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Diversity, traits and use of traditional vegetables in Tanzania

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AVRDC—The World Vegetable Center is an international not-for-profit organization committed to alleviating poverty and malnutrition through research, development, and training.

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Contents

Executive summary

Traditional vegetables, though not necessarily indigenous to a country, can be associated with traditional production systems, local knowledge of farmers and, usually, have a long history of local usage and selection. Furthermore, traditional vegetables are widely underutilized and neglected in research and development. In the framework of the project "ProNIVA I - Promotion of Neglected Indigenous Vegetable Crops for Nutritional Health in Eastern and Southern Africa" led by the World Vegetable Center (AVRDC) and partners, a baseline survey was performed in order to verify the potential of traditional vegetables that might help to fight malnutrition in Tanzania and to diversify income for resource-poor farmers under low-input conditions.

For this study, 359 individual interviews as well as 43 focus group meetings were conducted in 10-12 villages of four different districts (i.e. Arumeru district in Arusha, Singida district in Singida, Kongwa district in Dodoma and Muheza district in Tanga) in northeastern and central Tanzania to gather basic information on available traditional vegetables and to explore farmers' knowledge on production and consumption. The four districts researched differed highly in ethnicity as well as in agro-ecology including climate, altitude and soil conditions.

Farmers named 10-34 different traditional vegetables per village, summing up to an overall of 102 in all four districts. While 56 of these vegetables could be identified, 46 of them were only known by their local names. Only 12 traditional vegetables were present in all four districts. The number of wild traditional vegetables used was always greater than that of cultivated ones, with a ratio of wild:cultivated ranging from 11:9 in an urban highland district to 59:11 in a rural coastal district. In general, diversity of traditional vegetables is high which shows their importance in terms of adaptation to the environment but also in terms of consumer preference. At the same time, traditional and particularly wild traditional vegetables were threatened with genetic erosion due to change in land use and eating habits.

Preferred traits of the most important traditional vegetables differed for the different vegetable types and between districts. In terms of production aspects, drought resistance and easy cultivation, i.e. no transplanting, was especially important for amaranth, while fast growth and early maturing was more important for okra and a long production period and high yield for vegetable cowpea. African nightshade and African eggplant were mainly favored for their good marketability and some African eggplant types also for their pest and disease resistance. In terms of consumption some amaranth types were preferred because of their short cooking time and the fact that no other ingredients are needed, while for okra and African eggplant fruits, the bitter taste and the amount of mucilaginous material as well as softness of fruit was important. A sweet and good taste was an important trait for vegetable cowpea leaves while African nightshade was chosen for its bitter taste and medicinal properties.

The importance of traditional vegetables is often discussed in the context of wild and collected crops that contribute to food safety in times of hunger. Studies on the economic value of traditional vegetables are less common although the few studies that are available indicate that the market potential of traditional vegetables is very large. Most farmers cultivate traditional vegetables and in the study area, a total of 279 farmers (78%) had cultivated traditional vegetables during the preceding production cycle, including 14 different crop species. Although the majority of farmers are engaged in the cultivation of traditional vegetables, on average only 10.7% of the total cultivated area is allocated to these crops. Small farms tend to allocate a larger share of their farms to traditional vegetable cultivation to minimize risk since generally traditional vegetables require less input into production compared to exotic vegetables. Of all traditional vegetable crops produced, nearly half are sold at the market and the rest is either consumed at home or given away as a gift.

Traditional vegetables are a regular part of the diet, albeit at a varying degree within the four districts. Approximately three-fourths of the households consumed traditional vegetables the day prior to the survey, the share being highest in Singida and lowest in Muheza. The study revealed that a total of 19 different traditional vegetables were consumed, ranging from 9 crops in Arumeru to 16 crops in Kongwa. Traditional vegetables are an important component in the household diets of both low-income and high-income groups. The high-income group may increasingly turn towards traditional vegetables as health foods. This is already happening in some Asian countries like Malaysia where these vegetables are believed to be free of pesticides.

