International Journal of Innovative Research and Advanced Studies (IJIRAS)
Volume 7 Issue 8, August 2020

ISSN: 2394-4404

Accelerating Industrialization Through Agro-Processing: Access And Use Of Knowledge On Mango Processing Technologies By Smallholder Farmers In Tanzania

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Abstract: ***The Government of Tanzania strategy on reducing post-harvest losses to promote economic development, reduce poverty and increase food security is to support farmers to transition from subsistence to commercial. To support mango farmers, processing and preservation technologies are being transferred through training. However, the training provided is not wide-spread and is undertaken by multiple agencies with variations in the training content and approach. This study was conducted to assess the access and use of knowledge on mango processing technologies in Kibaha district in achieving the industrialization agenda of the country. The farmers were randomly selected from 21 trained farmer groups to obtain a sample size of 100 farmers for data collection using a pre-tested interview schedule. Data was analyzed using descriptive analysis and Multinomial Logit Model. The study established three technologies that are appropriate for mango processing; they include pulping for juice, pulping for jams and drying. Seventy-five-percent of the respondents have used these processing technologies at least once for jam and juice manufacture. Twenty-five-percent indicated not having used the technologies that they had been trained on. It was established that processing for home consumption and for sale was significantly influenced by the number of trainings attended, number of technologies trained on, hands-on experience and own fruits production. The study concludes that the farmers have ample knowledge on mango processing particularly from training but the practice is low. It is recommended that: training organizers should equally take advantage of the varied mango processing technologies available to help farmers diversify on the products produced; the government and organisations can take initiatives of setting up a facility for solar drying; the need for smallholder farmers to develop business skills, acquire better access to both processing and market information to be able to reap the benefits of engaging in fruit processing activities.***

Keywords: Processing, technologies, training, mango, industrialization

I. INTRODUCTION

Various mango processing technologies for fruits exist although these are often confined to commercial industry and are not conventionally practiced at the cottage level by most smallholder producers. Some of the technologies like pulping for jam and juice manufacture, drying, fermentation into wine and pickling which are simple and can be transferred to smallholder farmer through tailor-made training. Training of the farmers on these simple processing technologies can address seasonality issues and reduce post-harvest losses. It will also help to diversify the use and markets of the fruits (Gitonga *et al*., 2014).

There is very high potential of agro-processing in Tanzania (MMA, 2008). This is indicated by the fact that most farmers in the country grow Apple, Tommy Atkins which are appropriate variety for processing (AMAGRO, 2016). There is also ready market for the processed product. However the challenge remains in the fact that most of the producers are lacking when it comes to processing information and training. Previous studies in Tanzania indicated that only two farmers knew how to process mango juice and had tried it before (MMA, 2008). Another study by Musyimi *et al.* (2012) indicated that a value added product like mango wine exists

ISSN: 2394-4404

but there is no proper documentation of information regarding its processing and production. It is against this background that the study was designed to assess farmers' access to trainings on the technologies and to what extent they practice the technologies. The study was designed as a case study on smallholder farmers in Kibaha district. It is located in the coast region of Eastern Tanzania with high potential for production of high value crops. Therefore, this study aimed at understanding the access and use of trainings received, the study was based on one fruit Mango (*Mangifera indica*) as an example of an exotic fruit, because of its high demand/market value and one indigenous fruit in the area with great potential for processing.

