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ASSESSMENT OF FACTORS INFLUENCING FARMERS' NUTRITION KNOWLEDGE AND INTAKE OF TRADITIONAL AFRICAN VEGETABLES IN TANZANIA

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ABSTRACT

Traditional African Vegetables (TAVs) form a significant component of many families' diets in Tanzania. Traditional African Vegetables contribute to reduction of malnutrition, stunting and poor health among consumers by providing vitamins and essential minerals in family diets. However, the consumption of vegetables is still below the per capita per day intake level recommended by World Health Organization and Food and Agriculture Organization, causing millions of deaths annually due to nutrient-deficiency related diseases. This study examined the factors that influence the nutrition knowledge, frequency intake and farming households' attitudes towards consumption of traditional vegetables. The Standard Poison and the Generalized Poison models were used for analysis. Factor analysis was used to assess the attitudes towards TAVs consumption. Data were collected from randomly selected 63 households in Arumeru District of Tanzania in the months of July to November 2015. Generalized Poison model results showed that gender of the respondent, years of schooling, age of the respondent, household size and TAVs farm size influenced farmers' nutrition knowledge. Frequency intake of TAVs is influenced by the farmers' age, annual household income, household size, TAVs farm size and market price of TAVs. Factor analysis results indicated that medicinal properties of traditional vegetables positively influenced farmers' intake of vegetables. The "health factor" accounted for 31.4% of the total variance in the principal components analysis. 'Personal perception factor' accounted for 13.79% whereas 'personal taste factor' accounted for 12.71% of the total variance. It was concluded that rural farming households consume traditional vegetables majorly because of their health attributes. Thus, there is need to improve medicinal and nutritional knowledge of these crops among households. These findings imply that consumption of TAVs can be enhanced by educating households on nutrition importance and medicinal attributes of TAVs. Besides, farmers need training on simple but user-friendly technologies that could prolong storage and preserve freshness as well as nutritional contents of traditional vegetables.

Key words: Traditional vegetables, nutrition knowledge, frequency intake, farmers' attitude, Arumeru District

INTRODUCTION

Most of the vegetables consumed by urban residents in sub-Saharan Africa are grown by small-scale farmers in the rural areas [1]. Vegetables provide farmers with higher income per unit of input compared to staple crops especially for growers with small arable land [2]. Traditional African Vegetables (TAVs) have gained popularity due to their role in providing vitamins and essential minerals in family diets for many years [3]. The increase in production of TAVs has been brought about by lower usage of farm inputs as compared to global vegetables. Of all the TAVs cultivated, almost 50% are sold in local markets and the remaining 50% are either consumed at home or given out as a gift [1]. This shows the importance of TAVs and the need to improve their consumption.

Consumers in many parts of the world derive a major portion of their diets from vegetables which has been found to play a significant role in human nutrition, especially as an important source of vitamins, essential minerals, dietary fiber, and various phytochemicals and antioxidants [4, 5]. Thus, TAVs form a significant source of food and nutritional security in rural areas of sub-Saharan African (SSA). However, most SSA countries have not prioritized these TAVs in their policies, crop research, training and development programs [6, 7, 8]. Ultimately, several studies have noted that the frequency of intake of TAVs has been declining over the years [9,10, 11]. Decline in use of TAVs by many rural communities has resulted in poor diets and increased incidence of nutritional deficiency disorders and diseases among the most vulnerable groups – women and children under five years [12]. Low consumption of TAVs could also be due to the negative perception held by some consumers. Some people view TAVs as 'poverty food' or 'food for the backward', a notion that explains why some consumers are not positively inclined to them [13]. Even though some consumers are aware of the benefits of TAVs, literature suggests that some have both positive and negative attitudes towards them [13]. Ultimately, efforts are needed to increase intake of traditional vegetables due to their nutritive and health values. The objective of this study, therefore, was to determine the factors influencing farmers' nutrition knowledge and consumption of traditional African vegetables in Arumeru District of Tanzania.

Vegetables play a significant role in human nutrition, especially as important sources of vitamins, essential minerals, dietary fiber, and various phytochemicals [4]. However, Traditional vegetables contain more of these nutrients as compared to global vegetables such as cabbages and kales [14]. Daily diet consumption of traditional vegetables has been strongly associated with overall good health, improvement of gastrointestinal function, good vision, and reduced risk of some forms of cancer, and other chronic diseases [15]. Women and children in particular can benefit from a diet with high vegetable content (for example, good vision and improved gastrointestinal), especially during later stages of pregnancy and in lactation period [16]. However, consumption of TAVs is low and varies widely with geographical region, nationality and local customs.