Traditional vegetables are used in diverse forms and many of them can be considered multi-purpose crops, e.g. most of them are used for their preventive and curative medicinal properties besides serving as daily food. Despite their recognized importance, existing taboos can hamper general consumption: for example in one district, men were not allowed to eat green leafy vegetables. Preservation of traditional vegetables was non-satisfying since leaves were usually dried in direct sunlight which causes the loss of vitamin C.

As a result of this study, it is suggested to launch an educational program focusing on preparation and processing methods of traditional vegetables and to increase awareness of wild traditional vegetables, the conservation of their habitats and the possibility to save these genetic resources through enhanced utilization. Marketing of wild traditional vegetables, which is not commonly practised in Tanzania, could be a source of income and is one possibility to enhance preservation through usage of these important food sources.

1 Introduction

With the onset of the market economy and modernization of agriculture in Africa, conventional agronomy has, to a large extent, concentrated on conserving the genetic resources of exotic rather than indigenous or traditional vegetables. Consequently, the latter are threatened with extinction as they have to compete for attention with the much more popular exotic vegetables (Maundu et al., 1999b). Indigenous knowledge on production methods, preservation, use and nutritive value is no longer transmitted systematically from one generation to another (Weinberger and Msuya, 2004). Furthermore, urbanization has also led many growers to prefer introduced vegetable crops.

This neglect of traditional vegetables is unfortunate since these crops are usually better adapted to the environment than the introduced exotic vegetables. Furthermore, traditional vegetables provide low-cost quality nutrition for large parts of the population in both rural and urban areas (Chweya and Eyzaguirre, 1999). In fact, almost all of these vegetables are good sources of micronutrients including iron and calcium as well as vitamins A, B complex, C and E. One example is amaranth which contains more of these nutrients compared to a typical exotic leafy vegetable, white cabbage (Weinberger and Msuya, 2004). As traditional vegetables can play such an important role, their genetic diversity should be conserved and enhanced.

The recent revival of economic growth in Tanzania, and the liberalization of the export sector have contributed to a rapid increase in fruit and vegetable production (Mwasha 1998). In 1995/96 the ten most important vegetables produced in terms of yield were cabbage, tomato, onion, garden pea, amaranth, Chinese cabbage, eggplant, carrots, cauliflower and okra. Only three traditional vegetables are part of this list of important vegetables, namely amaranth, eggplant and okra. Clearly, traditional vegetables are being replaced by exotic ones.

In this Technical Bulletin, we outline the diversity of traditional vegetables in northeastern and central Tanzania, including both those preferred by farmers and those which are available in general. The Bulletin is structured as follows: Chapter 2 introduces the objectives and the methodology of this study; Chapter 3 provides an overview on the crops known and its diversity across four research districts; Chapter 4 focuses on the positive and negative traits of several important plant varieties as seen by farmers in Tanzania; Chapter 5 describes the importance of traditional vegetables in production; and Chapter 6 outlines the importance of traditional vegetables in consumption and its multiple uses including food preparation and preservation, medicinal values and food taboos. The paper provides conclusions and recommendations in Chapter 7.

2 Objectives and methodologies

2.1 Purpose

The main objective of this study was to identify the relevance of traditional vegetables in production and consumption in Tanzania in four distinct agro-ecological zones of Tanzania. The three main research questions were:

- What are the most important traditional vegetables to farmers?
- What are the beneficial traits and constraints in the consumption and production aspects of traditional vegetables?
- What are the main differences between the four regions in Tanzania in terms of:
  - Diversity of traditional vegetables: wild or cultivated;
  - Genetic erosion: loss of traditional vegetables;
  - Purposes of traditional vegetables (e.g. subsistence or cash crop); and
  - Multiple uses of traditional vegetables (e.g. as food, medicine, cosmetic).

In this study, the vegetables examined are called "traditional" vegetables. By traditional we mean indigenous or exotic species which, due to long use, have become part of the culture of a community.

2.2 Study area

Geographically, Tanzania is highly diverse in terms of topography, climate, and geology (Rodgers, 1998). Mainland Tanzania is divided into 21 administrative regions, of which four regions, namely Arusha, Singida, Dodoma and Tanga located in northeastern and central Tanzania, were chosen as research regions for the Project (Figure 1). These regions are further subdivided into districts, and one district in each region was selected based on different factors such as climate, altitude, ethnic groups and distance to urban centers; Arumeru district in Arusha, Singida district in Singida, Kongwa district in Dodoma and Muheza district in Tanga.