There are many missed opportunities for smallholder farmers for adding value to fruits for preservation, nutritional benefits and for income diversification through fruit based enterprise development (Kehlenbeck *et al*., 2013). MMA (2008) indicate that focus on both local and export market on fruits has been on fresh market and not processed fruit products. Therefore, the potential of most fruits in Tanzania remain underutilized (URT, 2016). Processing is quite low and confined to large scale commercial industries. The fruit value chains have not been fully developed (Kehlenbeck *et al*., 2010) and strengthened to mitigate post-harvest loss and wastage. According to Kehlenbeck *et al*. (2013) this is attributed by high losses during the seasonal gluts. Among the most commonly a grown and processed fruit in Tanzania is mango. There are between a 40 and 50% loss in mango value chains in the country due to inappropriate post-harvest handling at the smallholder farmer level (URT, 2016). Poor organization of fruit marketing and largely informal, limited information on fruit processing is available to the Tanzanian smallholder farmer which severely limits fruit processing in the sector (MMA, 2008). According to URT (2016), the challenge in the use of processing technologies by farmers is due to many factors including lack of knowledge and training, lack of capacity to operate in a competitive market because of bottlenecks of poor access to the available technologies, poor technical expertise, low production, poor infrastructure, lack of market information and organized markets and failure to meet the required international standards. There has not been any significant expansion of *Mango* processing in Tanzania. URT (2016) estimates processing operations are not at full capacity and are between 40%-80% due to constraints/ limitations in consistent supply of good quality raw material. In Tanzania, the fruit processing sector provides an opportunity for fruit producers and smallholder farmers to engage in due to market potential. The study was designed to assess the access and use of knowledge gained from training in fruit processing technologies by smallholder farmers in Kibaha district. Specifically, it aimed to: (i) identify the available technologies for mango processing with potential for adoption by smallholder farmers in the study area; (ii) establish the socio-demographic and socio-economic characteristics affecting the use of mango processing technologies in the study area and (iii) study the level of knowledge and practice of mango processing technologies by the farmers in the study area.

II. MATERIALS AND METHODS

A. STUDY AREA

The study was conducted in four villages of Kibaha District. The district is one of the six districts of the Coast Region. It is located 40 km west of Dar es Salaam, along the Dar Es Salaam-Morogoro highway. It lies between latitude 6.8° in the South and longitude 38.2° and 38.5° in the East. Kibaha District shares common borders with Bagamoyo District in the North, with Bagamoyo District again and Morogoro Rural District in the West and with Kisarawe District in the South. The District consists of 5 administrative wards: Magindu, Kwala, Soga, Mlandizi and Ruvu. There are 25 registered villages and 71 sub villages. The area is located at an altitude of about 50 m above sea level and has an average annual rainfall of 1000 mm. There are two rainy seasons, long rains from March to June and short rains from October to January. The area has an average temperature of 29.70 C. The population of the area is about 132 045 out of whom 66 296 are females and 65 754 are males. The district has a total arable land of 76 554 ha of which 26 794 ha of the area is cultivated with different types of crops. The fruits most commonly grown include *Mangifera indica*, *Caricus papaya*, *Citrullus lanatus*, *Passiflora edulis*, *Citrus cinensis* and *Psidium guajava*.

B. STUDY DESIGN

The study was cross-sectional as it selects an entire population or a subset thereof and data collected to answer objectives of the study. The study involved both qualitative and quantitative data collection through semi-structured questionnaire, key informant's interview, informal discussions with farmers and personal observations.

C. SAMPLING PROCEDURES

The district was purposively selected because of its potential for high value exotic fruit crops production for the market. The study conducted a scoping study to identify trained groups in the area. This was done through consultation with key informants. Snowball effect was also used to further identify the groups. The scoping study established 21 trained groups (900 trained farmers) who participated in different trainings on fruit processing. That is they similarly grow the same crops and attended training on fruit processing. In selecting the number of mango small scale farmers to be interviewed, the sample was calculated using the formula used by BaoThoa (2006), as shown in Equation 1:

$$n = \frac{N}{1 + N\varepsilon^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where: n is sample size; N is total number of small-scale groundnut oil processors; ε is the level of precision or error of detection (10%).

Therefore, $n = \frac{900}{[1+900(0.1)^2]} = 100.111 \sim 100$

Hence the sample size for mango small-scale farmers was 100 households. Random sampling was used to select a sample of 100 from the trained farmers.