In Africa, vegetable consumption per capita has been reported [17] to be below the minimum recommended intake of 400 g per capita per day [18]. Though consumers in Tanzania are still below the recommended intake levels of vegetables, there have been some improvements in recent years. For example, between the year 1993 and 2000, vegetable consumption grew from 107 to 113 g per capita per day [19] while in 2007, vegetable consumption reached 200 g per capita per day among high income consumers [1]. However, for most medium and low-income consumers, vegetable consumption per capita per day is still below the recommended levels. This situation has led to high prevalence of malnutrition, stunted growth and general poor health in the region [20]. Forecasts [21] have shown that there will be 18% increase in the number of malnourished children in sub-Saharan Africa from the year 2001 to 2020. Hence, understanding the factors that determine household's knowledge, frequency of TAVs intake and farmers' attitudes towards TAVs consumption is essential for both promotion and nutrition improvement for rural households. The most consumed TAVs in Tanzania are: African Nightshade (*Solanum* spp.), Amaranths (*Amaranthus* spp.), Ethiopian Mustard (*Brassica carinata*) and African Eggplant (*Solanum* spp.).

MATERIALS AND METHODS

Theoretical Framework

Models for count data have been prominent in many empirical studies of economic behavior, for example, in health economics (in cases with numbers of visits to health facilities), management (in cases with numbers of patents), and industrial organization (in cases with numbers of entrants to markets). A common foundational building block in this modeling framework is the Poisson regression model. However, it has implicit restrictions on the distribution of observed counts. As a result, researchers routinely employ more general specifications, usually the negative binomial (NB) model which is the standard choice for a basic count data model. However, when data preclude zero responses, negative binomial regression is also inappropriate [22]. Hence, Generalized Poisson Regression (GPR) model is recommended for analytical estimation. Thus, this study determined the factors influencing nutrition knowledge and frequency intake of TAVs by using generalized Poisson model.

The probability distribution function of generalized Poisson distribution can be defined [22, 23] as:

$$f(y;\lambda,\theta) = \theta\left(\theta + \lambda_i^{y_i}\right)^{y_i} \frac{exp\left(-\theta-\lambda_i^{y_i}\right)}{y_i!} \quad (1)$$

Log-likelihood (LL) transformation for the above generalized Poisson probability distribution is given as:

$$\mathcal{L}(\mu,\alpha;y) = \sum_{i=1}^{n}\left\{y_i ln\left(\frac{\mu_i}{1+\alpha\mu_i}\right) + (y_i-1)ln(1+\alpha y_i) - \left[\frac{-\mu_i(1+\alpha y_i)}{1+\alpha\mu_i}\right] - ln\Gamma(y_i+1)\right\} \quad (2)$$

Or in terms of $x\beta$ as

$$\mathcal{L}(\beta,\alpha;y) = \sum_{i=1}^{n}\left\{y_i ln\left(\frac{exp(x_i'\beta)}{1+\alpha exp(x_i')}\right) + (y_i-1)ln(1+\alpha y_i) - \left[\frac{exp(x_i'\beta)(1+\alpha y_i)}{1+\alpha exp(x_i'\beta)}\right] - ln\Gamma(y_1+1)\right\} \quad (3)$$

Where: y_i= random response variable corresponding to the number of nutrition knowledge known to respondent (i)
x =covariate vectors of explanatory variables
β= linear predictor of random response variable

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This study used this framework to model the factors affecting nutrition knowledge and frequency intake of TAVs by farming households.

Model Specification: Factors Affecting Consumers' Nutrition Knowledge
In an effort to assess the level of nutrition knowledge of TAVs by different rural household consumers, this study adopted five scale levels [24]: i) understanding of nutrition terms, ii) awareness of dietary recommendations, iii) knowledge of foods as source of nutrients, iv) ability to apply information on choices; and v) awareness of diet-disease associations. Respondents were then asked whether or not they knew each of the nutrition scales and its implication. Depending on the responses for each case interviewed, the total nutrition knowledge scales were tallied. The dependent variable was the number of nutrition knowledge scales the household was aware of and had an understanding of its implication. The model independent variables were the various socio-economic factors as shown in equation 4. A key null hypothesis was that education and income of the household jointly had no effect on farmers' nutrition knowledge. The study estimated the following generalized Poisson regression model for household nutrition knowledge:

