* (2003), who reported that farmers who participated in FFS farmers had significantly more knowledge about use of improved technologies than the non-participating comparison group.

In relation to adoption of the proper seeding rate, the study shows that 87.8 % of the FFS participating farmers used the recommended seeding rate of 17-25kg/ha of maize, while only 28.9% of the non-FFS participating farmers used the rate of 17-25kg/ha of maize. Many (40.0%) of the non-FFS participating farmers used less than 10kg/ha of maize seed which was below the recommended seed rate thus resulting into low crop productivity due to few plant population/ha.

At the same time, 80% of the FFS participating farmers used the recommended seeding rate of 61-80 kg/ha of bean seeds, while the proportion of non-FFS participating farmers was only 20%. Therefore, the participating farmers showed a higher rate of adoption compared to non-FFS participating farmers. The use of proper seed rate for maize translates into 44,000 – 66,000 plants/ha which can increase yield from 3.5 t/ha up to 9 – 10 t/ha under optimum management depending on seed variety (Kanyeka *et al.*, 2007).

In the case of proper spacing, the vast majority (85.6%) of the FFS participating farmers adopted the use of recommended spacing at 75cm x 30 cm in maize while only about one-third (35.6%) of non-FFS participating farmers adopted proper seeding rate. However, 74.4% of the FFS participating farmers used the recommended spacing of 50cm x20cm in beans while less than half (40.0%) of the non-FFS participating farmers adopted. Mureithi (2005) reported that to get high yields, proper spacing is important. The available soil moisture and nutrient levels will determine the crop population recommendation. Closely spaced plants cause competition for light, moisture and nutrients resulting in low yields. Low yields also result from widely spaced plants since fewer cobs will be harvested from any given area.

The rate of fertilizer application was measured in terms of kilograms of fertilizer rather than the amount of Nitrogen. The study shows that while 80% of the FFS participating farmers applied fertilizer at the recommend rate of 250kg-375kg of fertilizer/ha, only 24.4% of the non-FFS farmers applied fertilizer at the recommended rate, the rest either did not apply any fertilizer (35.6%) or applied at less than the recommended rate (38.9%). In the case of beans, 76.1% of the FFS participating farmers applied the recommended rate of 100-125kg/ha of DAP fertilizer at planting while only 17.8% of the non-FFS participating farmers applied the recommended rate of fertilizer in beans,

and the rest either did not apply at all (61.1%) or applied at sub-optimal levels (18.9%). In addition, due to the high cost of agricultural inputs, some of the FFS and non-FFS farmers were not able to purchase a 50kg bag of fertilizer; instead they bought small amounts from the retail shops which did not meet the nutrients required by the plants resulting into low crop productivity.

In relation to adoption of proper crop storage, the study indicated that almost three-quarters (73.9%) of the FFS participating farmers stored the grain by using industrial pesticides at the rate of 100g actellic super dust for 100kg of maize while the rest used botanicals (usually *Tephrosia sp*.). Only a quarter (25.5%) of the non-FFS farmers used industrial pesticides at the rate of 100g actellic super dust for 100kg of maize while 36.7% used botanical pesticides and 37.8% did not use any storage pesticide. In the case of beans while 83.9% of the FFS participating farmers used actellic super dust at the rate of 100g for 100kg of beans, and 16.1% used botanical pesticides, about a half (45.5%) of the non-FFS participating farmers used industrial pesticides for storing beans and 25.6% relied on botanicals. FFS farmers were therefore more likely to use industrial pesticides compared to non-FFS farmers.

During focus group discussion farmers explained the procedures they followed in the preparation and application of the botanical pesticides. First, they pound 1 kg of *Tephrosia sp* green leaves in a mortar then they mix with five litres of water and then strain. The five litres were mixed into 5 to 10 bags of grain of 100kg each. Thereafter the grain is dried in the sun up to about 13.5% moisture content. The grain is kept free from insect/pests for almost three months. Alternatively they pound 1kg of dry *Tephrosia sp* leaves and mix with 5 to 10 bags of grain which keeps the grain free from pests for the same period. Sometimes the *Tephrosia sp* powder is spread in the store as disinfectant before arranging the bags of grain to kill the insect/pests. At the same time, the extension officers explained that farmers were taught to use botanical pesticides in order to reduce the cost of production to farmers who could not afford to use industrial pesticides; also it is safe for their health. They pointed out that before FFS, most farmers used novathion and kynakil to store maize which was dangerous for their health. Dubey *et al.* (2008) reported that botanical insecticides are best suited for use in organic food production in industrialized as well as developing countries.

In the case of adopting livestock keeping, there are three systems of animal rearing that are used by farmers in Mbinga and Mbeya Rural Districts. These are the intensive system whereby animals/birds are kept indoors, the semi-intensive system where animals/birds are sometimes kept indoors and at other times they are taken out for grazing, and the extensive system whereby animals are taken out for grazing or free range in case of birds. Animals feed on grasses in the bush and when they come back in the evening they can be provided with supplements such as maize bran and grasses.

The study results show that while most of the FFS participating farmers used intensive system for rearing livestock, most of the non-FFS farmers used semi-intensive or extensive system. Generally, intensive and semi-intensive systems of livestock rearing are more productive than the extensive system. Sartika and Noor (2005) for example reported that local chicken in Indonesia performed better under semi-intensive system than in extensive system because extensive rearing system exposes the chicken to predators, adverse environment such as excessive heat, chilling and exposure to parasites and diseases.

The findings show that farmers who participated in FFS activities were more likely to adopt improved farming practices and hence to intensify their agricultural activities compared to those farmers who did not participate in FFS activities. This shows that the FFS approach had an influence on farmers' tendency to intensify their agricultural activities.

Diversification

Diversification reflects the reduced dependence of farmers on agriculture as a source of income. The study observed that after the FFS training farmers adopted farm innovations and increased productivity which enabled them to establish new agricultural as well as non-agricultural enterprises. Discussions were conducted with farmers to know if there were new enterprises that had been established as a result of the FFS training. They reported that after the FFS training and after adopting farm innovations they increased productivity and obtained a good income from selling crops which enabled them to diversify into other enterprises.

The study shows that 35.0% of the respondents diversified into dairy cattle, improved chicken and pig rearing. Other farmers (14.4%) were engaged in the

production of horticultural crops such as tomatoes and other vegetables. About 18.9% diversified into business such as milling machines, butchery, catering and guest houses. Others were involved in tree planting (11.7%); fish farming and bee keeping (3.9%). Only 16.1% had not diversified into other economic activities because they spent their farm income on house construction and paying school fees for their children. Some of the farmers reported that after FFS training they sold their local breed cattle and bought improved cattle which produced more milk, while others engaged in keeping improved pigs and local chicken as an additional source of income. A similar case was also reported by Van den Berg, *et al.* (2002) that from the increase in profits after FFS training, farmers diversified from agricultural production into non-farm income generating activities such as purchasing refrigerators for selling yoghurt , milling machine, sales outlets for vegetables, inputs distribution, selling of pesticide-free rice, fruits, legumes and food processing.

Extensification

Extensification was measured by the extent to which farmers were able to increase the land under cultivation. The study observed that there was statistically significant difference in acreage increase after joining FFS for both maize and beans at $p < 0.0001$. The mean area under cultivation for maize before joining FFS was 0.81 ± 0.032 ha for FFS participating farmers and 0.86 ± 0.054 ha for non-FFS participating farmers. Area cultivated before FFS for beans was 0.41 ± 0.030 ha for FFS participating farmers and 0.38 ± 0.029 ha for non-FFS participating farmers. Thus, no significant difference was observed. After joining FFS there was an acreage increase for FFS participating farmers from 0.81 ± 0.032 ha to 1.27 ± 0.047 ha for maize and there was an increase from 0.41 ± 0.030 ha to 0.93 ± 0.037 ha for beans, while for non-FFS participating farmers there was no acreage increase for both crops. During the early stages of FFS training farmers were encouraged that acreage increase was not an issue but the emphasis was put more on agricultural productivity through intensification. Farmers were advised to cultivate small pieces of land, which under good management could produce enough crops.

During focus group discussion the farmers reported that after completing the training at the end of the cropping season they noticed an increase in productivity. They reported that before the introduction of FFS they used to produce 1.6 t/ha of maize, and 0.3 t/ha of beans, but after the introduction of

FFS the productivity increased to 4.2 t/ha of maize, and 1.2 t/ha of beans. The increase in productivity was noticed after knowledge had been acquired from FFS, which encouraged the farmers to expand their farm acreage.

Effect on crop productivity

Baseline data obtained from the District Agricultural offices of Mbinga and Mbeya Rural were used to compare the crop productivity before and after the introduction of FFS. That means crop productivity before the introduction of FFS was the same for FFS and non-FFS participating farmers but the difference in the increase in crop productivity was observed from the farmers who joined the FFS groups. It was indicated by the DALDO's offices in Mbinga and Mbeya Rural that before the introduction of the FFS approach the maize average productivity was about 1.63 t/ha and for beans 0.32 t/ha. After the introduction of FFS approach maize average productivity was reported to have increased up to 4.75 t/ha and beans 1.21 t/ha.

A t-test was employed to check if there was statistically significant difference in crop productivity between the FFS and non-FFS participating farmers before and after joining FFS. The results show that before the introduction of FFS there was no statistically significant difference in maize productivity between FFS and non-FFS farmers ($P = 0.296$). The mean productivity for both FFS and non-FFS participating farmers was 1.6 t/ha. After the introduction of FFS, the FFS participating farmers increased maize productivity up to 4.2 t/ha while there was no increase for non-FFS farmers (1.6 t/ha). Therefore, there was a high statistically significant difference in maize productivity ($P = 0.0001$) between FFS and non-FFS participating farmers. Likewise, for beans there is no statistically significant difference between FFS and non-FFS participating farmers before joining FFS ($P = 0.457$). The mean productivity was 0.3 t/ha for both FFS and non-FFS participating farmers. After the introduction of FFS, the FFS participating farmers produced 1.2 t/ha of beans which showed a high statistically significant difference ($P = 0.0001$) between FFS and non-FFS farmers.

Participation in FFS activities therefore resulted into an increase in crop productivity of the FFS participating farmers. Increased productivity was a result of the FFS members adopting improved technologies based on knowledge and skills that were acquired during the FFS sessions.

Conclusion

The study shows that as a result of participation in FFS activities, farmers acquired knowledge and skills that enabled them to adopt agricultural innovations which led to increased productivity. The non-FFS participating farmers on the other hand lacked the knowledge and skills on the new innovations. The increased income obtained by FFS farmers facilitated them to diversify into new enterprises and also encouraged them to expand the area under cultivation. The study shows that the FFS approach was very effective in stimulating farmers to adopt farm innovations and in increasing agricultural productivity. Given adequate resources, more farmers in the study districts and elsewhere could also benefit from participating in FFS activities.

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Research Productivity and Scholarly Impact of Forestry Researchers at Sokoine University of Agriculture: A Bibliometric Analysis

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Abstract

A bibliometric analysis was conducted to understand the research productivity and scholarly impact of forestry researchers at Sokoine University of Agriculture for the period of 1998 to 2013. Data were obtained using the Publish or Perish software that uses Google Scholar to retrieve scholars' publications, citations and related metrics. A total of 1031 publications were recorded for all forestry researchers, giving an average of 64.4 publications per year and an annual growth rate of 6.3%. The year 2008 had the most (12.7%) publications followed by 2007 with 9% of all publications while the year 2003 had the lowest (3.2%) number of publications. Majority (88.1%) of the publications were multiple-authored and the degree of collaboration was 0.88. The top ten ranked forestry researchers contributed nearly half (46.3%) of all publications; hence corroborating to the Lotka's Law of scientific productivity. However, these top ten scholars showed considerable variation since no single scholar maintained the same rank in all nine metrics. These findings suggest that many factors should be considered in combination when evaluating research performance. The study findings call for a paradigm shift for scholars to focus on the scholarly impacts of their publications.

Keywords: Research productivity, scholarly impact, forestry, bibliometrics

Background information

Evaluation of research performance can be conducted at various levels and for different purposes. Governments use research performance to get insights as to how far a country has progressed in research and development (Wickremasinghe, 2008), to plan and implement research policy, and for the value for money considerations. Funding organizations use research performance evaluations to decide the level of research funding (Arora *et al.*, 1998). At times, institutes that seek research funding are required

to provide evidence of their research accomplishments. In universities and research institutions, research performance is an important criterion for recruitment, promotion, rewards, professional recognition, workload decisions, and for allocation of resources and facilities. Research performance is also one of the most important indicators in ranking universities and research institutes. Moreover, disciplines' progress and reputation can be tracked based on their research performance (Ingram and Petersen, 1991; Read *et al.,* 1998). In addition, companies use research performance as a way of detecting expertise within universities, with subsequent hiring of faculty and graduates as consultants or employees (Gonzalez-Brambila and Veloso, 2007).

In principle, research performance has two components - productivity and impact. Traditionally, research productivity has been measured through the number of publications produced in a given time period. On the other hand, the quality of publications, which reflects the impact, is measured by how many times the publications are cited by other authors - the higher the number of citations, the higher the level of impact. That is to say, research performance has been determined by ascertaining the total number of publications and counting the number of times such publications have been cited by others. This is based on the fact that carrying out research and communicating the results go together, and that, any scientific research is often steered by previous similar works. However, in many cases a great deal of weight has been placed on the quantity of publications produced (Frost *et al*. 2007). Nevertheless, considering that research is a complex activity, a combined use of several performance indicators that consider its breadth is highly recommended (Van Leeuwen *et al*., 2003). Consequently, several sophisticated indicators have been developed in recent years for assessing and comparing performances of researchers, research groups, institutions or countries. Such indicators are a result of technological advancements that enable detailed analysis of data on publication and citation counts.

Research productivity and impact can be combined into a single index to determine research performance. Such indices include the h-index which integrates the number of publications and citation counts in a single number indicator. According to Hirsch (2005), "a scientist has index h if h of his or her Np papers have at least h citations each and the other (Np-h) papers have at most h citations each". The advantage of the h-index is that it combines an

assessment of both quantity (number of publications) and quality (citation counts) (Glänzel, 2006) - simultaneously conveying information about productivity and impact. That means, the h-index has been designed to improve upon simpler measures such as publication or citation counts. Large h scores indicate that a scholar has produced many publications that are well received within the field based on a high citation count. The h-index works properly when comparing scientists working in the same field over the same time period. Other variants of the h-index include the g-index which is a supplement to the h-index in that highly cited articles are given more weight. The contemporary h-index (hc-index) gives more weight to new publications. Furthermore, the HI-norm index normalizes the citation counts before the h-index is calculated by first dividing the citations by the number of authors for each individual work (Harzing, 2008).

Over the years, bibliometric techniques, which are part of scientometrics[1], have been important methods for evaluating research performance. According to Pritchard (1969), bibliometrics deal with the application of mathematical and statistical methods to analyze quantitative and qualitative aspects of publications. These techniques are used in identifying the most productive individuals or units, describing collaboration patterns, determining the popularity and impact of specific authors or publications, and in discovering research anomalies. Traditionally, the most commonly used sources of scientometric data for individual researchers are the Science Citation Index (SCI) and the Arts and Humanities Citation Index (A&HCI). Recent advances in information technologies have enabled innovative creation of large databases that incorporate publication and citation data from which, among others, a variety of metrics are derived. Consequently, new data sources including the Web of Science, Scopus, and Publish or Perish (PoP) have emerged in recent years.

The Publish or Perish (PoP) software, which was released in 2006, uses Google Scholar to obtain the number of publications and sources which cite them. Google Scholar is a search engine that utilizes a highly-guarded algorithmic procedure to identify scholarly works and index them accordingly. Hence, using Google Scholar to identify publications and citations allows for the inclusion of the author's entire body of published work rather than a

[1] Scientometrics is the science of measuring and analyzing science.

selected list of publications (Harzing, 2008). The PoP software produces a number of descriptive statistics for individual authors including the total number of papers, total number of citations, years since first publication, average number of citations per year, total citations per paper, total citations per author, and total papers per author. In addition, PoP calculates several indices including the h-index, g-index, Hc-index and HI-norm index. Comparative studies indicate that the PoP software retrieves more publications and citations compared to others such as Web of Science and Scopus (Bar-Ilan, 2008; Saad, 2006).

Forestry research in Tanzania dates back to 1893 when the first nursery was established near Dar es Salaam for testing tree species. Other notable developments in forestry research during the colonial period include the establishment of the Biological Research Station in 1902 in Amani, Tanga; shifting of the Amani Station to Muguga Kenya in 1948; and the establishment of Sivilcultural and Utilization Research Stations in Lushoto and Moshi respectively during the 1950s. Establishment of the Department of Forestry at the Morogoro campus of the University of Dar es Salaam in 1973 and its elevation to a division in 1974 further augmented forestry research in Tanznia. In 1980, the Tanzania Forestry Research Institute (TAFORI) was established to carry out and coordinate forestry research in the country. Following the establishment of the Sokoine University of Agriculture (SUA) in 1984, the then Forestry Division became the Faculty of Forestry (Nshubemuki, 1998; Abeli, 2000). In 1998, this Faculty underwent some transformations including renaming it to the Faculty of Forestry and Nature Conservation along with the establishment of the Department of Wildlife Management. At present, most forestry research in Tanzania is carried out at SUA mainly because there is a high number of researchers. SUA is the only university in the country with a dedicated faculty dealing with forestry and allied sciences.

This study was designed to understand the performance of forestry researchers at SUA for the period between 1998 and 2013. Forestry researchers in the context of this study include all academicians in the Faculty of Forestry and Nature Conservation at Sokoine University of Agriculture during the study period. Research performance was measured through the analysis of research productivity and scholarly impact of all researchers at the Faculty of Forestry and Nature Conservation. Specifically, the study analyzed the growth of

forestry scholarly literature, the year-wise break up of publications, and determined authorship patterns and the level of collaboration. The study also analyzed individual researchers' productivity and impact. The 16 years period was chosen in order to get insights about developments in forestry research since the Faculty of Forestry and Nature Conservation attained its current status. This study was also important in that no similar studies have been carried out at SUA and in Tanzania at large.

Literature review

Bibliometric methods have been used to measure the performance of researchers across disciplines around the globe. The field of forestry is no exception. A bibliometric analysis of the Journal of *Indian Forester* for the period between 1991 and 2000 indicated that the number of articles published yearly ranged between 114 in 1992 and 156 in 1996. Multiple-authorship was dominant (64.6%) and the degree of collaboration was 0.64 (Hazarika *et al.*, 2003). A bibliometric analysis of forestry research (1977-2007) in Bangladesh established a strong increase of forestry papers from 1998 to 2000 but they started to decrease in 2001 and again increased in 2005 due to various factors. Most of the published papers were multi-authored with degree of a collaboration of 1.0 (Miah *et al.*, 2008). Joshi *et al.* (2010) analyzed the global trends of forest fungal research during 1987 - 2008 and the results revealed that the numbers of publications had increased significantly especially during 2004 - 2008. Similarly, a bibliometric analysis of global biodiversity research during 1900 - 2009 revealed that the number of publications on biodiversity increased from 117 in 1980 to 7,533 in 2009 (Liu *et al.*, 2011). In a recent bibliometric analysis of global forest ecology research covering the period between 2002 and 2011, Song and Zhao (2013) found that the number of articles published annually grew at a stable rate.

Several bibliometric studies have been conducted in other fields as well. Among these studies, Sevukan *et al.* (2007) analyzed a total of 348 bibliographic records of plant sciences retrieved from Science Citation Index (SCI) during the interval 1997 to 2006. The study found that there was a sudden increase of publications in the years 1998 and 2003 while a decreasing trend was noted in the years 1999, 2002 and 2004 probably attributed to changes in funding sources for research. In his study of Plant Science research productivity in Chile during the past 20 years, Krauskopf (2008) noted that the

number of articles published within the Plant Science discipline grew throughout the 20-year period. The research productivity of social scientists at the Centre for Development Studies in India during 1998 – 2008 indicated that there were 599 publications (Sudhier and Abhila, 2011). Baby and Kumaravel (2012) examined the research productivity of Periyar University faculties in India during 1998 – 2010 and found that the growth of research has steadily increased from a single article in 1998 to 102 articles in 2010. Abramo *et al.* (2009) analyzed differences in research productivity of researchers in the scientific-technological disciplines of Italian universities. They confirmed the presence of significant differences in productivity between men and women although the differences were smaller than reported in the literature.

A number of studies have computed h-indices of individual researchers in different disciplines. Hirsch (2005) found that the h-indices of some prominent physicists ranged from 62 to 110; that of Nobel prize-winning physicists ranged from 22 to 79; and that of the top ten scholars in the life sciences ranged from 120 to 191. The study concluded that these were clearly huge figures and they reflect the publication habits in natural sciences. The h-indices of information scientists in the United Kingdom were found to range from 5 to 31 (Oppenheim, 2007) whereas the h-indices of 31 American information scientists ranged from 5 to 20 (Cronin and Meho, 2006). Saad (2006) found that the h-indices of consumer researchers ranged from 3 to 17 and Sidiropoulos *et al.* (2007) found that the h-indices of computer scientists ranged between 14 and 24. In evaluating the research productivity of Zahedan University of Medical Sciences (ZAUMS) from 1976-2011, Vatankhah (2012) found that the h-indices increased from 1 to 19 during the interval of the study. Abramo *et al* (2010) observed that the h-indices differ depending on what publications a database covers and analyzes. Generally, the literature confirms that the h-index is sensitive to the disciplinary background of researchers.

Other studies have ranked researchers according to various productivity and impact measures. Abrizah and Wee (2011) estimated the research productivity of Malaysia's computer science researchers using data from the Web of Science database during the period of 2000 to 2010. Among other findings, it was observed that 74.4 percent of 1662 authors published only one article and the most prolific author had 34 papers. Author productivity was not in agreement with Lotka's law. Using PoP, Khey *et al.* (2011) re-ranked the top

female academic "stars" in criminology and criminal justice that were identified by Rice *et al.* (2007). Among other things, the findings were largely similar to those of Rice *et al.* (2007), although some scholars did move up in some rankings. In a similar study, Copes *et al.* (2012) assessed the most productive scholars in criminology and criminal justice using various productivity measures. Through disaggregation of productivity measures by academic ranks, Copes *et al.* (2012) determined the most productive assistant professors, associate professors and full professors.

Notwithstanding the growing use of bibliometric studies to evaluate research performance, such studies are very scarce in Tanzania. An extensive literature search could only identify a study conducted by Ocholla *et al.* (2012) to compare the publication output and patterns of academic librarians in Eastern Africa from 2000 to 2009. The authors established that there were minimal publications over the course of ten years; most academic librarians preferred publishing individually; and that the most published authors were from the University of Dar es Salaam and Sokoine University of Agriculture in Tanzania. Hence, the present study would contribute to the scarce literature on scientometric studies in Tanzania.

Methods

This bibliometric analysis was conducted for five days from 9th to 13th September 2013. This short period was important because citation counts keep on accumulating. At first, names of forestry researchers were obtained from the Faculty of Forestry and Nature Conservation. Efforts were also made to obtain the names of scholars who worked with the Faculty for different periods between 1998 and 2013 but had left for various reasons. In total, 72 researchers were identified for this study.

Using the PoP software, author impact analyses of all 72 researchers were conducted for the 16 years period. The study utilized data that were publicly available in the web; meaning that any publications and citations that were not available on the web could not be retrieved. A search strategy was developed including all authors' names and their possible variants. Each individual scholar was entered into PoP to determine individual statistics. Search results were carefully refined to ensure that only works of intended persons were captured and duplicates were removed. Publications from homonym authors

were identified and removed. If questions arose on the validity of particular publications, these were re-searched via the web to determine if they were actually written by those particular authors. The results were sorted by years of publications in order to obtain the year-wise distribution. In the context of this study, the types of publications considered were journal articles, books, book chapters, conference papers and book reviews. The total number of authors for each publication was manually counted. For each scholar, the retrieved statistics included the total number of publications, total citation counts, average citations per paper, average papers per author, average citations per year, h-index, g-index, Hc-index and the HI-norm. The limitation of this study, as alluded to earlier, is that it only focused on publications that were retrieved by PoP through Google Scholar. This could however also be considered as a strength in terms of wider reach and impact.

Results and discussion

Based on the "all counting method" whereby each author receives a full count for joint pulications, a total of 1031 publications were recorded for all scholars at the SUA's Faculty of Forestry and Nature Conservation during the period between 1998 and 2013. This gives an average of 64.4 publications per year and an annual growth rate of 6.3%. The year-wise distribution shows that the year 2008 had the highest number (131; 12.7%) of publications followed by the year 2007 (93; 9%). The year 2003 had the lowest number (33; 3.2%) of publications (Table 1). Although publications were produced every year, the trend does not show a predictable growth pattern. This may raise some questions such as why would the number of publications rise in the year 2000 followed by a fall in the following years? Why was there a rise again in 2007 and 2008 which was followed by a fall by almost half in the following years? Partly, such trends might be attributed to the unreliable availability of research funds, which are often obtained through donor support. It could also be due to the fact that sometimes manuscripts take long time to be published in journals. It should be noted however that these publication data were extracted in September 2013; hence the total productivity of 2013 might be incomplete.

Table 1: Year-wise Distribution of Publications

Year	No of publications	Percent
1998	58	5.6
1999	42	4.1
2000	85	8.2
2001	60	5.8
2002	36	3.5
2003	33	3.2
2004	61	5.9
2005	75	7.3
2006	48	4.7
2007	93	9.0
2008	131	12.7
2009	71	6.9
2010	46	4.5
2011	59	5.7
2012	68	6.6
2013	65	6.3
Total	**1031**	**100.0**

Source: Google Scholar

With respect to the authorship pattern, the study findings indicate that the great majority (88.1%) of the publications were multiple-authored with over a fifth (21%) of the publications being contributed by three joint authors. A total of 194 (18.8%) publications had six or more authors and 188 (18.2%) publications had four joint authors. Only 11.9% of the total publications were single authored (Table 2). The ratio of team work to that of sole work was 7:1, indicating a very high level of collaboration in forestry research. These findings support previous studies such as those of Hazarika *et al.* (2003) and Miah *et al.* (2008) that established somehow similar authorship patterns and levels of collaboration in forestry research.

The degree of collaboration among forestry scholars was computed as the ratio of the total number of collaborative publications to the total number of publications (Subramanyan, 1983). The degree of collaboration in this study was 0.88; which again points towards a high level of teamwork. This can be attributed to the fact that forestry research is highly multidisciplinary in nature, which often calls for researchers from diverse specializations to share their expertise. However, this is contrary to Onyancha (2007) and Ocholla *et al.*

(2007) who reported that research collaboration in Africa is weak. Nonetheless, collaboration in research is often recommended as it enables researchers to share skills and techniques; enhances transferring of knowledge (especially tacit knowledge); brings about cross-fertilization of ideas; provides intellectual companionship; plugs the researcher into a wider scientific network; and enhances the visibility of research works (Katz and Martin, 1997). However, it is often difficult to determine the actual contribution of each scholar when they collaborate in writing a particular scholarly article.

Table 2: Authorship Pattern of Publications

No. of Authors	No. of publications	Percentage
Single Authors	123	11.9
Two Authors	166	16.1
Three Authors	216	21.0
Four Authors	188	18.2
Five Authors	144	14.0
Six or more Authors	194	18.8
Total	**1031**	**100.0**

Source: Google Scholar

The study findings in Table 3 indicate various productivity and impact measures of the top 10 ranked forestry researchers at SUA. The mean scores for various metrics for these top 10 ranked researchers were 47.7 publications, 325 citations, 8.36 cites/paper, 18.67 papers/author, 21.88 cites/year, h-index of 8.4, g-index of 15.4, Hc-index of 6.1 and HI-index of 5.7. These mean scores are higher than the overall means for all researchers. The top 10 ranked forestry researchers showed variation among productivity and impact measures since no single scholar maintained the same rank in all nine metrics. Hence, these findings support the argument that multiple measures should be employed when assessing scholars' performance. This means that there are no all-purpose indicators for research performance. This argument is supported by Martin (1997) who argued that research performance is a complex multifaceted endeavour that cannot be assessed using a single indicator.

When considering the number of publications, the top 10 ranked authors together contributed nearly half (477; 46.3%) of all publications with an average of 47.7 publications per author. These findings corroborate Lotka's Law of scientific productivity (Lotka, 1926) which postulates that large

proportions of authors tend to produce relatively few article equivalents, with the bulk of production being made by a small number of individuals. In this case, S.A.O. Chamshama was the most prolific author (69 publications) followed by R.E. Malimbwi (67 publications) and G.C. Kajembe (64 publications). However, when re-ranked based on citation counts, which indicates the usefulness of the publications, E.J. Luoga ranked the first (528 citations) followed by E. Zahabu (495 citations) and A.N. Songorwa (468 citations). Surprisingly, the top three scholars in terms of publications had fewer citations compared to some scholars with fewer publications. For example, Chamshama had the highest number of publications but dropped to the ninth position in terms of citations whereas Songorwa with 19 publications moved up from ninth to the third place. This confirms the fact that ones' citation counts depend on factors other than the number of publications. Such factors include the visibility and accessibility of journals where one publishes, quality of publications, author's integration into scientific networks, age of publications, the size of the scientific community (Creamer, 1998; Zuckerman *et al*., 1991), and the topic or issues which ones publishes.

With respect to the researchers' yearly impact, Luoga ranked number one with 37.71 cites per year, followed by Songorwa (31.20 cites per year) and Zahabu (30.94 cites per year). On the other hand, if one takes into account the number of cites given to each individual publication, Songorwa ranked the first followed by Luoga and J.J. Kashaigili with 24.63, 14.27 and 7.90 cites per paper respectively. The average number of citations per paper indicates the relative extent to which certain publications generate interest in the scientific community. The top three authors with the most papers per single author were Malimbwi (25.55 papers per author), Zahabu (25.15 papers per author) and Chamshama (23.50 papers per author). The number of papers per author is obtained by dividing each publication unit by the number of authors of that publication and summing the results over all publications.

Table 3: Rank-list of most productive authors

Author name	No. of publications	Citations	Cites/paper	Papers/author	Cites/year	H-index	G-index	HC-index	HI-norm	Overall rank
E. Zahabu	63 (4)	495 (2)	7.85 (4)	25.15 (2)	30.94 (3)	12 (1)	20 (2)	10 (1)	8 (1)	1
E.J. Luoga	37 (7)	528 (1)	14.27 (2)	12.87 (9)	37.71 (1)	9 (3)	22 (1)	7 (3)	8 (1)	2
J.J. Kashaigili	40 (6)	316 (4)	7.90 (3)	14.43 (8)	26.33 (4)	10 (2)	16 (4)	9 (2)	6 (2)	3
G.C. Kajembe	64 (3)	280 (5)	4.38 (8)	19.82 (5)	17.50 (5)	8 (4)	14 (5)	5 (5)	5 (3)	4
A.N. Songorwa	19 (9)	468 (3)	24.63 (1)	12.43 (10)	31.20 (2)	6 (6)	19 (3)	4 (6)	5 (3)	4
R.E. Malimbwi	67 (2)	252 (6)	3.76 (9)	25.55 (1)	15.75 (7)	7 (5)	12 (6)	5 (5)	5 (3)	5
P.K.T. Munishi	42 (5)	252 (6)	6.00 (6)	15.04 (7)	15.75 (7)	9 (3)	14 (5)	7 (3)	5 (3)	6
J.R. Kideghesho	34 (8)	244 (7)	6.97 (5)	20.98 (4)	17.43 (6)	8 (4)	14 (5)	6 (4)	6 (2)	6
S.A.O. Chamshama	69 (1)	206 (9)	2.99 (10)	23.50 (3)	12.88 (9)	8 (4)	11 (7)	4 (6)	4 (4)	7
G.C. Monela	42 (5)	213 (8)	4.84 (7)	16.90 (6)	13.31 (8)	7 (5)	12 (6)	4 (6)	5 (3)	8
Means	47.7	325	8.36	18.67	21.88	8.4	15.4	6.1	5.7	
Overall means	14.3	62.76	2.65	5.48	4.40	2.61	4.56	1.89	1.76	

Source: Google Scholar

Note: Number in parentheses is the scholars rank on that measure

The performance of forestry researchers was also measured on the basis of the h-index, which is regarded as the most robust and accurate measure of productivity and impact (Harzing, 2008). Zahabu had the highest h-index of 12, meaning that his 12 publications had been cited 12 or more times each, and the rest of the publications had fewer than 12 citations. Kashaigili ranked the second with the h-index of 10. These two were the only scholars with h-indices of at least 10. Since the h-index discounts the disproportionate weight of highly cited publications or papers that have not yet been cited, adjustments were made by giving more weight to the authors' highly cited publications (g-index). In this regard, Luoga had the highest g-index of 22 followed Zahabu (g-index 20) and Songorwa (g-index 19). The g-index therefore has a greater discriminatory power that makes it easier to compare performance.

When adjustments were further made to give more weight to newly published works (Hc-index), Zahabu (Hc-index 10) ranked the first followed by Kashigili (Hc-index 9). In this case, another scholar, P.K.T. Munishi, moved up sharing the third place with Luoga both having Hc-index of 7. The Hc-index often provides a slightly fairer comparison between junior and senior scholars. For junior scholars, the Hc-index is generally close to their regular h-index as most of their publications would be recent whereas for seniors, there can be substantial differences between the two indices as most papers included in their h-index are relatively old (Harzing, 2008). With regard to the HI-norm-index which evaluates the effects of co-authorship and estimates the per-author impact, Zahabu and Luoga occupied the first position with HI-norm index of 8 each whereas Kashaigili and J.R. Kideghesho ranked the second with indices of 6 each. Five scholars - Songorwa, Kajembe, Monela, Munishi and Malimbwi - tied at the third position with indices of 5 each.

Overall, Zahabu ranked the first followed by Luoga and Kashaigili. Whereas Zahabu maintained the first to fourth place in various metrics, Luoga fluctuated between the first and ninth position while Kashaigili fluctuated between the second and the eighth place. Interestingly, of the top ten most prolific researchers, five (Luoga, Malimbwi, Kajembe, Kashaigili and Zahabu) were from the same department - Department of Forestry Mensuration and Management. This ranking somehow echoes the ranking of SUA researchers in the Google scholar citations (SUA, 2013). It should be noted however that topping the list of researchers should not be considered that these scholars are

always more prolific; neither should it create any sense of superiority for these individuals. Instead, scholars should simply use this as a means to show how they fare among others in the discipline in a particular period of time. It should also be emphasized that ranking of researchers was based on publications and citations that were available online covering the period between 1998 and 2013. This means, some senior researchers could rank differently if their productivity and impacts were measured based on their career life and if offline publications and citations were retrieved.

Conclusion and recommendations

The study findings indicate that forestry researchers at SUA produced an average of 64.4 publications per year with an annual average growth rate of 6.3% from 1998 - 2013. However, there was inconsistent growth of research publications as the number of publications rose and fell. This situation can be attributed to, among other reasons, unreliable availability of research funds. The study findings also indicate a high level of teamwork as most publications were multi-authored. This high degree of collaboration is attributed to the multidisciplinary nature of forestry research. The top ten ranked forestry researchers showed considerable variation in various metrics as no single scholar maintained the same rank in all nine metrics. This supports the argument that multiple measures should be used when evaluating productivity and impact of scholars. Overall, Zahabu was the top ranking scholar.

The study findings suggest that several measures should be considered in combination when evaluating research performance of individual scholars. Relying on a single indicator such as total number of publications is inadequate because each indicator might present some drawbacks. The findings also suggest that researchers should publish substantial number of highly cited papers in order to improve their productivity and impact. This implies that researchers should publish their research papers in “visible” journals such as e-journals and particularly open access journals in order to receive high citation counts. This calls for a paradigm shift among researchers so that they focus on the scholarly impacts of their publications. Furthermore, since research in fields such as forestry has proved to be highly collaborative in nature, it is important for institutions to consider giving each author full credit when counting the publications. Future bibliometric research could include more parameters and involve all forestry researchers in Tanzania in

order to obtain a complete picture of forestry research in the country. A study can also be carried out to investigate factors that determine the research performance of individual forestry researchers. Further bibliometric studies can be conducted for other fields at SUA and Tanzania at large.

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Single and Co-education Enrolment and Performance of Students in Agricultural Science Senior Secondary Schools in Zaria, Nigeria

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Abstract

This study assessed enrolment and performance of students in single and mixed schools in senior secondary agricultural science schools in Zaria, Kaduna State of Nigeria. Data on students' senior secondary certificate examination (SSCE) from 1996 to 2000 were obtained from Kaduna State Examination Board. Twelve randomly selected schools comprising of single and mixed schools were involved. Data were analyzed using simple descriptive statistics and spearman's rank correlation for testing significance (p = 0.05). Results showed that 7066 students were enrolled over the five years out of whom 33.3% were in single male schools, 36.4% in single female schools and 30.3% in mixed schools. Performance results showed that female students from single schools performed better (20%) than male students from single schools (16.6%). In mixed schools, male students performed significantly (r=0.89) better (15%) than female students (10.5%). A moderate relationship (r=0.6) existed between male students from single schools and male students from mixed schools, and between male mixed schools and female students from single schools. A significant difference (r=0.89) was observed when comparing female students from single schools versus those from mixed schools, and when comparing female students from mixed schools versus male students from single schools. It was concluded that gender does not affect performance in single senior secondary schools but it does in mixed schools.

Keywords: Gender, single and co-educational schools, performance, Nigeria.

Introduction

Some rural families in developing countries have been reluctant to send their daughters to school for fear of learning new values, become less inclined to accept domestic work and more interested in joining salaried occupation. More priority is given to boys' education because at adult stage,

they are expected to support their parents while the girls follow their husbands' families. The Education Encyclopedia (2012) reported that formal education, both in developing and developed countries tend to convey messages and experiences that reproduce traditional views of femininity and masculinity and as such, the girls do not acquire the knowledge to question the *status quo* and the boys do not learn to appreciate girl's needs and conditions. Consequently, Watkins (1999) reported that about 150 million of those enrolled in primary school tend drop out before completing four years of education, majority of who are girls from poor families or marginalized ethnic groups. He further estimated that by 2005 about U.S. $9.5 billion would be required in recurrent expenditure to close the gender educational gap in 51 countries that had the largest gender differentiation.

According to the Education Encyclopedia (2012), the benefits of educating women are enormous and they range from social payoffs (such as lower fertility rates, improved children and women's health, and greater life expectancy for women and men) to individual improvement (such as older age at marriage, reduced teen pregnancy, greater participation and productivity in the economy and a greater sense of independence). Despite these advantages of educating girls, some studies on gender enrolment in Nigeria secondary schools (Okeke *et al.*, 1996) have shown a decline in female enrolment with higher male enrolment at primary school level. Another study (Zymelman, 1990) reported that the proportion of students' enrolment into science secondary school was less than 40%. Nonetheless, another study (Nworgu and Agbo, 1996) in Enugu State, Nigeria reported higher enrolment of girls than boys in science secondary schools.

The reasons for a decrease in enrolment of boys hinged on socio-economic and cultural factors such as inability of parents to pay fees, cost benefit analysis of education, which mostly favoured females, a low rate of return from education, and inability of educated male to do well economically. There were also cultural factors which put emphasis on material wealth that must be held by men and the nouveaux riches and upstarts whose ways of life have become attractive to other males in the society. An insufficient output of student in science is another reason (Mohammed, 1994). In another study in Nigerian secondary schools, the enrolment of boys was 10% to 20% more than the girls (Azimi, 1993). Similarly, Jibril (2000) reported that boys' enrollment was

higher than that of girls. Gender disparity in school enrolment in favour of male students is further supported by Orire (1996) and Okwo (2001) who reported 73% enrolment for male and 27% for female in the University. These scholars reported further that male enrollment in secondary schools was 53% while that of female was 46%. Similarly, the scholars reported higher enrollment of male (56%) than female (44%) in primary schools.

Generally, enrolment trends in Nigeria are contrary to the national policy on education which stipulates that every child has the right to free education in any school of their choice with public funding. Instead, the responsibility for educating a Nigerian child is primarily on parents, leading to forced competition for the limited places. Inconsistent use of educational policy gave birth to multiple criteria of selecting students for enrolment based on sex discrimination and academic performance of the students in their entrance examination (Edam, 1987) as well as other criteria including catchment area, educational advantage, and disadvantage states (Nwanosike, 2006). Inadequate number and poor quality of agricultural teachers and equipment are also impediments to achieving quality education at senior secondary level. Differences in family background such as the occupation of parents have also contributed to differences in students' performance (Moos, 1978). Studies on the achievement of pupils are regarded often justifiable to account for huge government expenses on the education of children (Nwabuisi, 1998) as well as to serve as inputs for curriculum evaluation and assessment of educational policy implementation. Zaria in Kaduna State of Nigeria is one of the educationally disadvantage areas in the country. For socio-cultural reasons, girls who are in schools in this state are often not allowed to seat together or attend the same school with the boys, hence creating gender disparity and further aggravating the position of girls in the state.

