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## Changing knowledge and perceptions of African indigenous vegetables: the role of community-based nutritional outreach

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### ABSTRACT

African indigenous vegetables (AIVs) have potential to sustainably address malnutrition, a growing problem in sub-Saharan Africa. Their consumption is however, limited by poor perceptions and lack of awareness of nutritional benefits. There is limited evidence of the effectiveness of community-focused information dissemination approaches in influencing participants' perceptions and uptake of innovations in AIVs to address malnutrition. This article aims to fill this knowledge gap, using a case study focusing on pastoral communities in Monduli district in northern Tanzania. Target communities participated in a community-based nutritional outreach facilitated by the Good Seed Initiative (GSI), held at Monduli district hospital in September 2014. The results provide evidence of the achievements of the GSI intervention, and the effectiveness of alternative information dissemination approaches.

### ARTICLE HISTORY

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Environment (built and natural) – Agriculture; Civil society – Participation; Methods; Sub-Saharan Africa

### Introduction

Malnutrition continues to linger in sub-Saharan Africa, due to unhealthy and imbalanced diets. This has led to increased public awareness and advocacy for diversifying diets with highly nutritious foods, including efforts to ensure food fortification. Tanzania is one of 22 African countries with the highest burden of undernutrition, particularly of children under five (World Bank 2011). Stunting affects 44% of children under five years old. Anaemia among pre-school-aged children and pregnant women is 72% and 58%, respectively; while 24% of pre-school-aged children and 15% of pregnant women are deficient in vitamin A. Malnutrition is particularly low among households consuming diets of mainly carbohydrate-rich staples with low minerals and vitamins. Differences in chronic malnutrition among different ethnic groups, and between farming and pastoral households, are particularly striking. The prevalence of child stunting among under-fives is 59% among Masaai pastoral communities, compared to between 20 and 40% in neighbouring ethnic groups (Lawson et al. 2014). Similarly, 81% of Maasai herders are categorised as severely food insecure, compared to 72% of all farmers.

African indigenous vegetables (AIVs), also known as African traditional vegetables, hold excellent potential to improve nutrition and increase the dietary diversity of rural households. AIVs include all plants that originate on the continent, or have a long history of cultivation and domestication to African conditions and whose leaves, fruits, or roots are acceptable and used as vegetables through custom, habit, or tradition (Ambrose-Oji 2012). Over 275 species of vegetable are reported to be growing in Africa, of which 207 are indigenous to Africa. In Tanzania, popular AIVs in urban markets and rural settings include amaranth, okra, spider plant, jute mallow, celosia, jew's mallow, roselle, cowpea leaf, African nightshade, and African eggplant (Lotter et al. 2014). Indigenous vegetables are nutrient-dense and help address mineral deficiencies and hidden hunger, impacting

positively on well-being and productivity. For example, amaranth (*Amaranthus* spp.) and African eggplant (*Solanum aethiopicum*) are rich in micronutrients such as iron and vitamin A (Weinberger and Lumpkin 2007). Compared with, for example, cabbage, amaranths have been shown to contain 57 times more vitamin A precursor, 13 times more iron, and eight times more calcium (Yang and Keding 2009). As well as nutritional benefits, the production of AIVs has demonstrated higher returns to labour (Kansiime et al. 2016) and higher farmgate values per unit area (Afari-Sefa et al. 2016) compared to a typical cash crop such as maize or sunflower. AIVs also generally have shorter growing cycles compared to most staple crops, and can fit into year-round production systems. They have the ability to maximise scarce water supplies and soil nutrients better than crops such as maize (Weinberger and Lumpkin 2007).

Despite their nutritional, income, and environmental benefits, the production and consumption of traditional vegetables in Tanzania and other countries in sub-Saharan Africa remains low due to factors including cultural values, human perceptions, and lack of consumer awareness about their benefits (Afari-Sefa et al. 2016; Faber et al. 2010; Vorster et al. 2007). The culture of using vegetables is richer in some communities than in others. Maundu and Imbumi (2003) show significantly low consumption of AIVs among Masaai pastoral communities in Kenya and Tanzania compared to agro-based communities. Pastoralists traditionally survived on meat and fresh blood mixed with milk, and green plants were regarded as animal fodder only and not suitable for human consumption. Some people also associate the consumption of traditional vegetables with poverty (Afari-Sefa et al. 2016; Faber et al. 2010; Muhanji et al. 2011; Yang and Keding 2009). Negative perceptions have been more commonly reported among younger and urban consumers than older and rural consumers (Vorster et al. 2007). Kimiywe et al. (2007) did not find a significant relationship between household income and education level on the use of indigenous vegetables, implying the importance of perceptions in shaping the utilisation of AIVs. Such perceptions have generally reduced the status of AIVs. In Tanzania, negative perceptions of AIVs have led to a reduction in their share (from 20% to 11%) as a proportion of the total value of food in diets (Ambrose-Oji 2012).