Scales of knowledge in nutrition known (y) = f (lnage, gender, education, lnincome, work status, type of occupation, social capital) + e (4)

Model Specification: Factors Influencing Frequency of Intake of TAVs
In order to assess the factors influencing the frequency of intake of nutrient-dense vegetables, this study specified the dependent variable as the average number of times TAVs were consumed in the household per week. Hence, the dependent variable for the frequency of intake was a number such as 0 times a week, 3 times a week and so on. This study used generalized Poisson regression model to isolate the determinants of the frequency of intake because the dependent variable is a count data variable. The explanatory variables in the model were the socio-economic factors of the respondents as shown in equation 5. It was hypothesized that age and annual income of the household jointly had no effect on the frequency intake of TAVs. The model estimated was specified as:

Frequency of TAV intake (Z) = f (lnage, gender of household head, household size, lnincome, occupation, lnfsize, education, distance to market) + e (5)

Farmers' Attitudes towards Traditional African Vegetables (TAVs)
Factor analysis was used to identify latent dimensions underlying the different variables that measured various attributes preferred by rural households. Responses on a five-point Likert scale were subjected to principal component factor analysis (PCA) with Varimax rotation. The component factors were subjected to the Kaiser-Meyer-Olkin and Bartlett's test (KMO and Bartlett's test) to determine the sampling adequacy. A KMO measure greater than 0.7 is preferable and is inadequate, if it is less than 0.5 [25]. Kaiser-Meyer-Olkin test tells us whether or not enough items are predicted by each factor. This procedure was adopted to analyze the attributes that farmer households preferred so as to increase the frequency intake of nutrient-dense vegetables.

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Study Area, Data and Variables

Data for this study were collected from farming households in Arumeru District, Tanzania. It is one of the districts where a project called "Improving Income and Nutrition in Eastern and Southern Africa by Enhancing Vegetable-based Farming and Food Systems in Peri-urban Corridors (VINESA) is being implemented. Arumeru is one of the five districts in Arusha Region of Tanzania. It is bordered to the North and West by the Monduli District, to the East by the Kilimanjaro Region and to the South by the Arusha District. The district lies between longitudes 36.5^{o} and 37.5^{o} East and latitudes 3.5^{o} and 3.7^{o} South of the Equator. The economy of the district is almost entirely agricultural, consisting mostly of subsistence farming and livestock raising. The three major ethnic groups in the district are Wameru, Waarusha and the pastoralist Maasai. The study was undertaken for five months from July to November, 2015. Three (3) villages (Manyire, Embaseny and Bangata) were purposively selected for the study because they are the main producers of vegetables in Arusha region. Records of farmers developed by the project were used as the sampling frame. Random sampling technique was used to select study cases from the villages. A total of 63 households who grew TAVs for sale in the local markets were selected. A structured questionnaire was then administered to the sampled cases through face-to-face interviews. Variables used for analysis were then obtained as shown in Table 1. STATA software was then used for statistical analysis of the data.

RESULTS AND DISCUSSION

Descriptive Statistics Results

Table 2 shows the socioeconomic characteristics of the respondents in the study area. These results demonstrated that the majority of farmers interviewed, 57% were males and 43% were females. The majority (90%) of the farmers who produced TAVs had primary school education. Only a few (7.94%) had secondary education and none had middle-level College or university education. The mean age of the farmers was 40 years implying that youthful farmers (35 years or less) were relatively few. Hence, there is need to promote youth involvement in agriculture particularly in growing of TAVs. This trend raises a concern that if the youth group is not involved, there might be food and nutrition insecurity in the near future. It was noted that farming was the main occupation for 75% of the farmers and, therefore, most farmers derived the greatest proportion of their income from farming activities. About 37% and 35% of the farmers were from Meru and Arusha ethnic groups, respectively. The study also found that only 3% of the sampled farmers who produced and consumed traditional vegetables were from the Maasai ethnic community. The mean yearly income for farmers was Tshs 1,263,651 (US$ 577.54).The results further showed that farmers obtained TAVs from their farms, while a few spent Tshs 7,650 (US$ 3.50) per week to buy them from local markets.

