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# IMPACT OF NUTRITIONAL PERCEPTIONS OF TRADITIONAL AFRICAN VEGETABLES ON FARM HOUSEHOLD PRODUCTION DECISIONS: A CASE STUDY OF SMALLHOLDERS IN TANZANIA

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SUMMARY

Recent years have seen increasing political interest and growing public health awareness and advocacy for diversifying diets into highly nutritious traditional vegetables, fruits and other nutrition-sensitive crops as a more viable approach to mitigate the growing scourge of malnutrition due to unhealthy and imbalanced diets. These foods contribute essential micronutrients, vitamins, antioxidants, and other health-related phytochemicals to staple-based diets and their consumption is crucial for the attainment of several Millennium Development Goals. Despite their nutritional benefits and the high farm gate values per unit of land, the production and marketing of traditional vegetables from Tanzania and other countries in sub-Saharan Africa are constrained by factors such as poor quality seeds, lack of appropriate market information and support systems, and lack of consumer awareness of their nutritional importance. This paper investigates the determinants and pathways for smallholder participation in traditional African vegetable production and identifies entry points for farmers to increase traditional vegetable production by linking nutritional awareness and promotion with potential high value markets. A primary survey of 181 traditional vegetable growers from five regions of Tanzania indicates that perceptions about the nutritional value of traditional African vegetables are a main driver of household production decisions in the sector. The results of this study provide evidence that farmers tend to grow more African traditional vegetables as compared to other crops based on their increased level of perception towards nutritional value of traditional vegetables along with other factors such as their market value, timely availability of quality certified seeds, willingness to invest in labour, required training for women and better access to credits. Farm size negatively affects growing traditional vegetables, implying that on a comparative basis, smallholders tend to grow more traditional vegetables than larger-farm operators. Thus, more attention should be given to reducing production and its associated transaction costs by ensuring timely access to quality certified seeds, ensuring optimal use of inputs and increasing labour productivity, particularly for smallholders.

## INTRODUCTION

Nutrition has captured the international spotlight in an unprecedented way, as persistent global hunger and undernutrition have underscored the need for urgent action. One in eight people around the world still suffer from hunger, and more

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than double that number are victims of hidden hunger (IFPRI, 2014). Traditional African vegetables can make an important contribution to food and nutritional security and can enhance the livelihoods of marginal and smallholder farmers. In comparison with globally important vegetables such as cabbage (*Brassica oleracea*) and tomato (*Solanum lycopersicum*), traditional vegetables including amaranth (*Amaranthus spp.*), African eggplant (*S. aethiopicum*, *S. anguivi* and *S. macrocarpon*) and jute mallow *(Corchorus spp.*) have been shown to be rich in micronutrients such as iron, zinc, pro-vitamin A (Weinberger and Msuya, 2004) and phytochemicals that help protect people against non-communicable diseases (Uusiku *et al.*, 2010; Yang and Keding, 2009). Traditional vegetables complement staple-based diets, and their consumption is crucial for the attainment of several Millennium Development Goals, such as improving maternal health and reducing child mortality (Afari-Sefa *et al.*, 2012). For example, African eggplant, an easily cultivated vegetable, recently has been found to possess protective properties against ulcers induced experimentally, making it a cheap source of natural anti-ulcer remedy (Chioma *et al.*, 2011). In addition to their nutritional and medicinal importance, traditional vegetables are considered valuable because of their ability to fit into year-round production systems (Weinberger and Msuya, 2004). Most traditional vegetables are easy to grow in home and market gardens of less than 0.25 ha, or under non-mechanized commercial production systems of up to 2 ha. They typically require little space, and can thus maximize scarce water supplies and soil nutrients better than crops such as maize, which need a lot of water and fertilizer (Tenkouano, 2011). Many traditional vegetables have high yields within a short period of growth, are easy to harvest with minimum labour, and have widely acceptable taste.