Various initiatives aiming to change perceptions and increase awareness of the health benefits of AIVs and other nutrition-sensitive traditional foods have been initiated in Africa. They aim to reach rural and urban consumers through diverse approaches, such as community-based outreach, mass media, ICT-enabled campaigns, and educational programmes in schools and hospitals. Studies investigating the effects of some awareness campaigns have shown positive effects on participants' perceptions (Vorster et al. 2007), increased demand (Muhanji et al. 2011; Ojiewo et al. 2013), increased production (Afari-Sefa et al. 2016), and increased consumption (Taruvunga and Nengovhela 2015) of AIVs. Ochieng et al. (2016) showed that participation in AIV promotional activities had a positive and significant effect on children's and women's dietary diversity in northern Tanzania. However, there is limited evidence of the effectiveness of community-focused information dissemination approaches in influencing participants' perceptions and uptake of innovations in AIVs to address malnutrition.

This study aims to fill this knowledge gap by assessing changes in knowledge and perceptions of AIVs attributed to community-based nutritional outreach activities. It assesses the effectiveness of community-based outreach in influencing participants to take up AIV innovations, compared to other information sources available to farmers. A case study research design is used, focusing on pastoral communities in Monduli district in northern Tanzania. Target communities participated in a community-based nutritional outreach facilitated by the Good Seed Initiative (GSI), held at Monduli district hospital in September 2014. The results provide evidence of the achievements of the GSI intervention, and of the effectiveness of alternative information dissemination approaches. This awareness is important to project implementers and policymakers in designing interventions or policies aimed at improving rural livelihoods, and particularly those relating to the delivery of extension or advisory services to ethnic communities.

## Methods

### *Description of intervention and study area*

The goal of the Good Seed Initiative (GSI) is to contribute to food and nutritional security of small-holder farmers and other actors in seed and vegetable value chains in Africa. Working in Tanzania, the initiative used an integrated approach that promoted production and consumption of AIVs in various communities, particularly those at risk of malnutrition. The initiative used diverse community-focused approaches – road shows, seed rallies, cook shows, nutritional outreach events, agricultural shows, and radio programming.

In September 2014, GSI conducted a nutritional awareness event at Monduli district hospital, in northern Tanzania. The zone consists of semi-arid lowland plains, found between 500 and 1,000 metres. The population is estimated at 158,929, with a population density of 22.7 people per square kilometre. Children 0–14 years of age comprise 48% of the total population (NBS 2013). Households in this area have traditionally survived through a combination of pastoral and agro-pastoral livelihoods, balancing semi-nomadic cattle-raising and crop cultivation. Recent climatic variability and changes in land tenure systems in the country have threatened pastoralism, making households dependent on it vulnerable to food insecurity and malnutrition (Homewood, Kristjanson, and Trench 2010). A nutritional outreach was launched in this community aimed at enhancing the role of AIVs in the nutrition of these vulnerable groups. AIVs provide means to diversify diets with nutrient-rich foods as well as to contribute to incomes.

At the outreach event, participants received training and information on AIV nutritional foundations – types of AIVs and their nutritional benefits, healthy preparation methods, new recipes, and child nutrition during the 1,000-day window (the period from the start of a mother's pregnancy through to her child's second birthday). The outreach also tackled production and processing of AIVs – how to grow AIVs (kitchen gardens, small plots), use of quality seed, and appropriate preservation to ensure nutrient retention. Printed fact sheets on health and nutrition (including recipes and preparation methods) about different AIVs were distributed to participants. Participants engaged in preparing and tasting of various AIV recipes. An estimated 600 people participated at the event. Eighty-five people (eight male and 77 female) were randomly selected as primary participants who received AIV seed start-up kits (which included seed of up to five different AIVs, each 10 gm, and agronomic information for each AIV type). Primary participants filled in feedback forms to aid further follow up.

### *Data used and collection method*

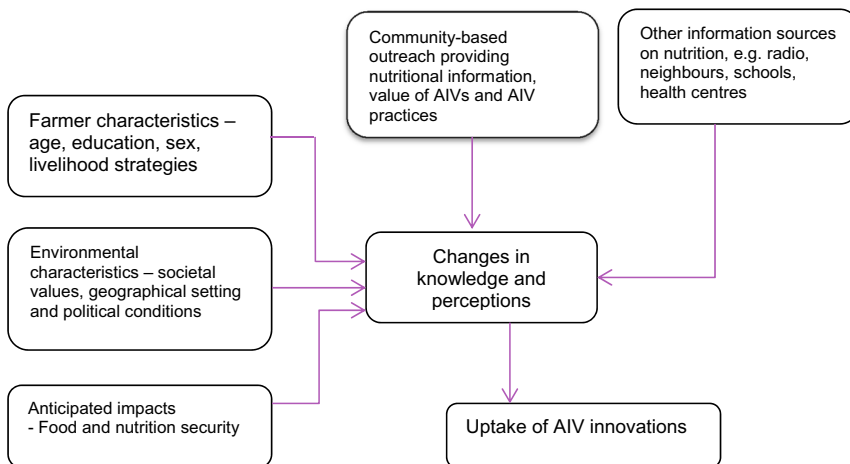
Data were collected in April 2016, 18 months after the GSI nutritional outreach. We undertook telephone surveys of the participants that signed feedback forms, and sampled field visits to observe practices at farm level and validate information obtained through phone interviews. The telephone survey reached 61 of the targeted 85 participants. All the registered participants were called, but only 61 still had active numbers that were reached. In order to increase the chances of reaching participants, calls were placed at different times of the day and each number tried at least five times before recording it as unavailable or unreachable. Field visits were done to 10 households, randomly selected from the registered list of participants. The questionnaire explored participants' knowledge of AIVs, awareness of nutritional benefits, changes in consumption patterns of AIVs, and AIV production and preparation innovations learnt and taken up. In addition, at least five officials at the hospital and district agricultural office were interviewed as key informants to understand changes in community perceptions, institutionalisation of the programme, and policy elements to sustainably address nutrition in the district. During telephone interviews and face-to-face interviews, informed oral consent was obtained first before proceeding with interviews.