Table 3 shows the common traditional African vegetables grown in the study area. The results indicated that African nightshade is grown by most farmers (81%) followed by Amaranths (65%), Ethiopian mustard (52%), African eggplant (49%), sweet potato leaves (11%) and spiderplant (5%). Table 4 shows the area (acre) under TAVs in the study area. The results showed that the mean area put under TAVs in each of the villages were Manyire (0.802), Bangata (0.531) and Embaseny (0.475). In general, Manyire

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farmers dedicated more area to grow TAVs compared to Embaseny and Bangata farmers. Embaseny and Bangata villages are located at the slopes of Mount Meru where many farmers are still growing coffee. Bangata, farmers grow both TAVs and exotic vegetables such as cabbages, kales etcetera. Many farmers engaged in exotic vegetables usually do not grow TAVs.

Table 5 shows the mean rankings of TAVs varieties with high nutritional potential cultivated in the study area based on the opinion of respondents. The results showed that in Manyire village, African eggplant had high nutritional potential (0.818) followed by Amaranth (0.591). In Embaseny village, African nightshade stood out in terms of nutritional potential (1.000) followed by Amaranths (0.733). In Bangata village, African nightshade had the highest nutritional potential (1.000) followed by Ethiopian mustard (0.625). Overall, African nightshade was ranked first followed by Amaranth in terms of nutritional potential among the TAVs cultivated in the study area. When compared to nutrient values obtained from literature [26], farmers' opinion was valid to some extent. For example, Amaranth had the highest Ca, Mg, and Zn content in comparison to other TAVs genera. African Nightshade had the highest K, Fe and protein content, whereas African eggplant had the highest amount of carotenoids [26].

Factors Affecting TAV Nutrition knowledge

Knowledge in nutrition was counted with the range of zero to five. Respondents were asked five questions to assess their knowledge in nutrition and scores from each case were added together. The results showed that the mean nutrition knowledge by was 57.2% (that is 2.86 out of 5). Hence, farmers had moderate awareness of TAV nutrition knowledge.

In order to examine the factors influencing nutrition knowledge among TAVs producers, models for count data that take the number of nutrition knowledge scale as a dependent variable was used to fit a standard Poisson regression model and generalized Poisson regression Model. The results of the fitted regression models are shown in Table 6. The Prob-chi^2 test statistic shows that both the models fitted the data well ($p = 0.0000$ and 0.0001, respectively). The mean deviance and the Pearson chi-square ratio (the Pearson chi-square value divided by its degrees of freedom) were used to assess the degree of fit of the standard Poisson model. The estimated deviance and Pearson ratios are shown below:

$$\text{Deviance/df} = 30.81093633/52 = 0.592518$$
$$\text{Pearson/df} = 25.95179108/52 = 0.4990729$$

These results showed that both ratios are significantly smaller than 1, indicating that there is evidence of under-dispersion. Hence, the standard Poisson model does not fit the data well. The results of Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) tests of goodness of fit for the two models were also shown in Table 6. Lower values of either Akaike Information Criterion (AIC) or Bayesian Information Criterion (BIC) indicate a better fit. The results showed that generalized Poisson model was a better fit for the data. Consequently, the discussion below is based on the results of generalized Poisson model.

Gender of the respondent significantly influenced ($p < 0.1$) the number of nutrition knowledge scales known to respondents. This implies that, gender of the respondent increased the expected knowledge in nutrition by some 18%. Thus, the expected number of nutrition knowledge scales known by males was higher relative to that of the females [27]. A similar finding was observed in a study [28] where the expected number of forest benefits knowledge scales known by male respondents was higher relative to the number of benefits known by female respondents.

Years of schooling significantly ($p<0.001$) influenced nutrition knowledge. The more the number of the years spent in school by the respondent the more likely that the farmer will possess higher levels of nutrition knowledge. This showed that education plays an important role in sourcing and accessing nutrition knowledge. The less educated farmers are likely to be associated with less nutrition knowledge. This implies that less educated farmers most likely are not well informed of the benefits they could possibly accrue from possessing nutrition knowledge of traditional vegetables.

Nutrition knowledge was positively and significantly ($p<0.05$) influenced by the age of the respondent. Each additional year would be expected to increase nutrition knowledge by a factor of 10.8%, while holding all other variables in the model constant. This meant that the older one gets, the more nutrition knowledge one accrues. Thus, younger farmers would be expected to have relatively little nutrition knowledge, which ultimately grows overtime with age. Other studies [29, 30, 31] have also observed that farmers in rural areas are more likely to possess adequate cultural knowledge on TAVs as opposed to the youth and urbanized dwellers.