D. DATA COLLECTION

The farmers were interviewed using a pre-tested questionnaire to collect data on socio-economic and demographic characteristics, current knowledge on and use of fruit processing technologies, knowledge sources and training on fruit processing. Both primary and secondary data were collected. Primary data were collected using a survey method. The survey was the main data collection method, complemented by data obtained through focus group discussions (FGDs), Key Informant Interviews (KIIs) and documentary review. Secondary data were collected using documentary review. The methods are explained in detail below.A survey questionnaire was administered to 90 household heads. The survey included both open-ended and closed-ended questions. The survey was conducted in 2018. Respondents were met at their homes and were asked for their consent to participate in the study. Those who agreed to participate in the study were requested to provide information to achieve the objective of this study.

Two focus group discussions were conducted using an FGD guide with pre-determined questions. Each of the discussions consisted of 10 participants, including five female participants. The FGDs were guided by one facilitator, whose duty was to moderate and guide the discussion. The FGD guide consisted of general questions which explored important topics related to the study objectives. A key informant interview was adopted in order to gain in-depth understanding of the mango sub-sector in the study area. Four key informants, including one woman, were interviewed from three wards. The informants were of different ages, ethnicity, religious affiliation and educational level. The informants were selected based on their training and personal knowledge/experience. Five informants in one ward were extension officer who had worked in the study area for more than ten years. The informants were also selected based on their ability to express themselves clearly. Each interview took about one and a half hours and was tape recorded. Notes were made after each interview from which key themes were identified.

Documentary review was employed to gather secondary information which otherwise could not be gathered using the other methods. The documentary sources covered by this study include, annual reports, government reports, acts policies and regulations, newspapers journals and circulars. Relevant literature was obtained from Kibaha district, Regional and District Commissioners office, NGOs offices, district community development office, books and internet.

E. DATA ANALYSIS

a. STATISTICAL ANALYSIS

The questionnaire data were entered in Statistical Package for the Social Sciences (SPSS) and analysed in the SPSS version 21. This study used descriptive statistics (frequency and percentage) to determine the available mango processing technologies (objective one) and current knowledge on and the use of mango processing technologies by the surveyed farmers (objective two). In addition, the data analysis process utilized inferential statistics, particularly the regression analysis to achieve objective 3 of the study. Statistical software (STATA) was used to analyze the Multinomial logit (MNL) model which was used to establish the factors (independent) affecting adoption/use (dependent) of mango processing technologies.

b. MULTINOMIAL LOGIT ANALYSIS

Models are derived from information-theoretic principles which try to find the most arbitrary predictions consistent with the observations and average of the selected populations. Multinomial logit models are applied if the nominal dependent variable has more than two categories andthey cannot be ordered practically (McFadden, 1987). This model is often considered because it doesn't assume linearity, normality or homoscedasticity. This model fits well in this study as the study tried to determine the use for home consumption, use for income and non-use of the processing technologies. In addition the model was adopted for this study as it is easy to estimate and its interpretation is more often quite easy. According to Panda and Sreekumar, (2012) the equation takes the below form:

$$Logit(P_i) = ln\left(\frac{P_i}{1-P_i}\right) = \propto + \beta_1 X_1 + \cdots + \beta_n X_n + \varepsilon_t$$

Where:

$ln\left(\frac{P_i}{1-P_i}\right) =$ Logit for different choices of use of the technologies

Pi = non-use of the technologies, $1 - Pi$ = use of the technologies β= Coefficient; X = covariates; ε_t= Error term

In the model, use of technologies with three choices, use for home consumption, use for income and non-use was set as the dependent variable. Non-use of the technologies was set as the base outcome and it took a value of zero. Use for sale/income took a value one while use for home consumption took the value two. Since the non-adopters were more than those who practice for sale and less than respondents for home use, they were used as the base outcome for comparison. It was assumed that the use depends on the number of trainings one has attended, the number of technologies one has been trained on, whether or not participants carried out hands-on experience during the training, socioeconomic and demographic characteristics. Unfortunately, other factors influencing use of processing technologies were precluded due to data limitations.