In Table 1, detailed geographic characteristics of the four research districts are indicated. For instance, Kongwa receives only about 560 mm of mean annual rainfall as compared to Muheza with nearly 1,900 mm (Anonymous, 1998). In terms of soil fertility, Arusha belongs to the four regions in Tanzania classified as suitable for productive agriculture with volcanic soils consisting mainly of sandy loam with good drainage. Muheza district, as part of the coastal zone has deep sandy to heavy-textured soils, with moderate to high water content (Anonymous, 1998) which results in imperfect drainage. In contrast, the central plateau areas, where Singida and Kongwa are situated, are mantled by sandy loams of low nutrient content and low water-holding capacity (Anonymous, 1998).

Figure 1. Map of Tanzania showing the research districts of Arumeru (Arusha), Singida, Kongwa (Dodoma) and Muheza (Tanga) (Anonymous, 2003).

Table 1. Characterization of research districts

District	Arumeru	Singida	Kongwa	Muheza
Location in Tanzania	Northern Highlands	Central Tanzania / Central Semi-Arid Lands	Central Tanzania / Southern Maasai Steppe / Arid Lands	Northern Coastal Areas / Northern Coast
Mean annual rainfall (mm)	1000 (humid)	200 - 400 (semi-arid)	500 - 1000 (semi-arid/humid)	1000 - 1200 (humid)
Altitude	1000 – 1500 m (high)	1100 – 1300m (high)	500 – 1200 m (medium to high)	150 – 1200 m (low to high)
Soils	volcanic soils; sandy loam with good drainage	plateau soils; loam with good drainage	red earth; loam with good drainage	loamy sand with imperfect drainage
Natural vegetation	brushland and thicket	woodland / brushland	woodland	savannah, woodland
Location	urban	urban	rural	rural
Population density	55 - 99 p/km^2 (dense)	30 - 49 p/km^2 (medium)	30 - 49 p/km^2 (medium)	> 100 p/km^2 (very dense)

Source: Hathout, 1983; Anonymous, 1998; Anonymous, 2007.

2.3 Methodology

The methodology for this study included both quantitative and qualitative components based on household surveys and focus group meetings.

2.3.1 Focus Group Meetings

Focus groups are group discussions designed to learn about a subject's perception on a defined area of interest. Like individual interviews, focus groups allow to gain access to, and understand people's activities and perceptions that cannot be directly observed (Kaplowitz and Hoehn, 2001). In each study area, one focus group meeting was conducted in 10 - 12 villages (Arumeru 10, Singida 11, Kongwa 10, Muheza 12). The participants, usually farmers, were selected by agricultural extension workers in Singida and Muheza, by the non-government organization (NGO) Helen-Keller-International (HKI) in Kongwa, and by HORTI-Tengeru staff in Arumeru. Half of the focus groups (5-6) in each study area consisted of women farmers only, while the other half were mixed groups.

Design and procedure

The aim and purpose of the project was explained in every focus group meeting. In the meeting, the term "traditional vegetables" was categorically explained to the participants, and facilitators ensured that every attendant

understood its meaning by its vernacular counterpart such as "asili" meaning traditional or "kienyeji" meaning local. For most of the farmers there was no problem to distinguish local and exotic or newly introduced vegetables such as white cabbage, Chinese cabbage, carrots, onions, tomatoes, etc.

During the discussion, a flip chart was used to collect the names of traditional vegetables in order to visualize the answers of participants. Participants were also given time to raise questions to researchers after every focus group discussion.

The questionnaire

The semi-structured questionnaire used for this study consisted of three main parts: (a) diversity of traditional vegetables in the area and their popularity to farmers based on several characteristics; (b) production and consumption aspects of the vegetables considered important; and (c) the level of genetic erosion taking place in the area. In the first part, households were asked which traditional vegetables were consumed and their source (either cultivated on farm or gathered in the wild). Then, the five to seven most important traditional vegetables were ranked according to different features such as amount cropped and consumed, popularity and availability, with the most important three or four vegetables discussed in detail. The participants were requested to supply detailed information on the selected vegetables, i.e. distinct characteristics vis-à-vis production period, susceptibility to pests and diseases, marketability, etc..