Household size positively and significantly ($p<0.05$) influenced nutrition knowledge. This implied that the larger the household, the greater the likelihood that the household members would access more nutrition knowledge and share it within the household. This finding was also supported by Pearson's Correlation coefficient of 0.0744 between nutrition knowledge and household size. Farm size also significantly (P-value<0.1) influenced the nutrition knowledge of the respondent. These results implied that putting one more acre under TAVs would increase nutrition knowledge by nearly 14%.

This study had hypothesized that education and income of the household jointly have no effect on the levels of nutrition knowledge among farmers. The results of Wald test (combined effect of education and income), however, found that education and income have a joint statistically significant effect on the nutrition knowledge. The joint test yielded a p-value of 0.0004. The null hypothesis that education and income jointly do not influence knowledge in nutrition was, therefore, rejected at 0.1 percent level of significance. Overall, the model results showed that nutrition knowledge of farmers was positively influenced by the gender of the respondent, number of years of schooling, age of the respondent, household size and TAVs farm size.

Factors Affecting the Frequency of TAV Intake

In order to examine the factors influencing the frequency of TAVs intake by farmers, models for count data that take the number of times a household consumes TAVs per week as a dependent variable was used to fit a standard Poisson regression model and generalized Poisson regression Model. The results of the fitted regression models are shown in Table 7. The Prob-chi^2 test statistic showed that both the models fitted the data well (p = 0.0363and 0.0000 respectively). The mean deviance and the Pearson chi-square ratio (the Pearson chi-square value divided by its degrees of freedom) were used to assess the degree of fit of the standard Poisson model. The estimated deviance and Pearson ratios are shown below:

Deviance/df = 20.34730709/48 = 0.4239022
Pearson/df = 16.16006631/48 = 0.336668

These results showed that both ratios are significantly smaller than 1, indicating that there is evidence of under-dispersion. Hence, the standard Poisson model does not fit the data well. The tests of goodness of fit measured by Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) for the two models were also presented in Table 7. Lower values of either Akaike Information Criterion (AIC) or Bayesian Information Criterion (BIC) [32] indicate a better fit. The results showed that generalized Poisson model was a better fit for the data. Hence, the discussion below is based on the results of generalized Poisson model.

Age of the respondent significantly influenced (p <0.05) frequency intake of TAVs. This implies that each additional year of age increases the expected frequency intake by an incidence rate ratio factor of 2.098. This indicates that the older the respondent gets the higher the frequency of TAV intake. Similar findings were made in a study [33] where the intensity of TAVs consumption significantly increased with advancement in age of the household head. Annual household income significantly (p<0.01) influenced the frequency intake of TAVs. Each additional Tshs. 1 of income increases the TAVs frequency intake by an incidence rate ratio of a factor of 0.771, while holding all other variables in the model constant. This shows that household income plays a vital role in frequency intake of TAVs.

Household size significantly (p<0.01) influenced frequency intake of TAVs. If the size of the household increases by one individual, the incidence rate ratio for frequency intake of TAVs would be expected to change by a factor of 0.359, while holding all other variables in the model constant. The bigger the household size, the higher the frequency of consuming TAVs. The farm size dedicated to TAVs production significantly (p<0.05) influences the frequency intake of TAVs. Farm size was associated with an estimated 25% increase in the frequency intake. This implies that in the study area, frequency intake of TAVs is positively related to farm size allocated to TAVs. Frequency intake of TAVs was significantly (p<0.0001) influenced by the price of TAVs. Price of TAVs was associated with an estimated 41% increase in the frequency intake. This implied that if the price of TAVs is high, farmers will tend to produce more of it for sale and at the same time, the frequency to consume it at the household increases.

The study had hypothesized that age and annual income of the household jointly have no effect on the frequency intake of TAVs. The results of Wald test (combined effect of age of respondent and household income), however, found age of the respondent and household income have a joint significant (p-value of 0.0035) effect on the frequency intake of TAVs. The null hypothesis that age of the respondent and household income jointly do not influence frequency intake of TAVs was, therefore, rejected at 1 percent level of significance. The model further showed that frequency intake of TAVs by farmers is influenced positively by age, annual household income, household size; TAVs farm size and market price of TAVs.