The position of agriculture both as a subject in schools and practice in Nigeria is dwindling every day, yet promoting agriculture was one of the cardinal policies at independence. Over the years, agricultural science is second to the least applied subject in the Nigerian University possibly due to the students' poor foundation in secondary schools. The question is; how can Nigerians justify the huge amount of money the government invested in agricultural teachers training and curriculum development without proper monitoring and evaluation of the students' performance while at school? Such investment was

made to train youths who would be self reliant after secondary in case they did not have the opportunity of pursuing furthering education. Monitoring is imperative to justify government expenses and to ascertain the level of implementation and performance of students in agricultural programme.

The purpose of this study therefore was to establish the enrolment and performance of students in agricultural science senior secondary schools. The specific objectives were to determine the enrolment of students in agricultural science senior secondary schools; examine the relationship between gender and performance in each of the different school types; and compare the performance of male and female students in three school types – single boys, single girls and mixed (boys and girls) secondary schools.

Methodology

The study was conducted in Zaria, Nigeria in 2003. Zaria is a cosmopolitan city that lies between latitude 11.07 and 12 degree North and Longitude 07.44 and 8 degree east. The city comprises of two local government areas, Zaria and Sabon gari, which hosts over ten tertiary institutions including a University, College, Polytechnics, Monotechnics and Military barracks as well as several public and private secondary schools. Twelve Science Secondary Schools were randomly selected for this investigation namely (i) Kufena Government Girls Secondary School, (ii) Chindit Barrack, (iii) Government Girls Secondary School, (iv) Kofan Gaya, (v) St. Bartholomew Secondary School, (vi) Dogon Bauchi Comprehensive College, (vii) Therbow Secondary School, (viii) Victory College (ix) Alhudahuda College, (x) Barewa College and (xi) Government secondary School, and (xii) Tukur-Tukur. Eight among the twelve schools were single schools (four boys' schools and four girls' schools) and four were mixed schools (Table 1). Data was collected from these schools during 2003, compiling information on students' enrolment and academic performance from 1996-2000. Data on students' enrolment and academic performance were obtained from the Educational Board in Kaduna State, Zaria centre. The record was both formative and summative and data were based on a students' cumulative record for their Senior Secondary Certificate Examination (SSCE) achievement over the five years.

The general annual performance of students in SSCE agricultural science was carefully collected using the grading system of A to F (i.e. A_1, B_2, B_3, C_4, C_5,

C_6, D_7, E_8 and F_9), where the grade A stands for distinction while B_2-C_6 covers credit, D_7-E_8 covers pass and F_9 stand for fail. The required grade, otherwise called quality of performance, which enables candidates to continue taking the subject in tertiary institution is A-C. Data were analyzed using simple descriptive statistics and spearman's rank correlation coefficient ('r').

$$\% \, Mean = \frac{X}{Y} \times 100$$

Where

X = number that made a particular score per school

Y = total number of students that enrolled over five years

The Spearman's rank correlation coefficient ('r') is given as;

$$1 - \frac{\sigma \sum d^2}{n(n^2 - 1)}$$

Where

d = difference in ranks

n = number of grades from A to F

б = constant

Results and discussion

The study findings in Table 1 show that 7066 senior students inconsistently and in a declining pattern were enrolled into agricultural schools over the period of five years from 1996 to 2000. In 1996 and 1998, the enrollment of male and female students in agriculture was around 20.5%. The highest enrolment of 21.3% was observed in 1997 and subsequently declined to 19.7% in 1999 falling further to 18.0% in 2000. The decline in enrolment for agricultural science in senior secondary schools suggests that the subject is in jeopardy. These results are in conformity with those of Nwanosike (2005a) who reported fluctuation in the enrollment of students in senior secondary agriculture in Owerri, Imo State in Nigeria. This situation was a result of parents' inability to pay school fees which consequently led to many of students to drop out and move to trade and skill apprenticeship training.

Furthermore, it was observed that out of the 7066 students that registered and sat for the SSCE examination, 33.3% were male and 36.4% were female students from single schools. The remaining 30.3% came from mixed schools

(Table 1). Of the 2139 students in mixed schools, 58.4% were males and 41.6% were females, which means out of 3461 girls in the sample, only 25.7% (890) attended mixed schools. These findings generally imply that parents in Zaria preferred their daughters to attend single (female) schools, but there was a higher enrollment of boys in mixed schools, which probably reflects the parents' preference to educate boys relative to girls (Table 6).

The results on academic performance in Table 2 show that 1177 students from single boys schools passed with grades ranging from A- E. This comprised 16.6% of all the students sat for the SSCE examination during the five year interval. Out of these only 7.8% obtained the minimum requirement (A-C), which qualify them to continue with the subject at the University or other tertiary schools in Nigeria. However, out of 2356 boys in singles schools 50% passed but only 23.5% scored the minimum requirement for continuing with the agricultural subject into tertiary institutions. This poor achievement was attributed to lack of qualified and trained teachers and inadequate facilities for teaching agriculture as reported earlier by Nwanosike (2002) as well as Nwanosike and Nwadibia (2005).

Table 1: Schools and students enrolment in agricultural science from 1996 to 2000
Number of candidate for year

S/N	Name of schools	Gender	1996	1997	1998	1999	2000	Total	% of enrolment
1	S.S. Kufena College	Male	146	124	126	118	109	623	
2	Barewa College	"	200	109	190	116	62	677	
3	Alhuhuda College	"	150	146	120	120	104	640	
4	G.D.S.S., Tukur-Tukur	"	96	70	80	86	84	416	
	Sub-total		**592**	**449**	**516**	**440**	**359**	**2356**	**33.3**
5	G.G.S.S., Chindit	Female	120	101	138	124	182	665	
6	G.G.S.S., Zaria	"	210	252	24	198	259	943	
7	G.G.S.S.,Dogon Bauchi	"	118	120	112	122	103	575	
8	G.G.S.S., K/Gaya	"	86	70	72	82	78	388	
	Sub-total		**534**	**543**	**346**	**526**	**622**	**2571**	**36.4**
9	St. Bath., Wusasa	Mixed	50	49	66	58	52	275	
10	Comp. College, S/Gari	"	151	148	162	145	112	718	
11	TherbowSec. Sch, Zaria	"	32	23	30	24	35	144	
12	Victory Sec. School	"	91	291	329	200	91	1002	
	Sub-total		**324**	**511**	**587**	**427**	**290**	**2139**	**30.3**
	Total		**1450**	**1503**	**1449**	**1393**	**1271**	**7066**	**100**
	Percentage (%)		**20.5**	**21.3**	**20.5**	**19.7**	**18.0**	**100**	

Table 2: Performance of male students in agricultural science in single schools from 1996 to 2000

Grades	**1996**	**1997**	**1998**	**1999**	**2000**	**Total**	**% of all males sec Schools N=2356**	**% of all student (N=7066)**
A	-	-	-	03	12	15	0.64	0.21
B	11	16	16	24	14	81	3.43	1.15
C	108	80	74	92	104	458	19.43	6.48
Credit	**119**	**96**	**90**	**119**	**130**	**554**	**23.5**	**7.84**
D	54	64	79	40	40	277	11.75	3.90
E	53	82	79	59	73	346	14.69	4.90
Pass	**107**	**146**	**158**	**99**	**113**	**623**	**26.4**	**8.80**
Su-total Pass	**226**	**242**	**248**	**218**	**243**	**1177**	**49.9**	**16.6**
F(Fail)	**366**	**207**	**268**	**222**	**116**	**1179**	**50.1**	**16.70**
Total	592	449	516	440	359	2356	100	33.30

Table 3: Performance of female students in agricultural science in single schools from 1996 to 2000

Grades	1996	1997	1998	1999	2000	Total	% of all females (N = 2571)	% of students (N=7066)
A	4	7	-	-	3	14	0.5	0.20
B	22	22	23	28	12	107	4.2	1.51
C	121	97	77	128	167	590	22.9	8.34
Credit	**147**	**126**	**100**	**156**	**182**	**711**	**27.6**	**10.0**
D	28	78	58	38	114	316	12.3	4.47
E	80	94	66	86	134	460	17.9	6.51
Pass	**108**	**172**	**124**	**124**	**248**	**776**	**30.1**	**11.0**
Sub-total Pass	**255**	**298**	**224**	**280**	**430**	**1487**	**57.7**	**21.0**
F(Fail)	**279**	**245**	**122**	**246**	**197**	**1089**	**42.3**	**15.4**
Total	534	543	346	526	627	2576	100	36.4

The results in Table 3 show that 21% out those who passed with scores A- E in agricultural science were female from single girls' schools. Out of these, 10% had good grades ranging from A-C while the remaining 11% scored D – E. Within this category, out of 2571 girls that registered, 57.7% passed with a score of A – E, but only 27.6% obtained high scores falling in the range A-C, which qualify them for further tertiary education in agriculture. This level of performance is also poor considering the number that enrolled for the subject. Generally in single schools, female students performed better (10% scored A - C) compared to only 7.8% of the boys within their category obtained the high score. These findings do not support an earlier report by Nwanosike (2005a) who concluded that the enrolment and performance of boys are higher than that of females in the senior secondary agricultural science in Imo State

The results in Table 4 show that 15% male and 10.5% female passed with A-E scores in the mixed schools from 1996 to 2000. However, only 10.4% of males and 7.3% of females obtained the required grades (A-C) for transmission to tertiary education institutions. Comparatively, students in mixed schools had higher grades than their counterparts in single schools because they had lower failure rate of 2.7% for boys and 2.1% for girls. Unlike the observation in single schools, the male students performed significantly (r= 0.89) better (10.4%) than the female (7.3%). These findings support those by Olanrawaju (1982) who reported that boys in the mixed integrated science performed better than in single schools. Furthermore, considering the number of students (2139) who registered in mixed schools, 49.7% of the males and 34.7% of female passed with A-E grade. However, only 34.4% of males and 24% of female scored the minimum requirement (A-C) grades (Table 5). This implies that in the mixed senior secondary schools, male enrolled more and performed better than female students in agricultural science.

Table 4: Relative performance of male and female students' in agricultural science in mixed schools 1996 to 2000

GRADE	**1996**		**1997**		**1998**		**1999**		**2000**		**TOTAL**		**% of all students (N=7066)**	
	M	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
A	8	4	6	11	9	7	8	6	13	5	44	33	0.60	0.47
B	30	16	19	19	43	22	27	20	6	19	125	96	1.80	1.36
C	98	86	52	47	162	96	161	83	93	74	566	386	8.0	5.46
Credit	**136**	**106**	**77**	**77**	**214**	**125**	**196**	**109**	**112**	**98**	**735**	**515**	**10.4**	**7.30**
D	31	6	56	49	53	22	50	31	34	8	224	116	3.17	1.64
E	15	19	39	48	31	24	15	16	3	5	103	112	1.46	1.58
Pass	**46**	**25**	**95**	**97**	**84**	**46**	**65**	**47**	**37**	**13**	**327**	**228**	**4.63**	**3.22**
Sub-total	**182**	**131**	**172**	**174**	**298**	**171**	**261**	**156**	**149**	**111**	**1062**	**743**	**15.03**	**10.52**
F(Fail)	**15**	**13**	**35**	**35**	**89**	**58**	**23**	**20**	**26**	**20**	**188**	**146**	**2.70**	**2.06**
Total	97	144	207	209	387	229	284	176	175	131	1250	889	17.70	12.58
r=0.89											**58.4**	**41.6**		

Table 5: Relative enrollment and performance of male and female students' in agricultural science in mixed schools 1996 to 2000

GRADE	1996		1997		1998		1999		2000		Number			% of students (N=2139)	
	M	F	M	F	M	F	M	F	M	F	M	F	Total	M	F
A	8	4	6	11	9	7	8	6	13	5	44	33	77	2.10	1.50
B	30	16	19	19	43	22	27	20	6	19	125	96	221	5.80	4.50
C	98	86	52	47	162	96	161	83	93	74	566	386	952	26.5	18.0
Credit	**136**	**106**	**77**	**77**	**214**	**125**	**196**	**109**	**112**	**98**	**735**	**515**	**1250**	**34.4**	**24.0**
D	31	6	56	49	53	22	50	31	34	8	224	116	340	10.5	5.42
E	15	19	39	48	31	24	15	16	3	5	103	112	215	4.80	5.24
Pass	**46**	**25**	**95**	**97**	**84**	**46**	**65**	**47**	**37**	**13**	**327**	**228**	**555**	**15.3**	**10.7**
Sub-total Pass	**182**	**131**	**172**	**174**	**298**	**171**	**261**	**156**	**149**	**111**	**1062**	**743**	**1805**	**49.7**	**34.7**
F(Fail)	**15**	**13**	**35**	**35**	**89**	**58**	**23**	**20**	**26**	**20**	**188**	**146**	**334**	**8.80**	**6.80**
Total	97	144	207	209	387	229	284	176	175	131	1250	889	2139	58.5	41.5
% of enrollment in mixed schools (N=2139)											**58.4**	**41.6**	**100**		
% of passing students in mixed school (N=7066)											**15.0**	**10.5**	**25.5**		

The study findings in Table 6 show that although female students had higher performance (21%) than the males (16.6%), but there was no significant difference between their performance (p = 0.05). Earlier, Nwanosike (2005b) reported that gender is not a strong factor determining performance in agriculture in junior secondary schools. However, the high correlation coefficient (r = 0.89) for the mixed schools shows that male students performed better (15%) than the females (10.5%). These findings are backed by a moderate correlation coefficient (r = 0.6), reiterating the observation that male students in single schools performed better (16.6%) than their male counterparts in mixed schools who scored 15%.

Table 6: Relative performance of students in the different schools types in Zaria from 1996 to 2000 using Spearman's rank correlation ('r')

No	Type of School	Spearman's " r"	Significance level
1.	Male and female in single school	0.0	Not Significant
2.	Male and female in mixed school	0.89	Highly Significant
3.	Male in single and mixed school	0.6	Moderately significant
4.	Male in mixed and female in single school	0.6	Moderately significant
5.	Female in single and mixed school	0.89	Highly Significant
6.	Female in mixed and male in single school	0.89	Highly Significant

However, the quality of performance with A-C grades was higher for boys in mixed schools (10.4%) than those in single male schools (7.8%). Similarly, only a moderate correlation coefficient of 0.6 (p= 0.05) existed between the performance of male students in mixed schools and females in single schools. The results show further that females in single schools performed better (21%) than males in mixed school (15%). The quality of performance (A-C) was similar for female in single schools (10%) and males in mixed school (10.4%). Furthermore, the correlation coefficient (r = 0.86) indicated that students in single male schools significantly performed better (16.6%) compared to female students in mixed schools (10.5%). Similar observations were also noted with respect to the quality of results where students in single male school performed better (7.2%) than female students in mixed school (7.3%). These results provide some evidence to support the argument that given equal opportunity, girls will compete favorably with boys in academic performance.

Conclusion and recommendations

Based on the study findings, three conclusions are drawn from this study. First, students in single female schools performed better than their male counterparts in single male schools. However, male students performed better in mixed schools. Secondly, students in mixed schools performed better than those in single schools with males students performing relatively better compared to female students. Thirdly, gender had no strong effects on the performance of students in single schools although it had a significant effect in the performance of students in the mixed schools. This might be due to competition in performance among male and female students.

Based on the study findings, this study recommends that:

- Enrolment of Nigerian youths (male and female) should be encouraged considering that the educational system and curriculum is designed to make the Nigerian child self reliant after secondary school if they cannot continue to tertiary education.
- Co-educational schools sets up academic competitions among genders hence increased performance among students. Such schools should therefore be encouraged both in urban and rural areas.
- Equal educational opportunity is required for both male and female students in terms of enrolment and training to encourage their attitude and interest towards the agricultural science subject.
- The government should ensure that schools are adequately monitored for proper implementation of polices on agricultural science in any school type and location
- The government should assist in providing tuition subsidies or scholarships for her youths mostly girls, to offset the family economic barriers as most of the parent complained of lack of funds.
- The government and other stakeholders who are involved in the management of public schools should intensify effort to provide trained and qualified teachers, an enabling environment and facilities for teaching agricultural science subject regardless of the environment.

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Inter-annual Anomaly and Seasonal Variability of Rainfall and Temperature in Selected Semi-arid Areas of Tanzania

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Abstract

Although climate variability and change are not new phenomena in semi-arid areas, their trends may change over time. Using data from Tanzania Meteorological Agency (TMA) during the interval of 2003 -2011, this paper examined inter-annual anomaly (deviation from long term mean) and seasonal variability of rainfall and temperature in Iramba and Meatu Districts. Results showed no significant increase ($P>0.05$) of inter-annual rainfall variability. Nonetheless, a considerable shift of heavy rains was evident in Iramba District. In both districts there was a shift of months with the most rain. In addition, considerable rainfall and temperature variability were depicted by the trends in the number of hot and cold years; number of dry and wet years as well as by trends in the number of rainy days in both districts. While temperature showed an increasing trend throughout April in both districts, rainfall showed a decreasing trend, which can increase evapo-transpiration and in turn reduces moisture available for crops, exacerbates poor pasture productivity for livestock, and leads to water scarcity for both crops and animals. Hence, adjustments in cropping and livestock production systems and institutional support are critical in order to buffer the impact of climate variability in semi-arid areas.

Keywords: Climate change, climate variability, rainfall, temperature, semi-arid, Tanzania

Background

One of the contemporary and serious global problems for sustainable development which is threatening rain-fed farming systems is climate change and variability. While climate change occurs over a long-term period, usually a minimum of 30 years, climate variability is a short-term change which occurs through variations of weather variables within or between growing seasons, between or within a year and between or within a decade (IPCC, 2007). In this study, variability is considered between years as well as between and within growing seasons. In the drought stricken, rural and semi-arid regions of Sub-Saharan Africa (SSA) including Tanzania where poverty is common, livelihoods are largely anchored on farming, pastoralism and agro-pastoralism. Dependence on rain-fed agriculture is 80% at the global level, but it is about 95% in SSA. In Tanzania, nearly all smallholder farmers and agro-pastoralists in semi-arid rural areas depend on rainfall (IWMI, 2010; Mongi, *et al*., 2010). Climate variability can adversely affect rain dependent livelihood options especially in semi-arid agro-ecological zones compared to other regions because rainfall in these areas is uncertain (Blench and Marriage, 1999; IPCC, 2007; Burke *et al.*, 2009). Notwithstanding their adaptation, crop yields can be more affected compared to livestock production system when climate variability occurs at a critical stage of growth (Midgley *et al.*, 2012).

Defining semi-arid areas has largely been based on climate. Yet, it is problematic to define semi-arid regions based on their climate[2] (Quinn and Ockwell, 2010). Some scholars have defined these areas as ones having mean annual rainfall as low as 200 and not above 600 mm (Huang *et al.*, 2012; Sarr, 2012). Others give a range between 500 and 800 mm of rainfall per year (URT, 2007; Mongi *et al*., 2010); while some report mean annual rainfall, which ranges between 600 and 800 mm (UDSM, 1999). According to Quinn and Ockwell (2010), the mean annual rainfall in semi-arid regions is between 400 and 1200 mm with mean monthly temperature exceeding 18^0C, with evapo-transpiration exceeding precipitation in one or more seasons. Unquestionably, an annual rainfall below 400 mm is too low and can define an arid agro-ecological zone, which is relatively drier than a semi-arid region. In addition, an annual rainfall of 1200 mm is too much for a semi-arid zone. This paper therefore defines the term semi-arid as an agro-ecological zone which

[2] Average weather conditions including temperature, rainfall and day length (O'Brien, 1993 cited in Quinn and Ockwell, 2010).

receives mean annual rainfall between 400 and 900 mm with a mean monthly temperature exceeding 18^0C (Quinn and Ockwell, 2010).

Based on dryness and temperature, semi-arid regions form nearly 30% of the total global land surface area (Lambers *et al.*, 2001; Tietjen and Jeltsch, 2007). They form 18% of the total land surface area in SSA, and cover a huge land surface area in Tanzania, between 45 and 75% (UDSM, 1999) and up to 80% (Quinn and Ockwell, 2010). Regions which lie in semi-arid areas among other places in Tanzania include Singida, Shinyanga, Dodoma, Tabora and some parts of Arusha and Iringa (UDSM, 1999).

The literature reveals a high degree of agreement that climate variability and change have already happened, and that they are global phenomena (Agrawala *et al.,* 2003; IPCC, 2007; Morton, 2007; Paavola, 2008; Kotir, 2010; Roudier *et al.,* 2011). Proponents of the phenomenon including Exenberger and Pondorfer (2011) are of the view that rainfall is decreasing while temperature is increasing over time. Yet, they fail to explain seasonal variability particularly within crop growing seasons over time. Some scholars are of the view that climate variability is not new in semi-arid regions and that it has been affecting smallholder farmers, pastoralists and agro-pastoralists for many decades (UDSM, 1999; Tietjen and Jeltsch, 2007; URT, 2007; Vetter, 2009; Midgley *et al.,* 2012).

Tanzania is no exception regarding climate variability. Rowhani *et al.* (2011) for example reported inter-annual variability of rainfall and temperature in Tanzania. Frequent dry spells have also resulted into reduced yields and increased food shortages leading to food insecurity (Lema and Majule, 2009). Generally, annual rainfall reveals a decreasing trend at the rate of 3.3% per decade - more so in southern Tanzania, while the mean annual temperature has increased by 0.23^0C per decade during the period between 1960 and 2003 (McSweeney, 2011). Both day time and night time temperatures show an increasing trend particularly during January and February, but night time temperatures reveal an increasing trend at 19.8% per year compared to day time temperature, which increased at 13.6% per year between 1960 and 2003 (McSweeney, 2011). Furthermore, Sarr (2012) predicts more decrease in rainfall in semi-arid regions of Africa including Tanzania and adds that if this trend continues, the growing season in semi-arid regions of Africa will be

reduced by 20% in 2050. While climate variability is differentiated by geographical locations (Challinor *et al.,* 2007; Moyo *et al.,* 2012), there is a paucity of information regarding trends of climate variability in semi-arid ecological zones. It is clear that climate variability will considerably affect rain-fed farming systems and natural resources in semi-arid areas, and therefore, a clear understanding of the phenomenon is critically important in order to inform decision making process to address the imminent impacts.

This paper analyzes climate variability with the view of contributing knowledge on rainfall and temperature trends over time in Iramba and Meatu Districts, some of the semi-arid areas located in central parts of Tanzania. The specific objectives were (i) to analyze inter-annual variability and (ii) to analyze seasonal variability during crop growing periods. The paper uses monthly rainfall and temperature data to analyze annual and seasonal anomaly and monthly trends, which can reveal whether a particular year or season was dry (negative anomaly) or wet (positive anomaly). An anomaly is defined as a deviation of mean annual or seasonal rainfall and temperature from a long-term mean. The anomaly can also demonstrate whether a certain season was hot or cold and whether the number of dry years increased or decreased over time. The trend on the number of rainy days is also analyzed over time. The paper concentrates on rainfall and temperature because these are among the most important climatic variables for a rain-fed farming system in semi-arid areas. Rainfall for instance, controls moisture for plant growth, whereas, temperature controls physiological processes in crops through evaporation and evapotranspiration. The following sections are devoted to explaining the study area, source of data and presenting the results and discussion. Finally, the paper provides conclusions and recommendations.

Study Districts

Meatu District is located in Simiyu Region (formerly part of Shinyanga Region) while Iramba District is in Singida Region. The mean annual rainfall ranges between 400 and 900 mm in both districts. These districts were selected for the study because they lie entirely within a semi-arid zone and that farming system is at risk.

Meatu District

Meatu District lies between latitudes 3º and 4º South and longitudes 34º and 35º East, South of Lake Victoria, and its altitude ranges between 1000 and 1500 meters above sea level. The district receives between 400 and 900 mm of rainfall in the southern and northern agro-ecological zones, respectively under a unimodal rainfall regime (González-Brenes, 2003; Rubanza *et al.,* 2005; Meatu District Council, 2009). The southern zone of the district is relatively drier compared to the northern zone, with more prevalent food insecurity compared to the northern zone (Meatu District Council, 2009). The district's vegetation is characterized by shrubs and thorny trees scattered or clustered in some areas revealing a characteristic of a semi-arid zone. Most parts in the southern zone of the district have bare soils especially during dry season. There are a number of seasonal rivers in the district. River Simiyu, is the biggest; it used to flow throughout the year but is now drying up.

Demographically, women comprise 52.1% out of 299,619 people, and the average household size is 7.4 (URT, 2013). Livelihoods of the majority depend on rain-fed crop and livestock production systems. Food crops include maize, sorghum, paddy, sweet potatoes, cassava, pulses and groundnuts. About three-fifths of the district's population grows cotton, which is the main cash crop. Livestock that are raised by farmers include cattle, goats, local chicken, donkeys and sheep. It is difficult to separate crop production and livestock keeping in Meatu District because the majority of livestock keepers are also crop farmers and vice versa. Agro-pastoralism is most common in the southern parts of the district which has less rainfall.

Iramba District

Iramba District lies between 4^0 to 4^0 $3^{'}$ latitudes South and 34^0 to 35^0 longitudes East. The district is divided into three major agro-ecological zones; the western Great East African Rift Valley zone, central highland zone, and the eastern zone. The Great East African Rift Valley zone is relatively drier compared to other zones. Generally, the district receives mean annual rainfall between 500 and 850 mm. The onset of rainfall occurs during mid-November and cessation is normally during mid-May. Surface temperature ranges between 15^0C in July and 30^0C in October (Iramba District Council, 2009). Vegetation is mainly natural including Miombo woodlands, acacia wood lands and grasslands. More trees are found on hills compared to flat terrains in the

low lands. Demographically, women constitute 50.5% out of 236, 282 people and the average household size is 5.3 (URT, 2013).

The profile for Iramba District (2009) shows that the district covers a land surface equivalent to 790,000 hectares of which 44.3% is arable land. However, only 19% to 25% of the arable land is under utilization. The grazing area covers 42.7% of the land, while forest covers 9.3%. The rest of the land surface area is covered by rocks and water bodies mainly Lake Kitangiri. Agriculture, which includes crop and livestock production, is the main occupation. About 85.2% of the population is engaged in agriculture and so are at risk of being affected by climate variability. Major food crops that are grown include sweet potatoes, white sorghum, bulrush millet, maize and beans. Cash crops comprise of; sunflower, groundnuts, sesame, cotton, onions, pigeon peas, cowpeas, lentils and green gram. Livestock include cattle, sheep, pigs, goats and donkeys. Other economic activities are mining and sunflower oil processing.

Source of data and analysis

Data for this study were collected from Tanzania Meteorological Agency (TMA) recorded on monthly basis. TMA is a government agency responsible for meteorology issues in the country. Due to lack of TMA meteorological station in Meatu District, the study used the mean of data obtained from two different meteorological stations managed by the District Agricultural and Livestock Department. One of the meteorological stations is located at Mwanhuzi (central part of the disrrict) and the other at Mwandoya in the northern part. Initially, the study intended to analyze rainfall and temperature data over a 30-year period[3]. Nonetheless, due to inconsistence in data recording caused by either failure to record readings for a certain day or period of time, or due to failure to submit the readings from meteorological stations to TMA, the time frame with continuous data was reduced to 17 years, covering a period between 1994 and 2011 (Table 1).

TMA does not record temperature at the district level. Temperature data were obtained from Shinyanga and Singida Regions meteorological stations situated at the regional headquarters (Table 1) to represent Meatu and Iramba Districts

[3] This is the classical period of time defined by the World Meteorological Organization (WMO) in which change in the climate system can be observed (IPCC, 2007: 81).

respectively. Hence, when interpreting temperature data, caution has been taken because temperature variability can exist from one district to another within the same region. The paper analyzes maximum temperature because it is recorded during the day time and thus, it is critical in controlling evapo-transpiration and drying up of water bodies, factors that are relevant for crop production. For rainfall variability, the analysis focused on annual and seasonal anomaly trends because anomaly can reveal dry and wet periods over time. During data analysis, both anomaly and monthly means were computed. The anomaly was computed as a deviation from a long-term (annual) mean. The significance and extent of annual rainfall variability was computed based on p-values at 5% level of significance.

Reporting that the annual rainfall and temperature variability was significant or not significant cannot however, tell much about variability, which threatens small-scale farmers, pastoralists and particularly agro-pastoralists. In order to uncover more about; (i) rainfall and temperature variability, the paper analyzed six-month rainfall trends from November to April, (ii) trends in the number of dry and hot years and (iii) trends in the number of rainy days. For temperature variability, the analysis focused on trends in number of hot and cold years. This study adopts a definition of a rainy day as defined by TMA to mean a day where at least 1.0 mm of rainfall is measured (Kahimba *et al*., n.d). A dry year is defined as one that gives a negative annual rainfall anomaly; otherwise, it is a wet year. The study also defines a hot year as one, which gives positive annual temperature anomaly; otherwise, it is a cold year. The calculated anomaly values are shown in Appendix 1.

Table 1: Location of meteorological stations involved: 1994-2011

District	Station	Latitude (degrees)	Longitude (degrees)	Elevation (meters)
Iramba	Kiomboi administrative centre – rainfall	$04^0$17'S	$34^0$24'E	1585
	Singida regional HQ - temperature	$04^0$48'S	$34^0$43'E	1307
Meatu	Meatu District HQ – rainfall	ND	ND	ND
	Shinyanga HQ- temperature	$03^0$39'S	$33^0$25'E	1000

Note: ND means data not available

Results and discussion

Trends in annual rainfall and temperature

Results for annual rainfall anomaly trends measured at Kiomboi meteorological station are presented in Figure 1. The analysis shows that the long-term mean was 852.2 mm per year for the period between 1994 and 2008. This is a typical trend for the semi-arid regions as defined in this paper, in which the upper limit for annual rainfall is 900 mm. In addition, the curvilinear trend reveals that the annual rainfall was decreasing at Kiomboi meteorological station between 1994 and 2001. This was followed by an increasing trend for the period between 2001 and 2008. The P-value was 0.3 (P>0.05) implying that the change was not statistically significant.

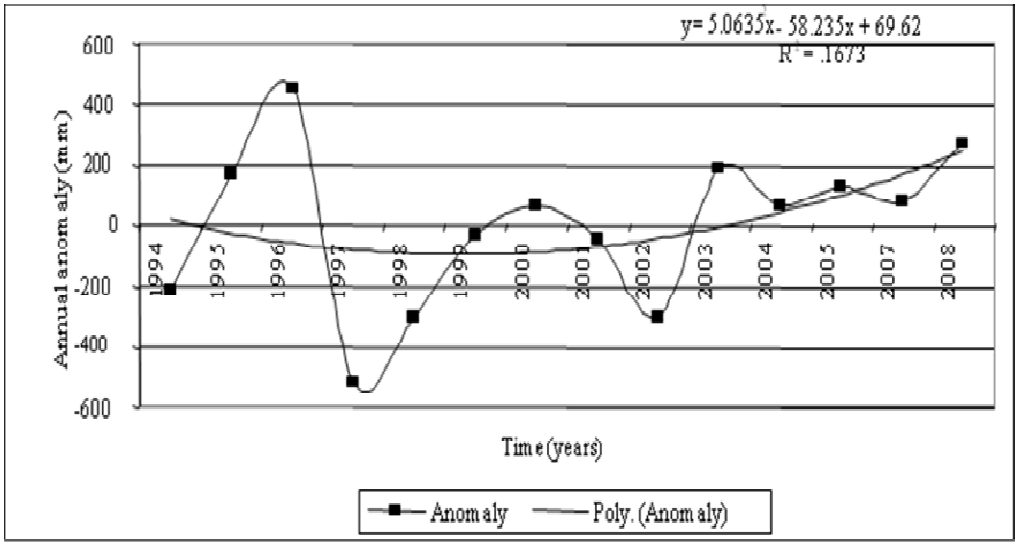

Figure 1: Kiomboi annual rainfall anomaly trends [1994-2008]
Note: Poly (anomaly) means anomaly with many curves

Results of the regression analysis where the anomaly was regressed against time (years) show that the coefficient of determination (R^2) was 0.17, which implies that 17% of the inter-annual rainfall variability was associated with change in time, while the rest of the variance can be explained by other factors. Annual rainfall decreased from 1994 to 2001 thereafter increased up to 2008. The increasing trend which occurred after 2001 as depicted in Figure 1 can be beneficial, but only if the increase was significant and, that rainfall patterns were consistent. Consistent rainfall patterns suggest that it rained at the time farmers and agro-pastoralists wanted or expected it to rain.

Furthermore, rainfall variability can be beneficial when the increasing annual rainfall trend exceeds the range for semi-arid regions. The values for mean annual rainfall and R^2 in Iramba District suggest that the rain-fed farming system was threatened. The dominant farming systems in semi-arid regions likely to be affected as reported by UDSM (1999) include maize and legume system; agro-pastoralist system; livestock/sorghum/millet system; and pastoralist system.

It was difficult to fit the data for maximum temperature in a linear or curvilinear equation because they were so scattered when plotted on a scatter diagram. This indicates that the linear or curvilinear trend was not exhibited. Results however, showed that the mean maximum temperature for Singida Regional Headquarters, which was used as a proxy for Iramba district was 27.5 ^{0}C over the period between 2003 and 2011. In addition, there was a higher number of hot years compared to cold ones over the same interval (Table 2). Comparing maximum temperature with annual rainfall anomaly presented in this paper, the period between 2003 and 2007 had the highest number of dry years compared to wet ones. This implies that the periods of highest temperature were also dry periods. It also implies that the increase in maximum temperature was associated with decreasing amount of rainfall in Singida Region and in Iramba District in particular because part of the district is located along the Great East African Rift Valley which is relatively warm (Iramba District Council, 2009).

Table 2: Number of hot and cold years in Iramba District based on annual temperature anomaly

Period	Number of hot years	Number of cold years
2003-2007	3	2
2007-2011	3	2
Total	**6**	**4**

Maximum temperature is normally recorded during the day time and so its increase can reduce soil moisture through evaporation and evapotranspiration, which in turn can negatively affect crops and pasture development. It is important to note, however, that maximum temperature data that were used in this study were collected at the Regional Headquarters in Singida because TMA does not record temperature at district level. Hence, when interpreting

the results on temperature, caution has been taken as there can be some temperature variability from one district to another within the same region.

In Meatu District, annual rainfall anomaly showed a long-term mean of 668.0 mm for the period between 1994 and 2011 (Figure 2). As in Iramba District, this mean annual rainfall was typical of the semi-arid regions. Based on mean annual rainfall, Meatu District was drier than Iramba District. Yet, the annual rainfall anomaly in Meatu District showed almost a constant trend between 1994 and 2003. The trend from 2004 showed a minimum increasing pattern up to 2011 (Figure 2). The P-value was 0.7 (P>0.05) implying that the increase was not statistically significant at 5% level of significance. The R^2 was 0.0074, implying that only 0.7% of the inter-annual rainfall variability that was associated with change in time between 1994 and 2011.

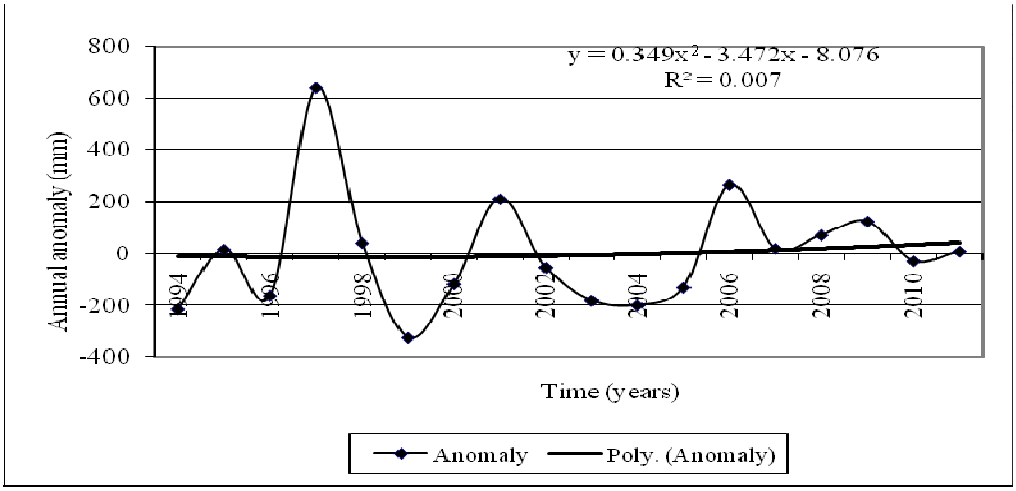

Figure 2: Meatu annual rainfall anomaly trends

Considering the R^2 values, it appears that the annual rainfall variability accounted for by change in time was relatively less in Meatu than in Iramba District. Furthermore, the P-value for each district revealed insignificant increase in annual rainfall over time indicating similar rainfall patterns in these semi-arid parts of Tanzania. The absence of substantial increase in annual rainfall is not surprising because both districts are located within semi-arid region where annual rainfall is usually insufficient. Rainfall variability can be high, though not significantly increasing over time. These results may not reflect local perceptions about the extent of drought and rainfall variability because the local people can define drought and rainfall variability differently

from the parameters measured by TMA. Insignificant increase in inter-annual rainfall anomaly was also reported by Nicholson (2000) in semi-arid southern Africa. Nicholson (2000) on the other hand reported strong inter-annual rainfall anomaly in the semi-arid northern hemisphere mainly influenced by land-atmosphere feedback mechanism.

As it was the case in Iramba District, it was difficult to fit the data for maximum temperature in a linear or curvilinear trend in Meatu District because the data were also so scattered when plotted in a scatter diagram, suggesting that the linear or curvilinear trend was not possible. Based on data from Shinyanga meteorological station, the mean for maximum temperature was 30.6 ^{0}C for the period between 1994 and 2011. In addition, the temperature anomaly showed more hot years compared to cold years for that period (Table 3). The period between 1999 and 2003 showed the highest number of hot years - hence the hottest period (Table 3). As reported for Iramba District, the hottest periods in Meatu District were also dry periods.

Table 3: Number of hot and cold years in Meatu District based on temperature anomaly

Period	Number of hot years	Number of cold years
1994-1998	2	3
1999-2003	4	1
2004-2008	3	2
2009-2011	1	2
Total	**10**	**8**

Trends in number of dry and wet years

Table 4 presents the number of dry and wet years measured at Kiomboi meteorological station. A dry year is defined in this paper as one whose annual anomaly was negative as opposed to a wet year which had positive anomaly. Results showed that there were 6 dry years and 9 wet years in the period between 1994 and 2008 at Kiomboi meteorological station. A higher number of dry years was recorded between 1994 and 2003. The number of wet years was higher for the period between 2004 and 2008.

Table 4: Number of dry and wet years measured in Iramba District

Decade	Dry years [Negative anomaly]	Wet years [Positive anomaly]	Years with missing data
1994-1998	3	2	0
1999-2003	3	2	0
2004-2008	0	5	0
Total	**6**	**9**	**0**

Table 5: Number of dry and wet years measured in Meatu District

Decade	Dry years [Negative anomaly]	Wet years [Positive anomaly]	Years with missing data
1994-1998	2	3	0
1999-2003	4	1	0
2004-2008	2	3	0
2009-2011	1	2	2
Total	**9**	**9**	**2**

Analysis of rainfall data in Meatu District showed a similar number of dry and wet years in the period between 1994 and 2011 (Table 5). This was expected because, as reported earlier, annual rainfall anomaly trend showed a slow increasing trend for the period between 1994 and 2011 and so the number of dry and wet years was likely to remain constant throughout the period. Nonetheless, the number of dry and wet years alternated up and down or down and up. An alternating pattern for dry and wet years in the district suggests presence of rainfall variability. Dry years were in principle, bad ones because the amount of rainfall was below the long-term mean. An increasing number of dry years can suggest increasing number of bad years measured at a particular rainfall station. These results were in line with a study conducted by Lema and Majule (2009) in Manyoni District, Singida Region, which indicated increasing frequency of dry spells. Moyo *et al*. (2012) also reported recurrence of drought in semi-arid SSA including Zimbabwe and stressed that it is not uncommon for drought to occur each year in semi-arid areas.

Trends in mean monthly rainfall and temperature

Table 6 presents trends in mean monthly rainfall measured at Kiomboi meteorological station during the six-month growing period from November to April. These results suggest that the highest amount of rainfall during the

growing season has been shifting from December (1994-1998) to March (1999-2003) and back to January (2004-2008). April and December showed a continuous decrease in amount of rainfall throughout the period under consideration, while the rest of the months showed fluctuating trends.