## Analytical framework

Extension and communication are crucial in the development of knowledge and perceptions about agricultural innovations. Five extension models are described in the literature; media-based, commodity-based, training and visit, farming systems research and extension, and community-based (Scherr 1992). Differences in extension and communication models take into consideration varying agricultural production systems and contexts. Irrespective of the model used, there is need to link farmers' knowledge and extension to better understand how effective the approach is. For this study, community-based nutritional outreach was used to extend nutritional messages and innovations related to AIVs, in a traditionally pastoral community. Effectiveness of the outreach is measured in terms of its potential to influence participants to apply specific innovations or information communicated.

Application of new innovations is directly associated with change in the knowledge and perceptions of persons exposed to outreach messages. Drawing from Meijer et al. (2015), knowledge refers to factual information and understanding of AIV benefits and innovations, while perceptions relate to the views participants hold about AIVs based on their felt needs and prior experiences. Change in knowledge and perceptions are inherent factors that affect farmers' decisions to apply new innovations. Other factors explaining change in knowledge and perceptions include extrinsic factors such as socio-economic characteristics, environmental factors, and characteristics of the innovation. Figure 1 shows the interaction of various factors in influencing knowledge, perceptions, and uptake of innovations.

We measured change in knowledge and perceptions by the details on relevance and application of the specific innovations communicated to participants at the outreach. Poisson count regression model was estimated, with the dependent variable as the number of innovations taken up (intensity of uptake) by each respondent from those that were promoted at the outreach. We included various explanatory variables to take into consideration extrinsic factors affecting knowledge and perceptions; a vector of explanatory variables for socio-economic factors that may affect adoption of new innovations (age, education, sex, and primary occupation) and dummy variable representing the various sources of nutrition information (e.g. radio, outreach, school, health centre) as reported by farmers. Selection of explanatory variables was based on empirical studies (Afari-Sefa et al. 2016; Meijer et al. 2015; Ramírez and Shultz 2000).



**Figure 1.** Conceptual framework showing the interaction of various variables on farmer learning and perceptions.

The number of innovations applied by participant  $i$  ( $T_i$ ) was expressed as a function of independent variables ( $X_i$ ) as follows:

$$T_i = \alpha + \beta_i X_i \quad (1)$$

Running the Poisson model produced estimated parameters ( $\beta$ ) for each explanatory variable. To determine the marginal effect of each variable, differentiation of the function was done with respect to the independent variable,  $X_i$  yielding:

$$\frac{dT_i}{dX_i} = \beta_i(\alpha + \beta_i X_i) \quad (2)$$

The sign of the estimated parameters of each variable ( $\beta_i$ ) produced depicts the sign of the marginal effect of each respective parameter. The marginal effect, as in other count data models, was interpreted as the unit change in the intensity of adoption variable resulting from a change in the explanatory variable. Since our interest was the effect of information sources, effects were computed for information sources that showed a positive effect on utilisation of AIV practices.

## Data analysis

Data were entered directly into Excel format during interviews, and later exported to Stata Version 12 for analysis. Descriptive statistics analysis was done involving percentages, means, and frequencies of variables to describe the characteristics of respondents, their current knowledge and practices regarding AIVs and nutrition in general, that are attributable to the nutritional outreach. Poisson count regression model was estimated to understand the effect of alternative information dissemination approaches/sources on participants' probability of taking up new innovations in AIVs.

## Results and discussion

### Descriptive statistics

Respondents were mainly women, who made up 82% of total respondents (Table 1). Average education of respondents was at least 8.8 years in formal education, equivalent to lower secondary school level in Tanzania. Men had slightly more years in formal education compared to women. In terms of age, men were slightly older than women, and the average age of all respondents was 45 years. Despite the fact that the community is traditionally pastoral (subsistence based primarily

