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Potential opportunities and constraints in utilising AVRDC-distributed vegetable seedkit in Arumeru District, Tanzania.

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ABSTRACT

The vast majority of yield growth in African agriculture to date has been due to improved seed varieties, as opposed to technological improvements in cultivation practices or other inputs. However, the lack of development and supply of high quality seed stock for Africa indigenous vegetables hampers cultivation, thus, lowering their production. This paper aimed to assess the potential opportunities and constraints in utilising AVRDC-distributed vegetable seedkit in Arumeru district, Tanzania, by identifying both the major types of AVRDC-vegetable seed preferred by farmers in Arumeru district and the important factors motivating farmers' households' willingness to adopt AVRDC-indigenous vegetables seedkit. Data were collected from 145 selected small-scale farmers, who received the seedkit from AVRDC, through administering questionnaire, participant observation and interview methods. Correlation and chi-square tests were used to test hypotheses using R software. The results showed that the most preferred vegetables were those with multipurpose [high yield, high consumption and income generation] benefits; and these included tomato, African eggplant, African nightshade and amaranthus. There was low level of willingness to adopt pumpkin leaves, jute mallow, spider plant and sunnhemp as vegetable crops. The main constraints to vegetable production included the lack of knowledge and skills on vegetable production, lack of capital and land to assess the entire seedkit. This study offers answers on opportunities and challenges regarding utilisation of the distributed vegetable seedkit and that farmers in the study area may be adopting multiple forms of vegetable varieties and types from the same kit simultaneously. These results are very important in understanding the challenges facing farmers' choice of production and consumption of the vegetables in Arumeru district and emphasise the role of knowledge dissemination in promoting and adopting agricultural technologies.

Key words: Arumeru district, Knowledge dissemination, Vegetable production and consumption, Vegetable seedkit.

INTRODUCTION

Vegetables have been collected from forests, uncultivated and cultivated land as weeds for millennia because they are significant component of the diet of households throughout sub-Saharan Africa [Shackleton *et al*., 2009]. Vegetables also play an important role in income generation and in subsistence agriculture.

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Previous surveys conducted in Africa indicated that vegetables offer a significant opportunity for the poorest people to earn a living, as producers/traders, without requiring large capital investments [Schippers, 2002]. This is because their prices are relatively affordable when compared to other food items. Many vegetable species are used as daily components of the diet. For example, the *Wasambaa* people in Tanzania consume 73 species of indigenous plant foods, most of which are ruderals growing by the roadsides or in arable lands.

Globally, annual growth rates for vegetable production have exceeded those for grain production since the 1970s by 200 to 800% [Moinester, 2007]. However, in sub-Saharan Africa [SSA] during the same period the average annual growth of *per capita* vegetable production was negative, while grain production growth was 0.4% [Moinester, 2007]. Vegetable production is closely correlated with consumption in SSA, where 96% of farmers are considered small-scale farmers who produce mainly for subsistence [IFPRI, 2001]. Insufficient vegetable consumption causes severe health problems in SSA, including visual impairment and blindness, iron deficiency and general malnutrition. Sub-Saharan Africa's decrease in vegetable production and consumption over the past three decades coincided with trends of increasing hunger and malnutrition, again, an exception to the overall global trend [UNICEF, 2011]. While hunger and malnutrition are declining in the world as a whole, however, in Africa they are still on the rise [FAO, 2003]

In a-2003 survey in north-eastern Tanzania, the Asian Vegetable Research and Development Center [AVRDC] found that the most significant constraint to indigenous vegetable cultivation, among small-scale farmers, was a lack of high quality seed stock. Seventy per cent of respondents cited seed as their primary constraint [Weinberger and Msuya, 2004]. Yet, local production of indigenous vegetables for marketing is relatively low, especially in the dry season [Chada and Oluoch, 2003]. Though African indigenous vegetable seeds are available to farmers from field crops, other farmers or from local vendors, it is the lack of development and supply of high quality seed stock for Africa indigenous vegetables that hampers cultivation.

Research results have shown that the vast majority of yield growth in African agriculture to date, has been due to improved seed varieties, as opposed to technological improvements in cultivation practices or other inputs [Evenson, 2004]. Such productivity growth is vital not only in addressing poverty in SSA, but it is also vital in addressing the malnutrition crisis. For each one per cent gain in agricultural productivity, malnutrition is expected to decrease by at least 0.4% [Moinenster, 2007]. Improved seed development is key to raising agricultural productivity and thus to addressing the economic and nutritional needs of small-scale farmers and their families in SSA.