Estimation procedure: The dependent variable included the following as listed in (Table 2). Based on past research by different scholars, a number of suitable independent variables likely to influence use and their expected signs (Mwombe *et al.*, 2014; Ngombe *et al.*, 2014) were identified such as: age, level of education, number of technologies trained on, number of trainings attended, acquired any other information sources, number of fruits cultivated and handson experience. By fitting the dependent variables, the model was presented as:

$$ln\left(\frac{P_i}{1-P_i}\right) = \propto + \beta_1 Age + \beta_2 Educ + \beta_3 Tech + \beta_4 AcqInfo + \beta_5 Fruit + \beta_6 Exp + \beta_7 Train + \varepsilon_t$$

Before the model estimation, it was necessary to check for multicollinearity and the test for the Assumption of Independence from Irrelevant Alternatives (IIA).

c. SPECIAL TESTS

Multicollinearity

Independent variables in a model can be related and this brings a problem when interpreting the models outcome. For this study, Variance Inflation Factor (VIF) was estimated using STATA software. As a rule of thumb, if the VIF exceeds 5, the variable is said to be highly collinear.

Testing For The Assumption Of IIA In The MNL

Hausman Specification test is the standard test for Independence from Irrelevant Alternatives **(**IIA). This test infers that the ratio of selecting any two alternatives is autonomous of the third choice (Small and Hsiao, 1985). "The assumption of IIA is rejected if the probability of chi-square result falls below 0.5, in the 5% level of significance and vice versa" (Nyaupane, 2010).

III. RESULTS AND DISCUSSION

A. MANGO PROCESSING TECHNOLOGIES

Table 1 lists the technologies applicable to mango that have potential for use by small processors in the study area. These technologies were identified based on availability of the markets for the processed products, simplicity and affordability of the technologies. The technologies were identified from primary sources.

Locally produced juices from mango are available in the market and will effectively compete with imported fruit juice of similar quality from importing countries like South Africa. The fruit pulp can still be pasteurized used in making jam and jelly. Markets already exist for these products domestically and internationally. There is also scope for pulps for use in flavouring ice cream and yoghurt. Tanzania has existing industries for ice-cream and yoghurt manufacture. To ensure availability of the pulps to these industries all year round, processing of shelf-stable pulp should be considered. Dried mango product are already processed in Tanzania and sold in the markets. Mango drying is a simple technology which can easily be practiced by small producers. The low cost solar and sun drying technology is available with both local and international market which makes it a very ideal technology that should be promoted among small mango processors. The small producers should only work hard to improve on the quality of the dried mangoes as quality is an issue with the smallholder farmers.

Technology	**Methods**	**Products**	**Reasons for choice of technology**
Production of pulps	Pulping	Juice Pulps for use in flavouring ice cream and yoghurt	Market pulp and juice available, Products can be prepared locally
Drying	Sun drying Solar drying Artificial driers	Dried slices, pieces	Market available (local and export) Can be applied locally Low cost sun and solar drying technology
Pickling	Lactic acid fermentation	Pickles	Both domestic and international market available
Fermentation	Yeast fermentation	Wine. Pulps are fermented into wine. However, grapes are the main raw materials for wine production but production of wine from mango fruits will offer cheaper alternatives especially in regions/districts in the country where grapes are not grown	Market potential
Production of vinegar	Oxidation	Vinegar. Vinegar from mango is a superior food additive over synthetic vinegar. The high carbohydrate content and sugars in the mango fruit makes it ideal for production of vinegar.	Both domestic and international market available

Source: Field survey, 2018

Table 1: Fruit processing technologies of mango appropriate for the smallholder farmers