Despite the wealth of agronomic, economic and nutritional benefits traditional vegetables provide, the production and marketing of these crops from Tanzania and other countries in sub-Saharan Africa are constrained by factors such as poor quality and availability of quality seeds and other production-related risks, lack of appropriate market information and support systems (e.g., cold storage), and high postharvest losses – all of which prevent farmers from better exploiting the opportunities traditional vegetable crops present. This partly stems from the fact that most past and some on-going efforts to address food security have concentrated on the provision of calories by enhancing the availability of staples, particularly cereals, and root and tuber crops, rather than placing emphasis on appropriate nutritional elements that can be attained from a balanced diet. A study on the patterns and determinants of dietary micronutrient deficiencies in rural areas of east Africa showed that staples provide somewhat more than 70% of the calorie intake of farmers in Rwanda, Uganda and Tanzania (Ecker *et al.*, 2010). Yet, awareness of the importance of nutrition has recently increased in many countries, which should create new opportunities for traditional vegetables. Research is needed to better understand the potential opportunities and perceived critical bottlenecks faced by smallholder farmers in their decisions to produce and consume traditional vegetables to devise effective dissemination and adoption strategies.

The underlying factors on the supply side of vegetable consumption outcomes seem to be quite well understood, but the socioeconomic behavioural constructs of producers and their perceptions of the nutritional benefits of traditional vegetables from the

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demand side require further evidence. This paper is possibly the first to empirically investigate the factors that motivate smallholder households to integrate traditional vegetables into their farming systems, and to identify pathways and entry points to increase their cultivation of traditional vegetables by linking their perception of the nutritional benefits gained from traditional vegetables with potential high value markets in Tanzania. It is hypothesized that (i) farmer's perception about the importance of nutrition will have a significant and positive effect on the share of traditional vegetables to total cultivated crop area; (ii) farmer's education and age positively and significantly influence share of traditional vegetables; and (iii) there is a positive and significant effect of regional impact on area under traditional vegetable crops; (iv) female-headed households' participation is significantly and positively related to the share of traditional vegetable cultivated area to total crop cultivated area. These hypotheses are tested through econometric estimations described in subsequent sections of the paper.

## MATERIALS AND METHODS

### *Study sites*

Our analysis is based on a primary survey of 181 farm households that cultivate traditional vegetables in five administrative regions of Tanzania known for vegetable production and marketing: Arusha, Tanga, Morogoro, Dodoma and Dar es Salaam (Figure 1). The Arusha site falls under the Northern Highlands agro-climatic zone and experiences bimodal rainfall of 760–1200 mm per annum (usually from October–December and March–May). The Tanga region (Lushoto district) is located within the Western Usambaras, with an altitude ranging from 610 to 2300 masl, characterized by steep slopes and narrow valleys (Vainio-Mattila, 2000) with a relatively high population density of 210 persons/km of agricultural land. Land use is a combination of traditional subsistence farming and modern cash crop production. Subsistence crops such as maize, field beans, bananas, cassava and sweet potatoes are grown on hillsides, while vegetables are mostly grown in valley bottoms (Vainio-Mattila, 2000). Compared to most other agro-climatic zones of the country, the Lushoto study site enjoys a relatively cool climate with temperatures ranging from 18–23 °C with the maximum occurring in March and minimum in July, and high rainfall of 600–2000 mm per annum. The area is characterized by high rainfall variability. The Morogoro region has a coastal climate with temperatures ranging from a minimum of 19 °C to a maximum of 30 °C, mean annual precipitation of 854 mm, and an altitude of 366–549 masl. The Dodoma region study site in central Tanzania has a semi-arid (savanna) type of climate with a unimodal rainfall regime of 500–700 mm per annum, usually starting as early as mid-November in some places and ending around mid-May, followed by a long dry season (Stigter *et al.*, 2005). The rainfall is relatively low in amount and rather unpredictable in frequency.

The unreliability of rainfall in these regions imposes a pattern of risk aversion in traditional farming. During the long dry season, persistent desiccating winds and low humidity contribute to high evapotranspiration and soil erosion.