Vegetable production in Africa is highly correlated with stronger rural economies and improved household food security. Smallholder farmers who cultivate vegetables often earn higher net incomes than farmers who only cultivate cereals [Weinberger and Lumpkin, 2005]. Particularly, vegetables play a crucial role in alleviating poverty and food insecurity among the people by providing them with inexpensive micronutrient-rich food and additional source of income [Pichop, 2007]. Despite the important role of vegetables in SSA, diets and economies of people in *per capita* vegetable production in the region has actually decreased over the past few decades, an exception to the global trend [Weinberger and Lumpkin, 2005]. Reasons for this decline include non-expansion of land under vegetable cultivation, land degradation; unavailability and non-affordability of high quality inputs, among other factors.

Vegetable consumption is also a key factor in improving nutritional security and micronutrient intake among food insecure households in Africa [Maundu, 1997; Ecker *et al*., 2010]. Keatinge *et al*. [2011] made the case that the increasing lack of vegetable consumption worldwide was having a seriously deleterious effect on human health and that the likely attainment of many of the millennium development goals [MDGs] was severely affected by this trend. This is demonstratively the case in SSA where under nutrition and lack of fruit and vegetable consumption substantively affects children's health and it is a major contributor to child stunting and mortality.

In an effort to increase household vegetable production and consumption in SSA, the AVRDC based in Arusha, Tanzania, started promoting neglected [under-utilised] indigenous vegetables in Tanzania in 2002 [AVRDC, 2005]. Under this programme, distribution of healthy gardening seedkits has been promoted and Arumeru district is among the districts that have taken up this vegetable seedkits intensively. However, there has been no study to understand and realise the potential opportunities and constraints in use of such seedkits. This study aimed at assessing the potential opportunities and constraints in utilising AVRDC-distributed vegetable seedkit in Arumeru district, Tanzania.

The specific objectives were: [i] identify the major types of AVRDC-vegetable seed preferred by farmers in Arumeru district; [ii] identify the usefulness in the utilisation of indigenous vegetable seedkits; [iii] determine important factors motivating farmers' households willingness to adopt AVRDC indigenous vegetables seedkits in their production decisions; and [iv] assess the constraints facing farmers in adopting vegetable seedkits.

RESEARCH METHODOLOGY

Study area

Arumeru district is located in Arusha region, in north-eastern Tanzania, within latitudes 30^0 00'S to 30^0 06'S and longitude 30^0 04' E. The district has a total area of 2,966 km^2 and a population of 514,651 where over 90% of them are involved in crop production [URT, 2005; Mwakatobe, 1999]. The annual rainfall of Arumeru district ranges from 500 to 1400 mm depending on elevation, which is characterised by banana/coffee intercropping, maize/bean intercropping and semi-intensive livestock keeping. Farmers in Arumeru district are predominantly small-scale, producing for subsistence with a portion going towards cash crop production. Home gardens are among land use systems of traditional farming systems, especially in regions of high population density and decreasing availability of arable lands. For example, in Tanzania, home gardens are well practised in the highland zones which exhibit high population densities. Arumeru district is one among these densely-populated areas with such land use system [Mwakatobe, 1999].

Sampling procedures and sample size

The population of the study was the list of individual households [selected purposively] from the wards in which the AVRDC programme is promoting production of vegetable seedkits in Arumeru district. In order to obtain the desired sample, random sampling technique was used to solicit the total number of farmers' households that have been working closely with AVRDC programme in the distribution of indigenous vegetable seedkits. A probability sample was used to ensure that each person in the population had a fair or equal chance of being selected. In this way, a sample that is representative of the population was obtained.

Since the sample size of not less than 100 respondents is recommended for small-case studies involving household surveys [Bailey, 1998], a total of 145 households was sampled out of 967 households for the interview which was about 15% of the total households in the six wards sampled.

Data collection and analysis

A structured questionnaire was used to collect data from 145 individual farmers' heads of households, and both open-ended and close-ended questions were designed to solicit information from respondents. A pre-survey was conducted to assess a general overview of the study area. The aim was to have preliminary analysis of the study area. This included meeting with village leaders, village field officers and observe households to be sampled. The questionnaires were pre-tested with ten respondents in the study area [Seela village] to test the validity and reliability of the questionnaire. All the respondents involved in the pre-testing were excluded from the main sample. A face-to-face [one-to-one] interview was used in administering the questionnaire.