**Table 1.** Characteristics of survey respondents by gender ( $n = 61$ ).

Characteristics	Male	Female	Total sample
Respondents (%)	18	82	100
Education (average no. of years of formal education)	9.27 (1.14)	8.71 (0.51)	8.81 (3.53)
Age (average age in years)	45.91 (4.41)	44.67 (1.49)	44.90 (11.08)
Livestock (control) (=1 if primary occupation)	0	0.02 (0.02)	0.02 (0.13)
Crop (=1 if crop farming is the primary occupation)	0.46 (0.16)	0.48 (0.07)	0.47 (0.50)
Business (=1 if business or trading is the primary occupation)	0	0.08 (0.04)	0.07 (0.25)
Formal employment (=1 if primary occupation)	0	0.14 (0.05)	0.12 (0.32)
Informal employment (=1 if primary occupation)	0.55 (0.16)	0.28 (0.06)	0.33 (0.47)
Average number of AIV innovations taken up by participants	2.18 (0.226)	2.24 (0.08)	2.23 (0.61)

Note: <sup>a</sup> Figures in parentheses are standard error.

or exclusively on livestock herding), only a small proportion of respondents (2%) reported cattle keeping as their primary source of livelihood. A majority of respondents reported crop farming (47%) and informal employment (33%). Primary occupation differed between men and women, with men more engaged in informal employment (55%) compared to women (28%). Women also had more diversified sources of livelihood compared to men, although these were limited.

The current livelihood strategies exhibited by respondents can be attributed to a general decline of pastoralism throughout the twentieth century, which has seen many pastoral communities increasingly diversifying livelihoods towards agro-pastoralism and off-farm activities (Homewood, Kristjanson, and Trench 2010). The growing importance of diversification away from livestock keeping is taking place alongside drastic changes in land tenure which have decreased access to grazing land due to the subdivision of formerly communal rangelands into private landholdings or their designation as conservation areas (Homewood, Kristjanson, and Trench 2010). Despite these transitions in livelihood strategies to crop production, vegetable production and consumption remains limited in this community, largely attributed to their socio-cultural beliefs and customs which influence their food choices.

### Awareness of AIVs and benefits

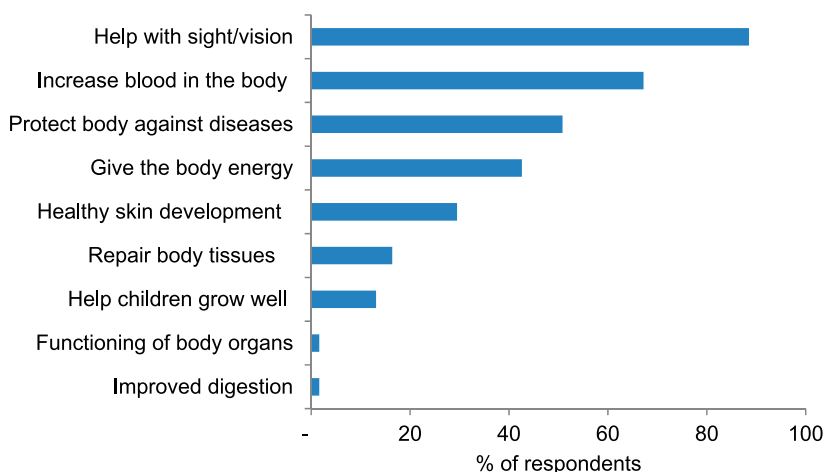
All the surveyed respondents indicated that they are aware of various AIVs and their associated nutritional and health benefits. In total, respondents mentioned up to 13 AIVs known in their community, with individual respondents mentioning up to seven AIVs. Commonly mentioned AIVs were: amaranth (*Amaranthus spp.*) (85%), pumpkin leaves (*Cucurbita maxima*) (82%), sweet potato leaves (*Ipomea batata*) (82%), nightshade (*Solanum nigrum*) (64%), and spider plant (*Cloeme gynandra*) (44%) (Table 2). Through field visits, respondents also mentioned other vegetables such as gallant soldier (*Galinsoga parviflora*) and blackjack (*Bidens pilosa*). These two vegetables were exclusively learnt at the nutritional outreach as they were commonly known as weeds, as narrated by one respondent.

"I didn't know that some of these weeds were actually vegetables and nutritious. When we had the nutritional outreach at Monduli, several vegetables were demonstrated and we participated in testing the recipes. Even "sungula weed" (gallant soldier only known as feed for rabbits) was prepared and now I am no longer looking at it as a weed but a healthy vegetable. My vision has improved and I attribute this to the frequent consumption of AIVs." (Resident of Monduli)

Respondents mentioned the key health benefits of AIVs as: improving vision, increasing haemoglobin in the body (reduced anaemia), and increasing body immunity (Figure 2). Other benefits mentioned included: giving the body energy, healthy skin development, repair of body tissues, and helping children grow. Responses from the farmers reflected the level of awareness, as the benefits mentioned

**Table 2.** AIVs known and the most preferred by respondents (n = 61).

No.	Common name	Scientific name	Known AIVs		Preferred AIVs	
			Freq.	%	Freq.	%
1	Amaranth	<i>Amaranthus spp.</i>	52	85	24	39
2	Pumpkin leaves	<i>Cucurbita maxima</i>	50	82	39	64
3	Sweet potato leaves	<i>Ipomea batata</i>	50	82	25	41
4	Nightshade	<i>Solanum nigrum</i>	39	64	29	48
5	Spider plant	<i>Cloeme gynandra</i>	27	44	6	10
6	Ethiopian mustard	<i>Brassica carinata</i>	18	30	4	7
7	Soybean vegetable	<i>Glycine max</i>	14	23	3	5
8	African eggplant	<i>Solanum aethiopicum (gilo)</i>	5	8	1	2
9	Black jack	<i>Bidens pilosa</i>	4	7	–	–
10	Jute mallow	<i>Corchorus spp.</i>	2	3	–	–
11	Cow pea leaves	<i>Vigna unguiculata</i>	2	3	–	–
12	Gallant soldier	<i>Galinsoga parviflora</i>	2	3	–	–
13	Okra	<i>Hibiscus esculentus</i>	1	2	–	–