The production and consumption issues of the most important vegetables were also explored. In the production part, which was performed with mixed gender groups, the traditional vegetables' cropping pattern, production constraints, and the family member(s) responsible for certain production steps were solicited from the farmers. In the consumption part, participants named the vegetable parts they use (e.g. leaves, flowers, roots, tubers), and the harvesting method and its frequency (twice a week, uprooting, etc). With focus groups consisting of women farmers only, preparation and processing methods were debated as well as medicinal values and taboos of a particular traditional vegetable. Finally, assessment as to why and during which time of the year wild vegetables were collected was also obtained from the participants.

The last part of the discussion with both mixed and women groups focused on genetic erosion. Farmers' perception as to the level of diversity of these traditional vegetables, possible occurrence of genetic erosion, and reasons for this loss were explored.

Analysis of results

Since most traditional vegetables were named only by their English or Swahili names, scientific names of cultivated vegetables were determined according to vegetable descriptions by farmers and compared with Schippers (2002) and Maundu et al. (1999a), while wild vegetables were looked up in Ruffo et al. (2002), and further names were found with the help of researchers from HORTI-Tengeru. Vegetables were counted as "units" rather than as species, cultivars

or types, since only local names were available in certain cases. Nevertheless, through these local names, farmers were able to distinguish one vegetable from another which contributed to vegetable diversity.

2.3.2 Farm and household surveys

Design and procedure

Quantitative data related to the production and consumption of traditional vegetables was collected based on detailed household and farm surveys. Data was collected based on two different schedules, one relating to production, the other relating to consumption aspects of traditional vegetables. For the production survey, 359 households were randomly selected from a household list available in the villages. A total of 381 rural households participated in the consumption survey. The majority of the households participated in both surveys, although usually with a different respondent.

Questionnaires

The production interview schedule comprised four sections which looked into: (a) various socio-economic factors of the household; (b) overall food crop production; (c) production of traditional vegetables; and (d) marketing-related aspects of traditional vegetables. Not all the questions asked have been used in the analysis. Some did not generate sufficiently homogenous data to be useful, and others proved to be less significant than originally thought. Where products are harvested piecemeal, it is difficult for people to estimate how much they produce altogether. Frequency of harvest and availability of the product were used to construct an estimate for the total production. This estimate was in terms of local units, i.e. bags, plastic canisters, bundles or heaps, and were converted into decimal units based on conversion values obtained from local markets. Each interview took approximately 60 minutes per household. The consumption schedule explored the socio-economic variables of the household, a general introduction to consumption aspects of traditional vegetables, attitudes and beliefs concerning traditional vegetables, and a detailed recall of food consumed in the past 24 hours. Each interview took approximately 40 minutes, and all respondents were women.

Analysis of results

A particular interest of this study was to analyze how different groups within the farming communities of northeastern and central Tanzania are involved in cultivation of traditional vegetables, and how their consumption patterns differ. Two methods were applied to assess differential significance. First, we formed quintiles of households. For the production-related questions, these quintiles were formed by grouping households based on land ownership per district. The first quintile represents the 20% smallest farms in terms of area owned, while the fifth quintile is the 20% largest farms per district. For the consumption-related questions, quintiles were based on the households' monthly per capita food ex-

penditure. Again, the first quintile represents households with the lowest per capita food expenditure, while the fifth quintile represents households with the highest per capita expenditure. In addition, we use nonparametric regression to assess the relationship between two variables of interest. Nonparametric regression estimates the function, $m(x)=E(y|x)$, by computing an estimate of the location of y within a specific band of x. If this band maintains a constant number of observations, the estimator is a "nearest neighbor" estimator while if it maintains a constant width it is a "kernel" estimator (Strauss and Thomas, 1995). We use a nearest neighbor estimator, known as LOWESS (Cleveland, 1979), because the distribution of wealth parameters (land owned and per capita expenditure) is skewed even after a log transformation. Thus, a kernel estimator may not give robust results (at least for the richer households where the data density is low) because the fixed width bands will have few observations in the upper tail.