Dar es Salaam, the commercial capital of Tanzania, has a coastal savanna agro-climate. Because it is close to the Equator and the warm Indian Ocean, the city and

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Figure 1. Map of Tanzania showing study regions.

surrounding towns experience generally tropical climatic conditions, typified by hot and humid weather throughout much of the year. Annual rainfall is approximately 750–1100 mm, and in a normal year there are two rainy seasons: the major rainy season is in April and May, while the minor season is usually from October to November. This region is characterized by infertile sands on gently rolling uplands and fertile clays on uplands and river floodplains.

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*Study approach and data*

The study employed a combination of key informant interviews, focus group discussions with farmers and detailed one-on-one sampled household survey. This was augmented with secondary data from various sources including published reports. A purposive sampling was employed to sample 181 traditional vegetable producers from the five regions based on the perceived relative importance of traditional vegetables in the various regions (i.e., cultivated area and market access) to farmers. In all, 57 respondents each were selected from the Arusha and Dodoma regions, while 25, 22 and 20 respondents were selected from Morogoro, Dar es Salaam and Tanga regions respectively between March and May 2013. The 12-month cropping year reference period for survey data was from March 2012 to February 2013. Purposive sampling was also used to select key informants from relevant organizations and service providers at district and national levels. Information collected from the respondents included: household socioeconomic and demographic characteristics, land use, cropping patterns, access and use of agro-inputs and services, practices in marketing of traditional vegetables, self-perceptions about new technology and traditional vegetable production, marketing and nutritional awareness of perceived health benefits from consumption of traditional vegetables.

*Empirical model*

The underlying empirical model examines the effect of farmers' perceived nutritional and health benefits obtained from consumption of traditional African vegetables towards their decision to grow them (otherwise, known as traditional African vegetable crop concentration) in terms of the ratio of the total area under their cultivation to total crop cultivated area using a log-linear regression model. According to (Bhatia, 1965), the measurement of crop concentration is normally used by geographers to understand the agricultural distributions using a ratio between two units of measurement in the same area – for example, the ratio of cropped area to total area or the ratio of vegetable area to cropped area in hectares. The measurement approach provides an idea of the variations in the density of crop distribution being investigated as well as the importance of the focus crop in comparison with other competing crops. The study also examines other determinants of household engagement in traditional vegetable crop production such as crop specific factors, socioeconomic characteristics of surveyed respondents and regional effects.

Since the dependent variable used in the estimation is the share of traditional vegetable cultivated area to total area under cultivation of all crops, a variable which is typically constrained between 0 and 1, the study used a logit transformation of dependent variable for the regression estimates. The specification for log-linear model can be stated as follows:

$$\ln Y_i = \beta_0 + \sum_{k=1}^{N} \beta_n \ln Z_{ki} + u_i, \tag{1}$$

where: $Y$ is a dependent variable that represents a logit transformation of the share of traditional vegetable cultivated area to total area under cultivation for all crops.

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$Z_{ki}$ = socioeconomic characteristics of the farm households[1]; $k = 1 \ldots . j$ (number of explanatory variables) and $i = 1,..N$ (number of farm households); Ln is the natural logarithm with base $e$. The parameters of the multiplicative regression model are estimated by the log-linear model proposed in equation (1), using STATA version 12.0 econometric software.

Gender is a dummy variable representing male and female respondents during the field survey. The reason for including gender as a dummy variable was to understand the role of female respondents on traditional vegetable production decisions. Women have traditionally been active in African agricultural production in addition to their responsibility for preparing food for the entire household and thus responses from female farmers with respect to their cropping preferences and related farm production decision is critical (Boserup, 1970; Gotor and Irungu, 2010; Lastarria-Cornhiel, 2008; Voster *et al.*, 2007). Enete and Amusa (2010) argued that women's contribution to farm decision making is dependent on varied socioeconomic characteristics of the farm households. Thus, this study explored an interaction effect between gender with other socioeconomic variables such as level of education, age of farmers. The results did not however show any significant causal relationships and were thus dropped in the final model results reported for this study.