Table 6: Mean monthly rainfall at Kiomboi meteorological station

Month	1994-1998	1999-2003	2004-2008
November	71.0	123.6	67.3
December	195.6	139.1	112.9
January	140.2	192.4	149.9
February	158.8	60.1	134.7
March	151.8	202.2	135.3
April	120.8	87.6	66.6

Both shifts of heavy rains and fluctuating decreasing trends during the growing season suggest presence of seasonal rainfall variability. A clear decreasing trend in the amount of rainfall in April suggests earlier rainfall cessation, which shortens the length of the crop growing season, hence affecting proper maturity of crops and pastures. The clear decreasing trend in December implies lack of rainfall at the beginning of the growing season, when crops need soil moisture most. The implication of both effects is to reduce the productivity of crops and pastures. Rowhani *et al.* (2011) for example, have reported a decrease in productivity for maize, rice and sorghum in Tanzania due to climate variability.

Results in Table 7 also show that the highest temperature at Singida meteorological station was recorded in November for the period between 2003 and 2007. November also recorded the highest temperature for the period between 2008 and 2011 implying that it was the hottest month throughout the period between 2003 and 2011. In addition, March and April showed an increasing trend of maximum temperature from 2003 to 2011. December, January and February showed decreasing trend throughout the period under consideration. It was difficult to establish the relationship between maximum temperature measured at Singida meteorological station and rainfall measured at Kiomboi meteorological station because there was inconsistency in time frame regarding rainfall and temperature records. Nonetheless, the data clearly showed that while rainfall decreased throughout the month of April for the

period between 1994 and 2008, maximum temperature increased by 0.1^0C in the same month between 2003 and 2011 at Singida Regional headquarters and presumably in the rest of the region, including Iramba district.

Table 7: Mean monthly maximum temperature at Singida meteorological station

Month	2003-2007	2008-2011
November	29.6	28.8
December	27.7	27.4
January	27.8	27.4
February	28.3	27.3
March	27.5	27.7
April	26.8	26.9

In Meatu District, rainfall data were available for the period between 1994 and 2011 (Table 8). The results show that the highest amount of rainfall was recorded in January (1994-1998), March (1999-2003), December (2004-2008), and February (2009-2011); implying a constant shift for the most rainy month. The data also show a clear decreasing trend in the amount of rainfall received in January. The trend is generally also declining for April during this period, especially between 1994 and 2008. The rest of the months showed fluctuating trends. The decreasing trend in January and the mixed trends in the rest of the months suggest that there was seasonal rainfall variability in Meatu District for the period under consideration. The common phenomenon for Iramba and Meatu Districts is that there was seasonal rainfall variability in both districts and the crop growing season normally began in November to April.

Table 8: Mean monthly rainfall in Meatu District

Month	1994-1998	1999-2003	2004-2008	2009-2011
November	132.9	64.6	108.4	62.5
December	141.0	77.6	135.0	175.0
January	168.4	108.9	101.2	48.0
February	124.1	74.9	102.1	139.9
March	102.1	138.2	133.3	136.0
April	130.5	88.3	84.3	96.3

These results also show that similar to Iramba District, the highest temperature in Meatu District was recorded in November throughout the study period except for the interval between 1999 and 2003 when February recorded the highest temperature (Table 9). Within months, trends showed that maximum temperature increased in April throughout the period between 1994 and 2011. The rest of the months showed fluctuations over the same period suggesting temperature variability in Shinyanga Region including Meatu District.

Table 9: Mean monthly maximum temperature at Shinyanga meteorological station

Month	1994-1998	1999-2003	2004-2008	2009-2011
November	31.7	31.0	31.4	30.9
December	30.2	29.6	29.9	29.3
January	29.5	29.1	30.3	29.9
February	29.2	31.3	30.3	30.2
March	30.7	30.1	29.6	30.4
April	29.6	29.8	29.9	30.5

Interestingly, while on one hand the amount of rainfall decreased in April, on the other hand maximum temperature showed an increasing trend over the same month between 1994 and 2011. As argued in this paper, higher temperature can intensify evapo-transpiration and in turn reduce soil moisture available for crops, particularly when it occurs during the growing season. This phenomenon can in turn threaten crop and pasture development and productivity. Water sources may also dry up thus adversely affecting smallholder farmers and agro-pastoralists whose livelihoods largely depend on rain-fed farming systems. Seasonal variability of rainfall and temperature was similarly reported by McSweeney (2011) and Rowhani *et al.* (2011) at the national level in Tanzania.

Trends in number of rainy days within the growing season

Table 10 presents the number of rainy days during a growing season which occurred between November and April. Results from Kiomboi meteorological station showed a fluctuating trend in the number of rainy days for the period between 1994. These increased during the period 1994-2003, but decreased in the period between 2003 and 2008.

Table 10: Number of rain days at Kiomboi meteorological station

Decade	Number of rain days between November and April	Mean (in rainy days)	Seasonal anomaly	Months with missing data
1994-1998	332	66.4	-2.6	0
1999-2003	341	68.2	-4.5	0
2004-2008	283	56.6	7.1	1
Total	**1115**	**63.7**	**0.0**	**1**

Although annual rainfall anomaly showed a slow increasing trend during this interval in the case of Meatu District as reported earlier in this paper, the mean number of rain days showed no clear decreasing trend throughout the period between 1994 and 2011, suggesting rainy days variability. This increasing rainfall trend is not necessarily beneficial to smallholder farmers and agro-pastoralists due to the fact that annual rainfall was also too low in Meatu District more so in the southern zone of the district as reported by the District (Meatu District Council, 2009). Rainfall variability coupled with insufficient annual rainfall can exacerbate the livelihoods poor smallholder farmers and agro-pastoralists.

A decrease in the number of rainy days especially during the crop growing season may not necessarily mean that the amount of rainfall decreased concurrently because the amount of rainfall depends on its intensity and duration when the rain falls. This can clearly be seeing in Meatu District where the annual rainfall anomaly showed an increasing trend (though insignificant) for the period between 1994 and 2011, while the number of rainy days showed a fluctuating decreasing trend. The results indicating a decrease in the number of rainy days are supported by Sarr (2012) who reports a substantial drop in the number of rainy days in semi-arid areas of West Africa, and by Gong *et al.* (2004) who reported the same in semi-arid regions of China. This implies that decrease in the number of rain days is a wide spread phenomenon in semi-arid areas not only in Tanzania, but also in other areas around the world.

Table 11: Number of rain days in Meatu District

Period	Number of Rain Days between November and April	Mean (in rainy days)	Seasonal anomaly	Months with missing data
1994-1998	240	48.0	-1.4	0.0
1999-2003	197	39.4	7.2	0.0
2004-2008	251	50.2	-3.6	0.0
2009-2011	151	30.2	16.4	2.0
Total	**839**	**46.6**	**0.0**	**2.0**

Conclusions and recommendations

This study examined trends in inter-annual anomaly and seasonal variability of rainfall and temperature in Iramba and Meatu Districts over time. Specifically, the study also assessed trends in the number of rainy days, number of hot and cold years, number of dry and wet years and also monthly rainfall variability. Based on the results and discussions therein, the study concludes that the trends of rainfall and temperature variability increased over time from 1994 to 2011. Annual rainfall anomaly trends however, increased minimally indicating that annual variability was somewhat a common feature in the study districts. Maximum temperature showed not only variability, but also an increasing trend - a typical characteristic of semi-arid areas. The study also concludes that whereas annual anomaly showed weak rainfall variability in both districts, within and between seasonal trends showed considerable rainfall and temperature variability. When analyzing climate variability, it is therefore important to consider both seasonal and inter-annual anomaly so as to have a clear understanding regarding the extent of climate variability.

Based on these results and conclusions, the study recommends that crop and livestock (which depend entirely on rainfall) that supports livelihoods in the study districts require adaptation in order to buffer farmers (crops and livestock keepers) from the impact of not only rainfall and temperature variability, but also higher temperature and decreasing rainfall during the critical period growth for crops and pastures. In addition to consolidating and improving local knowledge that smallholder farmers and agro-pastoralists might have regarding climate change and variability, and corresponding adaptation strategies, the district authorities should use meteorological data to create awareness and provide education regading the interpretation of such data. The districts should also advise farmers regarding appropriate adaptation

strategies, which can be applied to address the problem caused by insufficient rainfall, higher day time temperatures, as well as rainfall and temperature variability, which have been demonstrated to exist in this study. One of these strategies involves adjusting the planting dates for various crops, in order to overcome variability and shifts of rainfall patterns during the growing seasons.

Smallholder farmers and agro-pastoralists also require support on alternative livelihood options in order to reduce their dependence on rainfall. This can be done through investment on irrigation infrastructure and provision of credit for purchasing irrigation pumps. Through such support, farmers can be able to irrigate their crops, but livestock keepers can also be able to harvest water for their animals and use it even during prolonged drought. Such heavy investment calls for serious mediation of the government together with full participation of the private sector and other development actors.

For this reason institutional support to smallholder farmers on general husbandry of crops and animals such as supply of improved seeds and breeds that are short-term and drought tolerant need to be in place and strengthened. The private sector for example, should be facilitated to provide such services with district authorities providing guidance through policies and guidelines that enable private sector actors to operate efficiently and equitably thereby providing inputs and services that are affordable to smallholders. The paper also recommends further studies on two pertinent research issues: first, on farmers' perceptions of climate variability and change in order to increase our understanding of the phenomenon from a farmers perspective, and secondly, the effects of climate variability and change on rain fed farming system in semi-arid areas of Tanzania and how the system adjusts to minimize the impact on the people as well as on the environment.

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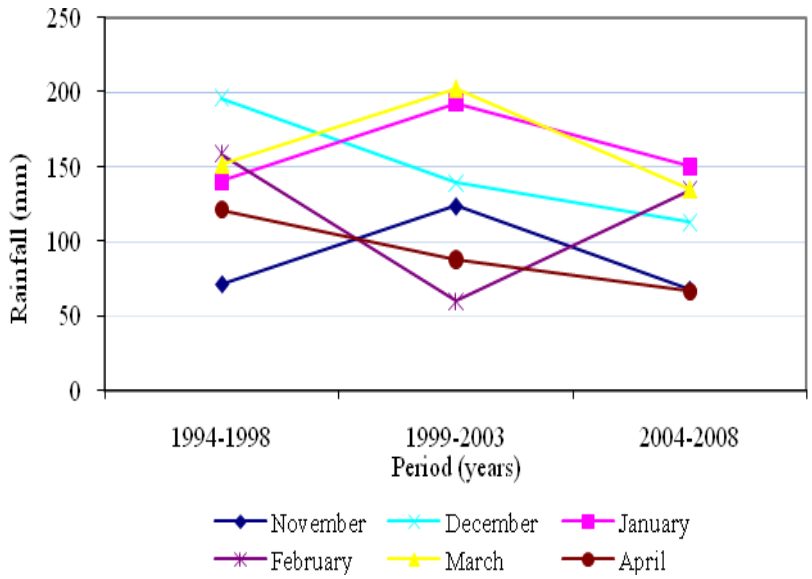
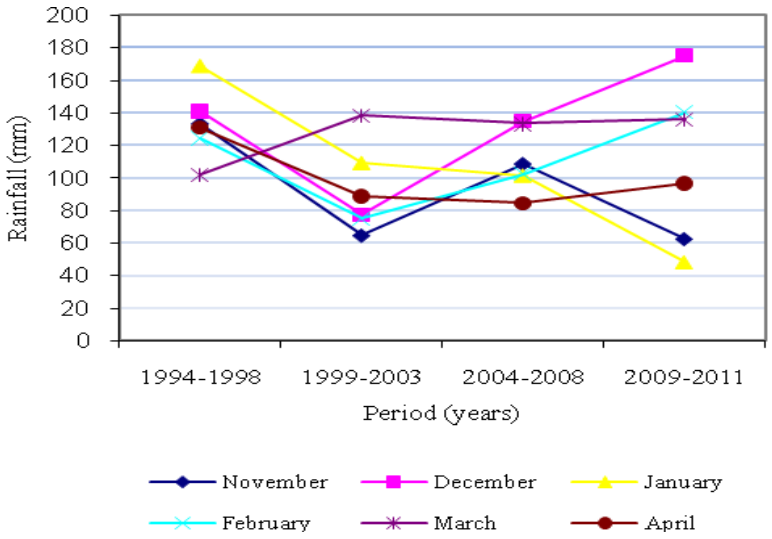
Appendix 1: Rainfall and temperature seasonal anomaly (November-April)

Year	Iramba		Meatu	
	Rainfall (mm)	Temperature (^{0}C)	Rainfall (mm)	Temperature (^{0}C)
1994	+233.0	NA	-134.7	0.3
1995	-207.4	NA	+75.2	-0.2
1996	-432.5	NA	-132.0	-0.1
1997	+429.6	NA	+598.6	0.3
1998	+281.7	NA	+241.2	-0.3
1999	+102.4	NA	-188.8	0.2
2000	-12.6	NA	-118.0	0.1
2001	+16.4	NA	+79.9	0.3
2002	+268.9	NA	-128.8	0.5
2003	-236.8	-0.48	-228.8	-0.6
2004	-33.7	0.29	-260.1	0.0
2005	-77.1	-0.25	-17.1	-0.8
2006	NA	0.18	+251.1	0.4
2007	-47.8	0.34	+18.9	-0.1
2008	-284.4	0.48	-20.5	0.4
2009	NA	0.08	+62.6	-0.1
2010	NA	-0.38	-45.8	-0.5
2011	NA	-0.29	-53.5	0.0

NA = Data not available



Appendix 2: Mean monthly rainfall variability in a six-month period in Iramba



Appendix 3: Mean monthly rainfall variability in a six-month period in Meatu

Factors Influencing the Adoption of Phosphate Fertilizers: A Case of Maize Growers in Njombe District, Tanzania

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Abstract

This study was conducted in Njombe District to identify factors influencing the adoption of phosphate fertilizers among maize growers. A structured questionnaire was used to collect quantitative data from 113 farmers. These were selected using simple random sampling to represent 5 percent of farmers residing in four villages namely, Igagala, Ulembwe, Kibena and Uwemba. A cross-sectional research design was employed for data collection. Chi-square, correlation and regression analyses were used to establish the relationship between the study variables. The respondents' needs, knowledge and perception (intervening factors) show a stronger and consistent relationship with their adoption behaviour than personal and environmental factors. The total contribution of intervening variables to the adoption behaviour explains up to 73.2% of the variation in the adoption behaviour. This overshadows the effect of personal and environmental factors that account for only 24.8% in explaining adoption behaviour. In view of this, the intervening variables seem to be better predictors of the adoption behaviour and the influence of personal and environmental factors become manifested via these intervening variables. Based on the study findings, further research should be conducted in different cultures for the purpose of verifying and identifying new intervening variables that are relevant in determining the adoption behaviour.

Keywords: Personal, environmental factors, intervening factors, adoption

Introduction

Maize is one of the most important cereal crops in Tanzania. Majority of people depend on maize as a source of food as well as a cash crop. In Tanzania, the main maize producing regions are Njombe, Iringa, Ruvuma, Mbeya, Kigoma, Morogoro, Dodoma, Rukwa, Tabora, Mwanza, Kilimanjaro and Arusha (URT, 2006; Amani, 2004). However, the Southern Highland agro-ecological zone currently comprising of five (Iringa, Njombe, Mbeya, Rukwa and Ruvuma) is the most important maize producing area. Prior to the split of Iringa region into two regions (Iringa and Njombe) the four leading maize producing regions were commonly referred to as "the big four."

In order to promote maize production, among other practices, maize requires an adequate supply of nutrients like Nitrogen (N), Phosphorus (P) and potassium (K) (Semoka *et al*., 2012). However, low or non-adoption of recommended fertilizers has been a common practice among many maize farmers. According to Shetto (2007) and Kilima (2011), majority of farmers who use fertilizers in their fields, apply at very low level of about 8 kg/hectare, most of this being nitrogenous fertilizers. The extent of phosphate use is much lower and in most cases farmers do not apply phosphate fertilizers at all. Within plants, phosphorus plays an important role towards seed formation. Low use of this fertilizer has therefore contributed to low average maize yield of 1.3 tons per hectare, instead of 7.2 tones per hectare expected under good management conditions (Shetto, 2007). The low use of phosphate fertilizer also applies in Njombe District despite being within the leading maize producing zone in Tanzania, thereby justifying a study to be conducted to determine factors that influence the adoption of recommended phosphate fertilizers namely, di-ammonium phosphate (DAP) and triple-super phosphate (TSP) application in maize production among maize growers in the study area.

Reasons for the non- or poor adoption of recommended practices have been associated with personal and environmental factors (Rogers, 1983; CIMMYT, 1993; Lugeye, 1994; Machumu, 1995). However, findings have been inconsistent as regards the relationship between personal and environmental factors and the adoption behaviour. Other researchers (Düvel, 1975; Botha, 1986; Düvel and Scholtz, 1986; Koch, 1986; Koch, 1987) argue that the intervening factors namely; needs, knowledge and perception are the more direct and immediate precursors of the adoption behaviour. Such opposing or

even contradicting findings call for further investigations. This study was designed with the main aim of comparing the role of personal and environmental factors and the other set of factors namely the intervening factors or variables in predicting the adoption behaviour among the maize growers in the Njombe District.

Personal and environmental factors which Düvel (1991) referred to as independent factors are conceived as consisting of responses which, from the point of view of a purely physiological analysis, are merely combinations of verbal, skeletal, and visceral reactions; but which from the point of the present action schema are identified and defined not in terms of their underlying physiology but in terms of their "action meanings" (Tolman, 1951). In contrast the author contends that the intervening variables are postulated explanatory entities conceived to be connected by one set of causal functions to the independent variables, and by another set of functions to the dependent variable. Tolman (1951) adds that personal and environmental factors are regarded as observable while intervening ones are not accessible to observation. Assessment of technology adoption should therefore take into account a wider range of factors including the unobserved intervening factors.

Methodology

This study used a cross section research design which allows data collection at a single point in time (Babie, 1990). A pre-tested structured questionnaire comprising of open and close ended questions was used to collect quantitative data from 113 farmers. These were selected using a simple random sampling technique to obtain a sample size that represented 5% of residents from four villages namely Igagala, Ulembwe, Kibena and Uwemba. Observations were used to supplement the collected information. The data was then coded, entered and cleaned in Statistical Product and Service Solutions (SPSS). Data was analyzed using frequencies, chi-square and correlation. The last two analyses were used to test whether there is a significant difference and relationship, respectively between the study variables under investigation. In addition, multiple linear regression analysis was used to establish the effect of various 'independent' variables (personal, environmental and intervening factors) on the dependent variable (adoption behaviour). Equation 1 represents the linear model which was used for analysis. Prior to using the outcomes of

the analysis for statistical inference, the model was tested for multicolinearity and autocorrelation, and both problems did not exist.

Equation 1: $Y = \beta 0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + \varepsilon_0$

Where Y is the predicted value on the dependent variable, A is the Y intercept, the Xs represent the various independent variables (of which there are k), and the Bs are the coefficients assigned to each of the independent variables during regression and ε_0 is error term.

Results and discussion

This section presents the results and discussion regarding the level of adoption of phosphate fertilization and more specifically the influence of personal, environmental and intervening factors on the adoption of phosphate fertilization among maize farmers in the Njombe District. The influence of personal and environmental factors is analyzed separately and then the total contribution is compared to that of the intervening factors.

Personal and environmental factors

Personal and environmental factors investigated in this study are sex, age, formal education, farm size and area under maize. In this section, each individual variable is assessed separately to explore its influence on adoption of the recommended rate of phosphate fertilization. Thereafter, the linear regression model is used to determine the influence of all investigated personal and environmental factors on adoption with the ultimate objective of assessing their relative importance in adoption behaviour.

It is assumed that the age of respondents has influence on the adoption of the recommended rates of phosphate fertilizers in the sense that adoption amongst younger farmers is expected to be relatively higher than that of older farmers. The survey results with respect to the relationship between age and adoption of recommended rate of phosphate fertilization are summarized in Table 1.

Generally, the level of adoption is low in the sense that the majority of respondents (61.1%) used the lowest rate (< 30 kg/ha) compared to only 10.6% who used the highest rate (> 50 kg/ha). The differences between the age categories are significant at 5 percent probability ($\chi 2 = 12.404$; df = 4; p =

0.015). The frequency distribution and negative correlation (r = 0.232) indicate not only that old farmers are less receptive than the young farmers in adopting the recommended phosphate fertilization but also, based on the linear relationship that the tendency to adopt decreases with increasing age. For example, the percentage of farmers not adopting or applying only a minimum phosphate rate increased from 41.9% for young farmers, to 61.1% percent in the case of the middle-age group and up to 87% for oldest category of farmers. Meanwhile, a higher proportion of the younger respondents applied the higher fertilization rates (30-50 kg/ha and > 50kg/ha). In other words, there is a clear negative relationship between the age and the adoption behaviour, which is in line with similar findings by Foltz and Chang (2002).

Table 1: Distribution of respondents according to their age and phosphate fertilization adoption

Age (years)	**Phosphate fertilization (kg/acre)**							
	<30		**30-50**		**>50**		**Total**	
	n	**%**	**n**	**%**	**n**	**%**	**N**	**%**
<36	13	41.9	14	45.2	4	12.9	31	27.4
36-56	36	61.0	17	28.8	6	10.2	59	52.2
>56	20	87.0	1	4.3	2	8.7	23	20.4
Total	**69**	**61.1**	**32**	**28.3**	**12**	**10.6**	**113**	**100.0**

χ^2 = 12.404; df=4; p=0.015; r = -0.232; p=0.013

Although women are considered to be key actors in agriculture, their adoption of recommended practices tends to be lower than that of the men (Shayo, 1991; Jefremovas, 1991; Stephens, 1992; Bwana, 1996). In view of this, it is assumed that the adoption of recommended phosphate fertilizer would be higher among men than among women respondents. The findings in relation to gender and adoption of phosphate fertilizer for maize production are summarized in Table 2, showing that there is no significant difference between the sex categories in terms of adoption of phosphate fertilizers (χ^2 =1.514; df=2; p=0.469). The correlation analyses also confirms the weak negative relationship between sex and the adoption decision (r = -0.116) where men are only slightly more likely to adopt than women. Alternatively state, the adoption rate amongst female farmers is lower than in the case of male farmers, as reported by Kalineza (2000).

Table 2: Distribution of respondents according to their sex and phosphate fertilization

Sex	Phosphate fertilization (kg/acre)							
	<30		30-50		>50		Total	
	n	%	n	%	n	%	N	%
Male	40	57.1	21	30.0	9	12.9	70	61.9
Female	29	67.4	11	25.6	3	7.0	43	38.1
Total	**69**	**61.1**	**32**	**28.3**	**12**	**10.6**	**113**	**100.0**

χ^2 = 1.514; df=2; p=0.469; r = -0.116; p=0.223

Table 3: Distribution of respondents according to their formal education and phosphate fertilization

Formal education (years)	Phosphate fertilization (kg/acre)							
	<30		30-50		>50		Total	
	n	%	n	%	n	%	n	%
0	20	100.0	0	0.0	0	0.0	20	17.7
1-7	40	62.5	19	29.7	5	7.8	64	56.6
>7	9	31.0	13	44.8	7	24.1	29	25.7
Total	**69**	**61.1**	**32**	**28.3**	**12**	**10.6**	**113**	**100.0**

χ^2 =25.356; df=4; p=0.000; r= 0.401; p=0.000

It is expected that the farmers' educational level has influence on the adoption of new technologies such as phosphate fertilization. An overview of the respondent's education and adoption of phosphate fertilization in Njombe District is presented in Table 3 below. According to these findings education has a very high significant influence on the adoption of phosphate fertilization. No respondent without formal education adopted rates greater than 30Kg/ha of phosphate fertilization while about 31.9% (7.8% + 24.1%) of those with formal education applied phosphate fertilizer at the same rate, which is recommended. The relationship between the two variables is further confirmed by a highly significant correlation coefficient (r= 0.401; p=0.000), which implies that as the farmers' years of formal education increase, they tend to adopt the recommended rate of phosphate fertilization, which is in line with similar observation by Rogers (1983).

Farm size and the area of the farm under maize production are considered to be a function of the environment in which the farmer operates. These factors are influenced by several other factors such as land tenure, wealth and social

status of the farmer and others. The distribution of the respondents' farm sizes in relation to their adoption of phosphate fertilization is presented in Table 4. Most of the respondents (39.8%) had farms that were between 3 and 6 acres. Only 25.7% of the respondents had farms that were larger than 6 acres. Although the differences between the farm size categories are not significant (χ^2 = 7.553; df = 4; p = 0.109), the analyses shows a significant positive correlation (r = 0.236; p=0.012) between farm size and the adoption of recommended phosphate fertilization.

Table 4: Distribution of respondents according their farm size and the adoption of recommended rate of phosphate fertilization

Farm size (acres)	Phosphate fertilization (kg/acre) <30		30-50		>50		Total	
	n	%	n	%	n	%	N	%
<3	27	69.2	11	28.2	1	2.6	39	34.5
3-6	29	64.4	11	24.4	5	11.1	45	39.8
>6	13	44.8	10	34.5	6	20.7	29	25.7
Total	**69**	**61.1**	**32**	**28.3**	**12**	**10.6**	**113**	**100.0**

χ^2 = 7.553; df = 4; p = 0.109; r= 0.236; p=0.012

This implies that the larger the farm size, the higher the adoption rate. The evidence in Table 4 shows that 20.7% of those respondents with farms that were more than six acres adopted the recommended rate of phosphate fertilization compared to only 2.6 percent of those with less than three acres. Conversely, 44.8% of the respondents with farms that were greater than 6 acres adopted the lower range of phosphate fertilization at less than 30 kg/acre compared to 69.2% of the respondents who owned farms that were smaller than 3 acres, adopting this rate.

Results in Table 5 provide information on the influence of the area under maize on the adoption of phosphate fertilization. Majority of the respondents (53.1%) applied phosphate fertilizer to about 1.1 – 3 acres of their maize farms. The remaining 23% and 24% applied the fertilizer to less than one acre or more than three acres, respectively. The proportion of respondents applying phosphate fertilizer to three acres or less was higher at the lower application rate (< 30 kg/acre) being 57.7% and 78.3% for maize farms that were less than one acre and those between 1.1 – 3 acres, respectively. The middle rate (30 –

50 kg/acre) and the higher rate (> 50 kg/acre) dominated for farmers who applied phosphate fertilization to maize farms that fell in the range of 1.1 – 3 acres (44.4%) or above 3 acres (29.6%).

Table 5: Respondents' area of maize farm under phosphate fertilization

Area under maize (acre)	Phosphate fertilization (kg/acre) <30		30-50		>50		Total	
	n	%	n	%	n	%	N	%
≤ 1	15	57.7	9	34.6	2	7.7	26	23.0
1.1-3	47	78.3	11	18.3	2	3.3	60	53.1
>3	7	25.9	12	44.4	8	29.6	27	23.9
Total	**69**	**61.1**	**32**	**28.3**	**12**	**10.6**	**113**	**100.0**

χ^2 =25.792; df=4; p=0.000; r= 0.276; p=0.003

Only 7.7% of the respondents with maize fields that were one acre or less applied the higher recommended rate of phosphate fertilization (> 50 kg/acre). An even lower proportion (3.3%) of farmers with the middle range of maize farms (1.1 – 3 acres) applied this higher recommended rate. The correlation coefficient (r= 0.276) between the area under maize and the level of phosphate application is significant (p=0.003) implying that the larger the area under maize, the higher the level of adoption. Other scholars had also reported this relationship (e.g. Rogers, 1983; Kalineza, 2000).

Total influence of personal and environmental factors

In trying to assess the total influence of all personal and environmental factors on the adoption of phosphate fertilization, a linear regression analysis presented in equation 1 was used. Data were tested for multicollinearity and autocorrelation. The model was found to be free of all these problems as reported by the respective test statistics in Table 6.

Table 6: Total influences of personal and environmental factors

Variable	Regression coefficient	T test	p
(Constant)		1.220	0.225
Sex	0.020	0.215	0.830
Age	-0.149	-1.492	0.139
Formal education	0.345	3.299	0.001
Farm size	0.100	0.930	0.355
Area under maize	0.129	1.322	0.189

R^2 = 0.248; Adjusted R^2 = 0.213; p = 0.000; DW = 1.946; VIF = 1.451

The overall contribution of independent variables to explain the variance of phosphate fertilization adoption rates is 24.8% (R^2) and 21.3% (adjusted $R^{2)}$ for the sample and the population respectively which is highly significant (p = 0.000). Given a small difference between the variance explained by the sample and the population, which is 3.5% this study considers the sample reasonably represented the characteristics of the population. This suggests that the conclusion drawn can be generalized across the population. However, only the coefficient for education (0.345) had a highly significant (p = 0.001) positive effect on the dependent variable. The influence of sex, farm size and area under maize was positive but not significantly different from zero. The coefficient for age was negative (- 0.149) as expected but also not significantly different from zero.

Intervening factors

After assessing how the conventional dependent variables influence adoption, the effects of intervening factors on the adoption of phosphate fertilization are also examined. These are (i) efficiency misperception (EM), (ii) need tension (NT), (iii) awareness and (iv) prominence.

Efficiency misperception refers to the degree to which individuals incorrectly rate (usually overrate) their efficiency of adopting new technologies (Düvel, 2004). The author notes that there is a tendency of individuals to overrate (or underrate) their own production and/or practice adoption efficiency. This, it has been argued, to have a tremendous effect on adoption behaviour due to the fact that the more the current efficiency is overrated, the smaller the problem scope or need tension becomes and thus the smaller the incentive to adopt recommended innovations. To establish this, farmers were asked to estimate their own efficiency. A five-point scale was used to assist in understanding the farmers' misperception. As shown in Table 7, only 15.9% of the respondents correctly rated their adoption efficiency. The majority of the respondents (about 84.1%) did not perceive their adoption efficiency correctly (in this case the adoption of recommended rate of phosphate fertilization). They either overrated (54.8%) or underrated (29.2%) it.

When respondents underrate the efficiency of their own phosphate fertilization, it tends to increasing their need tension and thus the assumed

tendency to change their current fertilization. It is significant that about 41% of the respondents who underrated their current adoption efficiency had adopted the recommended rate of phosphate fertilization (> 50 kg/acre) while not a single respondent who overrated or misperceived his/her current fertilization efficiency adopted the recommended rate.

The relationship between EM and adoption of the recommended rate of phosphate fertilization is negative and highly significant (r= -0.417; p=0.000), which implies that the adoption rate decreases as the overrating of the current adoption efficiency increases. The more respondents overrate or misperceive their current adoption situation to be better than it is, the lower the need to change their behaviour towards what is recommended, which is in line with similar findings by (Düvel, 2004).

Table 7: Distribution of the respondents according to their efficiency misperception (EM) and phosphate fertilization

Efficiency perception (EP)	**Phosphate fertilization (kg/acre)**							
	<30		**30-50**		**>50**		**Total**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Underrate	16	42.1	16	42.1	6	15.8	38	33.6
Slightly underrate	10	41.7	8	33.3	6	25.0	24	21.2
Assess correctly	14	77.8	4	22.2	0	0.0	18	15.9
Slightly overrate	11	78.6	3	21.4	0	0.0	14	12.4
Overrate	18	94.7	1	5.3	0	0.0	19	16.8
Total	**69**	**61.1**	**32**	**28.3**	**12**	**10.6**	**113**	**100.0**

χ^2 =26.617; df = 8; p=0.001; r= -0.417; p=0.000

Need tension (NT) or problem perception refer to the perceived discrepancy between the present situation and the desired situation or level of aspiration (Düvel, 2004). Based on this definition, farmers were asked to indicate their present and aspired level (or goals) of adoption. It is expected that the higher the goal or level of aspiration the higher the need tension. An indication of the NT regarding the adoption of the recommended rate of phosphate fertilization in the study area is shown in Table 8.

Table 8: Distribution of the respondents according to their need tension (NT) and phosphate fertilization

Need Tension (NT)	Phosphate fertilization (kg/acre) <30		30-50		>50		Total	
	n	%	n	%	n	%	n	%
Low	62	100.0	0	0.0	0	0.0	62	54.9
Medium	3	42.9	2	28.6	2	28.6	7	6.2
High	4	9.1	30	68.2	10	22.7	44	38.9
Total	**69**	**61.1**	**32**	**28.3**	**12**	**10.6**	**113**	**100.0**

χ^2 =92.268; df = 4; p=0.000; *r = 0.803, p= 0.000*

The need tension or need potential of farmers regarding the application of the recommended rate of phosphate fertilization is somewhat low in the sense that the majority of respondents (54.9%) were found to have a low need tension. All the respondents in this category (62) fall into the lowest adoption category (applying no or less than 30 kg of phosphate fertilizer). Meanwhile, 28.6% and 22.7% of those with medium and high need tension respectively, adopted the recommended rate of phosphate fertilization. As confirmed by the correlation analysis (r = 0.803, p= 0.000) there is a highly significant relationship between the NT and the adoption rate implying that the higher the NT the higher the adoption rate. In other words, a higher need tension score acts as the force that energizes and drives a farmer in a direction towards adopting the recommended rate of phosphate fertilization as contended by (Düvel, 2004).

Awareness about the technology also plays an important role towards inspiring farmers to adopt. It is assumed that lack of awareness or lacking knowledge of the recommended practices as solution to problems that a farmer faces can contribute to the non-adoption of recommended production practices (Koch, 1986; Koch, 1987). Respondents were asked to indicate the recommended rate of phosphate fertilization in their area and were consequently judged as being aware or unaware of the recommended fertilization. An overview of the relationship between awareness and adoption is presented in Table 9.

Table 9: Distribution of the respondents according to their awareness and phosphate fertilization

Awareness of solution	Phosphate fertilization (kg/acre) <30		30-50		>50		Total	
	n	%	n	%	n	%	n	%
Not aware	43	79.6	10	18.5	1	1.9	74	47.8
Aware	26	44.1	22	37.3	11	18.6	59	52.2
Total	**69**	**61.1**	**32**	**28.3**	**12**	**10.6**	**113**	**100.0**

χ^2 =16.833; df = 2; p=0.000; r= 0.385, p= 0.000

According to results in Table 9, the majority (52.2%) of the respondents seem to be aware of the recommended rate of phosphate fertilization. The knowledgeable and the non-knowledgeable farmers exhibited a significant difference (χ^2 =16.833; df = 2; p=0.000) in terms of adoption. As expected, farmers who were aware of the recommended level of phosphate fertilization tended to adopt the technology more than those did not have the knowledge. This relationship between awareness and adoption is highly significant (r= 0.385, p= 0.000). From the distribution in Table 9, it can be concluded (with the exception of one individual who was supposedly unaware of the recommendation but nevertheless adopted it) that awareness is a precondition but not a guarantee for adoption, thereby contradicting arguments by Koch's (1987) who states that awareness or knowledge of the recommended practices as solution to problems that a farmer faces contributes to the adoption of recommended production practices.

Prominence is another intervening factor that is defined as the degree to which an innovation is perceived as being better than the idea it supersedes. It is contended that the more an innovation or a practice is perceived to be relatively better than the traditional practices, the higher the adoption is likely to be (Düvel, 1991; Düvel, 2004). Insufficient prominence – implies that the recommended practice is seen as less prominent or less advantageous than the current one or than other alternatives (Düvel, 1991). Table 10 shows the relationship between prominence and phosphate fertilization adoption.

Table 10: Distribution of the respondents according to their prominence and phosphate fertilization

Prominence	Adoption <30		30-50		>50		Total	
	n	%	n	%	n	%	N	%
Low prominence	53	94.6	3	5.4	0	0.0	56	49.6
Medium prominence	5	71.4	1	14.3	1	14.3	7	6.2
High prominence	11	22.0	28	56.0	11	22.0	50	44.2
Total	**69**	**61.1**	**32**	**28.3**	**12**	**10.6**	**113**	**100.0**

χ^2 =59.535; df = 4; p=0.000; r = 0.673, p= 0.000

As indicated in Table 10, the majority of the respondents [55.8% (49.6% +6.2%)] perceived the recommended rate of phosphate fertilization to have a low or medium prominence. Poor or low prominence clearly seems to have an influence on the adoption behaviour since no respondent who perceived the recommended rate of phosphate fertilization to have low prominence adopted it. This clear positive relationship between perceived prominence and adoption is also reflected in the correlation coefficient of 0.673 and the probability (p= 0.000) implying that the more the recommended rate is perceived to have a high or higher prominence compared to the current one or than other alternatives, the higher the adoption tends to be as stipulated in (Düvel, 1991).

Total influence of intervening variables

To assess the total influence of all the intervening variables (efficiency misperception, need tension, awareness and prominence), a regression analysis model presented in equation 1 was used. Prior to regression analysis data were tested for multicollineality and autocorrelation and the respective test statistics are reported in Table 11, indicating absence of both problems. The same Table presents the findings regarding the influence of the different individual intervening variables as well as their combined contribution towards the total variance in adoption behaviour.

The combined effect of intervening variables accounts for 73.2% (R^2) and 72.2% (Adjusted R^2) of the variation in the adoption of phosphate fertilization for study sample and population, respectively, which is highly significant (p=0.000). Given the small difference between the variance explained by the sample and the population, which is 1%, this study considers the sample

reasonably represented the characteristics of interest of the population. This suggests that the conclusion drawn can be generalized across the population.

Table 11: Linear regression analysis showing the relationship between intervening variables and adoption of phosphate fertilization

Variable	Regression coefficient	t value	p
Constant		16.685	0.000
Efficiency misperception	0.030	0.514	0.608
Need tension	0.708	9.093	0.000
Awareness	0.053	0.933	0.353
Prominence	0.172	2.144	0.034

$R^2 = 0.732$; Adjusted $R^2 = 0.722$; $p = 0.000$; DW = 2.032; VIF = 1.9365;

The findings in Table 11 further show that the coefficients for all the variables are positive but only two are significantly different from zero; Need tension (NT) at 0.708 (P=0.0) and Prominence at 0.172 (p=0.034). The findings suggest that the needs tension makes the biggest contribution towards explaining the adoption behaviour, which is consistent with similar findings by other researchers (Koch, 1986; Düvel and Botha, 1999; Düvel and Scholtz, 1986) who identified the NT to be a key dimension in adoption behaviour.

Comparison between personal, environmental and intervening factors

When comparing the influence of observed personal and environmental independent variables relative to unobserved intervening variables, it is clear that the intervening variables exhibit a significantly higher influence on adoption behaviour. Not only is the influence of intervening variables on the variation of the adoption rate higher, but the influence as reflected through correlation coefficients of individual variables is also much more significant. Figure 1 show that the influence of intervening variables far outweighs that of the personal and environmental factors in terms of the percentage variation explained. The intervening variables explain 72.2% of the variation in phosphate fertilizer adoption as opposed to the only 21.3% contributed by the personal and environmental variables.

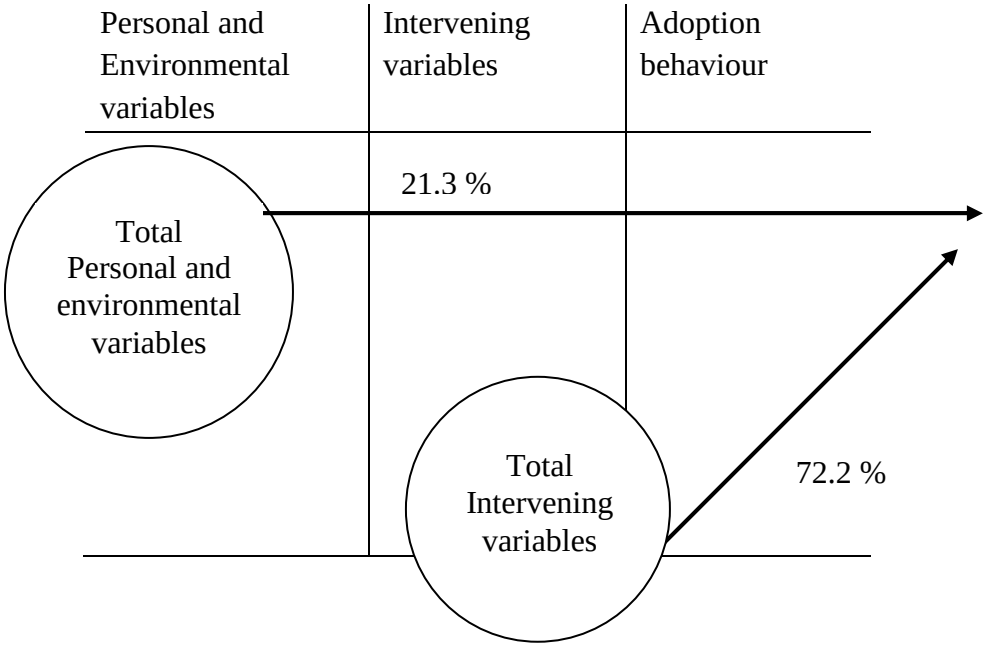

Figure 1: Comparative contribution of personal and environmental factors and the other set of intervening variables on adoption behaviour

Conclusion and recommendations

In general, the intervening variables show very strong relationships with adoption behaviour compared to personal and environmental variables. Most significant among the intervening variables is the influence from the need tension for the technology and prominence of the technology as perceived by the respondents. Moreover, the total influence of intervening variables very clearly overshadows that of the other set of variables. The logical explanation for this highly significant difference is that the intervening variables are probably the immediate and direct determinants of adoption behaviour while the influence of personal and environmental variables only becomes manifested in adoption behaviour via the intervening factors. Studies should be replicated in different cultural settings as well as for different commodities in order to further verify and search for other possible intervening variables, which should be considered as researchers and development agents strive to improve the adoption of various agricultural technologies.