Participant observation was also used during data collection. This method provided opportunity to physically observe what the farmers do rather than what they say they do. Secondary data were mainly used to supplement data that were collected. These included both published and unpublished relevant documents, from both AVRDC-RCA and Agricultural Department [Arumeru District, Arusha Tanzania]. Data from the questionnaires were summarised and analysed statistically using Microsoft Excel in combination with R software program. The collected data were first classified into categories that were assigned numerals/codes to assist in the analysis. Correlation analysis and chi-square test were used to test the hypotheses of the study.

RESULTS AND DISCUSSION

Reasons for vegetable production in comparison with growing other field crops

Farmers ranked household consumption as major important reason for vegetable production [Figure 1]. In Arumeru district, vegetables are regarded as subsistence crops and vegetables for own use are usually produced in home

gardens, and in general home gardening is acknowledged to hold an important potential as a food security strategy and in particular as a strategy for meeting micronutrient needs.

Paul [2009] stated that traditional African vegetables as a very good source of micronutrients and contribute to food security. In our study, the opportunity to earn an extra income was the second important reason [18.6%] for producing vegetables as indicated by farmers. Good price and market availability were additional incentives and farmers also cited vegetable production as profitable compared to other field crops. Similar results have been reported by Weinberger and Lumpkin [2005] who stated that, farmers who were engaged in vegetable production often earned higher net income than farmers who were engaged in production of cereals crops only.

Land option was ranked as the third [18%] reason for vegetable growing by farmers in Arumeru district. Where arable land is scarce; vegetables can be a priority since they require less space than other staple crops. The findings indicated that home gardens [as owned by small-scale farmers] are for growing own vegetables from a small area compared to other field crops such as staple cereals. A study Keatinge *et al.* [2011] supported this finding. They noted that, most of poor farmers were completely landless, as many live on income less than one dollar per day but still can have access to productive plots of land which could be a small piece of land. However, Midmore *et al.,* [1991] supported all three most important reasons of growing vegetable reported by farmers stating that, food production on small plots adjacent to human settlements is an age-old survival strategy in the developing world. Food gardens make a substantial, though rarely appreciated, contribution to the food security of the poorest segments of society. For instance, sales from homestead vegetable gardens in Bangladesh contribute more than 10% of the income of landless households; the value of the produce retained for home consumption is often high [Midmore *et al.,* 1991].

Crop diversification against market risk was reported by the farmers as another reason for growing vegetables [17%]. Vegetable production is used as alternative to different field crops. Thus, in case where price of field crop falls or no surplus, then vegetable crops grown help minimise the loss or earn money used for other household expenditures and that is how vegetables come into the system. Almost 13% of the households [farmers] indicated that they grew vegetables because their neighbours do it. This tendency occurs when one grows crops not so common in the area, then others also decide to grow the same crop. If someone made good money in nightshade in current season, for example, others will shift to that crop in the following season.