In recent years, the demand for traditional African vegetables has increased but lack of availability and accessibility of quality seeds of preferred varieties has not resulted in a corresponding increase in production, thereby reducing the ability of farmers to deliver improved produce to consumers (Afari-Sefa *et al.*, 2013; Gotor and Irungu, 2010). This study therefore, included selected explanatory variables in the log-linear model, namely: farmers' experiencing bottlenecks in access to traditional vegetable seeds in terms of timely availability, price and quality of seeds, cost of inputs and market demand trends through revenue from crop sales. In Tanzania, a large number of farmers are smallholders, with less than 2 ha, most of who grow traditional vegetables (Weinberger and Msuya, 2004). Thus, the net operated area (NOA) was included as a proxy variable for farm size to ascertain the contribution of traditional vegetable cultivation within the cropping mix of the farm household. In the context of developing countries, the sign of the coefficient of NOA is expected to be negative, as smallholders are known to be more efficient in land management particularly in the context of vegetable cultivation (Coelli and Battese, 1996; Rajendran, 2014).

[1] $Z_1$ = Gender (Dummy variable: Value is 1 if respondent is female, 0 if otherwise); $Z_2$ = Age (Age of household head for farm $j$); $Z_3$ = Education level of household head owning farm $j$, measured in years of schooling; $Z_4$ = Contact with extension agent (Dummy variable: Value is 1 if the farmer had contact with an agricultural extension agent in the past year, 0 if otherwise); $Z_5$ = Access to cash credit (Dummy variable: Value is 1 if the farmer received cash credit in the past year, 0 if otherwise); $Z_6$ = Net operated farm area per household $j$ in ha; $Z_7$ = Distance from farm to main road in km; $Z_{8,9,10}$ = Experienced bottleneck in access to traditional vegetable seed in terms of timely availability, price and quality of the seed (Dummy variables: Value is 1 if the farmer experienced a bottleneck in the reference season, 0 if otherwise); $Z_{11}$ = Total input costs, including seeds, fertilizers, agro-chemicals and labour costs in Tanzanian shillings; $Z_{12}$ = Perceived awareness of the nutritional importance of vegetables in human nutrition, measured using a 1–5 point Likert scale variable (i.e., 1 = strongly disagree; 2 = disagree; 3 = neither agree or disagree; 4 = agree; and 5 = strongly agree); $Z_{13}$ = Log of traditional vegetable crop sales value; $D_d$ = Region dummies ($D_5$ = Dodoma* (slope dummy); $D_1$ = Arusha, $D_2$ = Tanga, $D_3$ = Dar es Salaam and $D_4$ = Morogoro region).

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Awareness of the nutritional importance of vegetables in human nutrition influences their dietary pattern (Oniang'*o et al.*, 2003). Several other authors (see for example, Herforth, 2010; Jones *et al.*, 2014; Pellegrini and Tasciotti, 2013; Smale *et al.*, 2013; Thompson and Meerman, 2010) conclude that crop diversity and dietary diversity are associated with each other. However, very limited studies have linking farmers' perceived awareness of the nutritional importance of vegetables to their crop cultivation patterns and hence it is important to understand this causality linkage. Therefore, this study included a variable on farmers' perceived awareness of the nutritional importance of vegetables, measured on a Likert scale between 1 to 5 scale, (i.e., 1 stands for strongly disagree and 5 stands strongly agreed) connoting the level of farmers awareness about the importance of vegetables in human nutrition. Consistent with the sample design, district dummies are included to control for possible location-specific factors such as infrastructural endowment and agro-ecological conditions.