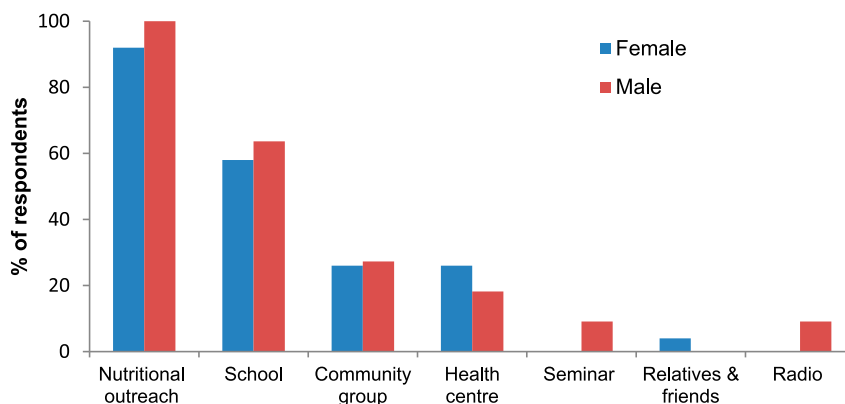


**Figure 2.** Farmer knowledge of health and nutrition benefits of AIVs.

correlate with information disseminated at the outreach, as well as empirical evidence on nutritional values of AIVs (Yang and Keding 2009).

The majority of respondents (100% male and 92% women) indicated that the GSI nutritional outreach was their primary source of nutrition information, with respect to AIVs, with 20% mentioning the outreach as their only source of nutritional information (Figure 3). This implies that 20% of respondents never received any other information related to AIVs and nutritional benefits after the outreach. Some respondents mentioned schools, health centres, and community groups as other sources of nutrition information, but mainly as follow-on programmes initiated by the respective institutions after the nutritional outreach. For example, at Monduli hospital where the event took place, nutrition awareness programmes were heightened, focusing on the value of AIVs. A vegetable garden was established at the hospital from where AIVs are occasionally harvested and included in meals for inpatients. The vegetable garden is also used to train outpatients on nutrition, by demonstrating the various possible sources of nutrients.

"At the outreach, we received a seed pack containing various AIV seeds – nightshade, amaranth, spider plant and African eggplant. We used that seed to establish a vegetable garden at the hospital. We include AIVs in meals provided to inpatients. We also encourage them to grow and consume AIVs for better nutrition. Feedback from returning patients is that they have increased consumption of AIVs in their homes." (Health worker at Monduli hospital)



**Figure 3.** Primary sources of information on nutrition benefits of AIVs.



Further, the District Commissioner, who was the chief guest at the event, facilitated the establishment of a vegetable garden for demonstration and awareness creation on the value of AIVs. The district leaders also lobbied for the inclusion of nutrition awareness programmes in the district budget, which was approved. A nutrition officer has been hired at the district level, and nutrition outreach activities planned. This is a positive step towards the institutionalisation of nutrition education for programme sustainability and scale out.

### ***Dynamics of AIV consumption and preference by households***

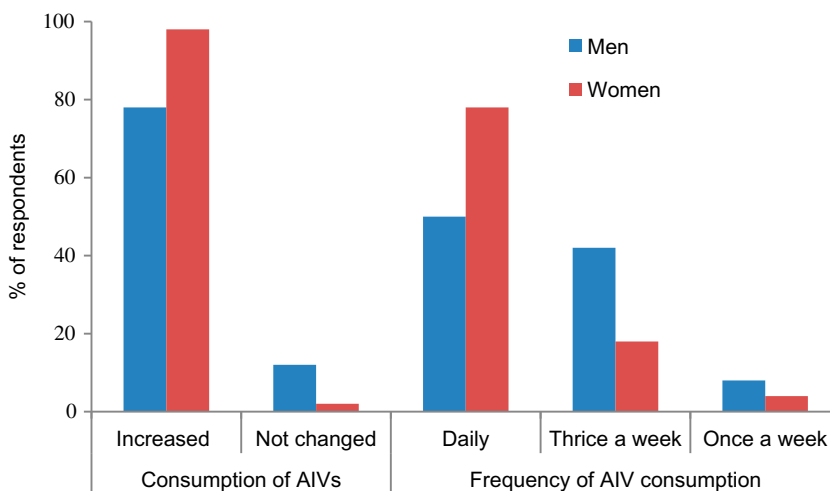
Prior to the outreach, community members hardly consumed AIVs, driven by the perception that indigenous foods are poor people's food. Consumption of AIVs was particularly less common among men, who considered it a taboo. Increased awareness on nutrition benefits translated into increased and deliberate consumption of AIVs by households.