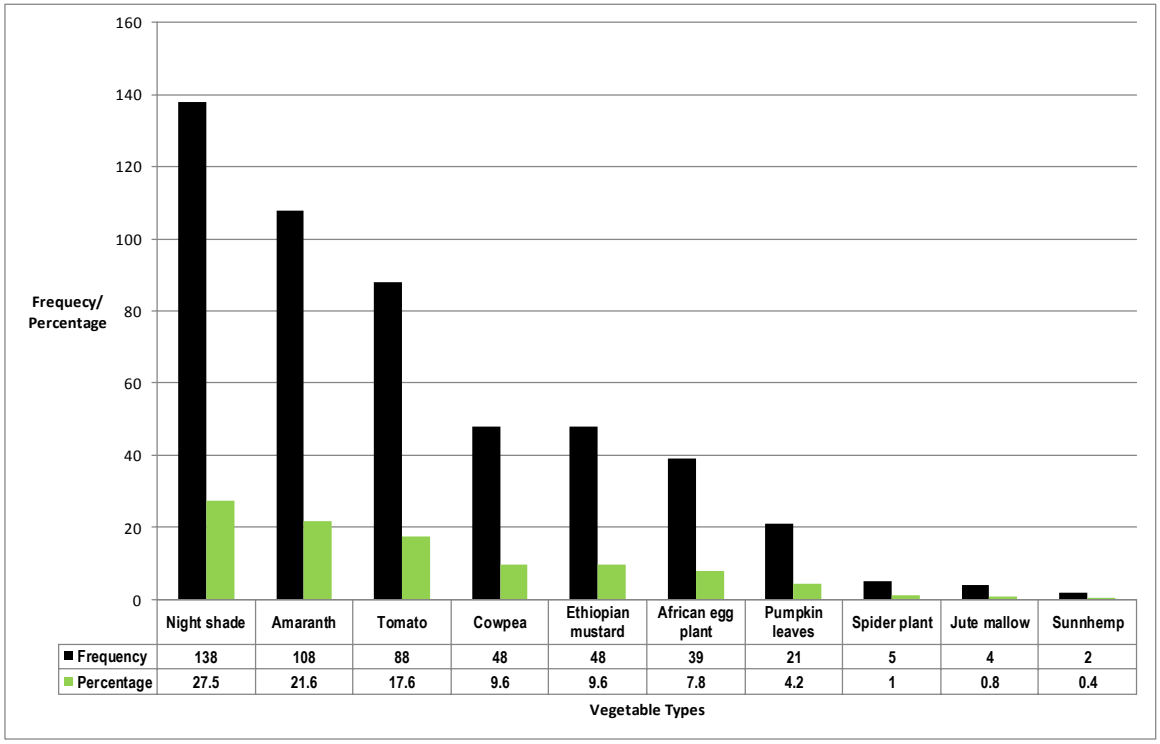
People's lifestyle was also cited by farmers as a factor that influenced vegetable production in Arumeru district [7%]. For example, tomato was preferred as condiment and vegetable instead of other vegetable crops. Nightshade's bitterness was a preferred taste; but the youth do not like such bitter taste. Therefore, some vegetable were planted more or less due to the individual choices. Consequently, choices influence vegetable production for subsistence and market and in vegetable production. This should be borne in mind when promoting types of vegetables.

Farmers' vegetable preferences from the seedkit

The results from the household survey showed that African nightshade [*Solanum* spp.], amaranth [*Amaranthus dubious* L.] and tomato [*Lycopersicon esculentum* L.] were the most important vegetable types in that respective order in all wards of Arumeru district [Figure 2]. The results further showed a significant difference in the level of preference among vegetable types from the distributed seedkit [$\chi^2 = 592.05$, $p = 0.00000$], with the most preferred vegetables [above] being produced at higher volume than the least preferred. Therefore, farmers had respectively higher level of preferences for nightshade, amaranth and tomato than Ethiopian mustard [*Brassica carinata* L.], cowpea [*Vigna unguiculata* L(Walp)], African eggplant [*Solanum aethiopicum* L.], pumpkin leaves, jute mallow [*Corchorus capsularis* L.] or [*Corchorus olitirius* L], spider plant [*Chlorophytum comosum* L] and sunnhemp [*Crotalaria juncea* L.].

African nightshade was the most important leafy vegetable. It ranked the first in Arumeru district due to its high yield, high market price, and high quantity of seeds, market preferences and good taste. Amaranth was the second common leafy vegetable grown in Arumeru district [Figure 1]. This was found to be important because of high yield, market preference, requirement of low inputs, good taste, fast growth, high quantity of seeds and softness [short cooking time]. Tomato ranked as the third most important crop for multipurpose uses among others [Figure 1] because of its income generating ability in Arumeru district. Farmers involved in production process reported tomato was sold to the local markets and the remaining was consumed by households as they are considered a condiments and also vegetable in adding a good taste and colour characteristic of a good a diet. Farmers said they could not cook without tomato and onion thus making them very important vegetables crops in term of use. Other crops that were ranked in the category

of vegetables [but not popular] in Arumeru district were pumpkin leaves [4%], spider plant [1%], jute mallow [0.8%] and sunnhemp [0.4%] [Figure 1].



	Night shade	Amaranth	Tomato	Cowpea	Ethiopian mustard	African egg plant	Pumpkin leaves	Spider plant	Jute mallow	Sunnhemp
Frequency	138	108	88	48	48	39	21	5	4	2
Percentage	27.5	21.6	17.6	9.6	9.6	7.8	4.2	1	0.8	0.4

Figure 1. Farmers level of preferences for different vegetables

Vegetable varieties' preferences

There was an indication and observations that farmers had cultivated the AVRDC accessions/varieties in seedkit without exempting local available varieties. Most of the farmers in Arumeru district cultivated more than one variety of each vegetable crop except pumpkin [GKK 174], jute mallow [HS], spider plant [PS] and sunnhemp [CML] with only one variety distributed but were not likely to be planted [Figure 2].