## RESULTS

Results from the key informants' qualitative surveys indicate that traditional African vegetables are well known by majority of Tanzanians. This dates several decades back when they were mostly collected from the wild, especially during the rainy season before their subsequent domestication. The preference differs from one community to another depending on their socio-cultural background as well their food and eating habits. Respondents confirmed that in the past the popularity of a certain vegetable used to be attributed by taste, medicinal properties, availability and access. Recent years has seen a resurgence in an increased awareness of the nutritional value of traditional African vegetables, partly due to increased promotional efforts by public health and policy experts and to some extent the mass media. This was further confirmed during the focus group discussions, where farmers confirmed that efforts in promoting nutritional awareness especially for pregnant women and children by development agencies have substantially contributed to increasing the consumption of traditional vegetables by several households. It is always common to hear from medical doctors and public health specialist referring their clients to increase their consumption of traditional vegetables as an option for ensuring balanced diets and improved nutritional as they are easily affordable, easy to prepare and very rich in micronutrients that are mostly deficient in most diets. In schools, teachers will also make reference to traditional vegetables especially when they are trying to cite simple measures to prevent some health conditions during classes. Currently, traditional vegetables can be grown easily and harvested within a short time without investing a lot of resources. Farmers can now access seeds from their own saving or buy from seed stockiest and grow for sale and earn income. In recent times, traditional vegetables occupy higher proportions in local markets thereby substantiating their increased demand triggered by increased awareness in nutritional value from the consumer side. In the past, the tendency was to prepare vegetables for certain meals only but nowadays people prefer to have most of their meals served with vegetables.

Table 1. Land ownership and cultivated area by farm size category.

| Farm size category | No. of households | % of households | Total area owned (ha)* | Net operated area (ha)* | Net operated irrigated area (ha) | % of NOA** (Weighting by household) |
|---|---|---|---|---|---|---|
| Marginal & small farm (0–2 ha) | 139 | 77 | 0.7 (0.6) | 0.8 (0.5) | 0.4 | 43.9 |
| Medium farm (2–4 ha) | 32 | 18 | 2.8 (1.1) | 2.7 (0.5) | 0.5 | 34.1 |
| Large farm (> 4 ha) | 10 | 5 | 6.0 (2.2) | 6.9 (3.4) | 0.5 | 27.2 |
| Overall | 181 | 100 | 1.4 (1.6) | 1.4 (1.8) | 0.5 | 100 |

*Numbers in parenthesis denote standard deviations.
**Net operated area.

Prior to specifying the model, the zero-order correlation matrix among the independent variables was computed to detect possible multicollinearity problems. The results (not reported) show there is no multicollinearity among the independent variable and hence the multiplicative regression analysis approach can be applied for the purpose of the study. The descriptive statistics of the regression variables are specified in Appendix 1. Table 1 presents results of land ownership patterns disaggregated by farm size. The percentage of NOA weighted by the number of households indicates that marginal and smallholders with total land of 0–2 ha and average NOA of 0.4 ha constitute the majority (44%) of the sample that cultivated traditional vegetables. This is critical knowledge for promoting traditional vegetable production to smallholders, such as through home gardens and urban and peri-urban market-oriented gardening for income.

Results from basic descriptive analysis show that overall, amaranth is the most preferred traditional vegetable cultivated followed by African eggplant, Ethiopian mustard, African nightshade and sweet potato leaves in that order (Figure 2).

The estimated parameters of log-linear models on determinants of crop concentration towards traditional vegetables show mixed results. The first task involved ascertaining if a farmer's awareness of the importance of nutrition will have significant and positive effect on the share of traditional vegetables to total cultivated crop area was estimated. There are observed differences in the choice of traditional vegetables that are preferred in the various regions (Figure 2). Overall, the model had a good fit with an $R^2$ of around 68% variation in the endogenous variables due to variation in explanatory variables.

The results show that when farmers are more aware of the nutritional benefit from traditional vegetables compared with other crops, the intensity of cultivation of traditional vegetable crops is significantly higher than other crops at the 10% probability level (Table 2). The result is consistent with earlier qualitative studies carried out selected African countries that conclude that, African traditional vegetables contain substantial amounts of micronutrients and are thus highly recommended for smallholder inclusion in their cropping mix for diversifying household cropping