Farmers' Attitude towards Consumption of Traditional African Vegetables

Factor analysis was used to identify latent dimensions underlying the different variables that measured respondents' attitudes. Responses to the 11 five-point Likert-type scale items were subjected to principal component analysis. Factor analysis was selected to create measurement scales. In order to develop these scales, exploratory factor analysis with Varimax rotation was employed. The objective was to obtain fewer dimensions that reflected the relationships among these inter-related variables. An Eigen-value greater than one rule was applied in identifying the number of factors. The variables that had large loadings on the same factors were grouped together. Factor loadings value of 0.50 and above is normally considered good and significant [34]. The analysis produced a solution with three factors that accounted for 58.95% of the total explained variance as shown in Table 8. The Kaiser's overall measure of sampling adequacy obtained was 0.694, which adequately borders on the recommended threshold of 0.7 suggesting that the data are marginally appropriate for factor analysis.

Seven attitude variables concerning importance and conservation of TAVs were loaded on factor 1 with the cross-correlation coefficients of 0.530, 0.574, 0.872, 0.753, 0.572, 0.733 and 0.716, respectively. This factor accounted for 31.4% of the total variance and was termed 'health benefits' because these variables involved the importance of consumption as well as conservation by local farmers. Higher scores and positive responses on this factor revealed a general understanding for promoting consumption and safeguarding of these varieties for the next generation. For example, the first three attributes with the highest factor loadings were: "Intake of TAVs variety each day guarantees vitamins and minerals required (0.872)", "It is important to choose diets accompanied with TAVs (0.753)" and "TAVs are best consumed when fresh (0.733)". These findings imply that rural households are persuaded that TAVs are important for human health and are best consumed when they are fresh.

Factor 2 had cross-correlation coefficients of 0.633. This attribute implied that TAVs varieties appear not to be good to the consumer. This factor was then labeled 'personal perception' and accounted for 13.79% of the total variance. One attribute (namely, personal taste) was loaded on Factor 3 with cross-correlation coefficient of 0.895. This attribute focused on taste issues. Hence Factor 3 was termed 'personal taste'. It accounted for 12.71% of the total variance. The cumulative percent of variance explained by the three factors was approximately 58.95%. Thus, rural farming households in the study area of Arumeru District consume traditional vegetables majorly because of their health attributes.

CONCLUSION

This study established that the factors explaining the nutrition knowledge of farmers include gender of the respondent, number of years spent in school, age of the respondent, household size and TAVs farm size. The null hypothesis that education and income jointly do not influence nutrition knowledge of farmers was rejected. Frequency intake of TAVs by farmers is positively influenced by age, annual household income, household size, TAVs farm size and market price of TAVs. The null hypothesis that the age of the respondent and household income jointly do not influence frequency intake of TAVs was rejected. The study, therefore, concluded that socioeconomic factors have a significant effect on nutrition knowledge and frequency intake of TAVs.

The attitude of the farmers towards consumption of TAVs was mostly positive. This was shown by the finding that the "health factor" had the highest loading in the factor analysis. The medicinal properties significantly influenced consumption of TAVs. Thus, it was concluded that there is need to increase medicinal knowledge of these crops to a larger population. In addition, households indicated that TAVs are best consumed when fresh. There is also need to improve preparation and cooking of these vegetables to maintain their taste and nutrient content. The findings also showed that the perception factor loading was relatively high. This implied that a change of attitude is important because TAVs play an important role in human health. In view of increasing intake of nutrient-dense vegetables (TAVs), innovative ways of mixing various TAVs varieties during preparation could improve taste. Health attributes of TAVs should be incorporated in consumption promotional campaigns. Various promotional approaches such as posters, road shows and cooking demonstrations can be used. There is need to promote storage technologies which would preserve freshness as well as nutrient contents of TAVs.

This study also recommended that further investigations of the indigenous knowledge on the value attached to these vegetables be explored. This could serve as an incentive to motivate the increased consumption of these vegetables by the youth and urban populations. There is also need to ensure the availability and accessibility of these vegetables by consumers because this has been demonstrated by other studies to influence rates or frequency of consumption.