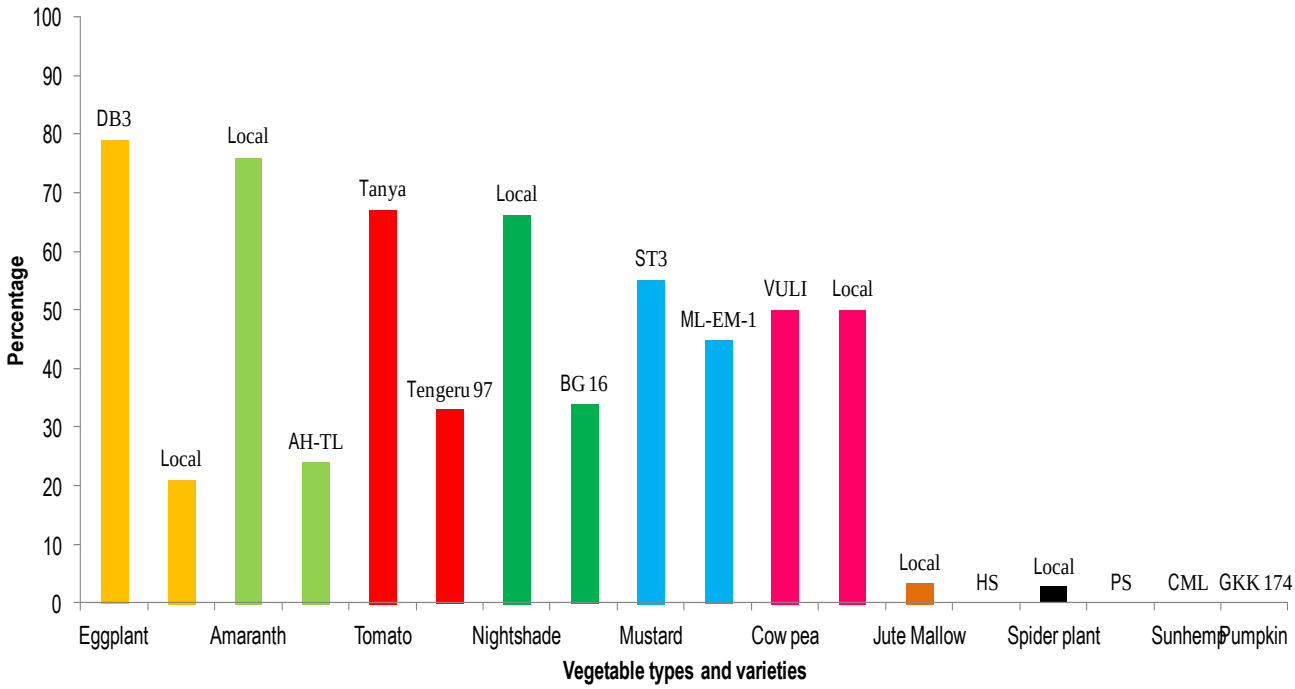


Figure 2. Vegetables varieties grown by farmers after receiving seedkit

The results also showed that farmers significantly [χ^2 = 16.73, p = 0.005049] preferred more of the locally available vegetable varieties when compared with new varieties [of the same vegetable type] from the distributed seedkit. It was observed that the use of traditional knowledge contributed to increased utilisation of local vegetables. For example, local variety of nightshade was more preferred than distributed nightshade [*Solanum scabrum,* BG 16]. This was similarly with amaranth, Ethiopian mustard, jute mallow and spider plant.

These results agree with the study by Shackleton *et al*. [2009] which indicated that, though many different plant species may be available in an area, they only become adopted once they are used by local communities. For this to happen, it requires innovation and willingness to experiment and with reasonable local knowledge on how to use the species. Such knowledge is handed down from generation to generation but it is also shaped through daily experience by members of local communities [Shackleton *et al*., 2009]. Thus, in our study, farmers may have been influenced by their choices [taste and marketability, among others] of vegetable for cultivation by their indigenous knowledge. This could be true because, our results from interview with farmers showed that farmers themselves take care to preserve indigenous [local] vegetable varieties despite the fact that they have received the new varieties of the same vegetable types. This view is also supported by Keller's [2004] study which indicated that agricultural genetic diversity is ultimately controlled by decisions of farmers [willingness] because they will choose what species/varieties to exploit and also select their mix of varieties. For example, if farmers chose to change from cultivating traditional vegetables to high yielding hybrids seeds, indigenous varieties that have been carefully selected over generations for specific ecosystems would be lost.