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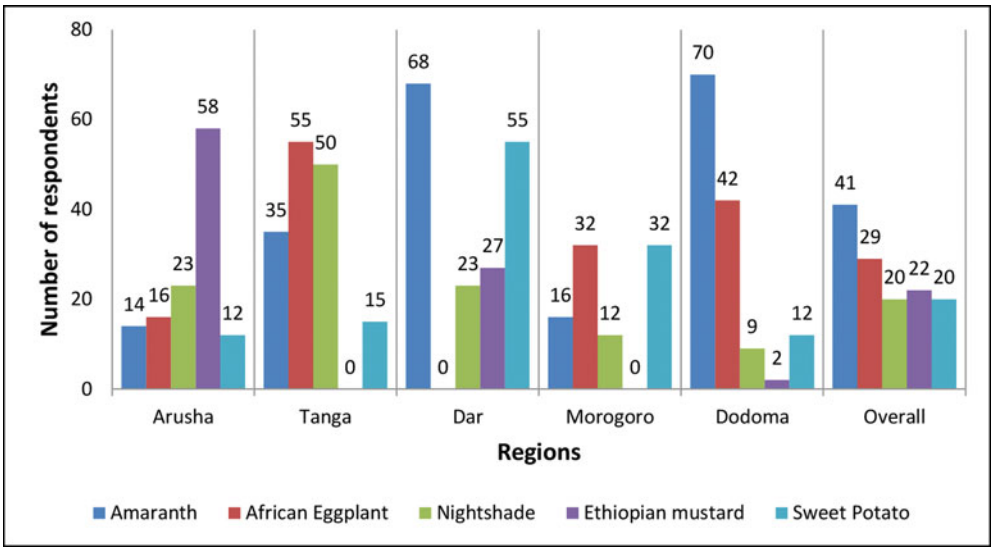


Figure 2. Household cultivation of various traditional vegetables by region.

income while meeting household nutritional needs (Odhav *et al.*, 2007; Voster *et al.*, 2007). In addition, female respondents were found to be on the average more intensively engaged in traditional vegetable cultivation compared to their male counterparts (see for example, Ecker *et al.*, 2010; Weinberger and Msuya, 2004). Interestingly, participation in traditional vegetable cultivation is largely dependent on smallholders whose NOA show negative relationships with crop concentration towards traditional vegetables in comparison with other crops produced by the same farm household.

Our results further show that a farmer's education level is negatively and significantly related to the share of traditional vegetables to total area under cultivation. This might be attributed to the fact that with increased education, farmers tend to generally increase their investment in non-traditional vegetable crop production. Alternatively, the divergent results might be attributed to possible opportunities for an investment transition from farm to non-farm income-earning activities. This is not surprising given their smaller volumes of per unit transaction, high perishability and shorter value chains compared to non-horticultural produce. Access to extension services does not provide much value to farmers, hence the need for a more dynamic approach to encourage farmers to diversify into vegetable cultivation. In addition, access to credit is also positively and significantly related to the share of traditional vegetable cultivated area to total crop area under cultivation. Farmers' tendency to spend more on inputs (i.e., seeds, fertilizers and chemicals) most likely leads to an increase in their share of traditional vegetable cultivated area to total crop cultivated area. Family labour capacity was found to be positive and significantly related with traditional vegetable cultivation. Since vegetables in general are mostly grown by smallholders, there is a possibility that family labour is the main labour source for

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Table 2. Determinants of African traditional vegetable crop concentration within existing farming systems.