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Significance of Sweet Potato Leaves Cultivation in Livelihood Sustainability in Sub-urban Morogoro, Tanzania

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Abstract

In Tanzania, the sweet potato crop (Ipomea batatas) is extensively used as a leafy vegetable crop providing food and cash income. This role is well appreciated for improving livelihoods, especially in urban and peri-urban areas. A study was conducted within and around Morogoro municipality in Tanzania to establish the relative importance of sweet potato leaves among leafy vegetables. Questionnaire were used to collect data from growers, market vendors and wholesalers handling the crop. The findings show that sweet potato leaves were cultivated much more frequently than other leafy vegetables. About 83% of the farmers preferred to cultivate sweet potato leaves and nearly half (46.7%) of the market vendors preferred selling sweet potato leaves because the leaves can easily be produced throughout the year. Vegetable wholesalers and vendors preferred the leaves due to a longer shelf-life. Economic returns were higher when grown in larger gardens for perennial harvesting. This study recommends intensive production, improved handling of the fresh product in markets, and developing value addition through processing and packaging to improve productivity and production. Further research is recommended to identify gaps in production and consumption patterns for promoting commercial production and marketing in future, while safeguarding the product's nutritional characteristics. Such a move would also contribute towards greening peri-urban areas.

Keywords: Sweet potato, Leafy vegetable, Market vendors, Morogoro

Introduction

Livelihood in urban populations comes from a wide range of activities. According to Scoones (1998) livelihood means the capabilities, assets (material and social) and activities required for a means of living. One very important source of livelihood for a great number of urban dwellers is

low-income self-employment activities such as agriculture. Worldwide, it was estimated in the mid-1990s that almost 20% of the population (about 800 million people) was engaged in urban agriculture (Emmanuel *et al*, 2006), majority of which constitute the urban poor (UNDP, 1996). Various urban agricultural activities are carried out including dairy cattle production, piggery, poultry, fish farming, gardening, mushroom production, raising tree nurseries and cultivating field crops. These activities contribute significantly towards ensuring household food availability, better nutrition, household income, as well as providing economic activities for many inhabitants in cities and towns.

Gardening, raising nurseries and various food crops as well as cultivation of other plants form the most significant part of urban agriculture (Foeken and Mwangi, 2000; Kaufman and Bailkey, 2000; Novo and Murphy, 2000). Among the crops grown in and around urban centers, production of perishable leafy vegetables is an important economic activity. These crops are grown within urban areas as an important adaptive strategy to offset the high costs of transportation and post-harvest handling losses of the products if they are to be brought in from rural areas. In many cities of the world, almost all perishable vegetables consumed within are produced in the cities and in the surrounding peri-urban areas.

Although this practice is more common in developing countries, urban agriculture is also common in the developed world such as USA (Kaufman and Bailkey, 2000). In Shanghai, China, 60% of the city's consumption of leafy vegetables is produced in the urban and peri-urban areas (Cai and Zhangen, 2000), while in Hanoi, Vietnam, urban and peri-urban agriculture account for 24% of all the fruit vegetables, 50% of the cruciferous vegetables, and up to 100% of the leafy vegetables (An *et al*, 2003). Examples from Sub-Saharan Africa show that up to 100% of all the requirements of vegetables in Bangui (Central African Republic) are produced from within the city (Tixier and de Bon, 2006). In Guinea Bissau and Antananarivo (Madagascar) the propotion of vegetables produced within the cities is about 90%. (Moustier and David, 1997). Between 60 - 100% of the consumed leafy vegetables in Dakar (Senegal) and Bamako (Mali) have also been reported to be produced from within the cities and their peripheries (Mbaye and Moustier, 2000; Smith, 2002; Drechsel, 2006). In Tanzania fresh vegetables cultivation within urban areas is also an established economic activity. About 60 – 100% of leafy

vegetables consumed in Dar es Salaam are produced from within the city and peri-urban areas (Sabel-Koschella *et al*, 1998).

Of all the vegetables cultivated in urban and sub-urban areas, leafy vegetables are perhaps the most important, because this group of products is indeed most limiting in the urban areas owing to their inherently very short shelf life under natural conditions. Moreover, leafy vegetables are usually very bulky and in most instances they cannot withstand any magnitude of compaction during transportation, conditions which are necessary for any efficient haulage of products over a long distance. Additionally, leafy vegetables cannot withstand any magnitude of dryness, high rate of air movement and build up of heat, conditions that are also very common when transporting bulky fresh products. For these reasons, most leafy vegetables have to be produced within or very close to urban centers where they are sold. Sweet potato leaves are perhaps an exception because they are less prone to post-harvest handling problems characteristic of most vegetables.

Sweet potatoes are often known for their tuber but the leaves are also used for food. Sweet potato leaves, locally known in Kiswahili as *matembele*, are of considerable importance among indigenous or traditional vegetables. The leaves have become an important vegetable in many countries especially in Asia and Africa. In Liberia, for example, the crop is often cultivated as a vegetable than as a tuberous root crop (As-saqui, 1982). The leaves are usually picked with their petioles from the vines as they become fully grown; and this continues consecutively as new leaves form. The leaves are then cooked by steaming/boiling or frying just like other vegetables. The vegetable is sometimes used for medicinal purposes in treating anaemia, since they are rich in Iron. It is now a common practice for medical personnel in Tanzania to prescribe sweet potato leaves for anemic patients. Sweet potato leaves are also rich in vitamin A, B_2 (riboflavin) and C and, according to Wolfe (1992), Ishida *et al* (2000) and Sokha *et al* (2008). In addition, they contain about 25.5 – 29.8% crude protein.

In Tanzania, there are many varieties of sweet potatoes some of which are specialized to supply leaves for use as vegetables; these varieties are usually narrow-leaved and often mistakably considered not a tuber crop. The traditional sweet potato clones have existed for a very long time as indigenous

backyard garden crops. It was not until the 1990s that the importance of indigenous vegetables in Tanzania began to grow, partly because of efforts made by the Asian Vegetable Research and Development Centre (AVRDC) since its establishment in 1970s (Villareal *et al*, 1982). In 1992, the Centre launched an African Regional Centre in Arusha, Tanzania, which has indigenous vegetables as one of its priority research agenda, working in collaboration with National Agricultural Research Institutes.

Establishment of the Tanzania Horticulture Research and Training Institute (HORTI) Tengeru during the 1980s also played a significant role in implementing the indigenous vegetables project. At the beginning, Amaranths was the most important leafy vegetable among indigenous vegetables. The importance of this crop increased drastically from an inferior traditional vegetable to become the most important vegetable in Tanzania in terms of production and consumption. Amaranths perhaps retains this position countrywide, but in some places nowadays, at least in Morogoro town and its sub-urban areas, the comparative status of Amaranthus seems to be strongly challenged by sweet potato leaves.

This paper reports findings of a study that assessed the production and marketing of sweet potato leaves in Morogoro municipality. Information on production of this crop as a vegetable in Tanzania is very limited both in terms of the technology used for production and the socio-economic significance including contribution to livelihood improvement. Despite observations that sweet potato leaves are prevalent at vegetable markets and farmers' gardens, hardly any research or development effort is reported on this crop beyond the AVRDC recognition of indigenous vegetables. The crop's seemingly growing importance seems to be spontaneous and localized.

The main objective of this study was to explore technical and economic information pertaining to the production of sweet potato leaves for food. Information emanating from this study is relevant for future development and improvement of the crop in terms of production, handling and marketing. The research also elucidates on the crop's contribution to poverty reduction, especially among urban and sub-urban dwellers who cultivate sweet potato leaves as a significant economic activity in their portfolio.

Methodology

This study was conducted through a survey in selected areas within sub-urban Morogoro where gardening activities and marketing of vegetable crops are carried out, almost throughout the year. Farmers as well as various marketing agents were interviewed using structured and semi-structured questionnaires. The areas surveyed were those along the Ngerengere river valley which constitutes the most important vegetable gardening area in sub-urban Morogoro. Three locations along this valley are important for vegetable production: Chamwino is located upstream towards the north-western part of Morogoro Municipality; Kihonda is located downstream as the river approaches the bridge along the road to Dodoma in a south-easterly direction; while Mazimbu is located in-between the two locations. The river floods every year during the long rains as water overflows from Mindu dam. Many farmers take advantage of flood water to undertake vegetable gardening along this valley; water for irrigation is also available from the river during most of the dry season as well. Farmers also benefit from the prolonged residual moisture after the rainy season.

Data for this study was collected between February and April 2010, from 50 respondents, of whom 30 were involved in gardening (farmers or growers) whereas 20 were those involved in marketing including retail vendors and wholesalers. However, many of the respondents were involved in both gardening and marketing. The survey involved at least 10 farmers for each sub-location of the river valley. Sampling was purposive for farmers who cultivated vegetables for sale in the study area. In addition, at least five vendors were interviewed at the market place for each locality. The number of vendors who sell the same product in the market may not be very big). After field work to collect data, the data was processed and analyzed using SPSS.

Results and discussion

Results of the analysis are presented in Tables 1 and 2 as well as Figures 1 – 7. Figure 1 shows the farmers' preferences to cultivate sweet potato leaves compared to other vegetables. Throughout the survey area, farmers showed higher preference to cultivate sweet potato leaves than all the other vegetables. On average, 83.3% of the farmers preferred cultivating sweet potato leaves compared to only 16.7% showed preference to cultivate other vegetables. These results generally show the significance of sweet potato leaves as a

vegetable crop for food and a source of income. Previously, as pointed out earlier, Amaranthus was the predominantly cultivated vegetable crop.

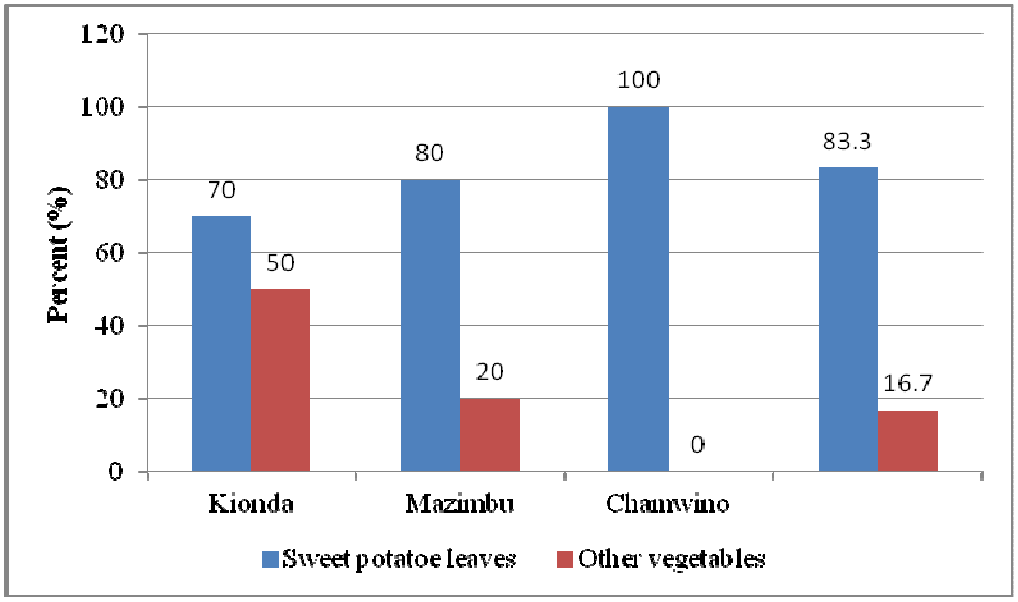

Figure 1: Preferential cultivation of leafy vegetables in different locations in sub-urban Morogoro

Figure 2 shows the frequency of cultivating vegetables other than sweet potato leaves. Other vegetables grown were Chinese cabbage followed by tomato, black nightshade, okra and Amaranthus in that order. There were an equal proportion of respondents who cultivated Pumpkin leaves, African eggplant and Amaranthus. Only a few farmers were growing sweet pepper (6.7%) and watermelon (3.3%). However, a good proportion of growers (20%) were cultivating sweet potato leaves only.

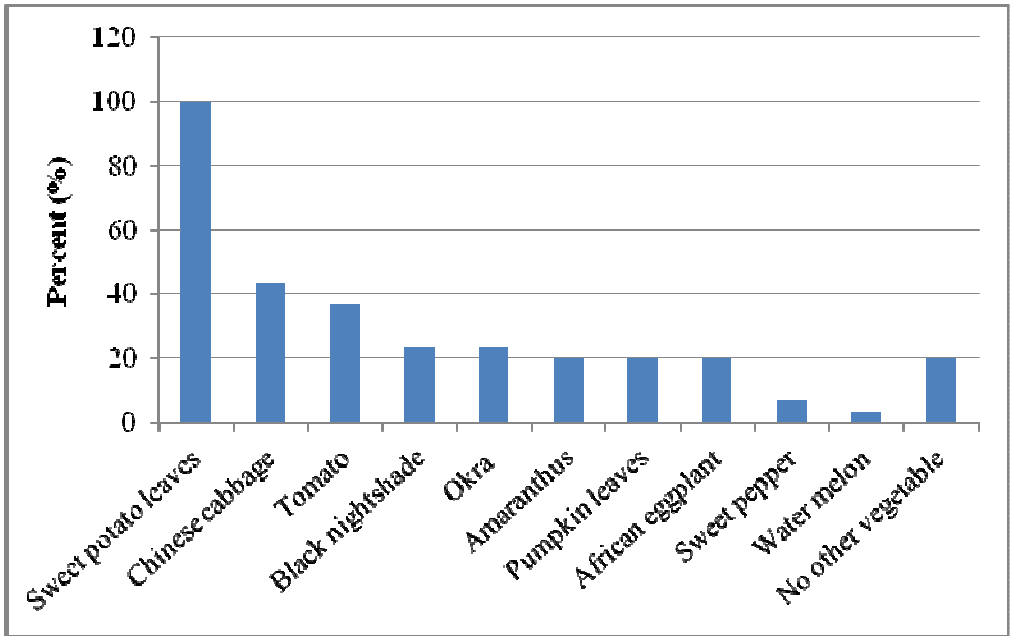

Figure 2: Frequency of cultivating different types of vegetables in urban and sub-urban Morogoro

Figure 3 shows the respondents' preference for sweet potato leaves at the markets relative to other vegetables. The market for sweet potato leaves was almost of the same magnitude (in terms of preference) as that of all the other vegetables combined. However, the degree of preference varied with location. On average, almost 50% of the vendors (46.7%) said they sold more sweet potato leaves than the other vegetables. At the market, the preference for all the other vegetables combined (Amaranthus, Chinese cabbage, black nightshade, pumpkin leaves, cassava leaves, cowpea leaves, kale, etc) was only about 53.3%. At Chamwino, sweet potato leaves were preferred by 80% of the respondents while the remaining 20% preferred other vegetables.

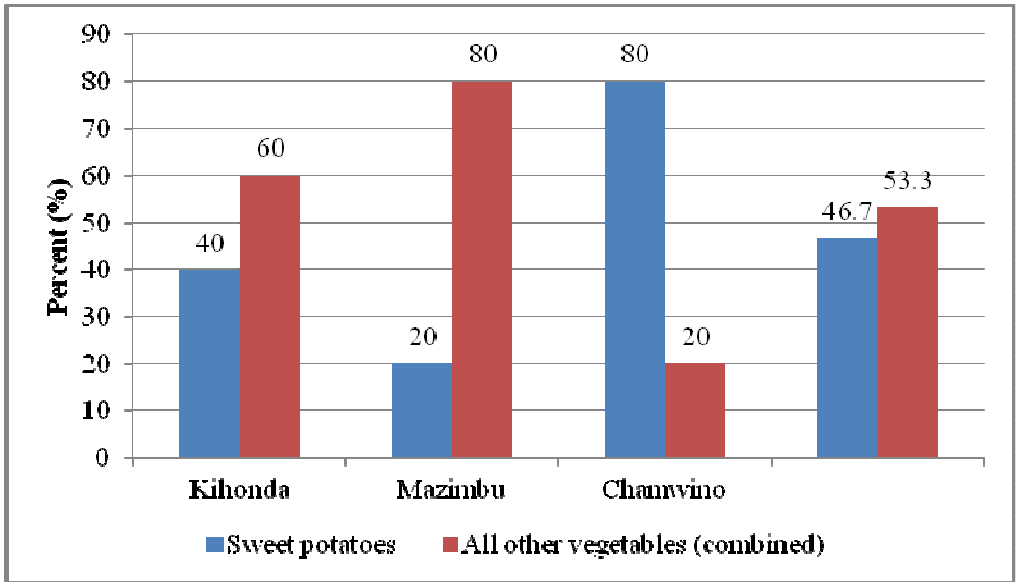

Figure 3: Preferential market of leafy vegetables (most sold) in different locations in sub-urban Morogoro

Figure 4 shows the frequency of vendors and wholesalers dealing with sweet potato leaves sold also other vegetables. The data shows that Amaranthus and Chinese cabbage were leading among other vegetables that were marketed at retail level. Chinese cabbage and African eggplant were the only other vegetable marketed by wholesalers. Dealers of tomato, okra and carrots appeared at very low frequencies of less than 10% of the vendors interviewed. These data suggest that there is distinct specialization and diversity with respect to urban and peri-urban production and marketing of vegetables.

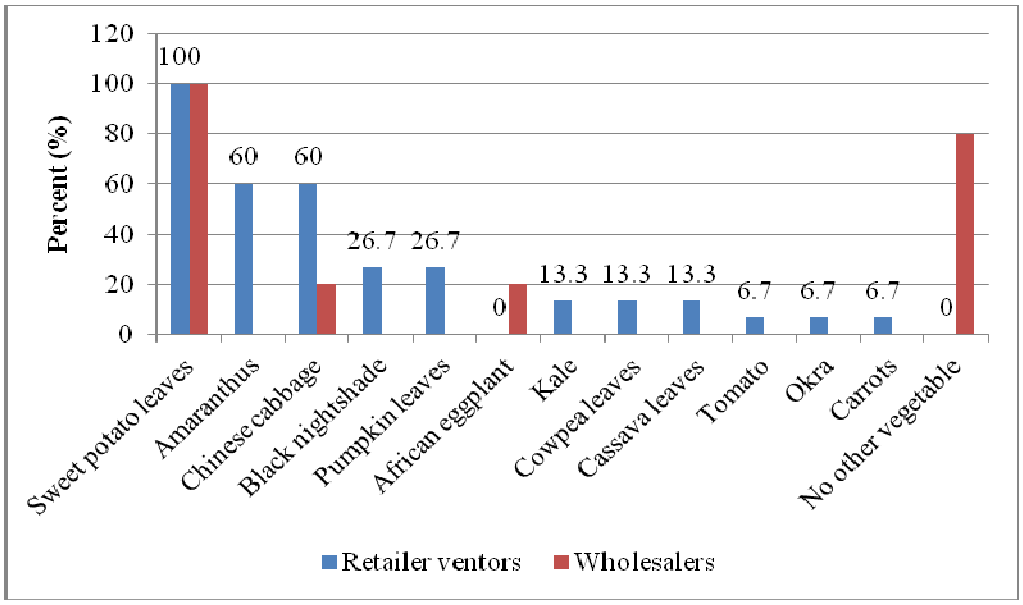

Figure 4: Frequency of vegetable vendors and wholesalers marketing various vegetables

The dealers in sweet potato leaves mentioned that the crop has a longer shelf-life compared to other leafy vegetables (Figure 5). Whereas the maximum shelf life of Amaranthus in the market is reported to be about 2 days, that of sweet potato leaves was 5 days. The advantage of 3 days was an incentive for market agents to prefer selling this crop in order to minimize to post-harvest loss. The crop can be transported conveniently to distant markets outside Morogoro. As reported in Figure 6, about 20% of the sweet potato leaves produced in Morogoro could be sold through wholesale outside Morogoro town whereas no other leafy vegetable could be dealt with in like manner.

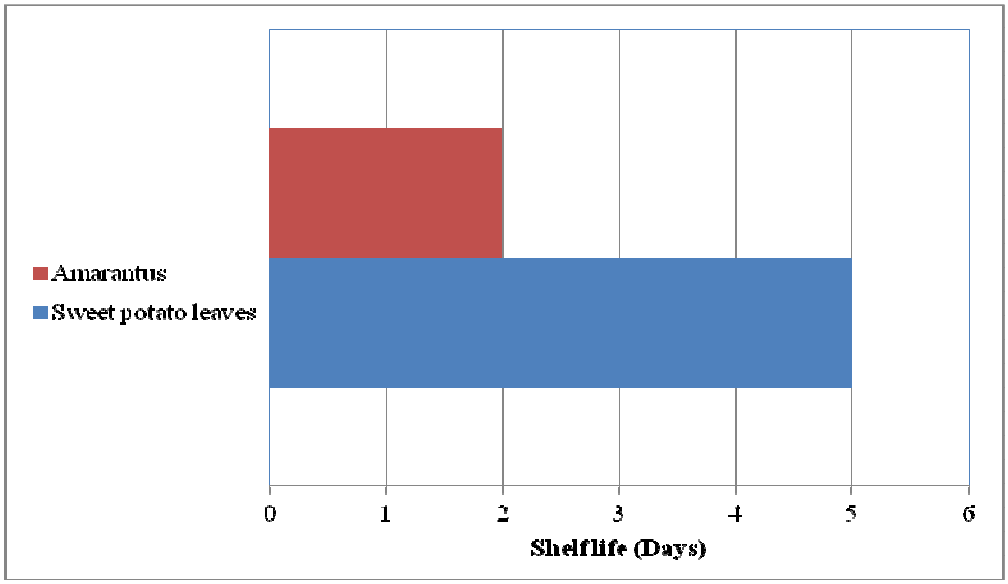

Figure 5: Reported market shelf life of the leading leafy vegetables in Morogoro town markets

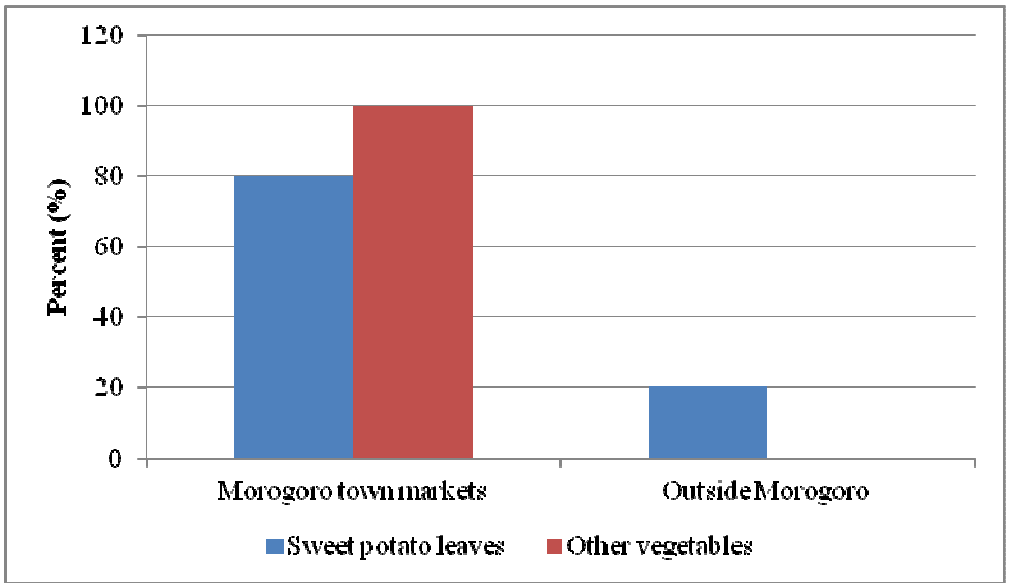

Figure 6: Reported wholesale marketing centres for sweet potato and other leafy vegetables cultivated in suburbs of Morogoro town

Figure 7 reports the availability of sweet potato leaves and other vegetables in the market. About 86.7% of the vendors indicated that sweet potato leaves are available in the market throughout the year while only 13.3% of the vendors

indicated that Amaranthus was available throughout the year. No other leafy vegetable was reported to be available year round.

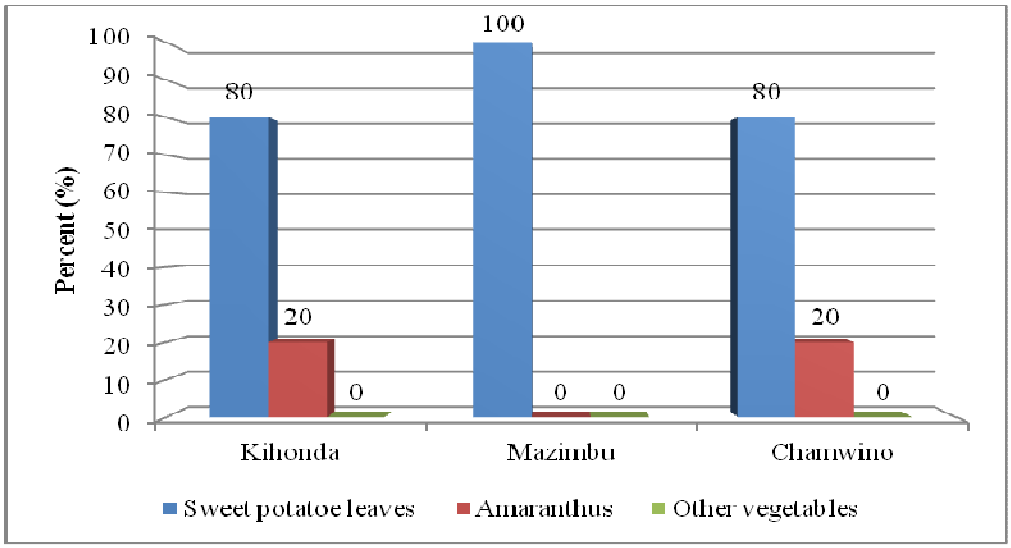

Figure 7: Reported year-round availability of leafy vegetables in markets in sub-urban Morogoro

The farmers normally sell to vendors based on the plot to be harvested. The price to venders is therefore given per plot. Based on the area cultivated per farmer, market price of the harvested crop and management practices the study established that farmers cultivating sweet potato leaves could earn between 91,000 and 9,750,000 Tshs per year with an annual average of Tshs 2,432,000 (Table 1). The study shows further that farmers cultivated areas ranging between 100 m^2 and 1,500 m^2 (equivalent to 0.01 to 0.15 hectares respectively), earning income from 7,000 to 25,000 Tshs from each hectare per harvest. An established and well managed farmer's plot can be harvested throughout the year at two weeks intervals. (i.e. 26 times per year). Thus, if area under the crop, price and the duration of harvest were highest the farmer could earn 9,750,000 Tshs from a small area of 1,500 m^2 (Table 2). When all the three criteria are at their minimum, the farmer's income would drop to to 91,000 Tshs. When the criteria assume average values, the farmer's earning rises to 2,432,000 Tshs. In Table 2, different combinations of the criteria are used. As reported in Table 1, the computed income falls between 91,000 Tshs assuming the lowest criteria for all three variables (area, frequency of harvest

and price) up to 9,750,00 Tshs when all criteria are at their highest. Pairs of combinations that give income above one million shillings (Table 2) include; high area and low harvesting cycle (1,365,000 Tshs;, low price and high area (1,365,000); high area and high harvesting cycle (2,730,000 Tshs); and high area and high price (4,875,000 Tshs). All these computations are made based on the assumption that costs of inputs used in production could be increased in any proportion since the inputs are divisible. The computations also assume negligible production cost because most farmers use household labour, and reasonably low cost of inputs. Many sweet potato leaves farmers use organic sources of soil fertility improvement, especially tobacco dust and they irrigate using manual water pumps such as Moneymaker model, which are fairly affordable. Considering the low cost of production for sweet potato leaves, the study considers only the gross revenue for comparison with other crops, which undoubtedly involve higher production cost. This is admittedly a weakness of the results that could be presented in this report, which warrants further study.

Table 1: Estimated income from production of sweet potato leaves based on high and low values of area, price and harvesting cycle

Name of criterion	Area (m^2)	Price per $100m^2$ (Tshs)	Harvesting Cycle		Estimated Gross Income	
			Cropping cycle (from 1st harvest)	Number of harvest (2 weeks intervals)	Computation	Computed value (Tshs)
All values lowest	100	7,000	6 months (26 wks)	13	1 x 13 x 7,000	91,000
Acreage highest	1,500	7,000	6 months (26 wks)	13	15 x 13 x 7,000	1,365,000
Acreage lowest	100	25,000	1 year (52 wks)	26	1 x 26 x 25,000	650,000
All values highest	1,500	25,000	1 year (52 wks)	26	15 x 26 x 25,000	9,750,000
Computed average	800	16,000	9 months (38 wks)	19	8 x 19 x 16,000	2,432,000

Table 2: Range of income from sweet potato leaves based on different combination highest and lowest income value criteria

Lowest criterion	Highest criterion	Computation	Gross income (Tshs)
Acreage	None	13 x 7,000	91,000
	Price	13 x 25,000	325,000
	Cropping cycle	26 x 7,000	182,000
	Both price and cycle	26 x 25,000	650,000
Cropping cycle	Acreage	13 x 15 x 7,000	1,365,000
	Price	13 x 25,000	325,000
	Both price and acreage	13 x 25,000 x 15	4,875,000
Price	Acreage	7,000 x 15 x 13	1,365,000
	Cropping cycle	7,000 x 26	182,000
	Both acreage and cycle	7,000 x 26 x 15	2,730,000
None	All	15 x 25,000 x 26	9,750,000

Based on the computations in Table 1 and 2, it is evident that by growing sweet potato leaves poor farmers can earn quite appreciable levels of income from the crop. Considering that many such growers do not only grow sweet potatoes for livelihoods, income from sweet potato leaves can be subsidiary to the main subsistence food (cereal) crop production or other vegetables. The average farm sizes for small-holder farmers in Tanzania is between 9,000 and 30,000 m^2 (URT, 2011) equivalent to 0.9 and 3 hectares respectively. This means many households can afford ro acquire or rent even the higher range (o.15 ha) of the area under vegetables in Morogoro municipality

Sustainable livelihoods, according to Scoones (1998), is one that copes with and recovers from stresses and shocks, maintains or enhances its capabilities and assets, while not undermining the natural resource base. Tanzania belongs to low income countries with of USD 530 equivalent to TShs. 848,000 in current prices (World Bank, 2012). This income level is just above the extreme poverty level (1.25 USD per day = TShs. 730,500 per year, *Ibid*). From the findings of this study, the average income from sweet potato leaves estimated at 2,432,000 Tshs. Based on the average household size for Morogoro municipality which is 4.1 (URT, 2013), then average income from producing sweet potato leaves wound translate to 591,170 Tshs per capita, which is more than half of the national per capita income.

It is evident from the study that sweet potato leaves have a clear comparative advantage relative to other leafy vegetables, receiving higher preference among famers as well as vegetable venders and whole sellers. The incentive to grow sweet potato leaves is threefold: economic, ecological and technical. Economically it has been established that the crop is easy to cultivate, but is also convenient to market even outside Morogoro Region, because it is preferred by many clients. Once a field is established with sweet potato leaves, it can be used for up to a year. In the case of Amaranthus is necessary to plough the land afresh every month, with additional planting cost. Owing to the short shelf life, much higher losses can be expected from Amaranthus during marketing compared to sweet potato leaves.

Ecologically, leafy sweet potatoes are much more adapted to water shortage conditions, low temperatures and flooding conditions than other vegetables. Leafy sweet potatoes can tolerate occasional dry conditions when irrigation water is insufficient or the frequency of irrigation is limited, compared to other vegetables like Amaranthus, Chinese cabbage or spinach. Sweet potatoes leaves are insensitive to low temperature conditions unlike Amaranthus, which does not grow well during cold periods. Additionally, during floods leafy sweet potato can even survive for several days under totally submerged conditions, which is impossible for other vegetables. The crop is technically very much easier to produce. The planting materials (cuttings) are usually locally available, often easily obtained from an old crop field. Sweet potatoes are also less demanding in terms of in irrigation frequency. These were also findings from this study and are summarized in Table 3.

Table 3: Comparison of ecological advantage of sweet potato leaves relative to Amaranthus

Ecological parameter	Sweet potato leaves	Amaranthus
Soil requirements	Can thrive well in heavy soils (as well as in light soils	Does well in light soils (sandy and loamy). Very stunted growth on compacted poorly aerated heavy clay soils
Heavy rains	Insensitive to heavy rains	Very sensitive to heavy rains. Young seedlings pre-emerged from the soil, and a few days later after germination are very weak and can be totally destroyed by heavy rains. Established plants especially when under a heavy canopy are often attacked by a terminal twig decay most likely caused by Botrytis fungi under heavy rain (and cloudy) conditions. The disease also attacks stems and lateral branches and makes recovered plants stunted with very poor and irregular canopy.
Drought	Can thrive better in drier soils. Stem and petioles are succulent and adapted to store more water. Leaves are usually narrow and seem to be losing less water through transpiration. The crop seems to be able to synthesis chlorophyll sufficiently even under moisture stress conditions.	Sensitive to low soil moisture and needs more frequent irrigation with sufficient water. Water stressed plants, especially at the vegetative stage become stunted and turn yellowish, which is a sign of difficulties in chlorophyll synthesis under moisture stress conditions. The crop generally has a wide leaf blade, which make them more likely to lose water through transpiration.
Poor drainage	Can withstand poor drainage conditions usual during rainy periods	The crop becomes stunted and yellowish under poor drainage due to poor root aeration
Flooding	Tolerates even temporary submerged conditions during floods	The crop and most other leafy vegetables are totally destroyed under submerged conditions after floods
Temperature	The crop grows well even during very cool temperatures	The crop growth becomes very slow and stunted especiallly at early vegetative stages during very cold periods of the year (especially the commercial vegetable types)
Nutrients fertility	Seems to be less sensitive to soil N deficiency. No very conspicuous chlorosis even when high levels of N application are not maintained	The crop generally has wide leaf blades which make them more likely to lose much water through transpiration
Propagules	Cuttings are very convenient propagules easily available and hardy	Propagation is by seed more difficult to produce. Establishment more difficult and demanding in land preparation
Post-harvest shelf life	Comparatively longer, up to 5 days	Very short, less than 2 days (Figure 5)

Source: Current research

As already stated, very limited information is available on the production of sweet potato leaves in Tanzania. Most publications on this crop focus on nutrients content and the nutritional importance of sweet potato leaves (Maeda and Salunkhe, 1981; Lyimo *et al*, 2003; Ngegba *et al*, 2009; Mwanri *et al*, 2011; Semu and Mlaki, 2012). However, Mwanri *et al* (2011) have indicated the ecological advantages of the crop as; being available for a longer period of the year because the plant is less sensitive to drought; being tolerant to heavy rains; and being able to grow in a wide range of agro-ecological zones. Production of sweet potato leaves also requires low inputs. These ecological advantages were also confirmed in the current research (Table 3).

In terms of the production and consumption (market) status of the crop, Keller (2004) provides perhaps the most comprehensive available information. In his study of traditional vegetables cultivated in Tanzania the author was able to report detailed information on production and the importance of various vegetables in four Districts of Tanzania: Arumeru, Kongwa, Muheza and Singida. According to this study, sweet potato leaves were cultivated in all the areas of the study with the exemption of Arumeru. Compared to other traditional vegetables, sweet potato leaves were ranked 4th in importance after okra (3rd), Amaranthus (2nd) and bitter lettuce (1st) in Muheza. In Singida the leaves were ranked 3rd in importance while in Kongwa they were ranked 6th in dry area and 3rd in irrigated area. This gives some clues of the comparative importance of sweet potato leaves in those areas.

Income and consumption are very important livelihood indicators (Bhandari and Grant, 2007) (WRI/IIED, 1988). The level of income can derived from producing a particular commodity provides some reflection of livelihood sustainability. In this study, even though no numerical consumption data was sought, the level of income estimated for different sweet potato leaves production options gives some indication regarding the extent to which the crop can contribute to improving livelihood sustainability. It is also important to state that farmers consume some proportion of the crops they harvest. In the literature it has been established that poor urban farming families eat more fresh vegetables than other families in the same income category (Potutan *et al*, 2000) because they are often farming these vegetables and hence, have free access to them. It is also important to note that urban and peri-urban horticulture is flourishing because of its contribution to household food and

nutrition security, especially among low income urban dwellers. Sweet potato leaves are also cheap, therefore more accessible among the poor. It can be argued therefore that the sweet potato leaves and other vegetables cultivated do not only contribute to the livelihood sustainability of the farmers producing them, but also of the majority of the consumers of these products.

Conclusion and recommendations

This study has established that the sweet potato leafy vegetable crop has significant contribution to the income of farmers and vegetable venders in Morogoro municipality. The crop also has additional comparative ecological advantage. It has generally been shown that sweet potato leaves are cultivated and marketed in the study area much more frequently than all other vegetables, and therefore, an important source of livelihood. The crop was preferred by market venders because of a higher shelf life than other leafy vegetables. The crop also enjoyed ecological and technical advantages in the sense that it can be cultivated throughout the year without sensitivity to; low temperature, excessive rain and floodwater; demanding less frequent repeated land preparation, and cheaper planting material.

Based on these findings, this paper recommends for further research to identify constraints, which if resolved, can improve production and marketing, both for wholesale and retail markets. This should include value addition such as processing and packaging in a form that minimize post harvest losses, while safeguarding the healthy nutrition. Research should also focus on consumption patterns for more commercial and income orientation in future. This should entail increasing consumption especially among high income urban dwellers. Improving the quality and assurance to consumers regarding the product's safety will enable the products to be marketed beyond vending into supermarkets thus broadening the market base, thereby creating a demand pull for increased production.

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Reducing Emissions from Deforestation and Forest Degradation (REDD+) in Tanzania: Where Are We?

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Abstract

Literature review was undertaken to gauge progress on implementing REDD+ in Tanzania. The review noted the willingness of the government to undertake measures to mitigate and adapt to climate change. The REDD+ initiative has received financial support from two donor agencies that has enabled the existence of functioning basic institutions at the national level including the National REDD+ Taskforce and the National REDD+ framework, strategy, and action plan. Others include REDD+ pilot projects, the REDD+ Technical working groups and Financial Mechanism (the National REDD+ Fund). Implementation of REDD+ readiness phase in Tanzania encountered several challenges including insufficient participation and ownership of the programme by local government authorities and higher learning institutions; inadequate coordination of National REDD+ pilot projects; inadequate efforts in addressing drivers of deforestation; erroneously considering carbon as the only benefit of a forest; inadequate baseline data on carbon credits; inconsistence in land ownership; gender inequality; poor governance and inadequate livelihood alternatives. Effective REDD+ process in Tanzania would require a robust mechanism which will address existing challenges by facilitating majority of the dependants from forest communities to derive their livelihoods mostly from outside the forests, and supporting the country in resolving the impending climate crisis, thereby protecting forests.

Keywords: Climate change, REDD+, deforestation, Tanzania.

Background

Deforestation contributes to the global climate change and it is considered to be the cause of about 20% of total Greenhouse Gas (GHG) emissions. To avoid the worst impact of human-induced climate change, average global surface temperature rise needs to be stabilized as far as possible below 2^0C above the pre-industrial level (Dhital, 2009; IPCC, 2007). Limiting warming to this level is likely to be critical to the protection of forests, which are considered the major natural sink for GHGs (Zahabu, 2008). Reducing emission from deforestation and forest degradation (REDD) is key to achieving such a goal. Climate change is the most pressing challenge facing the global community today. The adverse impacts of climate change on environment, human health, food security, human settlements, economic activities, natural resources and physical infrastructure are already noticeable in many countries, particularly the developing countries, which are most vulnerable (World Bank, 2009; FORCONSULT, 2010a). The United Nations Framework Convention on Climate Change (UNFCCC) recognizes various mitigation and adaptation options, including development of a policy on reduced deforestation and forest degradation, conservation, sustainable forest management and enhancement of forestry carbon stocks (REDD+). In addition to addressing emission, through deforestation and degradation REDD+ is a mechanism whereby carbon stored in developing countries' forests could be paid for as an incentive to reduce emissions from forested lands and invest in low-carbon paths for sustainable development (IRA, 2009; Regalia Media Limited, 2010).