However, farmers appreciated different benefits of some varieties distributed by AVRDC depending on their characteristics. For example African eggplant [DB3] was chosen and adopted by majority of farmers due to its high yield, repeated harvesting and high marketability. Variety DB3 was also preferred due to early maturity compared to other varieties like Tengeru White and Manyire Green and could therefore be sold on the market when other mentioned varieties were not ready to be sold thus bridging a market gap. Previous results indicated that DB3 was less preferred by farmers due to inadequate information on its potential benefits as well as seed availability [AVRDC-Report, 2005]. However, after current effort made by AVRDC to promote it through free seed distribution and training on its production, it has become popular and adopted by farmers in Arumeru district.

Amaranth [AH-TL] was reported to have a very short-growing duration of 21 days. Tomato [Tanya] was highly appreciated due to its firmness, long shelf life, repeated harvesting and market preference. Tomato [Tanya] was also highly preferred not only because of its long shelf life but also due to the flesh content that is essential to produce sauce and due to its shape [egg-shape type], which makes other varieties similar to Tanya [egg-shape varieties] to be most preferred by consumers in the market, thus egg-shape varieties not AVRDC variety was preferred because of its good traits while tomato Tengeru 97] was inferior to Tanya at the farm and as well at the market place but also appreciated for high yield and salad preparation which is not very common in rural lifestyle.

In addition, farmers mentioned nightshade-BG 16 as the most preferred leafy vegetable. This variety [locally known as Nduruma] was liked by farmers because of its good taste and high market preferences and not depending on seasons and their environment. Other reported productive leafy vegetables varieties were: Ethiopian mustard [ST 3 by name Arumeru] and Ethiopian mustard [ML-EM-1 by name Rungwe], cowpea [VULI] for home consumption and sales in the market. The least preferred vegetables in Arumeru district were pumpkin leaves, jute mallow, spider plant and sunnhemp. Four varieties from each crop, i.e. [jute mallow [HS], spider plant [PS],sunnhemp [CML] and pumpkin leaves [GKK174] were not grown at all. As a result, farmers had a good opportunity to select between AVRDC varieties for cultivation [Figure 2].

Income from the distributed vegetable seedkit

The only vegetables produced and sold by farmers in study area were tomato, nightshade, amaranth, African eggplant, Ethiopian mustard and cowpea. The total cost of production in US $, average production of vegetables per season, average revenues and profit from vegetable seedkit obtained from AVRDC were calculated per crop/ha and they varied considerably as indicated in Table 1.

Table 1. Economic performance of vegetable seedkit per season per hectare.

Vegetable crop	Total cost [US$/ha	Production [kg/ha]	Revenues [US$/ha]	Profit [US$/ha]
Tomato	759	4,275	1938	1,179
Amaranths	199	2,318	893	694
Cowpea	593	4,816	1089	496
African eggplant	739	4,890	1594	855
Ethiopia mustard	211	2,175	785	574
Nightshade	477	5,997	1564	1,088
Pumpkin leaves	124*	1,087*	340*	216*
Jute mallow	108*	1,248*	195*	87*
Spider plant	185*	1,532*	670*	485*
Sunnhemp	77*	1,287*	322*	245*

* Secondary data [Pumpkin: [Putter and Vissel, 2007], Jute mallow: [AVRDC-Annual Report, 2007], Spider plant: [AVRDC-Report, 2005], Sunnhemp: [AVRDC-Report, 2007].

The cost of production varied widely according to different crops. For example, vegetable crops like amaranths, African eggplant, tomato and nightshade cost less in term of land space and time [short growing duration] compared to others like pumpkin leaves, cowpea, spider plant and sunnhemp. Of all crops, amaranth and Ethiopian mustard required the lowest cost implying that; vegetable seedkit distributed to farmers had a significant contribution to income generation and poverty reduction.

Nightshade yield [5,997 kg/ha] was higher than average production from other vegetables followed by African eggplant [4,890 kg/ha] and vegetable cowpea [4,816 kg/ha, Table 1]. Tomato yield was also high being 4,275 kg/ha. amaranth and Ethiopian mustard yielded 2,318 kg/ha and 2,175 kg/ha, respectively.