| Variables | (1) Model 1 |
|---|---|
| Female | 0.332** |
| | (2.387) |
| Level of education (Years) | −0.0541*** |
| | (−4.113) |
| Age (Years) | −0.0110 |
| | (−1.349) |
| Family size | 0.0295 |
| | (0.897) |
| Log of net operated area | −0.873*** |
| | (−7.170) |
| Awareness on nutrition value of TAVs *(scale)* | 0.167* |
| | (1.673) |
| Extension services (Dummy) | −0.106 |
| | (−0.516) |
| Credit access (Dummy) | 0.808*** |
| | (3.121) |
| Log of total input cost (excl. family labour) | 0.207*** |
| | (2.920) |
| Timing of_seed (Dummy) | −0.507* |
| | (−1.839) |
| Price_of seed (Dummy) | −0.0329 |
| | (−0.141) |
| Quality of_seed (Dummy) | 0.0612 |
| | (0.255) |
| Log of family labour cost | 0.329*** |
| | (2.626) |
| Arusha region (Dummy) | 0.566** |
| | (2.400) |
| Tanga region (Dummy) | 0.609** |
| | (2.456) |
| Dar es-salaam region (Dummy) | 0.206 |
| | (0.390) |
| Morogoro region (Dummy) | −0.0412 |
| | (−0.116) |
| Log of sales value of traditional vegetable crops received | 0.139* |
| | (1.717) |
| Constant | −8.300*** |
| | (−4.714) |
| Observations | 122 |
| R-squared | 0.685 |

Robust t-statistics in parentheses; Significant Level: ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$.

traditional vegetable cultivation. There were also statistically significant regional effects of household participation in traditional vegetable cultivation for Arusha and Tanga regions, likely due to marked agro-climatic variations, particularly, relatively much higher precipitation than the three other study regions. Finally, farmers tend to expand their share of traditional vegetable cultivated area to total crop cultivated area when

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they perceive they can accrue relatively better market value and income for their sales; hence the need for strong market linkages for producers of traditional vegetables.

## DISCUSSION

There are observed marked regional differences in preference among the types of traditional vegetables cultivated in the survey sites for this study. In addition to likely differences in food eating habits as noted from the qualitative study and agro-climatic adaptations, the observed differences could be attributed to that fact that fruit-type traditional vegetables such as African eggplant have high farm gate values and can contribute significantly to household income in predominantly commercial vegetable producing centres such as Lushoto district (Tanga region) and other vegetable production baskets in the Morogoro region, while leafy types such as amaranth and African nightshade contribute mainly to household nutritional needs through their inclusion in home gardens in Arusha and Dodoma.

Several reasons may also account for the observed increasing trend in traditional vegetable crop concentration within the study locale. These could be due to one or more of factors such as: monetary benefits, awareness about nutritional benefits, better access to agricultural inputs and services, risk aversion mechanism/diversification (i.e., climate, income, food etc.). Results from the log-linear regression analysis specifically show that gender, level of education, farm size, awareness of the nutritional benefits of traditional vegetables, access to credit, total input costs, regional differentiation, timing of seed supply, family labour endowment and expected revenues accrued from sale of traditional vegetables are significantly related to concentration of traditional vegetable crops within the farming system.

Consistent with the results of an earlier study by Weinberger and Msuya (2004), the generally observed increased trend towards increasing traditional vegetable crop concentration within the farming system could partly be attributed to the tendency of shifting consumption baskets towards increased proportions of traditional vegetables resulting from increased awareness of their human nutritional and health benefits. Most importantly, farmers tend to reduce the share of their traditional vegetable cultivated area within the overall cropping mix when they perceive that traditional vegetables seeds will not be available in time for the next cropping season.

With regards to seed systems, the results underscore the fact that access to quality seeds alone (for example; Afari-Sefa *et al.*, 2013; Rohrbach *et al.*, 2003), is not sufficient to address the critical bottlenecks in the seed supply and distribution system of traditional vegetables. Principally, traditional vegetable seeds must be made available for smallholders in a timely manner and well ahead of the commencement of the season to facilitate production of these nutrient-dense crops. This outlined factor could also be the reason why most farmers are still dependent on own farmer-saved seeds, possibly a guarantee for timely availability for the next growing season.

In addition, there is the need to link smallholders to high value traditional vegetable markets as income from sale of produce increases with increasing crop concentration. This is consistent with earlier studies conducted by other authors

(for example; Chagomoka *et al.*, 2014; Weinberger and Lumpkin, 2007). The results call for the need for policy makers to target intervention programs emphasizing the nutritional importance of vegetables towards smallholders and home gardeners since the former contributed 44% of the weighted sample (Table 1) as the highest volume of traditional vegetable crops for both market and home consumption. Given the significance of female respondent households with crop concentration, there is also the need to encourage female participation in the traditional vegetable sector through provision of adequate farm management training and knowledge for value chain upgrading. Further studies could consequently look into gender time surveys to ascertain the gender division of labour and asset transfer relationships and dynamics along the traditional vegetable value chain and their associated impacts on nutritional perceptions of farmers.