Tanzania has been privileged to be one of the countries earmarked to piloting REDD+ activities in order to inform the UNFCCC global process on designing and implementing REDD+. Since April 2008, the country has been piloting REDD+ after signing a climate change partnership programme with the Royal Norwegian Government as part of its global goal for solving climate change crisis through supporting REDD+ initiative. This include a 100 million NOK (US$ 80 million) commitment to support national REDD+ strategy development, REDD pilot projects, research and capacity building projects (including the programme on Climate Change Impacts, Adaptation, and Mitigation (CCIAM)), private sector engagement, and establishment of a national REDD+ Trust Fund (Milledge, 2009).

Tanzania also received US$ 4.28 million from the UN-REDD Programme, which is largely funded by Norway. This is a collaborative partnership between three UN agencies namely Food and Agriculture Organization (FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP) (UN-REDD, 2009). Proposed interventions under the UN-REDD Programme are coordinated with other REDD+ activities through the national REDD+ Task Force (URT, 2011). Another support involved the development of a Readiness proposal from the World Bank's Forest Carbon Partnership Facility, the development of a national forest monitoring system from the Government of Finland (about US$ 5 million) and improving forest management in the Eastern Arc Mountains from the German Climate Change Initiative (US$ 3.5 million) (Burgess *et al*., 2010).

Tanzania qualified to participate in piloting and implementing REDD+ because the country has a total of 33.4 million hectares of forestland out of which 16 million ha comprise of reserved forests, 2 million ha are forests in national parks and 15.4 mil. ha are unprotected forests in village and general land (URT, 2009; FAO, 2010). Forests in unreserved village and general land are basically open access, characterized by unsecured land tenure, shifting cultivation, annual wild fires, harvesting of wood fuel, poles and timber, and heavy pressure for conversion to other land uses such as agriculture, livestock grazing, settlements and industrial development (URT, 2009).

The readiness process for REDD+, therefore, provides an exceptional opportunity for Tanzania to piloting REDD+ mechanism that recognizes the increasing importance of sustainable forest management in reducing emissions and increasing storage of CO_2 to mitigate climate change and its impacts. The challenges of REDD+ so far include insufficient coordination and integration of National REDD+ pilot projects, inadequate means of addressing drivers of deforestation, inconsideration of co-benefits of forests other than carbon, and inadequate baseline data on carbon credits monitoring, reporting and verification. The purpose of this paper was to gauge the REDD+ readiness process by looking at the progress attained so far and the challenges experienced in the piloting and propose on how to tackle the challenges.

Methodology

This is a review paper in which information was collected through a review and analysis of relevant literature from various sources including unpublished institutional REDD+ reports, published articles, workshop proceedings, REDD+ pilot project reports and web-based resources.

Progress of REDD+ in Tanzania

REDD+ institutions

As far as REDD+ piloting and implementation is concerned, the government of Tanzania has put in place institutions which provide guidance, overseeing and supervising the implementation of evolved REDD+ in the country. The institutions are made up by Permanent Secretaries (PSs) from the ministries responsible for forests and natural resources management. These institutions are advised by the National Climate Change Technical Committee (NCCTC) which oversees all technical issues related to the implementation of climate change issues, including the implementation of the National REDD+ Strategy (National REDD Task Force, 2009; FORCONSULT, 2010b; Vice President's Office Report, 2012). The Institute of Resource Assessment (IRA) of the University of Dar-es-Salaam provides secretarial and logistical services to the National Task Force in Tanzania. Despite the fact that the institutions are operating, overall supervision is done at the central level through the Vice President Office (VPO). Local authorities and private sector stakeholders are not fully involved. This causes unaccountability, lack of ownership, and unsustainability of REDD+ operations.

Institutions piloting the National REDD+ Projects in Tanzania

The National REDD+ Strategy and action plan has been finalized through stakeholders' consultation. The piloting was expected to draw lessons to feed into the Strategy development which was finalised in March 2013. Non-governmental organizations (NGOs) that participated include the African Wildlife Foundation (AWF); CARE Tanzania; Jane Goodall Institute (JGI); Mpingo Conservation and Development Initiative (MCDI); Tanzania Community Forest by Network (MJUMITA); Tanzania Forest Conservation Group (TFCG); Tanzania Traditional Energy Development Organization (TaTEDO); Wildlife Conservation Society (WCS); and Wildlife Conservation Society of Tanzania (WCST) (Vice President's Office Report, 2012).

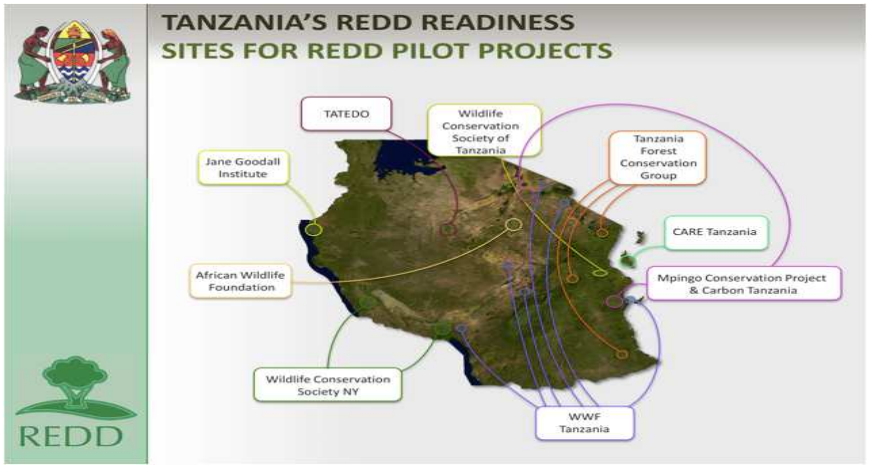

Figure 1: Map showing distribution of REDD+ pilot projects and facilitating institutions in Tanzania (Source: http//www.reddtz.org)

It is important to note that piloting the REDD+ strategy was spearhead by the Civil Society organizations (CSOs). The Central government, private sector, higher learning institutions and local government had minimal participation. The question is; who will take on board the implementation of the best practices documented in the REDD+ strategy after the piloting phase?

Activities of the REDD+ Technical working Groups

Three REDD+ Technical Working Groups (TWGs) have been established for implementing REDD+ activities. These include Legal, Governance and Safeguards; Monitoring, Reporting and Verification (MRV), and Financial Mechanism (National REDD+ Fund). On the legal, governance and safeguards, improvement on governance at local level that will eventually facilitate sustainable forest management and successful REDD+ implementation was envisaged. However, the review noted inadequate involvement and capacity building at local levels. To ensure sustainable management and conservation of Tanzania's forests, village level institutions need to be involved and their capacity improved in planning, finance management, good governance, and lobbying. The central government ought to provide relevant skills through training programmes at the regional, district, and village levels. Involvement of higher learning institutions in research and capacity building would add value to the REDD+ foundation setting.

The Monitoring, Reporting and Verification (MRV) system was meant to establish a participatory and functional monitoring and reporting verification system (MRV) to monitor deforestation and forest degradation, and respond to the needs for data collection, synthesis, analysis and provision of information on all aspects on REDD+. The MRV system is also meant to monitor rural livelihoods, conservation of biodiversity, key governance factors related to REDD+ implementation and assess the impacts of the REDD+ activities in the forest sector. The monitoring system will be implemented at the national, sub-national and local levels, involving the central government and state actors, civil society, private sector entities and local government authorities including villages, women groups, youth and consumer groups. However, the design of a national MRV system was developed from a policy perspective that prioritizes the overall objectives of lowering carbon emissions without hindering and potentially enhancing economic growth. To fulfil the policy requirements of this strategy, the MRV system needs to support decision-making through reliable, accurate and up-to-date information on forests, forest cover change and greenhouse gas emissions.

The financial Mechanism (National REDD+ Fund) will be established to consolidate and distribute funds to different stakeholders based on efforts in implementing REDD+ strategy. The fund will operate at the national level. It is believed that the fund will observe issues of transparency and accountability. Also, the performance of past forest revenue management systems, benefit sharing and incentive schemes will be assessed to provide lessons for REDD+ (VPO, 2012). In order to ensure the fund operates efficiently, there is a need to enhance mechanisms for ploughing back forest royalties to the managing authorities; harmonize forest administrative line of command (local government versus central government); explore other potential financing options; promote Payment for Environmental Services (PES) to support sustainable forest management, and approve cost-benefit sharing systems between the government and forest adjacent communities under Joint Forest Management (JFM).

Challenges of REDD+ development in Tanzania

REDD+ is theoretically well thought, but operationalizing it in the field and on a large scale remains a big challenge due to various reasons. First, the initiative is characterised by insufficient coordination and integration of the

ongoing National REDD+ pilot projects. Although there has been important progress and learning in the context of the pilot projects nationally, all activities are run by colourful individuals, elites, pro-market NGOs, and the national government ministries. It is doubtful whether local communities and private stakeholders will participate fully in REDD+ implementation. Further, there is no common approach among pilot projects (no agreed methodologies, no guidelines on data collection and carbon assessment), including establishment of baselines in REDD+ pilot projects across the country. This translates to lack of ownership by forest adjacent communities, which in turn threatens the sustainability of the same.

The second challenge hinges on having inadequate means to address the drivers of deforestation. The main direct causes of uncontrolled deforestation and degradation in the forests are; settlement and agricultural expansion, overgrazing, firewood, charcoal production, uncontrolled fires, timber extraction, development of infrastructure/industry, mining, refugees and most recently the introduction of large scale agriculture of bio-fuel production. Indirect causes include market and policy failures, rapid population growth, rural poverty, and the poor state of economy. Opening up new farms, developing new settlements coupled with demand on wood for curing tobacco, wood for fish smoking and making burnt bricks are among other causes that accelerate deforestation (Ministry of Agriculture, Livestock and Environment, 2009; Vice President's Office Report, 2012).

The third challenge relates to overstocking. Large herds of cattle arising from unwillingness of livestock owners to de-stock, who also takes the advantage that the forests/woodlands as open access (not reserved) contributes to deforestation and forest degradation.

Plate 1: A large herd of cattle in Kondoa District (Photo by Sangeda, 2012)

The high rate of using firewood is another serious problem. About 85% of the total population in Tanzania depends on fuel wood and charcoal for household cooking and energy for small and medium enterprises (Sawe, 1997; Angelsen, 2008; Blomley, and Iddi, 2009). The demand for biomass fuels for cooking is increasing due to population growth and unavailability of affordable alternative energy sources. To meet current biomass demands, people are forced to over harvest existing natural resources leading to an annual deforestation rate of around 412 000 hectares as shown in Plate 2.

Plate 2: Illegal charcoal making in Kilosa District (Photo by Sangeda, 2011)

Plate 3: Uncontrolled wild fire in coastal forests of Zanzibar (Photo by Tamrin, 2012)

The use of fire during land preparation for shifting cultivation, collecting honey, charcoal making, and hunting or livestock owners burning to prepare

areas to provide green flush for livestock and to control pests such as tick contributes to deforestation and forest degradation (Blomley and Iddi., 2009). Timber extraction is one of the main causes of forests loss. Timber harvesting had become an issue for public debate over the past 10 years, with the public media campaigns against the illegal logging scandals in Morogoro, Pwani, Lindi and Mtwara regions (Milledge *et al.*, 2007). The Joint Forest Management (JFM) strategy has not been able to facilitate improved local level governance, by opening dialogues over access and control over resources, financial management and the role of elected committees (Sangeda, 2013). Timber harvesting can also damage the remaining smaller trees, destroy much of the original forests and disturb the topsoil. Other effects include suppressing regeneration by weeds or failure to regenerate and damage to the watershed functions of the forests (Blomley and Iddi, 2009).

Plate 4: Illegal timber harvesting in Ruvu Forest Reserve, Morogoro, Tanzania (Photo by Sangeda, 2012)

Introducing bio-fuel farming without carrying Environmental Impact Assessment (EIA) has given way to clearing large areas of natural forests habitats (e.g. the Coastal forests) with high biodiversity. There is a need to support development and implementation of proper land use planning and

monitoring of commercial farming activities (FBD, 2000). While the drivers of deforestation and forest degradation are increasingly understood, addressing them in effective and equitable ways remains a major challenge. Unless Tanzania tackles the drivers of deforestation, emissions reductions will not be achieved. In order for Tanzania to move away from the use of fuel wood and charcoal so that REDD+ works, the programme should redirect its plans and strategies towards alternative energy sources (Solar energy, wind energy, bio fuels, gas and the use of efficient energy saving technologies (eg. energy saving stoves). Thus, forest conservation and sustainable forest management should go hand in hand with provision of alternative energy sources.

Thus far we have discussed various issues that impinge negatively on forest ecosystems. However, there are many ecosystem services and goods that are derived from forests other than carbon (Sangeda, 2013). Some of these other benefits are; water catchment areas, energy, fibre, wild food, honey, construction materials, climate regulations, biodiversity, scenic beauty, medicinal plants and erosion control (Figure 3). These are not considered by REDD+ policy makers. This is probably due to poor participation of stakeholders in the decision making process. Including such stakeholders in future processes will add value to REDD+ implementation.

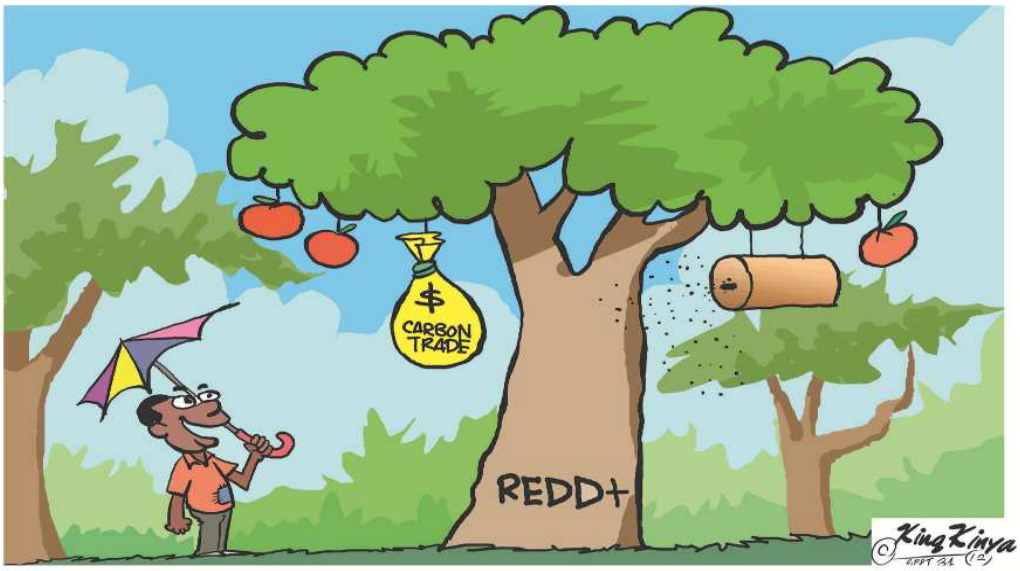

Figure 2: Showing multiple benefits of REDD+ projects (Source: Regalia, 2013)

Another problem relates to having inadequate baseline data on carbon credits monitoring, reporting, and verification. Tanzania started payments for carbon credits in 2006 in Ayasanda village, Manyara Region without having enough baseline data because there were no systematic national forest inventories as required (Zahabu, 2008). This arose because there were inadequate technical and financial resources. The starting point was therefore to initiate a rigorous National Forest Resources Monitoring and Assessment (NAFORMA) programme in order to facilitate the following; building the capacity on national forest inventories and remote sensing, determining the current land use cover/forest extent, determining the current forest growing stock, assessing drivers of deforestation and forest degradation, and designing a forest monitoring system using permanent sample plots (PSPs). It is expected that through NAFORMA most of the essential inputs to the Reference Emissions Levels (RELs) or Reference Levels (RLs) will be established. The first phase of NAFORMA was completed in December 2012 and construction of the REL has been done.

In line with the methodological guidance by UNFCCC in Durban, Tanzania is undertaking her national forest resources inventory, estimating historical deforestation and forest degradation as well as forest resources growth rates. However, as suggested in the guideline, there is flexibility on whether to determine RELs or RLs to enable the country to progressively include more REDD+ elements as data becomes available. With the emerging information, the national REL will be constructed based on activity data.

The dilemmas facing Tanzania in implementing REDD+ Strategy

In implementing the REDD+ strategy, Tanzania is faced by inadequate alternatives to biomass energy, leakage in carbon stock, poor governance in forest management, conflicts in land tenure, gender-blind REDD+ programmes, the money syndrome in REDD+ strategy implementation, and inadequate coordination and integration of National REDD pilot projects. Successful implementation of REDD+ hinges on reducing usage of forest resources. Meanwhile, Tanzania being a developing country, still relies heavily on using biomass energy to foster development because alternative energy sources such as solar energy, wind energy and biogas energy are inadequate. This dichotomy poses many challenges. How can REDD+ be successfully implemented under such scenarios? It is a common phenomenon

that protecting one area of a forest drives users towards another in another part of the landscape. This phenomenon is referred to as leakage. It occurs due to lack of alternative sources of biomass. People will always go elsewhere if one piece of forest becomes inaccessible to them. Hence if efforts are not made to minimize such leakage, the net effect of REDD+ initiatives may be minimal or even negative.

This syndrome was also observed during initiation of participatory forest management (PFM). Some forests that were under PFM improved in terms of resource base and the pressure of degradation shifted to nearby forests that were not under PFM. A good example of this is Kimboza FR (PFM) versus Ruvu FR in Morogoro rural District (Plate 4). While there are laws at the national level and bylaws at the local level to minimize such leakage, often the management and utilization of forest resources is fraught with corruption and mismanagement. Such poor governance may limit the successful implementation of REDD+. Currently, bad governance underlined by corruption is a common phenomenon in the management and utilization of forest resources in Tanzania, with some of forest caretakers being part and parcel of the corruption syndicate. Smooth implementation of the REDD+ strategy requires a clean and committed government.

Land tenure is another limiting factor. Inconsistencies in land legislation regarding the distinction between "general land" and "village land" could create conflicts between the Central government and Community forest managers over benefits from trees and forest carbon. Land in Tanzania is divided into three broad categories; (i) reserved, (ii) village and (iii) general land (URT, 1999; Regalia Media Limited, 2010). Reserved land is aside by the government for specific purposes such as biodiversity conservation through the establishment of forest nature reserves, game reserves or national parks. Village land is contained within the village area and falls under the direct management of village governments, including land for settlement and for local use. In contrast and somewhat confusing, the 1999 Land Act defines general land as *"all public land, which is not reserved land or village land and includes unoccupied or unused village land."* There are no provisions in the Act which clarifies the exact definition of unoccupied and unused.

As a result of these legal inconsistencies, interpretations vary widely between different parts of government about the exact coverage of village land, distinguishing it from general land. Looking into the future, it will be important for the government to clarify on a number of legal questions. First, clarity is required to establish the status and legal definition of "unused and unoccupied" within village land as well as outside village land forest reserves and in particular those lands with extensive natural forest or woodland cover. Second, the actual demarcation and geographical distribution of village, general and reserved land should be identified, and all stakeholders informed accordingly. Third, the rights of village governments to carbon revenues in unreserved forests on village land, and the possibility of creating more positive incentives for local management and conservation require clear and transparent guidelines. Fourth, clarity is required regarding the rights of community level forest managers to carbon revenues from forests under Joint forest Management (JFM). Similar clarity is also necessary regarding the beneficiaries of carbon sales from wildlife management areas (WMAs), where agreements have been reached on sharing wildlife hunting revenues between village, district and central governments (URT, 1999; FBD, 2000; Regalia Media Limited, 2010). All these aspects affect the entire community, but, considering the position of women as managers and users of community forest resources, there is a need to consider carefully their position under REDD+.

Women have knowledge and skills that contribute to natural resource management and are effective agents of change. At the same time, women generally have limited formal and informal powers which limit their participation in forest governance systems. They also have limited access to justice, markets, capital, formal education, employment, and other resources. Consequently their role in forest management is often limited, despite their important forest knowledge and skills (Regalia Media Limited, 2010). These constraining factors to women's participation in forest management arise due to limited recognition of their values and interests in forest and ecosystem resources, insecure land and tenure rights, often due to lack of understanding and respect for statutory rights (Vice President's Office Report, 2012). However, women have greater responsibilities for food crop production; food preparation; and collection of fuel wood, wild foods, medicines, water, and other natural resources (Vice President's Office Report, 2012). In some cases, forest management requires that forests that have been highly degraded be

closed to allow for rejuvenation and for conservation. The rules of forest closure forbid entry by humans and livestock. Such rules not only burden women, who subsequently have to walk further and spend longer hours collecting firewood, but also prompt them to break the rules.

Generally, women face wide discrimination, and are thus more vulnerable to bearing the costs of REDD+ and losing out on its benefits. Because of these and other differences, gender-blind REDD+ programmes can exacerbate existing inequalities and exclusions. There are many reasons for seeking gender equity and women's empowerment in REDD+, including legal and ethical obligations to respect women's rights and freedom from discrimination. Many international and national laws, policies and strategies, as well as donors, investors and others engaged in REDD+, increasingly support gender equity principles. Additionally, engaging women in REDD+ programmes can enhance its benefits and effectiveness. Indeed, gender equity in REDD+ can result in broader social benefits as women tend to contribute more to family and community well-being (Vice President's Office Report, 2012). For these and other reasons, it is important that REDD+ mainstreams gender, and seeks opportunities for further gender equity through women's empowerment at all phases and levels of the initiative.

Financing REDD+ initiatives, especially paying for carbon credit, involves transferring money from developed to developing countries to protect forests for carbon credits. This opens another frontier for speculation within the global money economy that does not sound like the right recipe for protecting forests and people who live around them. Communities living adjacent to forests need to change their attitudes towards protecting their forest resources without payment. It would be better to think of a forest-cover facilitation mechanism which builds on the willingness of people to contribute to reforestation and forest protection efforts with their own means, if given the opportunity. The opportunity could be securing land rights for local people, providing alternative energy sources, strong reduction of drivers and some funding for things like seedlings and capacity building. Culturally, people value trees because of their importance in their livelihoods. They only need robust institutional framework that would prevent problems associated with communal resource ownership. This could tap existing potentials instead of

throwing around money that will corrupt the system. There is a need to think more on how to sustainably run REDD+ (TNRF, 2009; FBD, 2000).

Way forward

While there is commendable progress and learning regarding the implementation of REDD+ pilot projects, all these efforts need to be well coordinated, documented and disseminated to all stakeholders at the national, regional, district and local levels. Deliberate efforts need to be stipulated regarding the institutional arrangement for REDD+ strategy implementation. For Tanzania to benefit and be able to implement REDD+ sustainably, it is important that all foreseen challenges are properly addressed. First, there is need to strengthen coordination and integration of the National REDD+ pilot project. A National REDD+ coordination framework that is in line with existing government structures needs to be developed. This should go hand in hand with building the capacity of the REDD+ coordination teams at the National, Local government, Civil society organizations and at community levels. Improving coordination also entails supporting effective use of the national REDD+ coordination framework embracing all stakeholders and activities related to REDD+.

The second step for improving successful implementation of REDD+ involves addressing drivers of deforestation and forest degradation. This calls for developing strategic options which will address drivers of deforestation and forest degradation. Some of the strategic option involve; promoting use of wood fuel efficient technologies and wood wastes, promoting and supporting private investment in efficient and alternative wood technologies, constructing infrastructure for distribution of natural gas to facilitate easy access nationwide, supporting the development and implementation of land use and management plans, monitoring commercial farming activities to minimize negative environmental impacts, institutionalizing participatory land use planning, establishing Village Land forest Reserves (VLFRs) as well as encouraging the establishment of trees on farm and/or woodlots. In addition, as Tanzania becomes integrated into global carbon credits markets, there is a need to establish holistic methods of quantifying carbon credits payment from different forests categories. Ecosystem services and products that are obtained from forests include biodiversity, ecotourism, erosion control, firewood, timber, food, medicines, wildlife, climate regulation, and water for various.

At the national level, there is need for establishing a National monitoring, reporting and verification System for carbon trade transactions. Accurate determination of carbon changes based on historical trend against which additional carbon benefits are made as a result of any scheme is important. Integrated methods to quantify REDD+ and other forest benefits are as well important to realize equitable co-benefit sharing. The use of fast and accurate ways of measuring carbon stocks with new technologies such as satellite imageries and computer modeling are required. Nevertheless, there is the question of cost for the relatively new technologies and capacity building required to carry out effective monitoring and accounting system.

In order to resolve the land tenure issues, effective implementation of the new land tenure policy is necessary. The government through the Ministry of Land, housing and human settlement working in collaboration with Non Governmental Organisations (NGOs) should support and facilitate participatory land use planning. This should go hand in hand with facilitating construction of village and district land registries and supporting implementation of land reforms and issuance of Certificates of customary right of occupation (CCROs). These efforts will encourage reforestation at the efforts by individual and corporate investors at the village level, which is a necessary step for sustainable implementation of REDD+.

The gender dimension of REDD+ is equally important for sustainability and equity. As stated earlier, there is need to enhance women's full and effective participation, representation, and information sharing at all levels of REDD+ programmes. This entails taking explicit measures to ensure that forest conservation and management respect women's rights, but also that women are not inequitably burdened women as a result of these initiatives. Moreover, women should share equitably the benefits and co-benefits arising from REDD+. This calls for mainstreaming gender in the assessment, monitoring and reporting of REDD+ projects, as well as putting gender issues in international and national laws and policies. For this to happen it is important that under REDD+ there should be women’s empowerment as well as support to organization that facilitate the implementation of REDD+. This implies treating gender mainstreaming as a process – to be carried out all the time – rather than a one-off event.

At the local level, there is need to develop livelihood alternatives to address poverty in order to relieve the dependence on forest resources. Alternative ways for income generation include investment in non-forestry sectors and employment programmes targeting rural areas to reduce forest dependency. These efforts should go in tandem with vocational education to create skill-based training opportunities. An environmental tax mechanism could be established and the revenue used to generate more employment alternatives. Another alternative could be capacitating local government to be able to provide forest-dependent communities with other livelihood options such as income generating activities and making tree farming as an entrepreneurship to people and tackle the issue of poverty.

Conclusion

REDD+ is a new initiative in Tanzania and the world at large, and therefore still under progress. Much of what has been done involves preparation for implementation, actual implementation of REDD+ has not yet started. Nonetheless, REDD+ is rather promising for future of Tanzania because it strives to develop and test mechanisms for preserving the environment for sustainable use, hence sustainable livelihoods. Deliberate efforts are required to make it work in practice on a large scale. There are a number of challenges that need to be resolved, which include improving the participation and coordination of various actors and projects at all levels of the REDD+ initiative. Other challenges to be overcome entail tackling the drivers of deforestation, reducing leakage, developing cheap and appropriate alternative sources of energy; resolving land ownership issues, and improving gender balance. The other set of constraints to be overcome require resolving methodological for measuring carbon; issues such as looking at co-benefits of forests other than carbon and developing off-forest income generating activities, to provide livelihood alternatives to forest dependent communities.

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Improved Dairy Goats Farming in Transforming Gender Relations among Agro-pastoral Societies in Kongwa and Mvomero Districts, Tanzania

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Abstract

This study was conducted to investigate the position of improved dairy goats farming in transforming gender relations among pastoral societies in Kongwa and Mvomero districts in Tanzania. Specifically, the study examined the extent to which integration of improved goats within agro farming systems enhanced women's access to resources and their participation in decision making at intra-household level. Data were collected using focus group discussions, structured interviews and participatory gender analysis. Quantitative data were analyzed using SPSS while content analysis was used for qualitative data. The findings revealed that both men and women were engaged in dairy production with women participating more on foliage collection, cleaning barns and feeding livestock while men were involved in watering and health management of the animals. Joint decision making has become a common phenomenon in most households in the districts because of gender mainstreaming in most project activities. However, the study showed a clear gender disparity in decision making, land and cattle ownership with the women being disadvantaged. It is thus recommended that development practitioners should engage more on empowering both men and women to enhance their participation in decision making and enhance respect for women's opinions among community members.

Keywords: Gender relations, dairy goat, root crops, Kongwa, Mvomero

Introduction

Gender issues in agricultural systems have become an important subject of inquiry worldwide since the 1970s (Yisehak, 2008). The literature indicates that in the developing world, many development workers use the term gender, sex and women interchangeably which often results in mixing the terms with unintended results. Gender refers to the socially defined roles and relationships of men and women within specific socio-cultural and

economic contexts in a given place and time; this is in contrast to biological sex which is universal and unchanging (Bravo-Baumann, 2000; Miller, 2011). Gender relations focus not only on women, but on the relationship between men and women, their roles, access to, control over and ownership of resources, and distribution of needs. According to IFAD (2003) gender relations are among the key determinants of household food security, well-being of the family, planning, production and other aspects of life.

Gender equality and gender inequality are key issues when looking at relations among different groups such as men/women, boys/girls, rich/poor and young/elderly people, among others. Gender equality refers to the allocation of socially valued resources, opportunities and rewards without discrimination on the ground of sex, class, and ethnicity (Oledele and Monkhei, 2008). There is a common agreement among development agents that gender inequality limits economic growth and sustainable development in Africa. The World Development Report (2012) noted that gender inequality has been recognized as an underlying cause of food insecurity, malnutrition and poverty throughout the developing world. There is also overwhelming evidence that gender inequality in livestock production perpetuates discrimination against women, making them numerically and propotionaly predominant among the poor in the rural areas (FAO, 2009; Kristjonson, 2010). Unequal intra-household power relations, often results in limited education, limited access to resources and services, low participation in decision making as well as limited income earning opportunities. All these negatively affect nutrition and health practices in developing countries (USAID, 2012).

Worldwide, women constitute a larger proportion of the population that is economically involved in agricultural system. In most low-income countries like Tanzania, women are key managers of livestock. They are producers of food, managers of natural resources, managing children and providing proper nutrition for households (Mollel and Mtenga, 2000; Brown *et al.*, 2001; FAO, 2004). Despite their considerable involvement and contribution in development, women's roles in livestock production and management have often been underestimated or ignored (Yisehak, 2008). Understanding the prevailing gender relations in dairy goat ownership and production could contribute to developing innovative strategies, which facilitate more equitable development while also enhancing attainment of the goals for improving nutrition, food security and income among agro-pastoral households.

This paper is base on a study and a development programme that was designed for integrating production of improved dairy goats and root crops for increasing food, nutrition and income security of smallholder farmers in Tanzania (CGP Tanzania) funded by the International Development Research Center (IDRC) and the Department of Foreign Affairs, Trade and Development (DFATD) of Canada for the period. The CGP Tanzania project started in 2011 and expected to end in August 2014. The implementing agencies include the Sokoine University of Agriculture (SUA) and Alberta University in Canada in collaboration with the International Livestock Research Institute (ILRI), Kibaha National Agricultural Research Institute, a non-government organization known as the Foundation for Sustainable Rural Development (SURUDE) as well as Kongwa and Mvomero District Councils. The programme (CGP Tanzania) addresses gender issues in objective number four which aims to analyze the impacts of integrating improved goat breeds with sweet potatoes and cassava into agro-pastoral farming system in Kongwa and Mvomero districts. Improvement is measured in terms of changes in productivity, environmental quality, gender and empowerment relations, food security, and nutrition

The project uses crops (sweet potatoes and cassava) and livestock components as an entry point for raising gender awareness and equity in the communities. The two components are generally considered to be key assets for rural livelihoods because societies that are considered pastoral, almost all household members have access to livestock. They are also involved in integrated crop production and livestock activities. Involvement in livestock activities enables farmers to acquire animal products such as eggs, manure and milk, which are marketed throughout the year, without seasonal restrictions (World Development, 2012). The project implements a range of activities, including raising awareness regarding redistribution of intra-household tasks and responsibilities, decision making, control over and ownership of resources are among the activities conducted in the project sites.

It is against this background that the paper focused on understanding gender relations among agro-pastoral societies following the introduction of a new intervention which required integrating dairy goats and improved root crops. The study was conducted in Kongwa and Mvomero districts. Specifically the

study determined gender roles and women's time use in keeping dairy goats, examined access, control over and ownership of resources related to dairy goats and production of root crops; and examined women's' participation in decision making after the introduced dairy goats and improved cassava and sweet potatoes varieties.

Methodology

The study was conducted in four project villages namely Masinyeti and Ihanda in Kongwa district, Dodoma region, and Kunke and Wami-Luhindo in Mvomero district in Morogoro region (Figure 1). The findings cover two gender related activities; (i) a gender inventory study carried out in June - July 2012 and (ii) participatory gender analysis conducted in November 2012. Information from project reports such the report based on focus group discussion and the baseline survey was used to enhance the study findings.

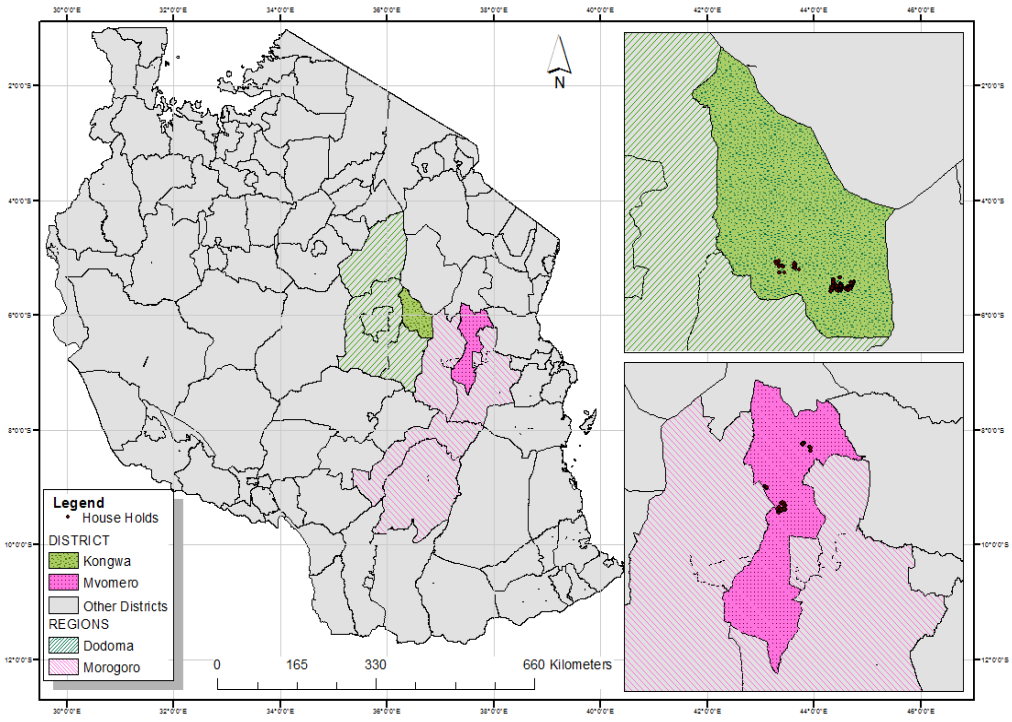

Figure 1: Map of study sites in Kongwa and Mvomero districts (Source: ILRI, 2013)

The conceptual framework for social relations places gender at the center of development practices. The framework focuses on gender analysis to identify

gender inequality as a consequence of structural and institutional forces that work through the rules (how things get done); activities (who does what); resources (what is used and produced) people (who is in or out) and power (who decides what and who has the last voice) (IFAD, 2003). The conceptual framework furthermore recognizes that gender relations are context-specific and constantly changing (FAO, 2009). The framework is therefore useful for identifying the driving forces for positive changes. The framework, including key issues associated with gender relations within crop-livestock farming systems are presented in Figure 2.

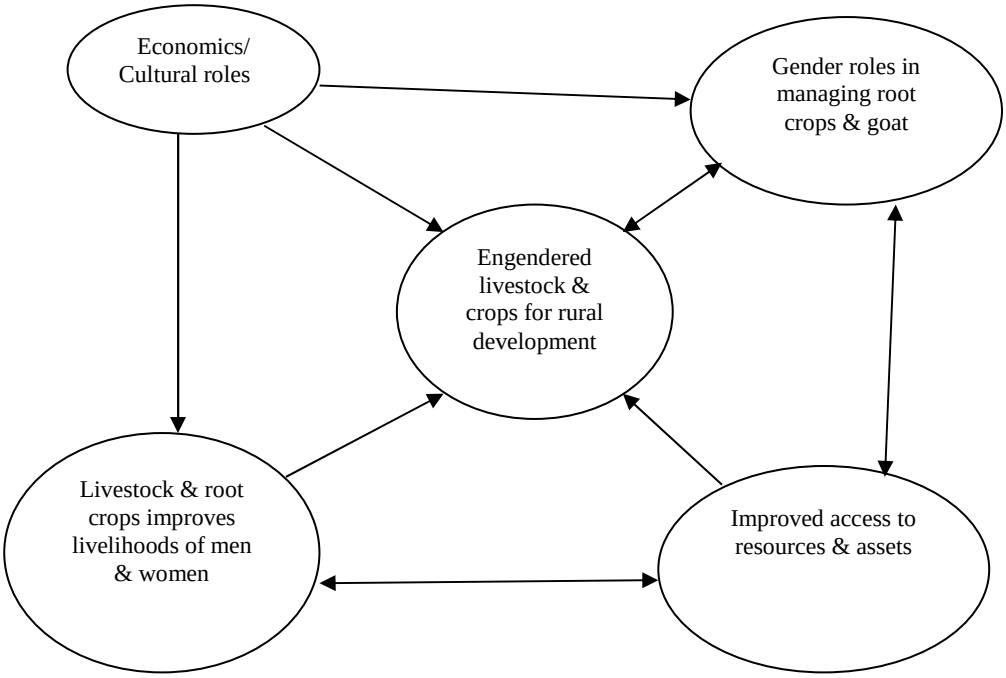

Figure 2: Key issues associated with gender crop-livestock farming (Adapted from IFAD, 2003)

A semi-structured questionnaire was administered to female farmers only (who were the projects' target group), while a checklist of questions was used to collect primary data from key informants comprising of both men and women. The study also used Focus Group Discussions (FGD) with women, men, village leaders and extension officers for the purpose of verification and triangulation of some key gender issues. Generally, the methodology was designed to encourage dialogue and the involvement of farmers in the research process. The questions sought to gather information on household

characteristics, gender division of labour for managing dairy goats as well as for production of cassava and sweet potatoes, participation in decision making, ownership, and control of livestock and other household resources. Quantitative data were analyzed using the Statistical Package for Social Sciences (SPSS) software. Qualitative data were analyzed using content analysis, which helped to reduce the volume of recorded information to a set of categories that represent some characteristics of the research. Secondary information was obtained from a review of published and unpublished reports as well as website sources.

Results and discussion

Socio-economic characteristics of respondents

The study findings show that only 5% of the respondents were less than 25 years, 36% were between 25 and 35 years old, 24% were between 35 and 45 years old while 36% were above 45 years old (Table 1). Farmers who are between 18 and 45 years old tend to be more active in practical "hands-on" livestock keeping activities compared to older farmers (Rota, 2007; Jackson, 2007). This aspect indicates that most of women involved in the sample for this study were in the productive age (25-45 years) implying that they are capable of undertaking various activities. This is a good indicator for project sustainability since a significant proportion of the participants are energetic and active to engage in project activities.

The findings show further that 47.6% of the females were single with or without children followed by those married (21.4%), divorced (19%) and widowed (12%). The prevalence of commuting households where husbands worked or conducted business far from the district while the wife remained at the family's residence, serving as a defector household head. The proportion of such households was higher in Kongwa district than in Mvomero district.

Table 1: Distribution of Female Respondents' by characteristics in the study areas

Characteristic	Category	Frequency	Percent (%) (n=42)
Age	15-24 yrs	2	4.8
	25-35 yrs	15	35.7
	35-45 yrs	10	23.8
	> 45 yrs	15	35.7
Marital status	Single (with/without child)	20	47.6
	Divorced	8	19.0
	Widow	5	12.0
	Married	9	21.4
Educational level	No formal education	21	50.0
	Primary education	20	47.6
	Secondary education	1	2.4
Household size	1-3 Members	7	16.7
	4-7 Members	27	64.3
	8 and more members	8	19.0

Most (50%) of the female household heads in agro-pastoral system had no formal education while 48% had primary education. Very few (2%) females had secondary education. These results are consistent with the baseline report for Kongwa and Mvomero districts, which indicated that many women farmers had no formal education compared to men (ILRI, 2013). Studies conducted in African countries have also shown a low level of education among the agro-pastoralists (Kristjanson, 2010). In a study conducted in Kongwa and Babati districts in Tanzania, many women confirmed having no formal education, which also hinders them from accessing credit from service providers (Jackson, 2012). This calls for efforts to design mechanisms for upgrading reading and basic mathematical skills among women in agro-pastoral societies. In addition it is important for development practitioners to design implementation strategies that accommodate slow learners using adult learning approaches, which are more participatory.