On yield basis, farmers were willing to produce only the above mentioned vegetable crops. Farmers appeared to be least interested in improved indigenous pumpkin, jute mallow, spider plant and sunnhemp distributed by AVRDC which incidentally were also those crops not likely to be cultivated. Usually, vegetable crops like spider plant, jute mallow and pumpkin are collected from fields and scarcely from wild because they are grown as volunteer crops [crops not intended as the major crop in the field]. There is no cost incurred in their production since they grow voluntarily as intercrops with maize [*Zea mays* L] or sorghum [*Sorghum bicolor* L.]. As volunteer vegetable crops, they are not removed during weeding because they usefulness as food. Farmers in Arumeru district reported that they were not very good consumers of those vegetable crops. Apart from these indigenous vegetables, farmers are used to such vegetables as tomato, nightshade, amaranth, African eggplant, Ethiopian mustard and cowpea; exotic ones [recently introduced vegetables] like cabbages, spinach, among others. The production of the above crops pumpkin, jute mallow, spider plant and sunnhemp growing uncompetitive from production to market.

Sunnhemp, for example, was considered as a wild or traditionally a livestock feed and some used it as a hedge plant. It was not important in any way for them as vegetable. Thus, pumpkin, jute mallow and spider plant were not adopted where a null average production of sunnhemp was related to low level of farmer's awareness of it as edible vegetable. Consequently, few farmers grew these vegetable crops because they knew them as hedge plant [for fencing], as a green manure crop or just as fodder for livestock [livestock feed].

Correlation analysis between profit generated from vegetable types and willingness to adopt seedkit technology was significant and positive with Pearson's correlation r = 0.98, *df* =*8, p* = 0.00000 [Figure 3].

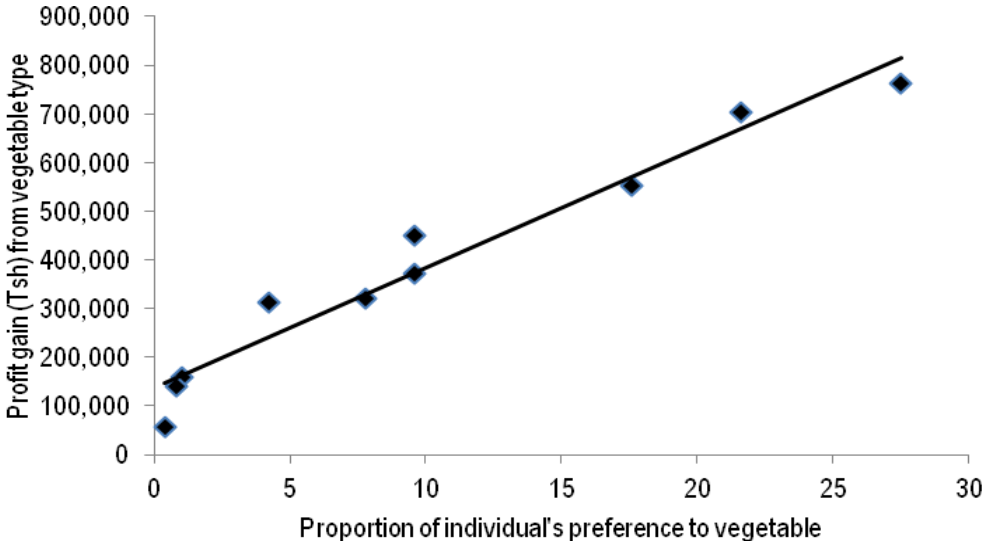


Figure 3. Proportion [%] of individual preferences for vegetable types

The implication of the results is that, the increase in profit obtained from sales of vegetables lead to further increase in the proportion of farmers willing to adopt vegetable seedkit. Therefore, profits obtained from vegetable seed kit contributed significantly to the farmers' willingness for adoption. This highlights one of the reasons advanced by Weinberger and Msuya [2005] that indigenous vegetables are particularly attractive for small-scale farmers since the risks of financial losses are smaller than they are for most of the exotic vegetables.

Household consumption of vegetables from the distributed seedkit

Tomato, amaranth, nightshade, African eggplant and Ethiopian mustard were reported as the most frequently [than six times a week] consumed vegetables by household members. This was also indicated by high preference of these vegetables for consumption with tomato showing high frequency [37.6%] of consumption followed by amaranth [23.1%], nightshade [17.9%], African eggplant [12%] and Ethiopian mustard [9.4%].in the area than the rest. Consumption of cowpea leaves had a low frequency of less than six times a week. Pumpkin leaves, jute mallow, spider plant and sunnhemp were not consumed at all in that week.