At least 98% of women and 78% of men indicated that they now deliberately consume AIVs, and the frequency of consumption increased after the outreach (Figure 4). The most commonly consumed and preferred AIVs were nightshade, amaranth, sweet potato leaves, pumpkin leaves, spider plant, and Ethiopian mustard. Preference for these AIVs coincided with their awareness (Table 1), and knowledge of nutritional benefits (Figure 5). Respondents also mentioned that these AIVs were preferred for their medicinal properties, and also mentioned other properties, such as ease of cooking, production, and processing as some of the reasons for preferring some AIVs to others.

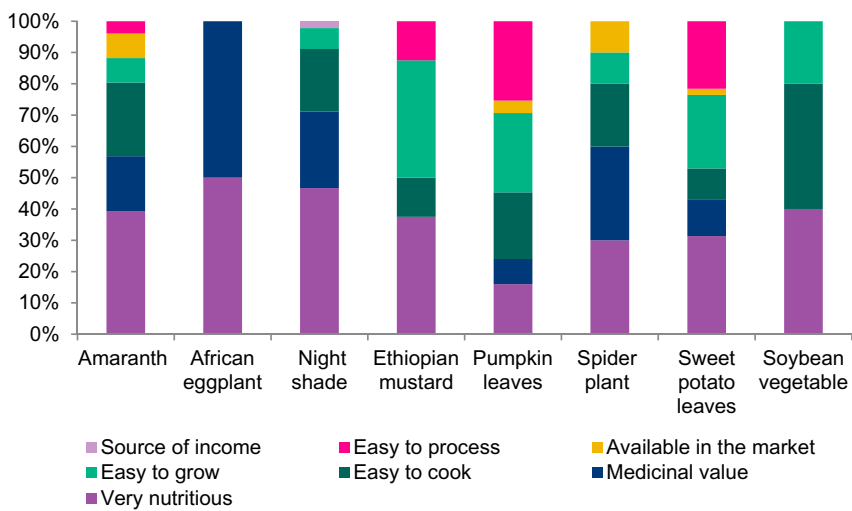
Frequency of consumption of AIVs also differed by gender, with women consuming AIVs more frequently than their male counterparts. At least 78% of women, compared to 50% of men, consumed AIVs on a daily basis. Respondents also mentioned that men's perception of AIVs has greatly improved, and more men were beginning to consume AIVs at home, or at least ask for them in restaurants when there was an opportunity. However, the general consensus from key informants and visited participants was that men's perceptions of AIVs has not fully changed, requiring more targeted messages since men are the household heads and decision-makers on household food choices.

### ***Uptake of AIV innovations***

Innovations disseminated at the outreach fell into six broad categories: types of AIVs and their nutritional benefits in order to promote their consumption; healthy preparation methods and new recipes;



**Figure 4.** Frequency of AIV consumption compared to before the outreach.

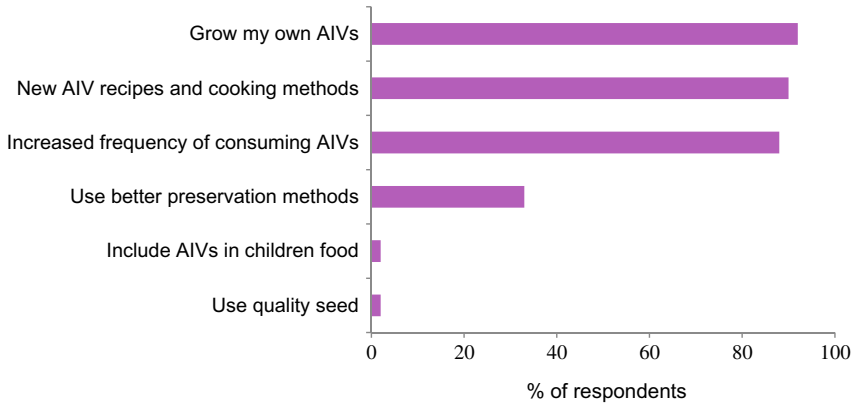


**Figure 5.** Reasons for the most preferred AIVs.

child nutrition during the 1,000-day window; production practices; use of quality seed; and post-harvest processing/preservation. All respondents indicated that they learnt and took up at least one of the innovations presented at the outreach. Uptake of innovations is observed in changes in AIV consumption dynamics, preparation practices, recipes, production, and processing (Figure 6).

The majority of respondents indicated that they now grow AIVs – 92% after the outreach compared to only 5% before. Participants were encouraged to establish home vegetable gardens and provided with AIV seed start-up kits. While the initial production of personal AIVs could be attributed to seed start-up kits provided to participants at the event, it may also be an indication of enhanced awareness of AIV benefits. We observe that producers who initially used start-up kits continued to source seed locally either from neighbours (providing 64% of farmer seed), own saved seed, or markets. Afari-Sefa et al. (2016) report similar results where nutritional awareness shows positive impact on farmers' decisions to grow AIVs. However, the use of quality seed remains minimal, being mentioned by just 2% of respondents.