The household size varied greatly, the majority (64.3%) of respondents had family members ranging from 4 to 7, followed by 19% who had 8 or more household members, and the remaining 16.7% had 1-3 household members. The majority (54%) of the household members were still young (school going age and youths) with an implication that the sample's dependency ratio was

relatively high which could have negative effect on household labor availability with a direct bearing on food production and hence food security.

Resource endowments

Many studies conducted worldwide indicate that there is gender disparity in land and livestock ownership, with women being disadvantaged. Within the project villages land and livestock were predominantly owned by men as expected. Three quarters (75%) of the FGD participants said that land was controlled and owned by men. In a few cased male headed households (9.3%) and female headed households with their male children (6.3%) reported joint ownership of land. Ownership of land by the clan as well as by sons or daughters also exists at very low rate 6.3% and 3.1% respectively. Ownership of livestock reflected changing patterns in relation to the dairy goats introduced by the programme. Majority (55%) of the respondents indicated that dairy goats were jointly owned, 40% were owned by women (female household heads) and 5% were not sure who owned the goats (Figure 3). Key informants confirmed that women have rights to own dairy goats, which concurred with the project report indicating that 41% of the owners of dairy goats are women.

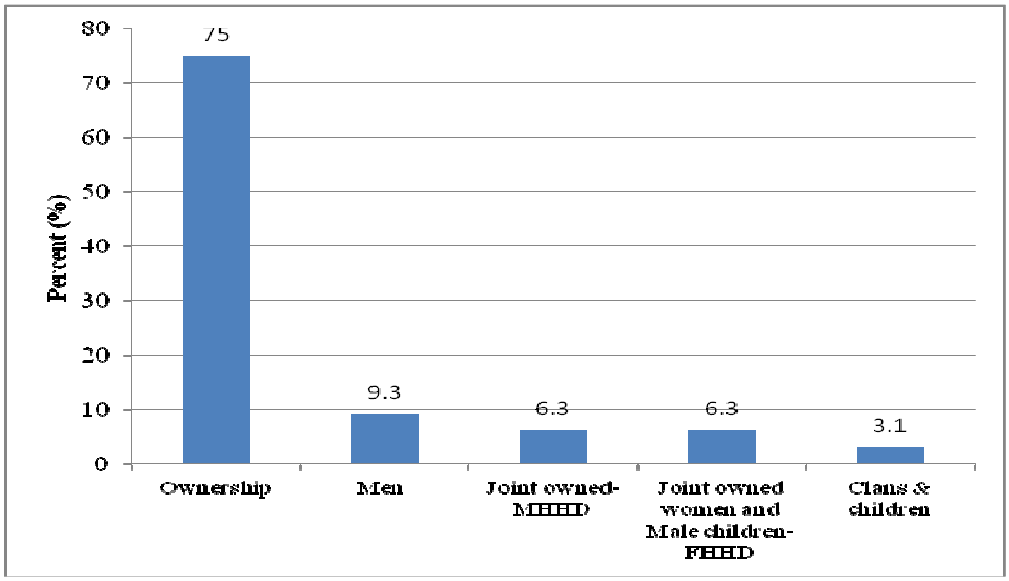

Figure 2: Land ownership in the study areas

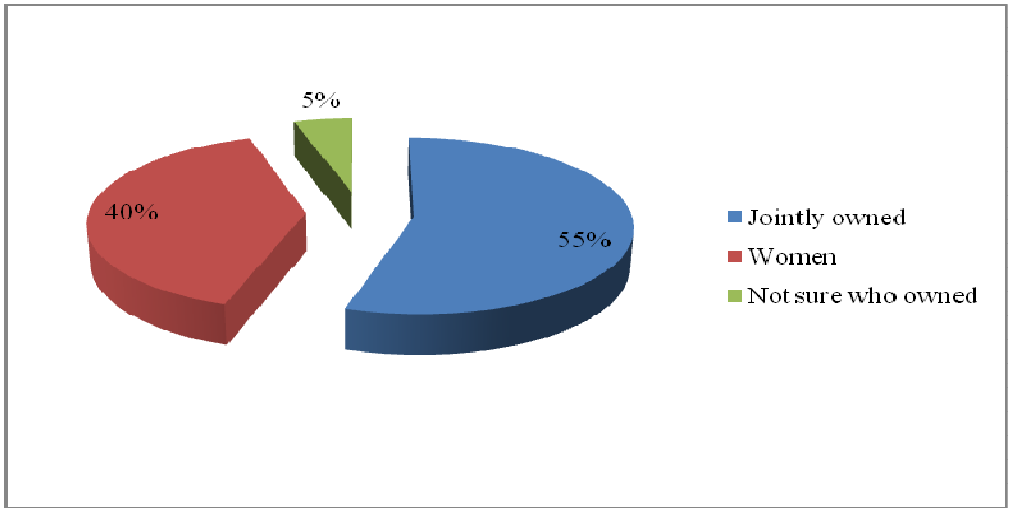

Figure 3: Ownership of dairy goats in the study areas

Traditionally livestock, particularly cattle, goats and pigs belonged to men as household heads. Women only had limited or no control over these productive resources. According to farmers, this was due to the strong influence of cultural and traditional aspects that privileged men and male children giving them rights to own productive resources. The current findings however, indicated a slight change in livestock ownership especially the introduced dairy goats. Respondents indicated that this was and is a positive move towards getting them (women) to have full control and ownership of the goats and their products, including making decisions on consumption and sale of milk. This change is attributed to efforts by project as well as other development practitioners who have promoted gender equity in resource ownership. In the case of dairy goats, the project has emphasized the importance of joint ownership as well as women empowerment to enhance their control over and ownership of productive resources. Dairy goats are easily accessed, available and more socially acceptable to be owned by women than land. These outcomes of the project show that deliberate efforts through women empowerment can improve women's control and ownership of livestock and livestock products (Kristjanson, 2010).

Dairy goat management activities

Dairy goats require food daily as well as water, sanitation, observation of diseases and milking, the only difference from local goats is that they are zero grazed. Within the study area, women, men, boys, and girls provide labor for different livestock-related tasks (Table 2 and 3). For the introduced dairy

goats, women participate mainly in collecting foliage (93%), cleaning animal sheds (83%), and feeding (73%) while men participate more (50%). on caring for sick animals and watering. Children in the households also participate in feeding and watering dairy goats. Men provide more support for rearing cattle and indigenous goats including grazing, watering and taking care of sick animals. Boys also participate in grazing cattle and indigenous goats especially after school hours as well as over weekends.

Table 2: Responses on gender responsibilities with respect to dairy goat husbandry (n=30)

Activities	Women	Men	Both (M & W)	Children
leaning the goat shed	25 (83)[1]	2 (7)	3 (10)	0 (0)
Feeding goats	22 (73)	1 (3)	4 (14)	3 (10)
Forage collection	28 (93)	0 (0)	2 (7)	(0)
Taking care of the sick animals	7 (23)	15 (50)	8 (27)	0 (0)
Watering animals	2 (7)	15 (50)	11(36)	2 (7)
Herding *	0	0	0	0
Selling**	0	0	0	0

[1] Figures outside the parenthesis show the number of respondents and Figures inside show the percentage.

* Dairy goats are kept indoors (zero grazing); ** Dairy goats are not ready to be sold

Purchasing inputs such as feed supplement and veterinary drugs were mainly done by men. There was further evidence that purchasing veterinary drugs varied depending on the proximity of the farmer to shops, milling machine and the education level of the household members. A female dairy goat keeper from Masinyeti village explained as follows during an interview with key informant interview (2012); *"..... if items such as medicine or concentrates are available in the village we (women) would walk to the shop and purchase it directly. But if it requires traveling outside the village, husbands or our sons will purchase it".*

Table 3: List of activities performed by different social gender groups in Kongwa and Mvomero districts

Livestock types	Men's tasks	Women's tasks	Boy's tasks	Girl's tasks
Cattles and Indigenous goats management	Grazing Caring of sick animals Watering Purchasing inputs (e.g. supplement feeds & veterinary drugs Selling	Grazing young animals (calves and kids)	Grazing Watering	Grazing young animals (calves and kids)
Dairy goats	Cutting grass for the goats Caring of sick animals Watering, Purchasing inputs	Cutting grass for the goats Caring of sick animals Watering Cleaning barn	Cutting grass for the goats Watering Cleaning barn	Cutting grass for the goats Watering Cleaning barn
Poultry	Selling (few)	Poultry management Selling	Feeding	Feeding and watering
Pigs	Raising pigs	Raising pigs		

Literate women and men were more confident about purchasing recommended items since they could read the labels. A study by IFAD (2006) recognized men's dominance in animal health management. This was reinforced by the fact that majority of extension agents are also primarily men who may have sidelined women in their service delivery. The prevalence of low or no formal education among women is another factor that inclined extension officers to exclude women from training and other activities involving animal disease management practices in the districts. Heffernan (2003) notes that men are more likely to have more knowledge on disease control due to increased contact with extension officers. However, there is growing evidence to shows that gendered roles are not cast in stone, being open to change, and accommodating different social and cultural practices. For example, there is evidence that the role of men in the project areas was changing as a result of project intervention. Within the households' respondents indicated that men and women now share most roles in dairy goat keeping including some decision making issues.

Root crop production and management activities

In contrast from livestock production, men and women participate in almost all root crop production activities. On average 40% of women said participate in tilling, 50% in planting and 50% in weeding only. During the participatory gender analysis exercise, majority (75%) of the participants pointed out that following the project intervention, they are now sharing roles in the production of improved varieties of cassava and sweet potatoes, as well as in harvesting, processing and selling. Women's involvement is higher in the case of non-cash farm activities, such as tilling, planting, and weeding whereas men's approach is more in soft activities related to cashable activities such as selling the cassava and sweet potatoes.

Table 4: Gender division of labour in cassava and sweet potatoes production

Activities	Responsible			
	Women	Men	Both (M & W)	Children
Tilling	16(38)*	11(26)	11(26)	4 (10)
Planting	21(50)	11(26)	7 (17)	3 (7)
Weeding	24 (50)	7 (17)	8 (19)	0 (0)
Harvesting	7 (23)	11(26)	8 (27)	0 (0)
Selling	18 (43)	22 (57)	0 (0)	0 (0)

- Figures in the table outside the parenthesis shows the number of respondents and inside the parenthesis shows the percentage for the activities with the corresponding gender.

Household daily chores

In interviews, women listed more than twice as men, the number of daily tasks (Table 5 & 6). This implies that men's support and involvement in household tasks was minimal. Women were the main caretakers of household chores, but men provided some support towards domestic activities such as water fetching and firewood collection. However, men used bicycles or animal drawn carts, hence more convenient than carrying on heads as most women do.

Table 5: Twenty four hours household tasks distribution in Masinyeti village in Kongwa District

Time	Activities	Who does what?				
5:00 – 6: 00 am		M	M-Child	W	F-Child	M &W
	Cleaning the house & their surroundings	−	−	√	√	−
	Getting water	−	−	√	√	−
	Monitoring goat &other animals	√	−	√	−	−
7:00– 11:00 am	Cutting grassed	√√	√	√√	√	−
	Cleaning goat barn	√	−	√√	−	−
	Feeding animals	√	−	√	−	−
12:00 – 2:00 pm	Cooking	−	−	√√	√	−
	Getting water	−	−	√√	√	−
	Giving water goats and other animals	√	√	√√	√	−
3:00 – 5:00 pm	Feeding goats	√	√	√√	√	−
	Grazing animals	√√	√	√	√	−
	Taking care sick animals	√√	−	−	−	−
6: 00 pm	Cleaning barn	√	√	√√	√	−
	Feeding animals	√	√	√√	√	−
	Milking	√	−	√√	−	−
7:00 – 11:00 pm	Cooking	√	√	√√	√	−
	Monitoring animals	√√	−	√	−	−
	Sleeping	√√	√√	√√	√√	−
	Remark			*		

Key: √√ = More involvement; √ = Participate in this kind of work; −Does not participate; *= the one who participated more

Table 6: Twenty four hours household tasks distribution in Ihanda village in Mvomero District

Time	**Activities**	**Who does what?**				
5:00 – 6:00 am		M	M-Child	W	F-Child	M &W
	Cleaning the house & their surroundings	−	−	√	√	−
	Cleaning utensils	−	√	√	√	−
	Cooking tea	−	−	√	√	−
7:00 – 11:00 am	Cleaning goat barn	√	√	√	−	−
	Fetching water	√	√√	√	√√	−
	Cutting grasses	√√	√	√√	√	−
	Feeding animals	√	√	√	√	−
	Farms' works	√	√	√	−	−
	Lunch preparation	−	−	√	−	−
12:00 – 2:00 pm	Cooking	−	−	√√	√	−
	Giving water goats	√	√	√	√	−
	Fetching water	−	−	√	√	−
3:00-5 :00 pm	Dinner preparation	−	−	√	−	−
	Washing utensils	−	−	√	√√	−
	Housework's	√	√	√	−	−
6: 00 pm	Milking	√	−	√	√	−
	Feeding goats	√	√√	√	√√	−
7:00 – 11:pm	Cooking	−	−	√	√√	−
	Cleaning young ones	√√	−	√	−	−
	Preparing beds	−	−	√	√	−
	Sleeping	√√	√√	√√	√√	−
	Remark			*		

Key: √√ = More involvement; √ = Participate in this kind of work; −Does not participate; *= the one who participated more.

Discussions also illustrated that men had fewer tasks during the day compared to women. Consequently, men had more leisure time and could often visit their friends and have time to enjoy drinks with their fellow men, which is not the case for women in both districts. It was also mentioned that women were not ready to get more support from their husbands in home chores, fearing that it would be shameful if someone found their husbands and other male household members doing household chores. Even if husbands were willing to support, it is said that women do not trust men to be good caregivers.

During discussions men recognized and appreciated that women have more tasks and are therefore are overworked. Consequently women face more time constraint than men, following the introduction of dairy goats. They (men) agreed to take up some of the household activities such as cleaning, fetching water, collecting fuel wood and also collecting foliage for the dairy goats to relive the women from the work burden. Meanwhile, most of the women especially female household heads acknowledged benefiting from keeping dairy goats despite being overworked. These include milk for household consumption and income for purchasing household items using income from selling milk. One respondent from Ihanda village commented that "…*income earned from selling dairy goat milk - half a liter per day, helps me to buy salt, soap, pencils and exercise books for my children.*" It has been reported elsewhere that even though the income earned may be small, it nevertheless forms a large proportion of the total income among poor households (ILRI, 2000; Jackson, 2007; Rubin, 2009). This implies that dairy goats can easily be owned by both men and women in rural areas, and are particularly important for improving household nutrition and diversifying income sources. Hence, improving women access, control and ownership of dairy goats is likely to improve human welfare and contribute to livelihood improvement.

Decision making on resources management

For most households, besides dominating in terms of livestock ownership, men also dominate in decision making regarding the use of most resources and assets (including land, cows, pigs, goats, poultry, and food crops). Decision making involves addressing the questions; what? When? and how much to dispose or retain of the resources owned or income earned. Men therefore control and make decisions on whether to sell or not, while women and girls may or may not control, or be part of the household decision-making processes. Women who are household heads have the right to control the disposal and use of benefits from cattle and other livestock if they happen to own them. In most cases however, these women have a much lower probability of possessing such assets. Women in male-headed households control some of the assets especially small stock such as poultry and eggs. In the case of large stock however, they cannot act alone (even if the animals technically belong to them) for fear of jeopardizing relations with their husband. Sometimes women lack confidence in decision making. This was contrary to female-headed households, who had full ownership of almost all productive assets including land. This gave such women an opportunity to

access loans from financial institutions using their assets as collateral. Out of 58% of respondents who accessed savings and credits in Village Community Bank (VICOBA) and Savings and Credits Cooperatives (SACCOS), 48% were female-headed households and 10% were women in marriage. The loans were used for running income generating activities such as food vender, kiosks and sale of green vegetables.

Table: 7: Respondents access to credits and participation in the social-economic groups (n=42)

Aspect	Response	Female household heads	Women in marriage	Total
Access to credit (VICCOBA & SACCOS	Yes	20 (48)[1]	4 (10)	24(58)
	No	13(31)	5 (11)	18 (42)
Participate in social groups	Yes	16(38)	6(14)	22(52)
	No	17(41)	3(7)	20(48)

[1] Figures in brackets represent percentage (%)

In general, the decision by women to dispose-off livestock and use accruing income increases, as the stock type gets smaller. Joint decisions between husband and wife to dispose and control the use of proceeds from dairy goats, cassava and sweet potatoes were observed on the study area. The study established that dairy goats were not seen as individually owned assets. Participants in gender analysis emphasized on the virtue of making decisions together and consulting within the family before selling or buying an asset. They even showed differences in term of poultry, cassava and other leguminous crops, by highlighting that women did or could independently sell these products because the price is known and stable during the season. In some instances households that practiced joint decision exceeded those where either male or female decision dominated (mostly in male-headed households). Even so, there is a clear disparity in authority and influence over the final decision. The head of household, due to his income earning role supported by a dominant patriarchy system, can override his wife's opinion.

Nevertheless, women reported to use benefits from dairy goat products and assets over which they have more control to meet household basic needs including food, education and health of household members. For example, women make goat milk yoghurt, which is consumed with staple foods,

contributing to a balanced diet and improving their nutritional status. Based on this understanding, supporting women to acquire at least one dairy goat is expected not only to enable them meet the basic household nutrition but also enable them to cover a wider scope household issues including health, and educational needs. Such a move will also build their confidence and self-esteem in decision making as well as in ownership of productive resources.

Conclusion and recommendations

In agro-pastoral system in rural areas of Tanzania, the participation of women in raising cows, sheep and indigenous goats is still very low. However, a high percentage of women show interest in keeping dairy goats launched by projects, and other public and private sector actors in the study area. High variation was found between men and women in terms of their participation in livestock activities. Men exercise control in the management of and decision making related to large animals such as cattle, indigenous goats, sheep and pigs, whereas women dominate in poultry farming and raising dairy goats. It was further established that the participation of women from male-headed households in decision making is still negligible, which affects their confident in decision making even for small stock, which fall under their control.

It was evidenced from this study that engendered interventions empower women in agro-pastoral societies. The study findings showed changes in gender relations in terms of roles and responsibilities in dairy goat keeping where men took some roles that were previously carried out by women. It can therefore be concluded that as a result of the project intervention women now participate in decision making over the resources owned but not as final decision makers. It is also evident that some women now control and own dairy goats (de facto) and hence supplement their household income as well as diversify their diets using goat milk.

Gender analysis from the study suggest that empowerment is an important pre-requisite for projects, development programs and implementers to ensure women effectively contribute to the livestock sector and move from subsistence to market oriented production. As part of the transformative gender strategy of the CGP Tanzania project, it is important that the project team engages more on empowerment, which will build the capacity of men and women to improve production and change outdated gender relations.

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Evidence of Climate Change-related Weather Patterns and their Effects on Food Production and Nutrition Status of Women and Children in Kilosa District

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Abstract

Climate variability and change do affect environmental condition of an area and consequently the population's socio-economic characteristics. Weather patterns in Kilosa District for the last 40 years have been examined. The study aimed at determining linkages between health, nutrition and climate change related weather patterns (rainfall, temperature and humidity). Meteorological data as well as data on food productivity and nutrition status were used. Peoples' perceptions on long term weather patterns, morbidity, sanitation, and household food security were assessed as well. Results showed increasing rainfall fluctuations over time, more of the fluctuations occurring in recent years. The duration of rainfall was diminishing and dry spells were increasing. Temperature and relative humidity have been increasing over time and extreme weather events coincided with the lowest food production. Women from food secure households had significantly higher body mass index (BMI) than their counterparts in food insecure households. Households with low hygiene and sanitation had significantly higher sanitary related diseases occurrence. Climate change-related weather patterns had negative effects on food crops productivity and human nutrition. Hence, improvement in adaptability to climate change is required. In formulating strategies to address climate change related challenges, the study recommends that extension agents should work closely with farmers, who have valuable local knowledge and experience for adaptation.

Keywords: Climate change; weather extremes; sanitation; nutrition status

Introduction

Humans are exposed to climate change directly through extreme weather occurrences and indirectly through various ways related to changes in water, air, food, ecosystems, agriculture and economies. From 1970 to 2000 globally, at least 160,000 deaths and 5,000,000 disability-adjusted life years occurred from malaria, diarrhea, flooding and malnutrition alone (McMichael, 2004). Climate change affects food availability in vulnerable communities and extreme weather like drought and floods induces multiple risks, including less food production and even reduced food intake in some circumstances (Chiu *et al*., 2010; Crahay *et al*, 2010). Floods cause deterioration of sanitation, which may lead to disease epidemics and associated decreased nutrient utilization in the body thereby increasing the occurrence of under-nutrition risk. However, the precise nature of climate change effects varies considerably from area to area, therefore necessitating establishment of more information on local condition in relation to observed weather and food availability trends.

Kilosa District within Morogoro Region in Tanzania is a typical example of areas that have been adversely affected by extreme weather in recent years. Periodic floods and drought are common in Kilosa, affecting the lives of many people through damage to crops and property as well as increased incidences of diseases, worsened sanitation and malnutrition. Although there is substantial evidence of climate change in the district, there has been insufficient information relating village scale evidence of climate change with farmers' perception on the same and its consequences. This paper examines evidence of change in long term variation in weather variables in relation to food production, nutrition and health.

Methodology

Kilosa District extends from Latitude 5^0 55' to 7^0 53' South and Longitude 36^0 30' to 37^0 30' East. It is characterized by dry tropical and semi-arid type of climate with bimodal rainfall pattern (REPOA, 2003). There is a dry season separating the short rains, locally known as vuli, from October to December and the long rains locally known as masika from March to May. Agriculture is the main economic activity and the area is dominated by crop farmers (mainly Sagara and Kaguru tribes). Rice, maize, pigeon peas, beans, cassava, sorghum, peanut and banana are the main crops grown. Maasai and Barbaig are

pastoralists also found in the area. Other sources of livelihood include charcoal and bricks burning as well as harvesting other forest/natural resources.

A combination of data sources and methods was employed (structured household interviews and focus group discussion) for data collection. Secondary data were obtained from various sources including the local meteorological station for weather data, District Council office for food production data, and child health clinic for anthropometric data. These were examined and trends established. Then household interviews (cross sectional) were conducted to discern; socioeconomic characteristics, availability of food in the household, amenities and practices related to sanitation and perceptions regarding climate change.

A sample that was representative of the district population was obtained through multistage sampling where the Division, Ward and Village were obtained randomly from their respective sampling frame. Consequently, Rudewa-Mbuyuni village in Rudewa ward within Kimamba division was selected. At the village level 256 households were selected based on the Hulley and Cummings' (1988) formula ($N=4Z\alpha^2\ pq/d^2$). At this level proportionate probability sampling was employed because a village is further subdivided into hamlets. The number of households in each hamlet was therefore obtained using proportional sampling from the village register. This involved listing the numbers of households in each hamlet. Then, a proportional number of households were sampled in accordance with the cumulative total for the village.

In order to assess weather pattern over the last 40 years in the area (since 1970s), weather records from Ilonga meteorological station, situated 15 kilometers from the study village, were examined. Corresponding district food production data for the same period were also collected. Household level production data was collected for the last five years only due to recall problems. For the cross sectional household survey, a structured questionnaire was administered to mothers through face to face interviews. Part one of the questionnaire collected data on the characteristics of household members (sex, age, education), characteristics of household's dwelling unit (household water source, type of toilet facilities, materials used for building the house in which they live and assets or durable goods owned by the household), household

income, hygiene and environmental factors. Part two focused on household food availability whereas part three collected information on perceptions of people on weather variability and change. The questionnaire was pre-tested in a nearby village (Peapea village), based on which the questions were reviewed accordingly. Focus group discussions (FGD) were held with 12 elders (60 years and above) to document long term weather variation. The nutrition status of women and children was assessed using anthropometric measurements, which were then used for computing anthropometric indices including; height-for-age, weight-for-height, weight-for-age and BMI (weight-for-height in adults). Ethical clearance was obtained from the National Medical Research Institute (NIMR/HQ/R.8a/Vol IX/1189) and parents granted verbal consent to participate in the study.

For this study, the year 1996 was set as a dividing period between past and recent times, based on the fact that 30 years is normally used as the period over which accurate estimates of long term weather variables can be obtained. It was therefore thought proper to divide years between past and recent at 15 years (half of the period) counting from 2011 (the year of data collection) backwards. However, meteorological records for the most recent years (2010 and 2011) could not be accessed. Nevertheless, peoples' perceptions for the most recent years were easily obtained. In examining meteorological data, mean monthly rainfall that was less than 10 mm was defined as a dry spell (Mutabazi, 2007) and annual mean temperature above 31° C was defined as extremely hot. Hygiene was assessed based on hand-washing practices covering all times that require hand washing namely; before eating, before feeding babies, after cleaning baby's bottom and after going to the toilet. Mothers were asked to state when they their wash hands. Sanitation was assessed based on availability of toilets, their quality and use. The quality of toilet facilities and their use were assessed through observation in each household. A four-point scale scoring system was devised whereby a household with no toilet was given a score of 0, a temporary toilet scored 1; a semi- permanent toilet with unroofed structure score 2, a permanent toilet but dirty scored 3 and a permanent toilet which was clean was given 4 points. Overall household sanitation was assessed by combining hand washing practices and the toilet scores.

Among children within the households, indicators for stunting (height-for-age), wasting (weight-for-height) and underweight (weight-for-age) were used to assess the prevalence of under-nutrition. The Anthro (3.1) software was used to compute nutritional indices (z-scores for underweight, wasting and stunting in pre-school children). For non-pregnant women, BMI was used. A BMI below 16.0 indicates severe under-nutrition, a BMI below 18.5 indicates thinness or acute under-nutrition while a BMI of 25.0 or above indicates overweight or obesity. Normal nutrition status falls between a BMI of 18.5 and 24. Data were analyzed using SPSS (version 16) and statistical tests to establish association between variables at 95% level of significance.

Results and discussion

Respondents' personal characteristics

In total, 256 women participated in this study. These respondents had 234 children under five years of age (121 males, 113 females). About half (49.6%) of the women had primary school education, 29.7% had no formal education and only 11.5% had education above primary school. Households of low socioeconomic status (SES) dominated as reflected by the low quality houses such as earth floor (93.8%), grass roofing (57%); only 41% had houses with galvanized iron sheet roofing. However, burnt bricks were used by 64% of the households and 23% used poles for construction of walls. Most (94.9%) of the households produced their main source of food.

Weather related variables

Evidence of climate change is presented from the analysis of meteorological records from Ilonga meteorological station and respondents' perceptions regarding long term weather variation and environment quality. The results indicated sufficient agreement between the two sources (peoples 'perceptions and meteorological records). The average annual rainfall for 40 years (since 1970) has been fluctuating from 50 mm to 135 mm with an overall average of 85 ± 17.6 mm per annum. There has been a slight decrease in the average annual rainfall (Figure 1) but more fluctuations have been observed over time (more so in recent years compared to the past). The duration of dry spells was increasing while rainfall amounts were diminishing. There has been a gradual decline of rainfall over the years up to 2009. The lowest annual rainfall was recorded in 2005 (50 mm) while the highest was recorded during the el-nino phenomenon of 1997 (135mm). The data revealed a clear difference between

the recent past and past periods. It was observed that in the past (before 1996), years of extreme weather used to happen roughly every seven to sixteen years but recently drought has been happening more frequently (less than five years). This is to say that years with rainfall below average have occurred more frequently during recent years than in the past.

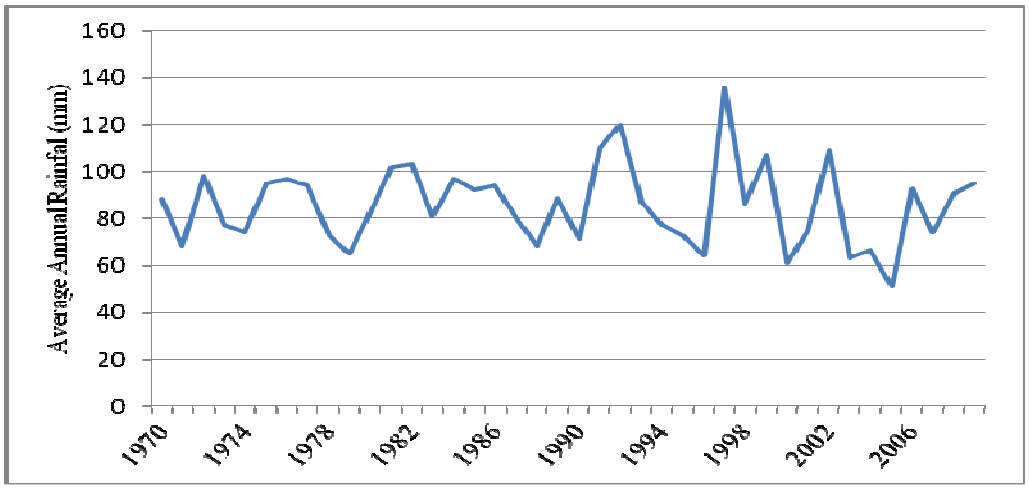

Figure. 1: Average annual rainfall from 1970 to 2009 recorded at Ilonga meteorological station (15km from Rudewa-Mbuyuni village)

Table 1: Occurrence of extreme low rainfalls and dry spells over the last 40 years

Category of study period	Year	Interval (Yrs)	Rainfall (mm)	Dry spell
PAST	1971		68	4
	1979	7	60	4
	1996	16	59	3
RECENT	2000		56	3
	2003	2	58	1
	2005	1	50	7

Similarly, based on the criteria that a dry spell has mean monthly rainfall less than 10 mm, then the pattern of dry spells distribution was examined. In the past, the occurrence of rainfall below average happened relatively less frequently. The year 1971 had annual rainfall below average that was accompanied with 4 months of dry spell. This recurred in 1979 (7 years latter) with accompanying 4 months of dry spell and finally in 1996 (after another 16 years) with accompanying 3 months of dry spell. In comparison, recent

occurrence of years with rainfall below average was in the year 2000 accompanied with 3 months of dry spell. It happened again in 2003 (2 years after) followed by 1 month of dry spell and finally in 2005 (after 1 year) followed by 7 months of dry spell (Table 1). All these had negative implications on crop production and productivity. Further negative implications on overall socioeconomic factors surrounding farmers depend on many other factors like the ability to diversify sources of livelihoods.

The data show that temperature has been increasing gradually over the past 40 years. The maximum annual temperature has increased by 1.78 ^{o}C (from 29.8 to 31.58 ^{o}C) and the minimum annual temperature by 2 ^{o}C (from 18.9 to 20.9 ^{o}C). The lowest maximum annual temperature was recorded in 1970, at 29.8 ^{o}C and the highest maximum temperature was recorded in 1983, at 31.58 ^{o}C. The lowest minimum annual temperature was recorded in 1981 and highest minimum annual temperature was recorded in 2006. The average maximum annual temperature for that period was 30.68$\pm$0.43 ^{o}C and the minimum annual temperature was 19.8$\pm$0.43. Assuming that any temperature above 31 ^{o}C is extreme, the results indicate that extremely high temperatures were not observed before 1983 (Figure 2).

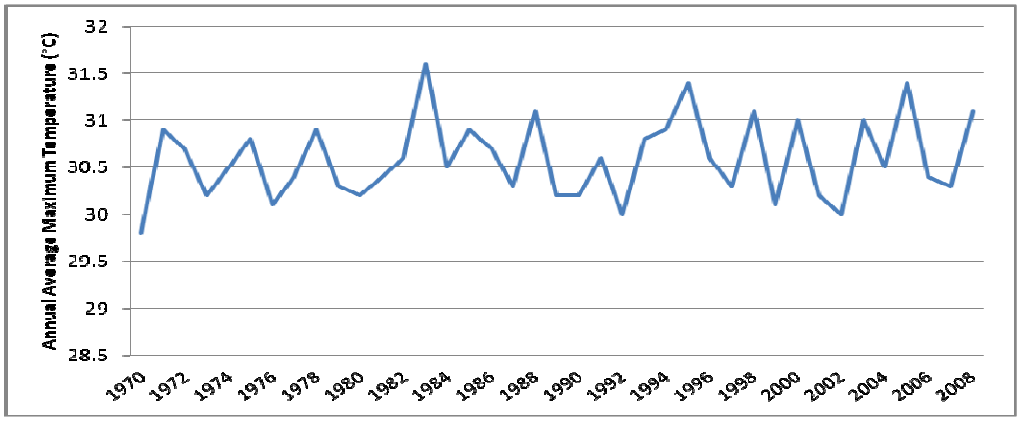

Figure 2: Trend of Average maximum temperatures trend of 40 years in Rudewa

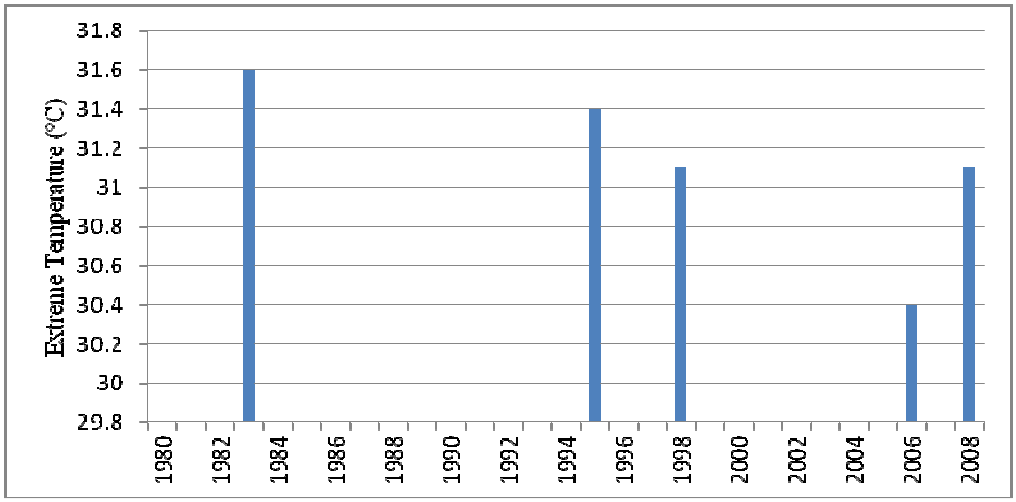

Figure 3: Extreme mean annual temperature trend during 40 years interval in Rudewa village

Figures 2 and 3 show that there was an increasing occurrence of high mean annual temperatures. These occurred in 1983 (31.58 ^{o}C), 1995 (31.41 ^{o}C), 1998 (31.05 ^{o}C), 2006 (31.38 ^{o}C) and in 2008 (31.08 ^{o}C) and the intervals between the occurrences being 12, 3, 8 and 2 years respectively. Looking at the mean monthly maximum temperatures reveals that most of the high records were observed in recent years and none before 1982. Out of 12 records of warmest months, five occurred between 1970 and 1990 (20 year period), seven occurred between 1994 and 2009 (15 year period), of which five occurred after 2003 - during the last six years period. These findings are consistent with projections made by other researchers who affirmed that global warming is real. The fourth assessment report of Intergovernmental Panel on Climate Change (IPCC) predicted that climate change and variability will lead to more intense and longer extreme weather parameters than have been observed in the past, which was the case in the current study. Similarly, past researches have suggested a close link of these changes to food and nutrition security. Projections indicate that in tropical regions, even slight warming (1-2^{o}C) will reduce yield (Easterling *et al.*, 2007). Normally when there is a dry spell of more than 14 days at 30% probability of occurrence for most months and when average rainfall in a season is below 18 millimeters, then there is a high possibility of crop failure from water stress (Mutabazi, 2007).

Average annual relative humidity before 1995 did not have much variation. It increased steadily from the lowest (49.4%) recorded in 1995 to the highest

(72.2%) recorded in to 2004. A marked jump occurred between 1999 and 2000 (from 50% to 70%). Monthly variation was high especially during the long rains. Based on average monthly humidity, the most humid month was June but humidity decreased from 88% in 1989 (the highest over the entire 40 year period) to 35% in 1993 (Figure 4).

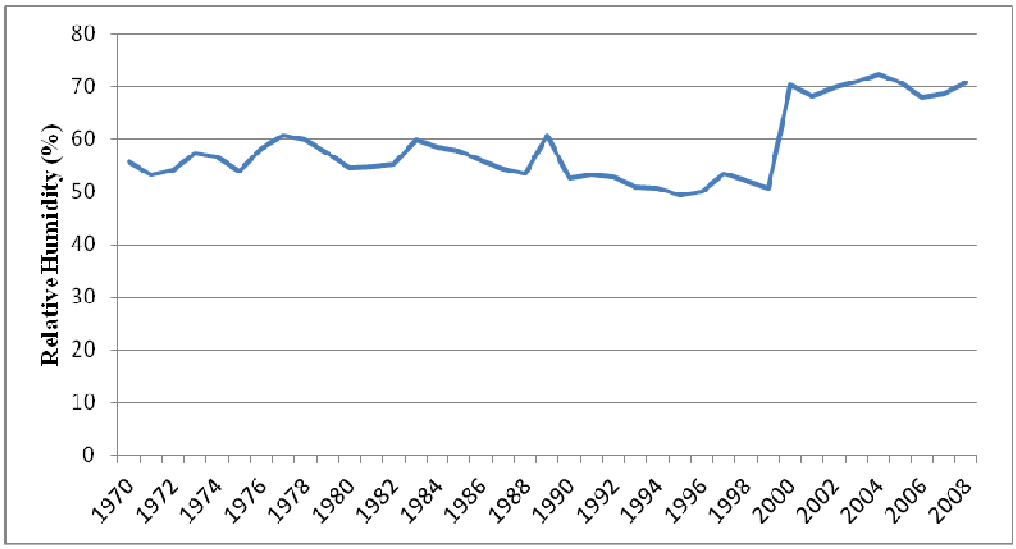

Figure 4: Trend of Average relative humidity from 1970 to 2009 in Rudewa

Crop productivity and production

Examining the corresponding district food production data, a gradual decreasing trend in productivity (yield) was revealed. The worst season was 2008/9 for all food crops examined (Figure 5), probably due to the shortest rainfall duration of 3 months experienced in that cropping season. Productivity reduction for maize and pulses was also consistent with reduction in rainfall for the period as the lowest productivity was observed in the poorest season (2004/2005).

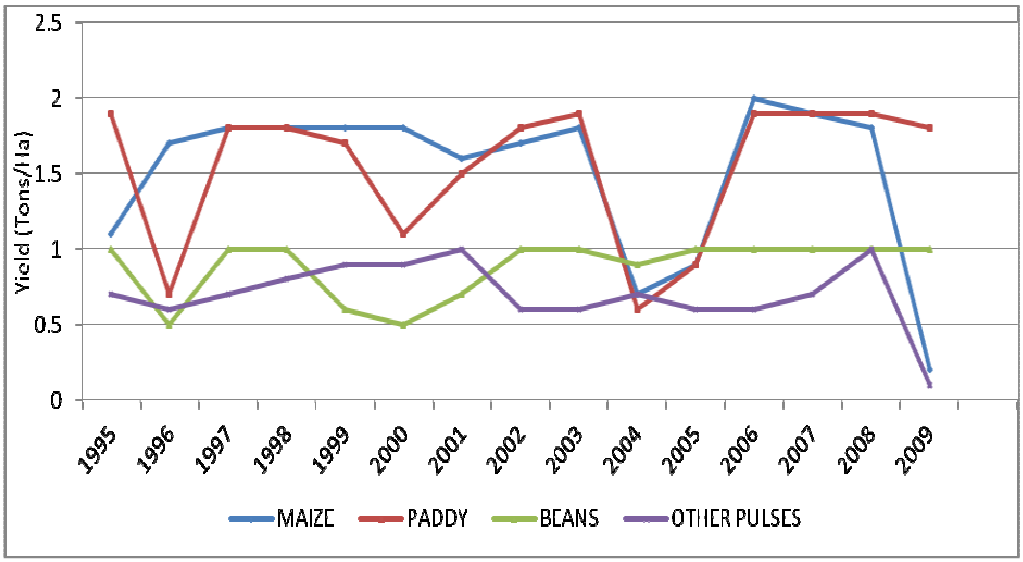

Figure 5: Productivity level (MT/ha) for major food crops in Kilosa district 1995 - 2009

Perceptions on climate change and environment quality

Attempt made to explore perception of respondents on consequences of the observed climate change revealed that immediate consequence perceived was deterioration of the environment followed by reduced production and productivity. Findings from FGD showed that unpredictable rainfall patterns forced farmers to engage in excessive and illegal harvesting of forest products, contributing heavily in the loss of forest and environmental degradation. Majority (97.2%) of the respondents were of the opinion that climate change has occurred. It was reported that seasons no longer reflected a bimodal rainfall pattern, which had been characteristic of the study area. This change has contributed to diminishing agricultural productivity, diminishing tree cover, environment degradation; all these jeopardizing livelihoods. It appears that productivity was affected most compared to production because farmers compensated by expanding the area under production by clearing new land (traditional forest). They were concerned about such clearance; expressing the opinion that it will further increase the likelihood of getting adequate rainfalls and degrade the environment.