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LIST OF ABBREVIATIONS

IRR	Incidence Rate Ratio
TAVs	Traditional African Vegetables
VINESA	Improving Income and Nutrition in Eastern and Southern Africa by Enhancing Vegetable-based Farming and Food Systems in Peri-urban Corridors

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Table 1: Description and expected sign of variables included in the Nutrition knowledge and Frequency Intake Models for TAV Farming Households

Variable Name	Variable name	Variable coding.	Expectations: Nutrition knowledge, Frequency Intake Models	Nutrition knowledge -sign	Frequency intake-sign
Gender	Gender of household head	1 if male, 0 if female	Men are expected to be generally more knowledgeable of their environment than women	+	+
Years of schooling	Number of years spent in school	Natural logarithm of number of years of school	The more the education the more the nutrition knowledge and frequency intake	+	+
Age	Age of the household head	Natural logarithm of age in years	One is expected to accrue more nutrition knowledge with age and increase intake	+	+
Occupation	Farmer's regular work or profession	1 if nutritionist, exposed to agricultural training, teacher, 0 otherwise	Farmers who are nutritionists or exposed to agricultural training are expected to have more nutrition knowledge and intake	+	
Income	Annual household income	Natural logarithm of income	The more the income the more the nutrition knowledge and intake	+	+
Group membership	Farmer is a member of a group	1 if yes, 0 if otherwise	Farmers with membership in groups are expected to have more nutrition knowledge and intake	+	+
Household size	Number of members in a household	Natural logarithm of the size of household	The more the number of members in a household, the higher the nutrition knowledge and intake	+	+
TAVs farm size	Number of acres put under TAVs	Number of acres under TAVs	The bigger the area under TAVs the greater the likelihood of the farmer seeking for nutrition knowledge to increase intake	+	+
Distance to market	Number of minutes to the nearest market	Natural logarithm of number of minutes	The more the time taken to the market the less the frequency of intake		-
Culture/ Taboos	Influence of Culture/taboo on consumption	1 if yes, 0 if otherwise	If culture influences consumption of TAVs at the household, the lower the frequency intake		-
Medicinal value	Medicinal value influence intake	1 if yes, 0 if otherwise	The more the attachment to medicinal properties of TAVs, the higher the intake		+
Price of TAVs	Price of TAVs affect frequency of intake	1 if yes, 0 otherwise	If TAVs prices are perceived to be high, the less the frequency intake		-
TAVs weekly expenditure	Amount spend weekly to purchase TAVs	Natural logarithm of expenditure	The higher the weekly expenditures on TAVs the lower the frequency of intake		+

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Table 2: Socio-economic Characteristics of the sample

Demographic properties	Frequency	
Gender (%)		
Female	42.86	
Male	57.14	
Marital status of respondent (%)		
Married	92.07	
Single	6.35	
Separated	1.59	
Divorced	-	
Widow or widower	-	
Knowledge in Nutrition (count) mean	2.854	
Ethnicity group (%)		
Meru	36.51	
Maasai	3.17	
Arusha	34.92	
Chagga	15.87	
Others (Sukuma, Nyakyusa, Iraqw, Pare)	9.52	
Main Occupation (%)		
Agriculture	74.60	
Casual labor	-	
Formal employment	-	
Business	4.76	
Agriculture and livestock	20.63	
Level of education (%)		
None	1.59	
Primary	90.48	
Secondary	7.94	
Middle-level college	-	
University	-	
Frequency intake (count) mean	1.06	
	Mean	**Standard Deviation**
Age of respondent (mean)	40.17	12.43245
Number of years of schooling (mean)	7.13	1.539712
Household size (count) mean	4.20	1.259272
TAVs Farm size (acres) mean	0.61	0.5387085
Distance to nearest market (minutes) mean	52.403	56.24004
Amount spent to purchase TAVs per week (Tshs) (mean)	7,647.62	5819.845
Household income (Tshs) (mean)	1,263,651	1,146,966

Source: Survey of TAVs farmers in Arumeru District, July to November 2015

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Table 3: Common Traditional African Vegetables grown in the study area last season

Botanical Name	English name	Swahili name	No. of farmers	%
Solanum spp.	African eggplant	Ngogwe	31	49.21
Amaranthus spp.	Amaranths	Mchicha	41	65.08
Solanum spp.	African nightshade	Mnavu	51	80.95
Cleome gynandra	Spider plant	Mgagani	03	4.76
Brassica carinata	Ethiopian mustard	Loshuu	33	52.38
	Sweet potatoes leaves	Tembele	07	11.11

Source: Survey of TAVs farmers in Arumeru District, July to November 2015

Table 4: Area under traditional African vegetables cultivation

Standard Measure of the Sample	Manyire (acre)	Embaseny (acre)	Bangata (acre)
Mean	0.802	0.475	0.531
Minimum	0.250	0.250	0.250
Maximum	3.000	2.000	1.000
Standard deviation	0.687	0.411	0.247