"I received seeds of nightshade from the outreach and I established a vegetable garden at home. I also included cow peas, sweet potato leaves, and other vegetables where I could easily get seed locally to diversify my



**Figure 6.** Proportion of respondents taking up AIV innovations communicated at the GSI nutritional outreach in Monduli.

vegetable garden. I produce enough vegetables for my family and also [to] sell to my neighbours. Many of our community members have learned the benefits of AIVs, and some of those who have no gardens buy from me. On a good day, I can earn up to TZS 5,000 (approximately US\$2) from AIV sales alone.” (Resident of Monduli)

Respondents seemed to be self-sufficient in terms of AIVs produced and consumed at home. Only 48% of respondents supplemented their AIV requirement with market sources (mostly from farmers within the community). This provides an opportunity for farmers to earn additional income from their production. It is interesting to note that no respondent mentioned that they obtain AIVs from the bush, which was a common practice before the outreach.

Uptake of new AIV recipes and preparation methods was mentioned by 90% of respondents. New recipes learnt and taken up by participants included pumpkin soup, amaranth porridge and pumpkin seeds, and better cooking methods – steaming or boiling, as opposed to frying, which was the most common method prior to the outreach. As narrated by one respondent:

“These days I prepare pumpkin seeds, which previously I used to throw away because I did not know the benefits. I also occasionally prepare pumpkin soup. My family is getting used to consuming these new preparations.” (Resident of Monduli)

Promoted preparation methods aimed to ensure maximum nutrient retention and enhancing palatability of AIVs alongside the common staples in the region – maize and cassava. As well as the cultural beliefs around the value of certain foods, it has also been noted that palatability is as important as health or nutrition information when making individual food choices (Glanz et al. 1998). In particular, the unpleasant bitterness and sometimes flat taste of dark green vegetables in part affects their consumption and acceptability. Cooking methods that mask the bitterness and improve palatability would enhance consumption of these nutrient-dense vegetables. In a related study, Vorster et al. (2007) report that exposure to other preparation methods enabled participants to increase the variety of AIVs in their diet. Along with recipe books, participants’ ability to vary their diets increases. This could also be a reason a large proportion (88%) in this study reported increased frequency of consuming AIVs – the availability of information of different AIV preparation practices. The establishment of home gardens could have further promoted consumption of AIVs due to ease of access.

Lastly, farmers mentioned better preservation methods (33%) and child nutrition (2%) as other practices taken up from the outreach. The adopted preservation method for green leafy vegetables was parboiling and drying on a rack in a shade, which is different from their traditional practice of pounding and drying, or direct sun drying. The promoted preservation method aimed to retain nutrients. As Monduli is a generally dry place, vegetable preservation was considered a novel approach to help households ensure year-round supply and access to AIVs.

Use of quality AIV seed was mentioned, albeit by a small proportion of farmers. This points to areas that require further investment in order to enhance the potential of AIVs in nutrition. Participants mentioned lack of access to quality seed, along with limited skills in technical production practices as limitations to continued AIV production. The implication of this is that the long-term benefits of AIVs may be low unless the seed value chain can be improved. Related studies on AIV development have also pointed to a general lack of good quality seed for AIVs, coupled with a lack of technical packages, as key constraints to AIV production (Onim and Mwaniki 2008). Seed system development for AIVs is therefore a necessary long-term strategy for successfully unleashing the potential of AIVs to improve nutrition and livelihoods, especially for the most vulnerable populations.

### ***Effectiveness of nutritional outreach strategy***

An effective model for information delivery is identified as one that delivers tailored, high-quality advice and a service that is responsive to its users. Earlier results indicate the level of learning that is associated with the nutritional outreach. In this section we measure effectiveness in terms of how useful the nutritional outreach was in influencing participants to take up the AIV innovations disseminated. Results from model estimation suggest that at the 1% level of significant the standard

Poisson model is suitable for describing participants' uptake of nutrition and AIV innovations. The estimated Pseudo  $R$ -squared value is low (17.7%), but overall significance of the Poisson model, as reported by the Chi-square value, is satisfactory (Table 3).

Poisson count regression shows that the nutritional outreach was significant in influencing participants to take up AIV innovations. In addition, community groups showed significant positive effects on uptake of new innovations. These approaches use group learning and sharing information which provide a useful way for information to be retained among learners. These findings are consistent with expectations, as community outreach allows exposure and participation of participants, giving them an opportunity to observe practices first hand. The approach also uses discovery-based learning, where target audiences observe and participate in trialling new innovations, which promotes skills and knowledge retention, particularly for adult learners. Through trialling, participants are able to test an innovation to determine its usefulness, taste, quality and public acceptance. Studies conducted on other participatory methods such as farmer field schools and community workshops also show favourable outcomes for participants (e.g. higher adoption, better incomes, better productivity) (Bentley et al. 2007). Community groups provide an environment for peer learning and information exchange, explaining the observed positive effects on uptake of practices. The observed negative effect of information from relatives and friends, and health centres on the probability of uptake of AIV innovations, can be attributed to the fact that these approaches are limited in terms of group engagement and validation of innovations. This may also be comparable to other non-interactive information delivery mechanisms such as radio, as information is one way, with no feedback or validation mechanisms.