Meanwhile, periodic drought in pasture land has caused migration of pastoralists to river basins which traditionally were not for herding cattle. The increasing number of cattle per unit area in the basins, coupled with ever-

increasing firewood cutting for cooking, and booming charcoal making business are viewed by farmers as threat to environmental quality and is likely to exacerbate change of microclimate in their area. The national assessment of climate change impacts done recently gave results consistent with this study and estimated the current national annual production of charcoal at 500,000 tonnes (World Bank, 2008; Yanda, 2009). The general perception of farmers is that extreme weather events, deteriorating land quality and growing pressure on the environment brought by ever increasing population collectively contribute to worsening their standard of living as key sources of livelihoods are negatively impacted.

Results of household interview also revealed that there were food shortages in many (63.1%) households during the season preceding the study. Consequently, food consumption (number of meals per day had a mean of 2.9$\pm$0.6), which is considered to be low. The main coping strategy employed by the community was selling labor (53.0%) followed by petty business (47.0%) which included making local brewing, food vending, bricks making and charcoal making.

Farming risk sources identified by farmers

Almost all of the respondents were of the opinion that their farming operations have been impacted by risks associated by climate change. Respondents were asked about incidences of climate related risks that they had experienced and sources of risks were many (Table 4). Direct weather related risk factors collectively formed the main (63.8%) contribution to risks of crop failure according to farmers' opinion. Respondents were also required to rank the incidences risk factors, to get an impression of their order of importance by scoring their responses on a 100-point scale. Results showed that dry spell ranked as the most important factor contributing to the perceived farming risks. To cope with the situation, most farmers (43.1%) decided to change their main source of livelihood while others decided to change the crops they planted (40.2%) and only 16.7% of the respondents changed the crop husbandry practices (Table 5).

Table 4: Sources of farming risks perceived by farmers and their ranking (n=130)

Risk factor	HHs perceiving it as a risk factor (%)	Ranking score in 100 point scale
Insufficient rainfall	31.3	22
Dry spell	32.5	24
Crop pests & diseases	14.7	21
Loss in store	13.7	23
Human disease	7.8	10

Table 5: Farmer's adaptation strategies for experienced drought (n=130)

Strategy/Action	Households employing the strategy (%)
Changing crop husbandry	16.7
Changing crops cultivated	40.2
Changing livelihood	43.1

To gain more insight on perception of farmers on the prevailing climate variability they were asked to estimate durations of rainfall for the last eight years (pretest results had shown difficulties in memorizing beyond that year for most of them)and to rate the seasons' performance in terms of rainfall favorableness to crops. Table 6 presents results of respondents' estimates of rainfall duration for recent seasons, overall weather rating, corresponding food production in the households, income and infants nutrition status. Results showed that the rainfalls for the last eight years were marginally sufficient for sustaining farming. Estimates of respondents on duration of rainfalls revolved around three to four months.

Table 6: Season's performance as perceived by farmers and prevalence of under-nutrition in infants (<1 year) assessed by village dispensary staff (facility based data)

Year	WR*	RD**	Maize yield in kg	Paddy yield in kg	Non-farm incomes in Tshs n=130	Underweight (prevalence % of undernourished)
2011/12	G	5	342	152	18,460 (164,782)	-
2010/11	G	4	436	352	12,883 (38,048)	-
2009/10	G	4	387	513	10,290 (26,982)	3.7
2008/9	G	3	401	142	8,777 (23,916)	2.0
2007/8	P	3	375	138	7,766 (20,853)	3.2
2006/7	G	3	-	-	-	3.0
2005/6	P	4	-	-	-	3.5
2004/5	P	4	-	-	-	10.2
All Years	G (74.4%) P (25.6%)		388.2 (314.9) 259.4 (1782.3)			

*WR= Weather rating of season as judged by farmers (P = poor; G = good)

**= Rainfall duration in total months of rains (short (vuli) and long (Masika)

From clinical data, the rate of under-nutrition was prevalent among children under the age of 1 year based on the weight-for-age indicator for the last six years (2005 – 2010), but the trend of underweight children was decreasing; having decreased from 10.2% in 2005 to 3.7% in 2010 (Table 7). The current prevalence of under-nutrition among under-fives as observed from sampled households using weight-for-height indicator was consistent with the clinic data. Global acute malnutrition is not a problem, however, chronic under-nutrition measured through height-for-age is a common public health problem; about 39% of the under-fives were stunted.

Table 7: Prevalence of under-nutrition (weight-for-age index) among children under the age of 1year

Year	Prevalence (%)	Number of children assessed
2010	3.7	53
2009	2.0	50
2008	3.2	93
2007	3.0	66
2006	3.5	85
2005	10.2	68

Environmental sanitation and consequences

Diseases are known to be major causes of under-nutrition particularly for children under five years of age and for infants. Major diseases afflicting children were diarrhea and malaria, and these are known to be sanitary related (most common in contaminated and unhealthy environments). Assessment of water accessibility, sanitation and hygiene (WASH) revealed a serious gap compared to the World Health Organization (WHO) standards and guidelines for each of the variables. The WHO guidelines outlined critical points for reducing infection risks to include; access to adequate and safe water, improved human excreta disposal, improved toilets, improved garbage disposal, improved hand-washing, improved food hygiene and reducing areas of stagnating water (Brikke and Bredero, 2003; SCN, 2010). While the recommended standard is to have protected groundwater sources (a dug well, a borehole, a spring or disinfected surface water), about 30% of households did not meet the recommended standard.

The mean distance to water sources was 0.61 kilometers and it took 13 minutes on average (to and from the water source). Similarly, the guidelines emphasize hand-washing with water and soap as one of the most important hygiene behavior. On the contrary, about 22% of the respondents did not use soap for hand-washing. Another 11% of households had no toilets, most of them (75%) saying that they lacked resources for constructing the toilets. The remaining 25% did not give any significant reason; it was sheer negligence on their part. Many of the toilets (52.7%) were unroofed temporary structures and about 30% were dirty. Only 11.8% of the households had good, clean toilets with permanent structure. For minimizing the risk of disease spread, toilets need to

be secure, clean and culturally appropriate. The prevalence of diseases related to sanitation was 72%. Households with low hygiene and sanitation score had significantly higher reported sanitary related disease occurrence ($p<0.001$). The most common diseases afflicting this community were malaria followed by diarrhea – both most prevalent during the rainy season.

Table 8: Nutritional Status: Indices of meal frequency and women's BMI

Index	Socioeconomic status (SES)				p-value[1]
	High SES		Low SES		
	n	mean± SD	n	mean± SD	
Number of meals per day	39	2.3 ± 0.8 86	86	2.6 ± 0.9	p<0.05
Adult BMI	39	23.6 ± 3.8	26	21.5 ± 3.3	p<0.05

Chronic under-nutrition among children who are under-five years old is often reflected as stunting, which was high (39%) within the sample, and is normally associated with poor overall economic conditions and/or repeated exposure to adverse conditions. This means stunting which is an indication of accumulated stress is a public health problem. Long term weather failure and repeated exposure to adverse conditions have a bearing on the observed stunting of children under-five years of age in the area. The prevalence of under-nutrition among women was 5.8% (BMI< 18.5). The BMI for women positively and significantly correlated ($r=0.25$; $p<0.05$) with the households' annual income was positively and significantly correlating ($r=0.2$) with the reported number of meals per day ($p<0.001$). Households from low socio-economic categories had significantly ($p<0.05$) lower BMI (Table 8).

Frequent occurrence of dry spells and the observed diminishing duration of rainfall were evidence of climate-related problems perceived by farmers and supported by meteorological station records. Rainfall reliability has been diminishing over time since 1970 although the amount has not changed much over time (Figure 1, 2, 3 and Table 1). Fluctuation in the onset of rainfall, rainfall duration and temperature from 1970 – 2009 have shown an increasing trend with significant negative impacts on farming. Recent studies on rainfall

unreliability in relation to farmers cropping culture have reported similar results showing the extent at which planning by farmers has become more risky, such that farmers' expectations from farming are not met. Normally when there is a dry spell of more than 14 days at 30% of occurrence, and when average rainfall in a season is below 18 millimeters, then there is a high possibility of crop failure due to water stress (Mutabazi, 2007). Moreover, in tropical regions, crop productivity decreases when the temperature increases by $1^{o}C$ over 30 years (Easterling *et al*., 2007). In the current study, the temperature increased by 2°C over the 40 years duration. This was accompanied by both extended dry spells and food crop productivity reduction.

Results from FGD have shown that unpredictable rainfall pattern forces farmers in the study area to engage in excessive and illegal harvesting of forest products, thereby contributing heavily towards the loss of forests and general degradation of the environment. Hieronimo *et al* in 2010 similarly observed that a significant area of Rudewa-Mbuyuni village was degraded woodland (8.5%) and mixed degraded woodland with scattered cultivation (11.4%) suggesting obvious negative consequences on environmental quality. Land degradation obviously elevates risk of household food insecurity.

The high level of under-nutrition could be explained by the fact that the unreliable weather influenced the underlying causes of under-nutrition namely food availability and income. Reduced food availability coupled with infections that partly emanated from poor sanitation precipitated under-nutrition. Under-nutrition in women was associated with lower socioeconomic status and food shortage ($p<0.05$), which implies that income and availability of food in the household contribute significantly to the observed under-nutrition (Table 3 and 5). Total household income (Tshs per annum) positively and significantly correlated ($r=0.2$) with the reported number of meals per day ($p<0.001$). Normally, income influences the quantity (frequency) and quality (variety) of meals. The most unfavourable weather in the last 15 years coincided with the lowest staple food crop productivity (maize and pulses) in the area. A similar pathway (unpredictable weather influencing food production) has also been reported in Canada by Wesche and Chan in 2010. They established linkages between long term weather variation, shift of seasons and food security. The observed prevalence of stunting in children

under five years of age in this study (39%) were similar to the national prevalence estimated at 38% (NBS and ICF Macro, 2011). This implies that malnutrition is both a national and local problem calling for intervention to address this serious problem.

Conclusion and recommendations

Climate change-related weather patterns are real, and they have negative effects on the productivity and production of food crops, hence food security and nutrition in the study area. Extreme weather events such as extended dry spells, shorter rainy seasons and extremely high temperatures as observed in the study area, have negatively affected household food production and this led to increased risk of under-nutrition for household members particularly among women and children who are globally known to be affected most by malnutrition. In order to minimize such risk, it is imperative that communities in Kilosa district and similar areas should be supported to improve their adaptability to climate change. This will be possible through the assistance of Extension Agents, working closely with farmers to tap on their indigenous knowledge in relation to climate change and adaptation. Farmers perceive and interpret climate variability accurately and they have valuable experience, which need to be incorporated into adaptation strategies designed by the government and other development agencies. The involvement of farmers in formulating adaptation strategies is therefore recommended.

Acknowledgement

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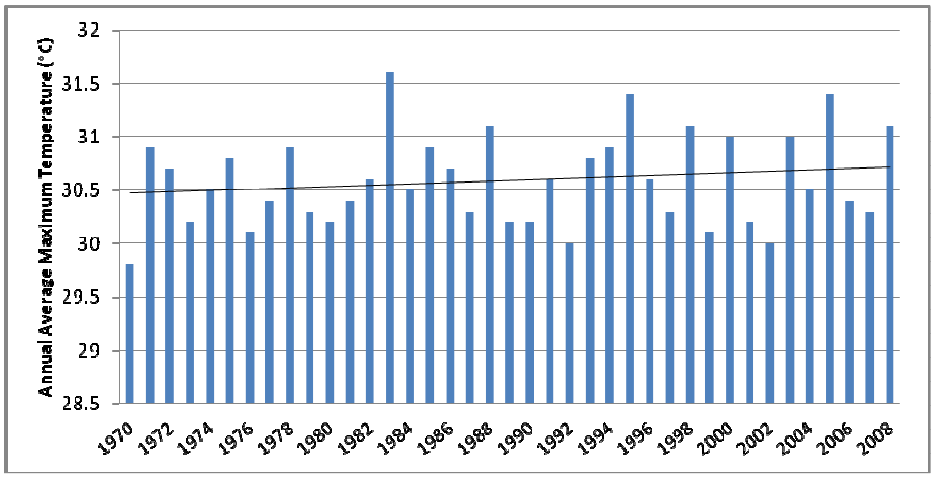
Appendix 1: Mean annual temperatures for Rudewa village showing the trend line with extremes and the diminishing intervals between the extremes (39 Years)



Appendix 2: Respondents perceptions on climate change and weather variation

Variable	Variable name	Number	Percentage
Think climatic conditions have been changing	Yes	173	97.2
	No	5	2.8
	Total	**178**	**100.0**
Effects of climate change	Rains different from the previous	140	63.9
	Long dry spell	64	29.2
	Water fetched far	1	0.5
	Weather change	13	5.9
	High diseases occurrence frequency	1	0.5
	Total	**219**	**100.0**
Causes of climate change	Deforestation	127	57.4
	Too many animals	26	11.8
	Cultivating in catchment areas	29	13.1
	Does not know	30	13.6
	God will	9	4.1
	Total	**221**	**100**

Appendix 4: Respondents'perceptions on environmental degradation

Variable	Variable type	Number	Percentage
Think there are fewer trees than previous years?	Yes	170	95.5
	No	8	4.5
	Total	**178**	**100**
Major cause	Household energy demand	57	19.3
	Charcoal making	118	40.0
	Brick making	23	7.8
	Opening up agriculture	78	26.4
	Trees for building	19	6.4
Think agricultural yield per acre has gone down?	Yes	175	98.3
	No	3	1.7
	Total	**178**	**100**
Any environmental problem?	Yes	164	93.7
	No	11	6.3
	Total	**175**	**100**

Coping Options and Poverty Traps in Tanzania's HIV/AIDS Hit Areas: An Illustrative Example of Rungwe District

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Abstract

The HIV/AIDS epidemic impedes agricultural production and household livelihood development since it affects consumption and exchange conditions. Among others, the scourge is mostly affecting adults - the economically productive individuals in the household, thus contributing to labour shortages and destruction of rural farmers' human capital. This has profound implications for rural household and community income generation capacity and livelihood security. Despite enormous theoretical and empirical studies in this area, there is very scanty empirical evidence on the determinants of households' choice of coping options and its implications for the odds of households falling into the poverty trap. A multinomial logit is used to determine factors influencing households' choices of coping options. A probit model is then employed to examine determinants of the odds of households falling out of or into the poverty trap. The results reveal that individual characteristics and household resource endowment play a critical role in the choice of coping options as well as the resilience and vulnerability to HIV/AIDS impact. Hence, mitigating against the impacts of HIV/AIDS and reducing the vulnerability of the households from falling into the poverty trap is imperative. Development policies and programs should be designed to address different conditions that increase the odds of households falling into the poverty trap while enhancing factors that increase the possibility of households getting out of the poverty trap.

Keywords: HIV/AIDS; Coping Choices; Rural Poverty; Tanzania, Rungwe

Introduction

The HIV/AIDS epidemic, especially in Tanzania's rural areas, impacts and impedes agricultural production and household livelihood development, while simultaneously affecting consumption and exchange conditions. In fact, the scourge takes a heavy toll on adults, the economically productive individuals in the household, hence further impoverishing rural communities (Gillespie and Kadiyala, 2005; Cogneau and Grimm, 2002). Consequently, areas with high HIV prevalence face enormous problems related to income generation and food security. This reality affects consumption and increases poverty and vulnerability of households (Barnett and Rugalema, 2003).

In an attempt to cope with, and respond to the impact of HIV/AIDS, households use diverse coping mechanisms to sustain their livelihoods. These among others include sales of household assets, seeking wage labour, child labour, migration, reducing consumption, decreasing spending on education, and depending on charity (Mutangadura *et al*., 1999; Topuozis, 1998). Available empirical literature on whether household using these options are better off or not is mixed. Some sources report that certain households appear to be coping better with the impact of HIV/AIDS while others do not (White and Robinson, 2000). This is due to the fact that the vulnerability and resilience of rural households into the poverty trap tends to differ across households. Very limited information, however, exist regarding the determinants of a household's choice of survival-coping mechanisms and its implications for households to fall into or out of the poverty trap. This paper attempts to fill this information gap. The objective of this paper is to analyze the factors influencing the choice of a household among coping mechanisms and their implications for the household's wellbeing. These issues are essential for poverty reduction and for defining HIV/AIDS mitigation measures to improve households' resilience to HIV/AIDS impacts and develop sustainable household livelihoods as a whole.

The rest of the paper is organized such that; section two explores the literature on the impact of HIV/AIDS and coping mechanisms adopted at the household level to tackle the impact of HIV/AIDS. Section three presents the methodology employed by the study, including the theoretical and empirical

techniques presented in section four. Section five presents and discusses the results. In the final section, the paper provide some concluding remarks and policy implications.

HIV/AIDS impact and coping choices

Impact of HIV/AIDS

HIV/AIDS-related illnesses impacts on households from the time one of the members is affected, and long after the person's death. Survivors of an HIV/AIDS victim continue to cope with the effects of losing a family member who may also have been the principal breadwinner. The most immediate impact of HIV/AIDS is on the human capital base, principally in terms of the availability and allocation of labour. At the household level, the HIV-affected person's labour input gradually diminishes, and the labour of other household and extended family members is often diverted into caring for the sick relative (World Bank, 2000). Such responsibilities necessarily detract labour from agricultural and nonagricultural productive activities; it has been estimated that each year the illness and death of one individual results in the loss of labour of approximately two individuals (FAO, 2002).

Consequently, HIV/AIDS reduces household income as family members are drawn away from production and other income-generating activities. Households suffer in terms of loss of crops and livestock, loss of assets, loss of farm management resources and skills, and disruption of the income earning potential. In Tanzania, for instance, a woman with a sick husband may spend 60% less time on agricultural activities than usual (Rugalema 1999; UNAIDS, 2000a; 1999; Mwakalobo, 2007; 2008; Asenso-Okyere *et al.*, 2011; Asenso-Okyere *et al.*, 2010). In addition, very often, HIV/AIDS is transmitted to more than one family member, suggesting that if a household member dies from the disease, more members may die from it too, as reported by Mutangandura (2000) who notes that, HIV-related female mortality in particular is likely to represent a second death for many households.

Not surprisingly, adult morbidity and mortality, and the associated reallocation and withdrawal of labour, have an adverse effect on household food and livelihood security. Crop production is highly affected in terms of; a decline in the range of crops grown, reduction of crop area under cultivation, and

declining crop yields (Gillespie and Kadiyala, 2005; FAO, 1997). A shift has also been identified whereby farmers substitute labour-intensive crops with those that require less labour input and also with those that are drought-resistant such as cassava and sweet potatoes, which are cultivable throughout the year but may contain lower nutritional values.

This situation (illness or death) also contributes significantly to reducing food consumption and nutrition levels. It has been reported that due to the effects of HIV/AIDS, households have reduced food consumption by as much as 15% up to 41%t in certain areas of Tanzania (Gillespie and Kadiyala, 2005; Isaksen *et al*., 2002; UNAIDS 2000b). In addition, as households become more vulnerable to HIV/AIDS, caregivers switch to less economically productive activities in general, which are lower risk and but also lower profit. This development contributes not only to the immediate but also to the future deterioration of the household income earning potential, disrupting the household production system and posing a serious threat to food and livelihood security. As the ability to produce and accumulate food and income decreases, the household falls into a downward spiral of increasing dependency, poor nutrition and health, which leads to increasing the allocation of resources (both time and money) towards addressing health problems. Consequently, the family faces more food shortages, which sometimes reduces the family's resilience to cope with changes in the production system. All these changes further disrupt the household's livelihood security, hence increasing poverty. As a family falls more and more into dependency, requring to seek more and more favours, the household's connections to the social network also tends to be disrupted (Barnett & Rugalema, 2003; UNAIDS, 1999).

Along with its effects on labour expenditure and earning potential, the HIV/AIDS pandemic forces households to divest their tangible assets and savings towards medical care, transportation, day-to-day expenses, and funeral costs. A study by Rugalema (1999) conducted in one village in Kagera region revealed that AIDS leads to accelerated dispensing of household funds, and a wide variety of tangible assets are disposed off to generate cash. In East Africa, it has been reported that some households with an AIDS-afflicted member have experienced an overall reduction in assets by as much as 40% to 60% (Mutangadura *et al*., 1999). On average, household expenses on medical care

and funerals amounted to US$104 annually, of which US$40 was spent on medical expenses and US$64 on the funeral, although there were wide differences among households, with some reporting expenditures of more than US$1000 (Tibaijuka, 1997). At any level, these amounts are very high, especially for rural people, whose usual budget per day is below one dollar.

HIV/AIDS Coping Choices

Households adopt diverse coping options as an ex-post response to shocks and stress. Explicitly, the impact of HIV/AIDS and coping mechanisms pursued by households are inextricably linked. This is due to the fact that household resource allocation is adapted as soon as a household becomes AIDS-afflicted or AIDS-affected, and each of these adaptations has a down-stream effect (White and Robinson, 2000).

Several types of coping mechanisms are undertaken by households to tackle the impact of HIV/AIDS. For instance, according to Topouzis (1999) three coping mechanisms are evident. First, there are coping options aimed at improving food security, including reducing household consumption; substituting some food items with cheaper commodities or indigenous/wild food; sending children away to live with relatives; having a small family; and begging. Secondly, there are coping options aimed at raising and supplementing income in order to maintain household expenditure levels. These include; diversifying income; migrating to seek work; borrowing; selling assets and drawing on saving and investments. Lastly, there are coping options aimed at alleviating the loss of labour including; intra-household labour re-allocation, withdrawing children from school, labouring for extra hours, hiring labour and using labour-saving technologies such as draught power, decreasing the area under crops, and relying on help from relatives. Topouzis (1998) provides a similar extensive outline of coping mechanisms employed by households against HIV/AIDS, including; seeking wage labour or migrating temporarily to find paid work, switching to producing low-maintenance subsistence food crops, liquidating savings accounts or stores of values (such as livestock, crop product etc.), reducing consumption, decreasing spending on education, selling land, equipment or tools, reducing crop area under cultivation and the range crops produced, depending on charity, breaking up of the households, and distress migration.

Despite enormous literature on HIV/AIDS coping mechanisms at household level, there is very scanty information on studies which have explored factors influencing the choices of these options and their implications for household wellbeing. This paper therefore aimed at analyzing the determinants of household choices of coping options and their implications for household wellbeing. In doing so, these findings provide a basis for assisting policy-makers and other stakeholders involved in mitigating HIV/AIDS impacts and in integrating HIV/AIDS into core poverty reduction strategies in order to achieve the millennium development goals (MDGs).

Methodology

Study area and data collection

Rungwe district was selected for this study as a representative of HIV/AIDS affected areas in Tanzania. The district was listed among highly HIV/AIDS affected areas in Mbeya region, which also ranks high nationally in this respect. Rungwe district lies between latitudes 8º30'and 9º30' South and Longitudes 33º and 34º East, South-west of Tanzania. Villages were selected to represent two different localities. Two villages - Masebe and Mpandapanda from the HIV/AIDS High Transmission Areas (HTA), close to the Tanzania-Malawi highway; and one village - Masukulu selected to represent villages which are far from the HTA. The selection of villages was done to capture differences regarding how these communities respond to HIV/AIDS. A cross-sectional research design was employed to achieve the objectives of the study. Data were collected from randomly selected households between March and April 2003. Data were collected at the household level, with the purpose of establishing how household members choose from among coping strategies and the implications of their chosen options for their adaptive capacity; and whether the family subsequently fell out of the poverty trap or they ended up deeper into poverty trap. Data were collected from 119 households and key informants. Interviews were conducted using a structured questionnaire and a checklist of questions respectively. These were complemented by focus group discussions with selected community members.

Theoretical and Empirical Models

The decision for this study units are households treated as single-family units. The household members' welfare is assumed to be summarized in a single

household-utility function, which is in turn assumed to depend on the prevailing coping choices available to the household. In which case, the choice of HIV/AIDS coping option can be seen as an outcome of the interaction between demand and supply. In analyzing the choice by individuals to choose coping mechanisms, we assume the existence of multiple activity choices, including not choosing any coping mechanism.

A number of factors determine the option by individuals to choose or not to choose any coping option, which depends on individuals' utility maximization. Hence, factors that influence the expected and reservation earnings from any particular option are important in the choice of a coping option. Household/individual asset endowments are important determinants in this trade-offs, depending on the pay-off of a particular coping option.

The multinomial logit model permits the identification of characteristics of individuals choosing multiple coping mechanisms. The motivation for using this model is based on several factors; first, data for the study consist of individual and household specific characteristics, which the model is well suited to analyze. Secondly, it is based on the assumption that alternative coping mechanisms are distinct and independent of one another, such that introducing a new alternative leaves the relative odds of choosing among the existing alternatives unchanged. Thirdly, the multinomial logit model is easy to estimate even for a large number of alternatives. A multinomial logit model is employed to provide empirical estimates of household specific variables that influence preference of the choice of certain coping mechanisms. The model estimates the probability of individual *i* choosing the use of certain coping mechanism *j* given a set of explanatory variables. The multinomial logit model is developed on the axiom of utility maximization. It is assumed that an individual associates some level of utility with the effect of explanatory variables on a dependent variable with unordered response categories, or a choice problem with multiple alternatives.

In the decision to choose coping mechanisms any individual is assumed to attach some level of utility *U*, with any possible alternative adaptation options. Based on the theory of consumer behavior it is assumed that individuals will choose a coping mechanism or activity type that offers the highest utility. An

individual *i* faced with the decision to choose among z alternatives can be described using the utility function:

$$U_{ij} = U_{ij}(Z_i) + \varepsilon_{ij} \qquad (1)$$

Where: U_{ij} is the utility that individual *i* derives from choosing a coping mechanism or activity *j*, Z_i is a vector of the characteristics of individual *i*, ε_{ij} is the disturbance term. The assumption is that individuals will choose the j^{th} coping mechanism or activity if and only if the utility derived from it is greater than that for all coping mechanism/activity that can be chosen. The decision choice can be summarized as follows:

$$U_{ij} > U_{ik} = U_{ij}(Z_{ij}) + e_{ij} > U_{ik}(Z_{ij}) + \varepsilon_{ik} \qquad (2)$$

In a more general form equation (2) can be formally expressed as follows:

$$U_{ij} = \beta_0 + \beta_1 Z_{1i} + \ldots + \beta_n Z_{ni} + \varepsilon_{ij} \qquad (3)$$

In which case $Z_{1i} \ldots Z_{ni}$ are the transformations of the characteristics of individuals/households. To simplify the econometric problem, the study used the logistic distribution function, with a linear logistic regression. Assume that the i^{th} individual prefers options *j* to k and other alternatives in a case of multiple choices, then the probability that the individual will choose the preferred option can be written as:

$$P_{ij} = \text{Prob.}\ (Z_{ij}\beta + \varepsilon_{ij} > Z_{ik}\beta + \varepsilon_{ik}) \qquad (4)$$

This probability can be given as the utility of the preferred coping mechanism or activity *j*, weighted by the total utility of the alternative coping mechanism or activity.

$$P_{ij} = \frac{e^{Z_{ij}\beta}}{N\sum_{j=1} e^{Z_{ik}\beta}} \qquad (5)$$

Equation 5 is the multinomial logit model representing a choice problem with multiple alternatives. Since the coefficients of the multinomial model are not directly interpreted as those of the ordinary least squares estimators, marginal effects are estimated instead to express the probability of the choice of coping mechanisms by the household with respect to each independent variable, measured from the mean of the variable.

$$\frac{\partial p_{ij}}{\partial z_{ij}} = \left(\beta_{ij} z - \sum_{k=1}^{k-1} p_{ij} . \beta_{ij} \right) p_{ij} \quad \text{, for k = 1, 2 .. K-1} \qquad (6)$$

where β_{ij} is the coefficient of Z for the coping option k chosen. The marginal effect on the redundant category is obvious, as the sum of the marginal effects of all categories equals zero. However, calculating marginal probabilities is not very useful to evaluate the magnitude of β in a multinomial logit model; instead here we adopt the use of the odds ratio, which is the exponentiated coefficient. The final empirical multinomial logit model with four choice categories (i.e. petty trade, child labour, sale of labour and local brewing) can be specified as:

$$\Pr(y_i = 1/x_i) = P_{i1} = \frac{1}{1+\exp(x_i'\beta_2)+\exp(x_i'\beta_3)+\exp(x_i'\beta_4)},$$

$$\Pr(y_i = 2/x_i) = P_{i2} = \frac{\exp(x_i'\beta_2)}{(1+\exp(x_i'\beta_2)+\exp(x_i'\beta_3)+\exp(x_i'\beta_4)}, \qquad (7)$$

$$\Pr(y_i = 3/x_i) = P_{i3} = \frac{\exp(x_i'\beta_3)}{(1+\exp(x_i'\beta_2)+\exp(x_i'\beta_3)+\exp(x_i'\beta_4)},$$

$$\Pr(y_i = 4/x_i) = P_{i4} = \frac{\exp(x_i'\beta_4)}{(1+\exp(x_i'\beta_2)+\exp(x_i'\beta_3)+\exp(x_i'\beta_4)},$$

where β_2, β_3 and β_4 denote the covariate effects specific to the second, third and fourth response choice categories with the first choice category as the reference. The equation for P_{i1} is derived from the constraint that the four probabilities sum to 1. That is, $P_{i1} = 1-(P_{i2}+P_{i3}+P_{i4})$.

One important item here is worth noting, that the coefficients of a multinomial logit model cannot be interpreted in the same way as those from multiple regression using ordinary least squares. Instead, the odds ratio may be interpreted as the effect of explanatory variables on the distribution of proportions of dependent variables. The odds ratio is the exponential of the multinomial logit model coefficient. This explains the effects on the odds rather than the probability. It is interpreted as follows; for a one-unit change in the independent variable, the odds are expected to change by a factor of exp (β) when other things remain equal. In interpreting the odds ratio the exponential of a positive number is greater than one, while the exponential of a negative number is less than one. Thus, the threshold between positive and negative effects is one. If the exponential coefficient is greater than one, it implies that increased odds, whereas, an exponential coefficient between zero and one indicates that the odds decrease. Additionally, the distance of exponentiated coefficient from one in either direction explains the size of the effect on the odds for a unit change in the independent variable.

In order to assess the implications of the choice of HIV/AIDS coping mechanisms on the probability of a household's resilience (vulnerability) to avoid falling into the poverty trap, a probit model is estimated. Household resilience (vulnerability) here is defined as the household's ability (inability) to cope with HIV/AIDS impacts, in terms of their ability to access food or maintain food stability and sufficiency over a period of time or command food from over market and non-market goods and services l. Food expenditure is used as a proxy for household welfare (the standard of living and poverty). The food consumption outcome at the household level is considered here implicitly to contain the effects of nutrition, health, asset endowment and market risks as well as institutional arrangements.

The model falls within the family of generalized linear models, with the exception that the response variable is not continuous but discrete. The probit regression specification represents a convenient way of quantifying the relationship between the characteristics of the household and their poverty status using the food poverty indicator.

The dependent variable takes the value of 1 (for poor) and 0 (for non-poor). Given that a household may be classified as poor or non-poor, a binary probit model is used for analyzing the data. A household is poor (Y=1) if its monthly food expenditure per adult equivalent is less than Tsh. 5,295 and non-poor (Y=0) if expenditure is equal or greater than Tsh. 5,295[4]. A set of explanatory factors that are included in the model are as described in Table 3, and gathered in a vector X, could explain the response such that:

$$Y_i^* = X'_i\beta + u_i \qquad (8)$$

where Y_i^* is the underlying latent variable that indexes the measure of household welfare (standard of living or poverty as defined above), X is a vector of explanatory variables-factors explaining household welfare, in terms of access to food, food stability and sufficiency as well as the vulnerability associated with household adopting HIV/AIDS impact coping mechanisms, u_i is the stochastic error term, and β is a column vector of parameters to be estimated. Assuming that the cumulative distribution is u_i a probit model is employed. In this case, the probability of being poor can be given by:

$$\text{Prob}(Yi = 1) = \frac{\exp(X_i'\beta)}{1+\exp(X_i'\beta)} \qquad (9)$$

Results and Discussion

This section presents empirical results on household characteristics; the coping mechanisms used to tackling the impact of HIV/AIDS; determinants of household choice of HIV/AIDS impacts coping mechanisms and determinants of household's resilience and vulnerability to HIV/AIDS impact. A multinomial logistic regression model and a probit model were estimated to determine the factors influencing the choice of coping mechanisms; and probability that a household would be poor and factors contributing to the odds of falling below the poverty line respectively.

Household Characteristics

Tables 1-2 provide information that describes the sample households. Table 1 depicts the summary of household food expenditure per adult equivalent and

[4] Adopted from the food poverty line for Tanzania used in the 2000/01 Household Budget Survey (NBS, 2002).

average household size for all four villages. The results show further that households in Masukulu were of a smaller size (2.8) when compared to Masebe (3.6) and Mpandapanda village (3.9). The results show that households in Masukulu and Masebe spent less on food per adult equivalent as compared to those in Mpandapanda village.

Table 1: Household size and food expenditure per adult equivalent

Village	Sample Household food expenditure per adult equivalent				
	Sample size	Minimum	Maximum	Mean	Standard Deviation
Masukulu	40	3149.6	8441.0	4778.0	1188.5
Masebe	41	3649.7	8057.9	4903.9	887.2
Mpandapanda	38	3889.7	16384.2	6389.9	2717.2
All respondents	**119**	**3149.6**	**16384.2**	**5336.0**	**1891.2**
Sample household size statistics					
Masukulu	40	1	7	2.8	1.3
Masebe	41	1	8	3.6	1.6
Mpandapanda	38	2	9	3.9	1.3
All respondents	**119**	**1**	**9**	**3.4**	**1.5**

Table 2 gives a summary of the incidence of poverty among the sample households. The results indicate that 56.3% of the sample households lived below the poverty line,of less than a dollar a day, while 43.7% fell above the poverty line.

Table 2: Households falling below and above the food poverty line

Village	Poor (%)	Non-Poor (%)	Total (%)
Masukulu	23.5	10.1	33.6
Masebe	21.0	13.4	34.5
Mpandapanda	11.8	20.2	31.9
Total	**56.3**	**43.7**	**100.0**

Household Coping Options in the Study villages

Table 3 and 4 summarize information on the distribution of households' coping mechanisms by village and wealth status, which was statistically significant at 1%. A close examination of the results reveal that a large proportion of households, over 37% in Masebe village and 24% in Mpandapanda village, opted for petty trade. Meanwhile, only a small proportion (10.5%) of the

respondents in Masukulu village, that is located far from the highway to Malawi made the same choice. A small proportion (21.3%) of the poor households also opted for petty trade in tackling the impact of HIV/AIDS. The plausible explanation for this is that Masebe and Mpandapanda are along the Tanzania-Malawi highway where there are more remunerative income-generating activities, which may provide capital for establishing small businesses. This option is not a priority for poor households as well as for those in Masukulu village, which is located far away from the Tanzania-Malawi highway, with less remunerative income generating activities.

Table 3: Distribution of HIV/AIDS Coping Options by Village

Coping Options	**Masebe (%)**	**Mpandapanda (%)**	**Masukulu (%)**
Petty Trade	37.5	24.4	10.5
Child Labor	7.5	12.2	39.5
Sale of Labor	20.0	34.1	34.2
Sale Local Brew	35.0	29.3	15.8
Total	**100.0**	**100.0**	**100.0**

$\chi^2 = 15.785***$, note *** indicates significant at 1%

Furthermore, the results show that a larger proportion of households opted for child labour (39.5%) and wage labour (34.2%) in Masukulu village. The corresponding Figures for the choice of child labour at Masebe and Mpandapanda are only 7.5% and 12.2% respectively. It is surprising that the there is a higher proportion (25.5%) of respondents among the non-poor who opt for child labour, compared to only 18.3% among poor households. This could be due to the fact that the elderly have assumed the role of taking care of their grandchildren and thus requiring them (the children) to engage in income generating activities to supplement household income. While a smaller proportion (21.6%) of non-poor households sell their labour, a higher proportion (30.5%) of the poor do the same. Other coping options used by households in the surveyed village include: seeking wage labor (sale of labour) and sale of local brew in response of the impact of HIV/AIDS.

Table 4: Distribution of HIV/AIDS Coping Options by Poverty Category

Coping Options	Non-Poor (%)	Poor (%)
Petty Trade	26.4	22.2
Child Labor	25.5	18.2
Sale of Labor	21.6	30.5
Sale Local Brew	26.5	29.1
Total	**100.00**	**100.00**

Determinants of household choice of Coping Options

This section describes specific factors that influence the choice of coping options by households. A multinomial logit model is estimated in order to establish household preferences and examine the effects of several explanatory variables on the likelihood of choosing particular coping mechanisms. To estimate the model, four major alternative coping mechanisms were considered as a dependent variable, namely petty trade, child labor, sales of labor and brewing. The estimation procedure takes $y_{ij} = 1$ if the household chose alternative j, otherwise 0. Independent group variables are defined in Table 3.

A number of explanatory variables were included in the model and each variable was individually tested and in combination with others, in various forms of specification (generic where possible, as well as alternative-specific variables with the coefficients respectively constrained to equal to or allowed to vary across two, three or all four major alternatives). After a step-wise regression analysis, a final model was identified; variables that were excluded at earlier stages were tested repeatedly for inclusion, to minimize the possibility of omitting significant variables. Table 5 summarizes results of a multinomial logit analysis of dynamic choices of coping mechanisms in the study villages.

Table 5: Estimation Results of the multinomial logit model for factors explaining the choice of Coping Options for the Sample Households (Petty Trade is a reference choice category)

Variables	Child Labor		Sales of Labor		Brewing	
	Coefficients	Z-value	Coefficients	Z-value	Coefficients	Z-value
Location	-38.640	-0.00	-1.245	-1.24*	-1.071	-1.09
Number of years of schooling	-0.282	-1.23*	-0.052	-0.34	-0.104	-0.76
SEX	3.139	1.30*	-0.981	-0.83	-2.739	-2.21**
Marital Status	-1.298	-0.68	0.224	0.32	1.248	2.10**
AGE2	0.007	2.08**	0.004	2.02**	0.002	1.13
AGE	-0.637	-1.91**	-0.332	-1.88**	-0.190	-1.12
Household size	0.606	1.03	0.488	1.49*	-0.184	-0.48
Dependency ratio	-1.400	-1.39*	0.642	1.45*	0.376	0.78
AIDS Death	0.288	0.32	-0.758	-1.11	-0.603	-1.08
Remittance	-2.038	-1.04	-0.661	-0.63	-0.318	-0.33
Crop area	-0.331	-0.44	0.167	0.55	-0.457	-1.29*
Household Affected/Afflicted with HIV/AIDS	-5.231	-0.44	-18.831	-2.67***	-19.675	-2.89***
Expenditure on Medical Care	-0.464	-0.68	0.342	0.68	0.268	0.53
Constant	24.104	-	20.764	3.08	24.215	-

Note ***, ** & * indicate significant at 1%, 5% & 10% respectively, Log likelihood = -66.491, Number of observation = 119, Chi-square value = 69.40, Chi-square probability = 0.0019, Pseudo R^2 = 0.3429

Table 5 shows that the coefficient on age of household head is negative and statistically significant at 5% level of significance for the option on child labour and sale of labour; but this option is not significant for the option on brewing. These findings suggests that the age of the household head decreases the odds to opt for child labor and selling their labor (seeking wage labour). Meanwhile, age squared, which captures the aging of the household head, is positive and significant at less than 5% level of significance.

This means aging increases the odds of adopting the options involving child labour and selling their own (household head) labor. The sex of the head of household is negative and statistically significant at 1% level of significance, implies that being a male-headed households decrease the odds of engaging in local brewing, but rather being a female-headed households increases the odds of adopt local brewing because local brewing is mainly considered as women-income generating activity. Furthermore, it can be noted that the coefficient on sex is negative but not statistically significant for the option on local brewing and sale of labour. This may suggest that sex did not significantly explain changes in the odds of these options. Despite being insignificant it can be deduced that women are less likely to engage in the sale of labor in coping with HIV/AIDS impacts partly because they are more devoted to taking care of children and sick people as well as in preparing food for the household members and performing other household chores.