Green mango can be used to make pickles as they have both domestic and international market and hence a very feasible product for the small processors to undertake. mango pulp can be used for fermentation into wine, however as Musyimi *et al*, (2012) suggests, grapes are the main raw materials for wine production but production of wine from these fruits will offer cheaper alternatives especially in countries where grapes are not grown. Vinegar from fruit fermentation is a superior food additive over synthetic vinegar as fruits are high in vitamins and minerals. This is an important technology especially in the *Mangiferaindica*sub-sector. The high carbohydrate content and sugars in the mango fruit makes it ideal for fermentation and production of vinegar. There is a great market potential of vinegar for use as a food preservative, dressing and as a disinfectant.

B. FACTORS INFLUENCING USE OF PROCESSING TECHNOLOGIES

Variance Inflation Factor (VIF) test was used to check if multi-collinearity exists among the independent variables. The

 ISSN: 2394-4404

VIF was found to be less than five therefore multi-collinearity does not exist in the selected variables. The likelihood ratio test P-value found was less than 0.0000, indicating that the coefficients of independent variables are not jointly equal to zero. Moreover, the model fit is within the range commonly seen using cross-sectional data with pseudo R^2 of 0.30. Also findings revealed that there was no reason to conclude that MNL model violates IIA assumptions as all choices gave a P-value of 1. Parameter estimates (coefficients and marginal effects) from the multinomial logit model are presented in Tables 2 and 3. The parameter estimates of the multinomial logit provide direction and not probability or magnitude of change. The marginal effects measure the actual effect of a unit change in each of the explanatory variables on farmers' use of the technologies.

	Use for sale			Home use		
Variables	**coeff**	**Std error**	$p > \|z\|$	**coeff**	**Std error**	$p > \|z\|$
Age (25–75)	-0.000	0.000	0.197	-0.000	0.000	0.322
Level of education (1=none, 2=some primary, 3=primary finished, 4=secondary, 5=tertiary)	0.096	0.473	0.838	-0.241	0.325	0.458
Number of technologies trained (1-4)	0.972	0.544	0.074*	0.436	0.372	0.242
Number of trainings attended (1–3)	1.922	0.647	0.003***	-1.326	0.489	0.00***
Acquired any other information sources (1=Yes, 0=No)	0.521	0.982	0.596	-0.130	0.594	0.826
Number of fruits cultivated (0–6)	0.152	0.485	0.754	-0.670	0.325	0.039**
Handson experience (1=Yes, 0=No)	2.501	0.466	0.011**	1.072	0.569	0.059*
Constant	-5.562	2.897	0.055	-2.476	1.906	0.194

*N=100;Pob> :0000; Pseudo R2:0.2095;Log Likelihood-69.673239***:significant at 1% level;**:significant at 5 level;* significant at 10 level; base outcome non-use.*

Field survey, 2018

Table 2: Parameter estimates for determinants of use of processing technologies (Non-use set as base outcome)

Coefficients from multinomial logit can be quite difficult to interpret because they are relative to the base outcome; therefore a better way to assess the effect of covariates is to examine the marginal effect of varying their values on the probability of observing an outcome. Table 3 shows the marginal effects computed.

	Use for sale			Home use		
Variables	**Discrete change of dummy variable 0 to 1**	**Std error**	$p > \|z\|$	**Discrete change of dummy variable 0 to 1**	**Std error**	$p > \|z\|$
Age (25–75)	-0.000	0.000	0.285	-0.000	0.000	0.651
Level of education (1=none, 2=some primary, 3=primary finished, 4=secondary, 5=tertiary)	0.007	0.035	0.851	-0.048	0.066	0.465
Number of technologies trained (1-4)	0.054	0.040	0.174	0.039	0.073	0.591
Number of trainings attended (1–3)	0.079	0.044	0.074*	0.182	0.089	0.042**
Acquired any other information sources (1=Yes, 0=No)	0.33	0.065	0.610	-0.000	0.120	1.000
Number of fruits cultivated (0–6)	-0.028	0.036	0.436	0.141	0.063	0.024**
Handson experience (1=Yes, 0=No)	0.142	0.077	0.063*	0.090	0.125	0.047**