When we computed the average treatment effect, participation at the GSI nutritional outreach was associated with a 0.47 increment in the number of AIV innovations a farmer utilised. This increment was relatively smaller for nutritional outreach than community groups (0.55), which also showed a positive effect on uptake of AIV innovations. This implies that community groups had much bigger impact on affecting farmers' knowledge and AIV practices, compared to nutritional outreach. This could be attributed to the fact that the outreach was conducted only once, yet community groups continue to share information on issues affecting their community and nutrition. Much as the outreach presents as an effective information dissemination strategy, the results in comparison to community groups underscore the need for continuous engagement with communities for more sustained behaviour change.

**Table 3.** Regression results for count data (intensity of uptake on nutrition and AIV innovations).

Variables	Coef.	Std. Err.	z	$P >  z $
Education = no. of years of formal education	0.022	0.009	2.50	0.012
Sex of respondent (=1 if male)	-0.075	0.060	-1.26	0.208
Age (years)	0.003	0.002	1.39	0.164
Primary occupation (Livestock = control)				
Crop farming	0.133	0.186	0.71	0.476
Non-farming	-0.034	0.184	-0.19	0.852
Source of information (1 = access, 0 = otherwise)				
GSI nutritional outreach	0.066	0.112	0.59	0.054
Community group	0.146	0.051	2.85	0.004
Relatives and friends	-0.389	0.150	-2.60	0.009
Health centre	-0.250	0.068	-3.66	0.000
Radio	-0.033	0.193	-0.17	0.865
Seminar	-0.091	0.170	-0.53	0.594
School	-0.042	0.048	-0.88	0.379
Constant	3.217	0.223	14.44	0.000
Number of obs.	61			
LR $\chi^2(12)$	89.98			
Prob > $\chi^2$	0.000			
Log likelihood	-209.662			
Pseudo $R^2$	0.1767			

Personal and occupational factors that positively influence the utilisation of nutritional practices include education, gender, and a household's engagement in crop farming as a primary occupation. Higher education is associated with a higher possibility of taking up nutritional practices, while men are less likely to take up nutritional practices compared to women. It is anticipated that people with higher education levels are able to fully internalise and integrate useful practices. This result is in line with empirical evidence that relates education level with adoption of improved technologies (Mugisha, Ajar, and Elepu 2012). While a number of studies have reported a higher likelihood for men to adopt new practices, the negative result in this case is largely dependent on the nature of practice. As men in this study area still hold strong perceptions about AIVs, it is likely that their uptake of related practices will be slow. Households whose primary occupation is crop farming are more likely to adopt AIV practices than those engaged in other activities.

## Conclusions and implications for research and practice

The study results offer many useful insights into the effectiveness of nutritional outreach as an information dissemination strategy and its role in changing perceptions about AIVs. Further results set light to gaps that require further attention, to further support production and consumption of micro-nutrient-dense AIVs for better nutrition. The study results show that participants at the outreach learnt about nutritional benefits of AIVs and subsequently changed their perceptions and consumption dynamics of AIVs. Participants are consuming AIVs more regularly than before the outreach, and have included other recipes and vegetables that they previously did not know about.

However, the results also indicate that strong cultural food beliefs and taboos still exist, which strongly influence attitudes towards traditional vegetables. As such, changing perceptions and food habits may be a slow process because food has important psychological associations with the family and community. The outreach held at Monduli hospital largely reached women, but decisions on what is consumed in the home may be influenced by men who may still hold strong cultural biases. There is need to integrate family-oriented approaches in the awareness campaigns for the long-term acceptance of various foods at household level.

The approach used during the nutrition outreach was very much appreciated as an effective way of promoting AIV production and consumption. A large number of participants were directly reached at the event, with functional information on nutrition and the value of AIVs. The outreach used participation as a strategy to achieve higher levels of knowledge and retain information longer. This can be evidenced by the high rate of uptake of promoted nutrition and AIV innovations associated with the outreach as a source of information. Practices taken up by farmers included vegetable production, processing and preparation of AIV recipes. Exposure to cooking methods, along with provision of recipe books is considered an important step in increasing the vegetables' popularity in diets and needs to be further adapted in awareness campaigns. Further to the strategy, the engagement of local administration and policymakers showed positive steps being taken towards the institutionalisation of nutrition education and outreach. This is critical for sustainability and the further sensitisation of communities to achieve better nutrition outcomes. However, we also note that community groups provided more favourable results compared to the one-off nutritional outreach, underscoring the need for the repeated provision of nutrition information to address perception change and uptake of practices.

Lastly, as a result of the outreach and seed kits given, a majority of farmers started growing their own AIVs. However, the results point to the need to further invest in seed system development, particularly targeting remote communities, less served by formal sector. This would go a long way in ensuring access to quality seed for better productivity. Based on participants' responses, there is also need to further invest in building knowledge in AIV agronomic practices, water management, and processing.

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