The choice of coping mechanisms based on accumulation of local knowledge and experience appear to significantly increase the odds of the choice of child labor and sales of labour. The results suggest that being older and with children increases the odds of choosing child labour and selling of their labour in response to the impact of HIV/AIDS. The results also reveal that households adversely affected and afflicted by HIV/AIDS decreases the odds of seeking wage labour and local brewing as indicated by their negative and statistically significant coefficients on the variable. This could partly be explained by the fact that households adversely affected by HIV/AIDS impact devote much of their time in caring for the infected members, in due course also spending most of the family resources on associated medical expenses. Consequently they have little or no resources left to invest in for local brewing or any other micro-enterprises.

The respondents' marital status is another important factor explaining the choice of brewing. Results in Table 6 show that being married increases the odds of engaging on local brewing as opposed to singles. A reasonable explanation for this could be from the fact that married couples may have enough resources jointly as opposed to single respondents, who in most cases are women. Women after the death of their husbands are often left with limited access to resources (Mutangadura *et al*., 1999; Rugalema, 1999; Over *et al*., 1966). Another explanation could be, if the husbands had died of AIDS, the likelihood of the wife being infected is high. Moreover, it is highly likely that their physical strength may have become weak, which reduces their ability to effectively engage in rigorous income-generating activities. Thus they often commit their limited remaining resources to local brewing, which provides relatively higher returns within a short time.

The results also demonstrate that resource endowments determine the choice of coping mechanisms among respondents. In this paper, the area under crop cultivation is considered as a proxy for resources endowments because in most rural areas of Tanzania land is the most important resource for providing livelihoods through farming and related activities. Households with a relatively larger area under crop cultivation are less likely to engage in child labor and brewing, but rather they are more likely to sell their labor in coping with HIV/AIDS impacts. The coefficients for this variable is statistically significant 5% level of significance for all three options.

The location of the respondent also plays an important role in the choice of coping mechanism to adopt. Households close to the Tanzania-Malawi highway are more likely to sell their labor as coping mechanism against HIV/AIDS impacts. Being close to the highway, one can find several alternative cash-earning activities to which they can easily supply their labor as opposed to being away from the high-way with limited options of cash-earning activities.

The results also show that larger households and those with many dependents increase the odds of responding to impact of HIV/AIDS by selling their labor. The plausible explanation for this is that households with

larger families and many dependants have more people to feed, therefore requiring more food. In this case the elderly are forced to look for any means to smoothen their consumption. This explains the fact that, households choose certain options not as a matter of preference, but rather as the only option available option for them. It can also been learnt from the results though insignificant that as the households spends more on medical services to care for HIV affected member, this increases the odds of opting for selling labor and brewing, while decreasing the likelihood of opting for child labor.

Determinants of Household Vulnerability into Poverty Trap

Generally, rural households use a range of options in order to cope with HIV/AIDS impacts. However, some of these coping options can have both positive and negative effects on the households' livelihood security. The option can be positive if it makes the household more food secure and reduces the adverse HIV/AIDS impacts, but, is can be negative if the option results into livelihood insecurity. For example, it was noted during interviews and focus group discussions that households are able to survive by gradually selling their assets in response to HIV/AIDS impacts. However, when the assets are exhausted, people with no other alternative migrate to other areas, which does not make life any better. Adapting to new places where they are unaccustomed is difficult. Eventually such people are driven deeper into the poverty trap. It was also learnt that by engaging in wage labor, poor farmers delay and/or limit working in their own fields. This leads to low crop yields and drives households further below the poverty line.

A probit model was estimated to establish factors that enable households to get out of poverty as well as factors that drive them into poverty trap. Food consumption expenditure is used as a proxy for household welfare, indicating the household command over resources. Consumption outcomes at the household level implicitly relate to the household's nutrition, health, asset endowment, education and other institutional arrangements.

There is quite a general agreement that poverty is a rural phenomenon in Tanzania, but its exact measurements and trends over time are difficult to establish due to the incomparability of surveys. In order to avoid this, this study adopted the food poverty line for Tanzania used in the 2000/01

Household Budget Survey (NBS, 2002). A household was classified as poor if its monthly food expenditure per adult equivalent was below Tsh. 5,295. Anything above was considered non-poor. The probit regression results in Table 6 reveal that HIV/AIDS made a significant contribution to poverty outcomes in households and in the communities surveyed.

Table 6: Probit Model Estimation Results Explaining Household Falling out of and into Poverty Trap

Variables	Child Labour		Sale of Labour		Brewing	
	Odds	Z-value	Odds	Z-value	Odds	Z-value
Location (LOCT)	-0.169	-2.63***	-0.164	-2.67***	-0.164	-2.63***
Number of Years of Schooling (NYSC)	-0.010	-1.51*	-0.011	-1.48*	-0.011	-1.39
SEX	-0.022	-0.65	-0.025	-0.72	-0.032	-0.84
AGE^2	-0.004	-0.39	0.000	1.82*	-	-
AGE	0.000	0.76	-[1]	-	0.004	1.75*
Household size (HHS)	0.065	2.84***	0.068	2.84***	0.074	2.84***
Dependency ratio (DEPR)	0.078	2.58**	0.081	2.59***	0.087	2.56***
Number of Deaths (NDTH)	0.132	2.51**	0.137	2.52***	0.147	2.56***
Remittance (REMT)	0.022	0.48	0.031	0.65	0.039	0.74
Crop area (CRAR)	-0.038	-1.99**	-0.040	-2.05**	-0.045	-2.09**
Medical expenses (EXHV)	0.073	2.11**	0.074	2.08**	0.077	2.05**
Obs. P	0.703		0.703		0.703	
Pred. P	0.971		0.970		0.966	
Obs.	119		119		119	
□[2]	48.70***		48.53***		48.53***	
Pseudo R^2	0.5407		0.5389		0.5389	
Log Likelihood.	-20.685		-20.766		-20.766	

Note ***, ** & * indicate significant at 1%, 5% and 10% respectively.

[1] Some of the variables (age and age^2 had to be dropped from the model on sale of labour and brewing due to multicollineality)

The results suggest that the death of household members from HIV/AIDS increased the probability of a household falling below the poverty line. This is indicated by the positive and statistically significant coefficient on the number of AIDS deaths in a household. A plausible explanation to this result is that as soon as one or more members become infected with HIV/AIDS-related conditions, income falls as the family members' ability to work

diminishes, and household living expenses increases due to higher costs for medical services as well as funeral and mourning expenses when the patient dies. The results also show that high medical expenses contributed to the households' odds of falling below the poverty line. This is indicated by the positive and significant coefficient on medical expenses (see Table 6).

A close look at the results presented in Table 6 shows that the area under crop cultivation reduced the probability of a household falling into a poverty trap as indicated by the negative sign on the coefficient. Crop production increases food as well as cash income, hence providing better options for households to cope with HIV/AIDS impacts. It is therefore expected that households with larger crop area under cultivation are more likely to absorb shocks due to HIV/AIDS impacts as opposed to those with small or without crop area. This means, a household's resource endowment can contribute to their ability to withstand vulnerability in the face of food shortages and abrupt changes in production, prices, income or other unforeseen events that create the need for additional food expenditures.

The results suggest also that the household's minimum average years of schooling as well as accumulated knowledge and experience explain the odds of the household resilience towards falling into the poverty trap, as substantiated by the negative sign of the coefficient. This signifies that human capital (education, accumulation of local knowledge and experience) is a very important household asset for steering them out of the poverty trap.

Household size and the number of dependants are significantly associated with poverty levels. The larger the household size and as more dependants are in the household the higher the probability of falling into the poverty trap. Simply stated, larger households are more prone to poverty than smaller ones, mainly because HIV/AIDS diminishes the households' ability to produce food, killing as it does mostly the productive young adults. Even when labor for participating in income-generating activities is available, much of it is devoted to caring for HIV/AIDS patients and less to production. This is indicated by the positive and statistically significant coefficient on the household size and dependency ratio. A larger household with more dependants translates into more people to feed such that an increasing

number of dependants and larger household size puts much more pressure on consumption than it contributes to production.

The coefficient on the location (a dummy variable) is negative contrary to prior expectation that villages that are far from the Tanzania-Malawi highway, would more likely become poor because they benefited less from income-generating activities brought about by the highway traffic. The negative effect could be explained by the fact that proximity to the highway increases the household risk of infection from HIV/AIDS, which is in turn related to the odds of falling below the poverty line.

Moreover, the results indicate that female-headed households are more likely to fall below the poverty line than male-headed ones. One plausible explanation is that men may have more access to productive resources such as land, credit, training, extension services and technology than women. After the death of her husband, a woman is left without access to the resources she had gained with her husband due to sale of assets to care for the husband during his sickness or due to expropriation by the husband's family members during the funeral. Consequently, the livelihoods or widows are threatened, and widows are more likely to fall below the poverty line. In addition, women are more likely to be illiterate, and of low socioeconomic status. Moreover, they have fewer legal rights, which limits their access to resources and social services. The results also show that households that did not receive any support in terms of remittances were more likely to fall into abject poverty. Remittances plays an important role in mitigating risk and providing consumption smoothening within the household. Thus, lack of support to HIV/AIDS affected/afflicted households increases their vulnerability to poverty.

In order to determine the overall likelihood of households and communities becoming poor because of HIV/AIDS, the results provide an analysis of a hypothetical household having the characteristics of the mean of the sample as indicated by the household predicted probability (Obs. P) and sample predicted probability (Pred. P). A glance at the results in Table 6 reveals that the predicted incidence of the household poverty level was about 70.3% on average in all three models, suggesting that HIV/AIDS had a significant

contribution towards households falling into the poverty trap. The results also indicate that undeniably, the overall impacts of HIV/AIDS played a considerable role at increasing the probability of the communities surveyed falling into the poverty trap as indicated by the sample predicted probability of approximately 97% confirming that indeed, HIV/AIDS had contributed to the impoverishment of the rural communities studied.

Conclusions

It is apparent from the study findings that individual and household characteristics and resource endowments explain the choice options for coping with HIV/AIDS impacts. Households that have accumulated local knowledge and had more experience are less likely to engage in child labour and sale of labor. Married couples are more likely to engage in brewing compared to single (unmarried) respondents. The findings also reveal that HIV/AIDS made a significant contribution to the probability of households falling below the poverty line, especially for households that experienced HIV/AIDS-related illnesses and AIDS related deaths. Moreover, the findings demonstrate that the higher the number of AIDS deaths, the more likely the household becomes more vulnerable to fall into the poverty trap.

The study also indicates that larger households and with higher number of dependents, female-headed households, and households located near the highway are more likely to be poor. Overall, the communities surveyed had high risks of poverty incidences because of being affected by HIV/AIDS. Female-headed households were more likely to be poor than male-headed households. However, the intensity of vulnerability into poverty was slightly different across the communities studied – communities close to the Tanzania-Malawi highway being more vurnerable. The differences in the odds of being poor are due to differences in socioeconomic and demographic characteristics. It is also evident that household assets and resource endowments, specifically the area under cultivation, average years of schooling, local knowledge and experience are the major determinants for pulling households out of the poverty trap in HIV/AIDS hit areas.

In order to design and implement effective and appropriate policies and programs for poverty reduction, efforts should therefore focus at addressing

different conditions and factors that contribute to the probability of falling below or above the poverty line. Some of these including; providing education, creating strategies aimed at raising household income and supporting households affected and afflicted by HIV/AIDS in terms of subsidizing medical expenses.

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From the Field

Identification and Promotion of Farmer Innovations in Agriculture Development and Natural Resource Management: Experience of INADES Formation Tanzania

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Introduction

Promoting farmer innovation is an initiative that evolved from the Rio Summit in Brazil in 1992 under the convention to Combat Desertification. The then president of Tanzania, His Excellence Ally Hassan Mwinyi, led the Tanzanian delegation to the summit in Rio de Janeiro, Brazil. Consequently, Tanzania ratified this convention. The United Nations (UN) initiated a programme known as Promoting Farmer Innovation (PFI) under the United Nations Development Programme (UNDP). In East Africa, the programme was piloted and implemented in Kenya, Tanzania and Uganda. In Tanzania, INADES[5] Formation Tanzania (IFTz) won to become the lead implementing agent from its proposal presented to the international technical team from virje University in The Netherlands. Since then, concepts of farmer innovations were developed, and farmer innovators with their respective innovations have been identified and promoted. The capacity of farmers for innovation has been recognized and today many programmes and projects are being developed to support these initiatives.

These farmer innovators have developed innovations that helped them to improve agricultural productivity, and conserve the natural resources in their environment. Such innovations are very effective, recognized and disseminated to many land users in and outside the country. Farmer innovators have received visitors from all over the world. At the same time, some farmer innovators have visited a number of countries in Africa, Europe and South America for sharing their experiences. The farmer innovations

[5] INADES is the French acronym for the African Institute for Economic and Social Development.

have contributed greatly to improving the socio-economic status of innovators. The improvement in socio-economic status is reflected through; increased income levels, acquisition of asserts such as vehicles, improved houses, and new roles as resource persons in agriculture and natural resources in and outside the country.

The present project titled "Combining Local Innovative Capacity with Scientific Research" is in its first year of implementation with IFTz being again the lead implementing agent. The new thrust now is to bring aboard scientific research to validate farmer innovations. This paper describes how identification and promotion of farmer innovations in agriculture development and natural resource management was conducted.

The Concept of Farmer Innovations

During the Rio Summit, it was realized that climate is changing and land is becoming drier, leading to desertification. National leaders then had to join hands to stop expansion of the desert and reclaim affected lands hence the formulation of the UN Convention to Combat Desertification (CCD). It was realized that many projects had been initiated and implemented but outcomes had not been encouraging. The desert was still expanding, rainfall becoming poorer and natural resources being endangered and depleted.

Surprisingly, despite all these project failures, still farmers were surviving. It was then brought to the attention of many people that the farmers must be doing something different to adapt to these changes, hence their survival. For that matter, UNDP initiated a PFI programme with the aim of going out to farmers in their locality to identify what they were doing that helped them to survive. The working hypothesis was what farmers were doing various things for their livelihood, but they conducting them in ways that were different from what development agents and agencies had trained them. What farmers were doing could have arisen out of their own initiatives and hence the idea of farmer innovation came up. The first step in this process was to develop a common understanding of some of the basic concepts and terms in relation to farmers' innovation. Some of the important terms related to farmer innovations include:

- **Indigenous knowledge** is the knowledge that grows within a social group, based on learning from experiences over generations but also including what was gained at some times from other sources.
- **Local Innovation** refers to the process by which people within a given locality discover or develop a new way of doing things using locally available resources and on their own initiatives.
- **Farmer innovator:** refers to land users who keep trying and doing things that help them improve agricultural production and natural resource management using ideas of their own or from other sources under their own initiatives without help from development agents.
- **Participatory Technology Development (PTD)** is a process of exploration and experimentations undertaken jointly by farmers, researchers and development agents and in many cases ideas or agenda come from research.
- **Participatory Innovation Development (PID)** is a process of exploration and experimentations undertaken jointly by farmers, researchers and development agents using local innovation as entry point to improve agriculture and NRM in an effective and sustainable manner.

Some of these concepts have been promoted in various countries including Tanzania by PROLINNOVA International Programme based in the Netherlands. PROLINNOVA stands for promotion of local innovation. The programme is constituted by partners in developing countries including Africa and Asia. IFTz was among the members who participated in the activities of PROLINNOVA Tanzania, which was hosted by PELUM Tanzania since 2005. In the early stages, INADES and the Institute of Continuing Education (ICE) provided a coordination role of PROLINNOVA Tanzania and provided capacity building on the PID related concepts.

How farmer innovations were identified

Development of farmer innovator and farmer innovations data sheets

These are two sets of questions where the first one was about the farmer's biography and another set asked about the innovation. Each set had about 15 questions. These questions helped to collect exhaustive information about the farmer him/herself and their respective innovations. The questions helped to understand the local practice and verify whether it is an innovation or not.

Identify a coordination team to lead the identification process

The team comprised of experts in soil and water conservation and specifically rain water harvesting (Agricultural Engineer), Soil Chemistry scientist, land use planning expert and Regional Soil Water Conservation advisor to Regional Commissioner for Dodoma. The team worked closely with farmer innovators with the aim of combining theory, practical, facilitation skills experiences. The coordination team was lead by Patrick Mbanguka Lameck (Agricultural Engineer), a Senior Trainer, IFTz, and PFI Tanzania national coordinator. Other members were George Budotera (Soil Scientist) form ARI Makutupora, Mohamed Mayega (Soil physics) form RAS Office Dodoma and George Lotti (Land Use Office) from DLUMP National Pilot Project in Dodoma Rural District.

Sharing the concepts and principles of farmer innovator/innovations and data sheets

A stakeholders' meeting was conducted for the purpose of sharing the principles and concepts of farmer innovations as well as sharing the developed data sheets for 2 days at VETA Dodoma in 1997. Participants came from Government Organizations (GOs) and NGOs programmes and projects in the field of agriculture and natural resource management from the then five districts of Dodoma region (Dodoma Rural, Dodoma Urban, Kongwa, Kondoa and Mpwapwa). During the meeting, the philosophy of farmer innovation was still new and many participants expressed reservation, questioning if there really existed farmer innovators in the rural settings. It was nonetheless interesting to find that there was a common understanding of concepts and principles of farmer innovator among the participants. Questionnaires for data collections were refined in that meeting for improvement and to accommodate such common ground. One of the major outputs of the meeting was that stakeholder provided a list of farmers whom they thought could be innovators, which turned out to be a corner stone of the process for identifying farmers' innovations.

Administering the questionnaire to proposed farmer innovator

The coordination team visited each farmer innovator at their innovation site to collect their personal information and that of their respective innovations.

The exercise was tough and tiring. Each farmer was asked and each member of the coordination team filled his/her own data sheets that were to be consolidated at the end. It was challenging to agree on some practices if they qualified to be innovations. Some farmers could not welcome the team at first because their innovations were not accepted in the community.

Analysis and approval of identified farmer innovator

After field data collection, all data sheets were consolidated and analyzed based on the following criteria:

- Is the innovation different from other local practices?
- Is the idea coming from farmer himself?
- Is the innovation contributing to improve farm productivity?
- Did the farmer have any support from development agent?
- Did the practice use locally available resources?
- Has the innovation been documented anywhere?
- Is the innovation replicable?

After this process farmers who qualified were identified as farmer innovator. Out of 100 proposed farmer innovators, 28 qualified, of whom only 8 were women despite the requirement that at least 50% of the selected farmers should be women. The low participation of women as innovators was mainly due to gender issues prevailed in the farming world; such as women lacking decision making power, not owning household resources and they were not given room by their husbands to explain the practices they had developed. In some cased however, some farmers persuaded the selection team so that would be included as innovators even though they did not have farms. For example, one farmer who owned a butcher could not show his plot to assess his innovation. He kept the innovation team walking for a long time without reaching his site. The team then discovered that he had neither plot nor innovation to show; hence he could not be included as farmer innovator.

Letter of approval sent to selected farmer innovator

Twenty eight (28) farmers who qualified were given a letter that they had been selected and became farmer innovators. Most of them could not believe it. Some of them had been considered crazy in their respective communities – equating them with low ranking people in their society; such as marijuana

smokers and criminals, based on the innovations they had been conducting. For example one of the innovators could not come before the team as she was afraid she could be punished because of her innovation. The innovation involved digging big composting pits of 2 meters diameter and 2 meters deep which was a strange practice for an old woman. Another innovator one was taken to the High Coult in Dare s salaam by her uncle (Father's younger brother) claiming to own land (9.5 acres) which had been healed by using the innovation developed and implemented by the innovative farmer. This piece of land was formerly a wide sand river owned by nobody. After learning about the PFI initiatives, the land, District Commissioner for Kondoa district advised the old man to pull out the case which he did. The list of innovations which had been developed and practiced by these innovators are presented in Table 1. In general all these techniques are an adaptation to climate change, restoring degraded and destructed land back productive use.

Table 1: Type of Innovations Implemented by Selected Farmer Innovators

SN	Village or District?	Type of Innovation	No of Farmers Practicing	Effect of innovation on Climate Change (CC) Adaptation
1	**Martha Mwasu** ***(Box 192 Loo Village Kondoa)*** **Wide sand river Gully healing to get land for crop production.**	The innovation involves digging trenches parallel to sand river bank (about one metre from the bank) and plant elephant grass and later sugarcane. When flood water came, silt and sand was trapped in the farrows between ridges. The piece of land eventually becomes a farm. The innovator farmer started implementing the innovation in 1989 by adding new farrows to trap silt and sand. Now she has healed 9.5 acres and built a good house on the healed land She went to Brazil and Germany to present her innovation.	About 50 in Kondoa District and another 60 from other districts in Dodoma.	The sand rivers which were abandoned are now being reclaimed into use for agricultural production. The elephant grass and sugarcane traps passing silts and sediments, with the incorporation of organic matter. In this way, an unproductive sand bed is transformed from a sandy soil into a good loamy soil suitable for agricultural production.
2.	**Suzana Silvesta** ***(Box 105 Haubi Village Kondoa*****). Local compost making given the name "Mapambano"**	The innovation involves digging a pit of 2 m diameter and 2 m deep and filling in all organic matter one can find. The organic matter mainly included, Kitchen ash, crop remains and grass and weeds, farmyard manure, waste water, food remains, livestock urine etc. In this compost pit you can even add waste water with soap. There is also no need of turning the pit contents. The compost improves soil texture, structure, moisture and	200 in Kondoa and an estimated 200 in Dodoma and about 200 in Kenya, 100 in Uganda and 100 in Ethiopia.	A good agricultural soils need to contain at least Sandy, Humus (organic matter) and clay soils in a 1:2:3. Ratio. In poor sandy soils, the compost increases the amount

SN	Village or District?	Type of Innovation	No of Farmers Practicing	Effect of innovation on Climate Change (CC) Adaptation
		fertility of the soil. She harvests up to 20 bags (100kg) per acre. She was a member of Central Zone Agriculture Research Executive Committee		of organic matter and clay by microbial activity. Climate Change increased sandy soils hence the innovation increased humus and clay.
3	**Rajabu Ally Bella** ***(Box 32 Choka Village Kondoa).*** **Planting of trees with 100% establishment rate and grows faster.**	The innovation involves digging pits (2 feet deep, 2 feet wide) at the midst of dry season, for planting. The farmer then puts a layer of grass - about 5 inches at the bottom of the pit, followed by 5 inches of top soil, then another 5 inches deep of grass and finish with 5 inches deep of top soil. The remaining 4 inches are left for harvesting flowing water. The first day the farmer applies 20 litres of water after planting a tree seedling, then, they apply only one litre of water every other day. When the rainy season begins water is no longer applied to the pit. Using this technology, the farmer has planted over 60,000 trees, some of which have matured and is selling them. He also heals deep gullies to get land for crop production and tree propagation. He has been awarded several certificates at various levels for the innovation.	100 in kondoa and about 300 in Tanzania.	The innovation increases vegetation trees and underneath grass and improves water cycle and hence the microclimate.
4	**Ramadhani Yousuph (*Box 1 Tura Village Kondoa*)**	The innovation involves identifying the target area, demarcating it with bushy fence and prohibiting entrance of human and livestock into the area. The tree trumps in the protected regenerate and grow into a forest.	About 100 in Dodoma.	Natural forest rehabilitation by just fencing a piece of land and protecting tree trumps which had

SN	Village or District?	Type of Innovation	No of Farmers Practicing	Effect of innovation on Climate Change (CC) Adaptation
		He had to pretend to be naughty such that people developed fears to encroach the protected forest. He has about 20 acres of natural forest In the land he has restored springs, which had disappeared are emerging and wild animals returning		been cut down, and leave them to grow into mature tree. The innovation increases vegetation trees and underneath grass and improves water cycle and hence microclimate.
5	**Ichirima Odi Ally** ***(Box 171 Kollo Village Kondoa).*** **Developing fish pond for fish production adjacent to sand river.**	The innovation involves digging a pond half of it to the land and the other half into the river. The soil dug from the land marks the boundary bund of the pod on the river side. The farmer smeared clay soil and farmyard manure to discourage de-percolation and provides feed to fish. He then dug an inlet canal from the sad driver long distance (25 m) upstream such that water will flow under gravity from the river to the pond. Note that the pond bed will be upper than the river bed. He now has two pods. He used to fish at a distant water pond (40 km) but now he gets fish just behind his house.	5 in Kondoa and 100 in the whole of Tanzania.	The innovation stops flowing water in the sand river and make it available for fish pond and local vegetation regeneration around the pond. Pond water is also used to irrigate the small garden nearby of 20 by 20 meters in area
6	**Subira Mwinyijuma** ***(Box 260 Kelema Balai Village Kondoa).***	The innovation involves digging a pit or trenches in a wide sand river during the dry season. Digging is done until you reach the underneath soil which is moist during most of the dry season and plant a seed into it. As the plant grows, sand is returned until when it has emerged above the surface level. The crop grows to	600 in Kondoa and over 500 in other districts in Dodoma	The innovation helps to reach the underground moisture which could not be available on the sand river in dry season.

SN	Village or District?	Type of Innovation	No of Farmers Practicing	Effect of innovation on Climate Change (CC) Adaptation
		maturity without any rainfall nor irrigation		This moisture was not used before and the sand river was abandoned.
7	**Raphael Chinolo (Box 57 Chamkoroma Village Kongwa). Deep Gully Healing for vegetables and crop production.**	The innovation involves developing a trash line across the gully bed after every 20 to 25 metres along the gully. It is developed by driving three feet peg into the soil spaced 2 feet in two rows across the gully bed. As water flows down the gully water passes gently through the trash line while silts and trashes are blocked and the gully bed rises gradually. He has healed a 2 meters deep and 5 metres wide gully. He is training farmers in Kenya and Uganda and has a passport.	300 in Dodoma and 200 in Tanzania. 100 in Kenya, 100 in Ethiopia.	The innovation heals gullies, retain moisture and increase organic matter into the soil. The innovation reclaims gullies, restoring them into agricultural production.

First farmer innovators and stakeholders workshop

The first workshop involving Farmer Innovators and other stakeholders was held at CCT Dodoma in 1997, chaired by the Regional Commissioner for Dodoma. The other stakeholders included; Development workers, and researchers from NARIs and Universities, politicians and decision makers. The main aim of the workshop was for farmer innovators to present their innovations before all these stakeholders. It was very surprising that all presentations made by farmer innovators were accepted and appreciated. One scientist commented that these farmers were like professors, they really knew what they were doing and it was their own initiatives. This was a turning point where other stakeholders started respecting farmers for their contributions towards research and development.

After the workshop all participants knew who farmer innovators are and their role in agricultural transformation. After the workshop participants were required to identify other farmer innovators when they go back to their respective working areas so that new innovators are continuously identified. It was realized that all stakeholders once equipped with the principles and concepts of farmer innovation are able to identify more farmer innovators. To about 50 farmer innovators have been identified by the snow-ball effect.

Farmer Innovators at work: Dissemination and sharing.

Among the ways farmer share their innovations includes:

- When innovations are recognized by development worker and visiting farmer innovators, neighbors get an opportunity to be aware of the innovations.
- Exchange visits organized by various institutions help to disseminate the innovations.
- In each village with farmer innovator, farmer innovator groups are usually formed for collective efforts, sharing, adaptation and dissemination.
- Field visits are organized by various institutions.
- Innovators use formal and informal gathering to share their innovations.
- Simple leaflets have been prepared by IFTz working in collaboration with farmers; they are distributed during various events.
- Farmer innovators are invited in the National farmers' day (NANE NANE) to share their innovations.

- Farmer innovators are conducting joint experimentation with researchers to validate some of the innovations. About 10 innovations have been jointly experimented. Research organizations include; Sokoine University of Agriculture (SUA), and Agricultural research Institute (ARI) Mpwapwa, Hombolo and makutupora.

Acceptance of the innovation

Innovations that are simple and do not require a heavy workload are accepted faster that those which are complex and involve heavy duty as well as those with long payback period. For example the tree planting innovation has been picked by very few farmers since it takes a long time before farmers can realize any benefits. Composting innovations are also picked slowly. However, due to continuing depletion of soil fertility the technology is now picking up faster than before. Pit cultivation is accepted faster compared to other innovations.

Once an innovation is understood, it is picked and accepted. It usually takes about 2 to 3 years of trying to understand the technology before it is adopted by other farmers. For tree planting, however, it is now 15 years since the innovation was developed but, the level of its acceptance is still low.

Limitation of acceptance

- Lack of inquisitiveness among farmers. They have been seeing the innovation before but they did not take the trouble to know what is it and how it works.
- Lack of support (even moral) from development agents, researchers and leaders.
- Heavy workload involved; some innovation require heavy earth work
- Some farmers are satisfied by low yield they are getting
- Dependence syndrome among farmers that innovations should come from experts only
- Attitude of academicians that the innovations are primitive.
- Lack of donor funding to support local innovations.
- Limited journals that accept manuscripts documenting local innovations.
- Long time to get produce such as a tree matures after 8 to 10 years.
- Continuing climate change experienced locally as drought and desertification..

- Lack of strong policy support
- Threat that extension agents and other development workers will have no job to do.
- Top down approaches to support farmers

Overcoming the above limitations.

- Support of all stakeholders to innovations
- Capacity building to farmers and other stakeholders
- Development of simple machines to reduce drudgery
- Facilitate farmers to start from what they have (Knowledge, experiences and skills
- Documentation of best innovation and dissemination
- Promotional strategies such as radio and TV programmes, competitions etc
- Use of bottom up participatory approaches
- Build technologies from farmer innovations
- Donor support to promotional activities.
- Journal provide for documentation of local innovations

Achievements

Since the inception of PFI programme to date, the following achievements have been obtained:

- Over 50 farmer innovators have been identified in Dodoma.
- Principles and concepts of farmer innovations have been institutionalized at INADES formation Tanzania and by other partners such as PELUM Tanzania. ICE SUA has provided one member Mr. Innocent Babili who participated in the training of trainers on participatory innovation development (PID) conducted in Manila, The Philippines and has subsequently participated (as facilitator) in farmer innovation intervention with PELUM-Tanzania and INADES Formation Tanzania. The Institute of Continuing Education (ICE) at SUA was once an associate member of PELUM).
- Farmer innovations have helped other farmers to improve their agricultural production, environment management and adaptation to climate change.

- Farmer innovators (after their contribution had been appreciated by various actors) are more confident and proud of what they have innovated.
- Farmer innovations have been documented through the publication – IFTz and farmer innovators themselves as authors) for wider dissemination in various forms at national and international levels.
- Farmer innovators have their socio-economic status raised though their innovations. They own assets such as vehicles, improved houses, pig plots, livestock, improved their microclimate and are assuming leaderships at village and ward level.
- Farmer innovators are visited by people from their village, ward, District, national and international levels.
- Farmer innovators are resource person in various forums, programmes and projects interventions constituting various stakeholders such as CSOs, District Councils, Research Institutions, Universities and international institutions. Some of innovators owns passports which have enabled them to visit various places all over the world.
- INADES formation Tanzania is the centre of excellence when it comes into farmer innovation issues.
- Farmers have improved their status in the community

Scaling-Up

There have been some scaling up on farmer innovation, but the limitations listed above have presented obstacles. There is a need to have a platform for networking and sharing. The national steering committee for farmer innovation programme was founded, but could not meet due to meager resources. Other institutions, due to donor pressure, could not welcome the innovation approach hence institutionalization of the approach remains low. However with continued CLIC-SR project there is training on PTD and PID which have been attended by farmers. These have been organized by CSOs and Government institutions. In addition, joint experimentation between innovative farmers, extension agents and researchers is being done and may foster scaling up. Some institutions have shown interest to work with these farmer innovators, including SUA, Misereor (Germany), ETC Netherlands, National research Institutions such as Mpwapwa, Hombolo, Makutupora, Uyole and Ilonga to mention a few.

Book Review

Holmen, H. (2010). Snakes in Paradise: NGOs and the Aid Industry in Africa

Sterling: Kumarian Press, pp. 295.

In the first part of this book the author presents different views and situations of poverty in relation to services provided by Con-governmental organizations (NGOs) and Cooperative associations in Africa. The author affirms that Africa is experiencing poverty and deprivation with half the continent's population living below the poverty line. Organizations are formed to alleviate this situation for accelerated development. Internationl NGOs provide donations and other forms of assistance to Africa. However, such aid from outside Africa has been declining since the 1980s because of donors' negative outlook of African governments as being too weak, undemocratic, corrupt or disinterested to take the lead in the development processes. Donors perceive and claim that African governments are not developmental, rather they pay lip service to empowerment and local ownership of development. Instead, they focus on shaping African to their own liking. As such, people tend to opt for self–help development initiatives.

The author then presents the views that, with the introduction of Structural Adjustment Programmes (SAP) during the 1980s, the cooperative systems virtually collapsed. However, since the 1990s, all over Africa, the Cooperative structures have officially been liberated from Government patronage; and are mostly independent organizations. Nonetheless, some cooperatives in countries like Uganda still enjoy support from the Government. Although cooperatives have been liberated and restructured all over Africa, and they now have full autonomy, their performance remains weak and shaky. After the liberalization, cooperatives have been virtually incapable of competing with private merchants in maize trade.

The big question been asked throughout Africa is whether the efforts to foster development through NGOs and cooperatives not yielding positive results. The author attempts to provide some plausible answers. First, he argues that most of these cooperatives are small and dispersed and they lack resources, information, and management skills. The author points out that, restructuring and rebuilding the cooperative systems in East and Southern

Africa (ESA) after SAP has been a slow and difficult process due to competition from a growing private sector.

Another problem relates to the emergence of organizations that are prone to corruption and nepotism. As exemplified by the experience in Tanzania, a type of public sector – civil society cooperation scenario has occurred whereby some public employees have created their own NGOs, which, at least in part do the same thing as those public servants would do anyway as their official duties. Most of these organizations are established virtually without funding but with the hope of being able to attract donor support at some later stage. Lack of solid financial granting and appropriate skills, as well as irregularity of contacts with groups involved, all show a common tendency to set up groups and associations in a hasty and ill- prepared ways. It is partly for these reasons that many projects, especially in agriculture have failed especially in Africa. Another notable shortcoming of some donors and NGOs is the tendency of by-passing local governments, to follow their own agenda, and to do things for local councils rather than with them.

Regarding organizations, ESA has seen both high organizational birthrates and extinction. This is so because many, perhaps most, NGOs and CSOs have been created by donors or in response to external demands. As a result, many were set up hastily, often by or in collaboration with foreign organizations.The majority of African local organizations and NGOs have lacked experience as well as management skills, technical competence, and financial resources. They also lack the capacity to analyze their problems as well as the skills to design and run projects. On top of this, the organizations lack visions and innovative capacity, instead, they tend to "ape other formal sector methods" rather than offering clear operational alternatives. Like many donor funded projects, projects organized by indigenous rural organizations are small, fragmented, and tend to be in isolation from each other, and are largely initiated by external agents.

The second part of the book deals with cooperative organizations in West Africa. Here the author reports the West African cooperatives to have experienced subordination and inefficiency as their counter – parts in ESA. Some are either in poor financial state, though there is still a significant

assistance pouring from donors. Some of the cooperatives like those in Ghana and Senegal are partially liberalized or totally privatized. However, there is strong and perhaps growing donor dependence among local organizations in this region than elsewhere in Sub-Saharan Africa. Within the West African region, development organizations in the former French colonies are said to perform better for they are stronger, more progressive and successful than those in Anglophone West Africa. Furthermore, there is much higher prevalence of member - based health - insurance associations in West Africa than in other parts of Sub -Saharan Africa.

The third part of the book is based on a comparative analysis of the two areas that is the ESA and West African NGOs and other organizations. NGOs and farmers associations in ESA often have a more confrontational attitude towards governments than have their counterparts in West Africa. Meanwhile, rural associations in Africa have grown in numbers during the past decade or two. Also, these associations now increasingly voice their members' needs in various forums such as in policy making and orienting service provisions to meet their needs.

The last part of the book is a summary, in which the positive and negative attributes of donor dependence by NGOs and other development organizations in Africa are reported. It is noted that many of these organizations have made great contributions towards emancipation and empowerment of the poor that they were expected serve. The negative aspects include the hand to mouth operation of the NGOs, making them highly risk averse especially when forced to dance to the requirements generally imposed by donors. Second, donor's preference to work with counter-parts that fit their criteria and understand their reference points and ideas, especially with regards to financial matters in the sense that they are discriminatory and selective for even grants and contracts go to organizations they are already well connected to. Third, rich countries (donor countries) deny aid to agriculture in poor countries. Instead, donor countries continue to dump their subsidized agricultural products in poor countries thereby undermining the development of domestic markets. Fourth, trade barriers are maintained against would-be export products from African countries, preventing the evolution of strong export markets in the African continent as

well. Fifth, African governments are also drained of resources in order to honor external debt-repayment obligations. Their abilities to invest in development are reduced - sometimes severely so.

There are many conclusions drawn from the book but three stand out. First, international institutions must remove obstacles and then leave development to Africans and their organizations. Second, African governments must be allowed to protect their emerging markets from overwhelming and often unfair competition. To that effect, donors should refrain from undermining market development in poor countries. Third, debt cancellation should become a necessity and a reality, it should not remain only an intention. However, the fact still remains, that African countries need funding from the developed countries.

In most cases the conclusions and recommendations made by the author seem to be attractive and garden honey to the African population but sour to the donors. Donors would wish to continue funding projects in Africa in support of development in the continent. As some West African countries positive experiences of working with donor funding has proved, it is possible for other African countries to benefit from the contributions of donor funds. What is more needed is to use the past mistakes for the bright future socio – economic development of the receiving agent, which is Africa.

This satire book is a school in itself to different professionals particularly those in the areas of economics, rural development studies, institutional development, agricultural and extension, education, and program planning and evaluation. Additionally, the book will continue to be a reference material for many coming years due to its inclusion of living examples on how to establish, develop and maintain positive relationship between donors and recipients so as to realize the common set goals.

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Information for Contributors
About JCEE

The Journal of Continuing Education and Extension (JCEE) is an official publication of the Institute of Continuing Education (ICE), approved and recognised by the SENATE of Sokoine University of Agriculture (SUA). It provides a professional medium of communication for creative and innovative action oriented discourse based on research, theory and practice.

The Journal's audience (contributors and readers) comprises of researchers, practitioners, scholars and educators in various fields such as; extension, continuing professional education (literacy, distance education, vocational education, adult education), experiential learning for different aspects of development, practical implications of cross-cutting issues such as gender, ICT, HIV/AIDS, environment and globalization. Multidisciplinary contributions that cut acr option is not significant for the option on brewing. These findings suggests that the age of the head of household decreases the odds to opt for child labor and selling their labour (seeking wage labour). Meanwhile, age squared, which captures the aging of the household head, is positive and significant at less than 5% level of significance. oss professional boundaries are highly encouraged.

The Journal now has three sections. Section one contains original journal articles, section two covers experiences from the field, which present case studies of various practical aspects of extension service delivery and continuing education. Such articles should represent best practices and other experiences that are presented for learning, sharing and scaling up. Section three is intended for book reviews.

Notes for Contributors

Articles

- Manuscript submitted to JCEE should not have been submitted to any other journal for publication.
- Manuscript should be submitted in electronic form only.
- Manuscript should be typed for printing on A4 paper, in Times Roman, font 12, using 1.5 spacing, with margins at the sides, top and bottom of at least one inch.
- Articles should not exceed 20 pages
- Manuscript should contain an abstract of 100 – 300 words

- The authors' name(s) and affiliation(s) should appear on a separate first page, also containing the abstract.
- Sub-titles should be bold and begin from the margin
- Figures and Tables should be presented clearly and precisely to permit reproduction
- Authors should use the Harvard Citation style. Cited works should appear on a separate page of "References". For example: Sife, A. S, Kiondo, E. and Lyimo-Macha, J. G. (2010). Influence of mobile phones and broadcast media on rural communicative ecologies in Kilosa and Mvomero District, Tanzania. *JCEE*. 3(2): 1 – 12. Within text such citation would appear as (Sife *et al.*, 2010)
- Submitted manuscript should be written in a standard and consistent manner, free of typographic errors.
- Manuscripts should be in UK English.

Field Experiences

- Manuscripts of the field experiences will not require the academic rigour expected of journal articles in terms of conceptualization and analysis. The articles are however expected to present good case studies of experienced providing lessons for others to learn from. Such experiences could be best practices to be adapted or replicated. There could also be examples of bad experiences to be avoided in relation to technical and institutional aspects of development
- Their content should contain a description of (i) the experience (ii) lessons (positive and negative as appropriate)
- Submitted manuscript should be written in a standard and consistent manner, free of typographic errors

Book review

- Book review are expected to be of interest and relevant to the field of extension and continuing education
- Book reviews should be concise, not exceeding one page of A4 with spacing 1.5.

The manuscript should be submitted electronically to:

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