***, * significance levels at 5 and 10 % respectively*

Source: Field survey, 2018

Table 3: Marginal effects of the MNL regression model for determinants of use of fruit processing technologies

a. THE NUMBER OF TECHNOLOGIES PARTICIPANTS HAD BEEN TRAINED ON

This factor was significant at 10% when it comes to use for sale for income generation in the MNL parameter estimates. This was not the case in the marginal effect. This might be explained by the fact that the respondents were relatively homogenous in those factors.

b. NUMBER OF TRAININGS ATTENDED

This factor was highly significant at 5% for use for sale and significant at 10% for home use. The number of trainings attended increases the probability of the respondent using the technologies by 8% for use for sale and 18% for home use. It was observed that those who attended more than one training adopted the technology both for home use and for sale to generate income. Non adopters did not attend more than one training program. This study is consistent with Ngombe *et al.* (2014) who also found that the more the trainings farmers attended the more the adoption of conservation agricultural technologies.

c. AVAILABILITY OF FRUITS

The cultivation of fruits on farm by the respondents was quite significant at 5% when it comes to use for home consumption. There was a greater likelihood of processing fruits for home use (14%) if fruits were grown on farm. This is because it is usually observed that those who grow a variety of fruits tend to do so mainly for subsistence use. They usually grow many varieties on a small piece of land. It is also observed that most people who engage in commercial processing tend to grow only one variety of fruit for commercial purposes and on a large piece of land.

d. AGE AND EDUCATION

Household characteristics such as age and education level were found to be insignificant. This contradicts with Mercer (2004); Okello *et al.* (2012) who suggested and found that farmers with more education are earlier and more proficient users of technologies. The insignificance may be because of the respondents' being relatively homogenous in those factors.

e. OTHER SOURCES OF KNOWLEDGE

Other information sources which include radio, farmers field days and agricultural shows, extension officers, friends and neighbours were found to be insignificant. This contradicts Tarnoczi and Berkes (2009) who found that the greater the number of information sources farmers had, the more likely they were to adopt new practices. The study however agrees with Läpple (2010) who reported no correlation between the number of different sources of information and the use adoption of organic farming.

C. THE LEVEL OF KNOWLEDGE ON FRUIT PROCESSING TECHNOLOGIES

The study sought to determine the respondents' knowledge about processing technologies and whether they had used the technologies before. It was established that 75% of the farmers admitted to having carried out mango processing at least once while 25% indicated not having ever processed previously. Among the reasons indicated for having used processing and value addition technologies were; to 'add value (20%)', for income generation potential (8%), 32% for home consumption and 20% indicated for purpose of practicing the knowledge and skills acquired from trainings attended. Other reasons as mentioned by 20% of the respondents were to utilize available resources and fruits. Similar reasons for the use of processing technologies have also been found in studies by others (Msabeni*et al*., 2010).

IV. CONCLUSION

On the basis of this research, the study concludes the following; there is existence of varied technologies for mango processing identified in this study. The technologies included production of pulps, drying, fermentation, production of vinegar, fermentation and pickling. The findings of this study suggest that socio-demographic and socio- economic factors are central in determining farmers' use of fruit processing technologies. The factors found to influence use of training were the number of technologies trained on, the number of trainings attended, the cultivation of fruits on own farm and the hands-on experience during the training. Trainings are therefore important in promoting the use of the technologies. The study also concludes that the respondents are quite knowledgeable on the fruit processing technologies but the practice is still quite low.

ACKNOWLEDGEMENTS

My thanks go to Kibaha District council for supporting the completion of this work.