## CONCLUSION AND POLICY CONSIDERATIONS

Our study highlighted the often ignored demand-side factors guiding smallholders' decision to cultivate nutrition-sensitive crops such as traditional vegetables and their contributions in addressing the nutritional aspects of food security within the household.

There are several challenges in the traditional vegetable value chain (mainly due to high perishability of produce, particularly of leafy types) that are important to all actors in the sub-sector, yet interactions among them are hampered by information asymmetry that results in farmers neglecting or evading recommended practices. The following recommendations are offered:

- Householders seem to be aware of the higher farm gate values for traditional vegetables per unit area. They also understand the importance of traditional vegetables for nutrition – a main driver of their production decisions. Detailed measurements of vegetables, staples and other food items consumed by households are required to understand other psychological constructs.
- Family labour size is positively and significantly related to crop concentration on traditional vegetable cultivation. This is an indication of the preference allocation of more labour resources for the cultivation of traditional vegetables as compared to other crops, perhaps because of their relatively higher farm gate values and household nutrition needs.
- There are marked regional differences in traditional vegetable preferences that need to be noted for targeting future interventions.
- Since female-headed households involved in traditional vegetable production are more intensively engaged in it than male-headed households, it is necessary to provide adequate farm management training and knowledge for female farmers to upgrade the value chain. However, a study of decision making on vegetable production by females within male-headed households would be an interesting area for future research, to better understand gender roles and division of labour in the supply chain, and to explore options to empower women via traditional vegetable value chains.

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- It is also important for government to implement enabling policies to enhance timely availability for traditional vegetable seeds and to avoid spatial gaps, as farmers tend to grow less traditional vegetables when they perceive that seed is not available in time for cultivation. As a complement, advocacy for enabling collaborative policies that will encourage public–private partnerships can enhance timely availability of seeds to smallholders to bridge the spatial and time gaps in seed systems.

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Appendix 1: Descriptive statistics of Log-linear regression variables.

| Variable | Number of observations | Mean value | Standard. deviation | Minimum value | Maximum value |
|---|---|---|---|---|---|
| Share of traditional vegetables to total area cultivated | 183 | 0.4 | 0.3 | 0.01 | 1.00 |
| Female (dummy) | 181 | 0.4 | 0.5 | 0.00 | 1.00 |
| Level of education (Years) | 181 | 6.8 | 3.9 | 0.00 | 46.00 |
| Age (Years) | 179 | 39.5 | 10.5 | 18.00 | 64.00 |
| Family size | 181 | 5.4 | 2.2 | 1.00 | 14.00 |
| Net operated area | 181 | 3.5 | 4.4 | 0.10 | 35.00 |
| Awareness on nutrition value of TAVs *(scale 1–5)* | 180 | 4.0 | 0.8 | 1.00 | 5.00 |
| Extension services (Dummy) | 159 | 0.6 | 0.5 | 0.00 | 1.00 |
| Credit access (Dummy) | 151 | 0.1 | 0.3 | 0.00 | 1.00 |
| Total input cost (excl. Family Labour) in US$ | 180 | 59.1 | 89.5 | 0 | 603.60 |
| Timing of seed (Dummy) | 177 | 0.1 | 0.3 | 0.00 | 1.00 |
| Price of seed (Dummy) | 176 | 0.2 | 0.4 | 0.00 | 1.00 |
| Quality of seed (Dummy) | 177 | 0.2 | 0.4 | 0.00 | 1.00 |
| Family labour cost in US$ | 180 | 14.0 | 10.7 | 1.0 | 93.70 |
| Sales value of traditional vegetable crops received in US$ | 179 | 188.7 | 241.4 | 0 | 1956.0 |