Source: Survey of TAVs farmers in Arumeru District, July to November 2015

Table 5: Traditional African vegetables varieties with high nutritional potential being grown in the study area

Variety	Location			Overall Mean	Overall Ranking
	Manyire (mean)	Embaseny (mean)	Bangata (mean)		
African eggplant	0.818	0.167	0.375	0.453	4
Amaranths	0.591	0.733	0.500	0.608	2
African nightshade	0.455	1.000	1.000	0.818	1
Spider plant	0.136	0.000	0.000	0.045	6
Ethiopian mustard	0.182	0.667	0.625	0.491	3
Others	0.182	0.033	0.000	0.072	5

Source: Authors' survey of TAVs farmers in Arumeru District, July to November 2015

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Table 6: Factors which influence farmers' nutrition knowledge

Dependent variable = Number of Nutrition knowledge known	Standard Poisson IRR (Incidence rate ratio)	P-values	Generalized Poisson IRR	P-values
Gender	1.219	0.091*	1.182	0.099*
Log of Years of schooling	2.330	0.000***	2.389	0.000***
Log of Age	2.687	0.027***	3.108	0.014***
Occupation	1.028	0.382	1.016	0.534
Log of Income	1.018	0.780	1.011	0.835
Group membership	1.028	0.309	1.055	0.620
Log of Household size	0.725	0.062*	0.717	0.046**
TAVs farm size	1.158	0.040**	1.139	0.072*
Constant	0.084	0.044	0.079	0.024
Number of observations	61		61	
Wald chi2(8)	38.16		33.21	
Prob>chi2	0.0000		0.0001	
Pseudo R2	0.0304		0.0660	

Akaike's and Bayesian Information Criteria for the Models

Model	Obs.	ll(null)	ll(model)	df	AIC	BIC
Standard Poisson	61	-104.4171	-101.2473	9	220.4946	239.4925
Generalized Poisson	61	-97.95632	-91.49381	10	202.9876	224.0964

*, ** and *** denote significance level at 10, 5 and 1%, respectively

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Table 7: Factors which influence farmers' frequency intake

Dependent variable = Frequency intake	Standard Poisson IRR	P-values	Generalized Poisson IRR	P-values
Gender	0.956	0.713	0.886	0.434
Log of Years in schooling	1.329	0.465	1.221	0.654
Log of Age	1.679	0.046**	2.098	0.035**
Occupation	1.023	0.384	0.979	0.568
Log of Income	0.879	0.076*	0.771	0.001***
Log of household size	0.459	0.001***	0.359	0.001***
Log of farm size	1.077	0.410	1.253	0.034**
Log of distance to Mkt	0.950	0.437	0.888	0.123
Culture/taboos	1.010	0.950	1.016	0.935
Medicinal value	1.029	0.875	1.029	0.903
Price of TAVs	1.336	0.027**	1.406	0.016***
Log of TAVs Weekly expenditure	1.063	0.658	1.131	0.248
Constant	0.974	0.986	3.297	0.523
Number of observations	61		61	
Wald chi2(11)	22.11		40.95	
Prob>chi2	0.0363		0.0000	
Pseudo R2	0.0288		0.1739	

Akaike's and Bayesian Information Criteria for the Models

Model	Obs.	ll(null)	ll(model)	Df	AIC	BIC
Standard Poisson	61	-69.30718	-67.31347	13	160.6269	188.0683
Generalized Poisson	61	-61.0714	-50.44855	14	128.8971	158.4493

, ** and * denote significance level at 10, 5 and 1%, respectively*

Table 8: Results of Exploratory factor analysis

Factor and item description	Factor loading	% Variance explained
Factor 1: Health benefits		31.44
Consumption of TAVs is important to women, children and men	0.530	
Fresh TAVs contain more nutrients than dried ones	0.574	
Intake of TAVs variety each day guarantee vitamins and minerals required	0.872	
It is important to choose diet accompanied with TAVs	0.753	
Consumption of TAVs improve eyesight and boost body immunity	0.572	
TAVs are best consumed when fresh	0.733	
I am willing to preserve TAVs for the next generation	0.716	
Factor 2: Personal perception		13.79
TAVs are not good to me	0.633	
Factor 3: Personal taste		13.72
TAVs are tasteless and bitter	0.895	
Total Explained variance (%)		58.95

Source: Author' survey of TAVs farmers in Arumeru District, July to November 2015

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