REFERENCES

[1] BaoThoa, H.T. (2006). The value chain management of garment companies in Vietnam. The University of the Thai Chamber of Commerce. Thailand.
[2] United Republic of Tanzania (2016). Groundnut Sector Development Strategy: 2016-2020.
[3] Gitonga, K. J., Gathambiri, C., Kamau, M., Njuguna, K., Muchui, M., Gatambia, E., and Kiiru, S. (2014). Enhancing small-scale farmers' income in mango production through agro-processing and improved access to markets.
[4] Kehlenbeck, K., Asaah, E., and Jamnadass, R. (2013). Diversity of indigenous fruit trees and their contribution to nutrition and livelihoods in sub-Saharan Africa: examples from Kenya and Cameroon. In Fanzo J., Hunter D., Borelli T., Mattei F. (eds.) Diversifying Food and Diets: Using Agricultural Biodiversity to Improve Nutrition and Health. EarthscanRoutledge, New York, USA, p. 257-269.
[5] Kehlenbeck, K., Rohde, E., Njuguna, J. K., Omari, F., Wasilwa, L., and Jamnadass, R. (2010).Mango cultivar diversity and its potential for improving mango productivity in Kenya. In Transforming agriculture for improved livelihoods through agricultural product value chains. Proceedings of the 12th KARI biennial scientific conference, Kenya Agricultural Research Institute, Nairobi, Kenya (pp. 657-665).
[6] McFadden, D. (1987). Regression-based specification tests for the multinomial logit model. Journal of Econometrics, 34, 63–82.
[7] Mercer, D. E. (2004). Adoption of agroforestry innovations in the tropics: A review. Agroforestry Systems, 61-62(1-3), 311–328.
[8] Marketing Marker Associates (MMA), 2011. Fresh fruits sub-sector value chain analysis in Tanzania. Small and Medium Enterprises Competitive Facility: 33pp.
[9] Msabeni, A., Muchai, D., Masinde, G., Samuel, M., and Gathaara, V. (2010).Sweetening the mango: Strengthening the value chain an anlysis of the organisational linkages along and within the mango value chain in Mbeere district, sweetening the mango: strengthening the value chain.
[10] Musyimi, S. M., Okoth, E. M., Sila, D. N., and Onyango, C. A. (2012). Prodcution, optimization and characterisation of mango fruit wine: towards value addition of mango produce.In 7th JKUAT scientific Conference proceedings.
[11] Ngombe, J., Kalinda, T., Tembo, G., and Kuntashula, E. (2014). Econometric analysis of the factors that affect adoption of conservation farming practices by smallholder farmers in Zambia. Journal of Sustainable Development, 7(4), 124–138.
[12] Nyaupane, N. P. (2010). Louisiana crawfish farmer adoption of best management practices. Journal of Soil and Water Conservation 66(1), 61-70.
[13] Okello, J. J., Kirui, O., Njiraini, G. W., and Gitonga, Z. (2012). Drivers of use of information and communication technologies by farm households: the case of smallholder farmers in Kenya. Journal of Agricultural Science, 4(2), 111–124.
[14] Panda, R. K., and Sreekumar. (2012). Efficiency assessment in agribusiness marketing channel choice and marketing efficiency assessment in agribusiness. Journal of International Food and Marketing Channel Choice and Marketing, 37–41pp.

[15] Small, K. A., and Hsiao, C. (1985). Multinomial Logit specification tests. International Economic Review, 26(3), 619–627 CR – Copyright and#169; 1985 Economics.
[16] Tarnoczi, T. J., and Berkes, F. (2009).Sources of information for farmers' adaptation practices in Canada's Prairie agro-ecosystem. Climatic Change, 98(1-2), 299pp.
[17] Zossou, E., Van Mele, P., Vodouhe, S. D., and Wanvoeke, J. (2009). The power of video to trigger innovation: rice processing in central Benin. International Journal of Agricultural Sustainability, 7(2), 119–129.