The result obtained from chi-square test revealed that, difference in the level of preference were significantly influenced by the frequency of consumption of different vegetable types from the distributed seedkit [$\chi^2 = 560.05$, $p = 0.00000$]. This supports the previous statement that farmers consume more or less of a particular vegetable type depending on whether they like it or dislike it. For example, low consumption of jute mallow and spider plant was highly attributed to difference in preferences or ethnic background among farmers. That is to say that majority of the consumers in Arumeru district did not prefer this kind of vegetables compared to a few who consumed it; Therefore difference in levels of preference highly determined the extent of the willingness to adopting distributed vegetables seedkit.

The high frequency of tomato consumption per week was related to its multi-use both as a vegetable and condiment and not high yield compared to other vegetable crops as indicated in Table 1 above. Low frequency of consumption of vegetables other than tomato, amaranths, nightshade, Ethiopian mustard and African egg plant was attributed to people adaptation of certain kind of vegetable depending on geographical zone. For example, jute mallow is a very common vegetable among people living in arid and semi-arid region of Tanzania like Singida while amaranth and nightshade are most common in areas with adequate rainfall or access to irrigation [Keller, 2004]. Moller [2009] reported that the types and quantities of vegetables consumed by farmers varied greatly, depending upon culture [between ethnic groups]. Some ethnic groups prefer bitter leaves, while others prefer sweet ones. The reason may be due to differences in taste among members of the communities whether the vegetable was indigenous or introduced as a part of the seedkit programme.

Proportion of vegetable consumption per week

This study indicated tomato had the greatest proportion of consumption per week. This might be due to its multi-purpose use both as a vegetable and condiment and not because of high yield. Another reason for high proportion of consumption was its availability [repeated harvesting]. Other preferred green leafy vegetables were nightshade and amaranth because of their taste and short cooking time. African eggplant exhibited high proportion of consumption because of its availability [repeated harvesting] and its good taste, followed by Ethiopian mustard preferred for its strong pungency and good taste and cowpea was chosen for a good taste. It is obvious that Ethiopian mustard and cowpea had low proportion of consumption during the week. The vegetables that had less than 1% proportion of consumption were pumpkin leaves, jute mallow, spider plant and sunnhemp. It was surprising to note that when farmers were asked about adequate vegetable consumption, the majority reported tomato, amaranth, nightshade, African eggplant and Ethiopian mustard to be regular part of their diet and that they are consumed adequately though figures were difficult to quantify. It should be noted that if vegetables are not consumed frequently, the chances of their becoming extinct are high. Another key constraint was lack of capital for managing vegetable seedkit production [that is the capital for running the project as whole], and this posed limitation to increased production in the study areas. Land shortage was also reported by farmers to hinder vegetable seedkit cultivation as the land already had other crops.

Farmers' constraints in adopting vegetable seed kit

This study also revealed that the key constraint in the production and consumption of indigenous vegetables seedkit was lack of knowledge and skills on vegetable production [Table 2].

Table 2. Farmers 'constraints influencing vegetable production and consumption

Constraints	Numbers	Percentage
Lack of knowledge and skills on vegetable production	63	59.4
No money for management	18	16.9
No enough areas for whole kit production	15	14.1
Ethnic background	10	9.4
Total	106	100

Vegetable crops like jute mallow, spider plant, pumpkin leaves and sunnhemp lack enough area for all vegetable seedkit production. Ethnic background was indicated as a challenge in the adoption of the AVRDC-distributed vegetable seedkit. Ethnic background posed the challenges especially to consumption habit consequently leading to even low production. The respondents mentioned that training and extension in vegetable production and processing as the most important priority areas for training.

CONCLUSION

Our results reveal that willingness to adopt seedkit was determined by different parameters such as yield, consumption and income. The vegetable crops in which farmers were motivated to adopt were those with high yield, high consumption and high *per capita* income. The multi-purpose [high yield, high consumption and income generation] vegetables included tomato, African eggplant, African nightshade and amaranthus. There was low level of willingness to adopt pumpkin leaves, jute mallow, spider plant and sunnhemp as vegetable crops. It should be noted that pumpkin leaves and jute mallow are delicacies in other countries in the Southern African Community [SADC] region. Thus, these results are very important in understanding the choice of vegetables, which are location specific. The results also provide basis for the assessment of opportunities and challenges facing farmers' choice of production and consumption of the vegetables in Arumeru district. By implication, the study offers answers on opportunities and challenges regarding utilisation of the distributed AVRDC-vegetable seedkit. Farmers in the study area may be adopting multiple forms of vegetable varieties and types from the same kit simultaneously. This would also emphasise the role of knowledge in the dissemination, promoting and adopting similar agricultural technologies eleswhere.

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