3 Diversity of traditional vegetables

Because a large variety of different traditional vegetables are used in all four districts, farmers selected the most important ones in order to be able to discuss them in more detail. Ranking was done for the top six, sometimes seven or eight traditional vegetables perceived as the most important.

The most important traditional vegetables discussed in the four districts are listed in Table 2. Based on the ranking, only amaranth, was consistently mentioned in all districts and was among the top six most important vegetables. Okra and sweet potato leaves were important in three districts, but did not rank first or second. The traditional vegetables which ranked first were important in only one or two districts. For example, African nightshade was the most important vegetable for farmers in Arumeru district, but was only gathered from the wild in Singida and Muheza district and mentioned in seven out of ten villages in Kongwa district. The same applied to bitter lettuce, the most important vegetable in Muheza district. This wild vegetable was named by farmers in only five out of ten and three out of eleven villages in Kongwa and Singida districts, respectively, and was not mentioned at all in Arumeru district. The most important traditional vegetable in Singida district, "mlenda", was also fairly important in Kongwa district (ranked 2). Mlenda is the name for leaves of different plant species which are all of slimy consistency when chopped and cooked. There are mainly three different vegetables gathered from the wild which are called mlenda: jute mallow (*Corchorus* spp.), wild simsim (*Sesamum angustifolium*), and false sesame (*Ceratotheca sesamoides*). Cowpea leaves, which ranked number 1 in Kongwa district, is the fifth most important vegetable in Arumeru district.

African eggplant was important only for farmers in the humid districts of Arumeru and Muheza but not in the remaining dry districts, and pumpkin leaves were included in the ranking only in the rural districts of Kongwa and Muheza. All other vegetables were mentioned only once in the different districts and are, therefore, only of local importance.

One highly interesting fact in Singida district concerns the mlenda group. All focus groups consider these vegetables as the most important ones and that they are commonly found in the wild. The second most important traditional vegetable, the bur gherkin or local cucumber (*Cucumis anguria*), is also mainly gathered from the wild. While several farmers in Singida district admitted cultivating them, it was not common in any of the other research districts. It is assumed that these vegetables are well adapted to the local conditions, necessitating no further human intervention given their sufficiently large quantities in the wild.

The total number of traditional vegetables identified by farmers are listed together with other indicators in Table 3. Participants in the Muheza district identified the highest number of traditional vegetables totalling to 73, followed by Kongwa with 35, Arumeru 24 and Singida 21.

Table 2. Ranking of the most important traditional vegetables in the four research districts in Tanzania (n = number of villages)

Traditional vegetable	Arumeru n = 10	Singida n = 11	Kongwa n = 10	Muheza n = 12
African eggplant (*Solanum* spp.)	3			5
African nightshade (*Solanum* spp.)	1			
African spiderflower (*Cleome* spp.)			3	
Amaranth (*Amaranthus* spp.)	2	4	4	2
Bur gherkin (*Cucumis anguria*)		2		
Cassava leaves (*Manihot* spp.)		6		
Cowpea (*Vigna unguiculata*)	5		1	
Ethiopian mustard (*Brassica carinata*)	4			
Bitter lettuce (*Launaea cornuta*)				1
"Mlenda" (*Corchorus* spp., *Sesamum angustifolium*, *Ceratotheca sesamoides*)		1	2	
Okra (*Abelmoschus* spp.)	6	5		3
Pumpkin leaves (*Cucurbita pepo*)			5	6
Sweet potato leaves (*Ipomoea batata*)		3	6	4

Source: Based on 43 focus group meetings conducted in collaboration with HORTI-TENGERU and AVRDC-RCA.

Table 3. Traditional vegetable diversity in the four research districts in Tanzania

	Arumeru	Singida	Kongwa	Muheza
Total no. of traditional vegetables (units)	24	21	35	73
Identified traditional vegetables (scientific names)	20	15	22	46
Unidentified traditional vegetables (local names only)	4	6	13	27
Mean no. of traditional vegetables per village	14	14	17	25
Range	11 - 19	10 - 17	14 - 22	18 - 34
Ratio wild: cultivated traditional vegetables	11 : 9 = 1.2	11 : 6 = 1.8	24 : 8 = 3.0	59 : 11 = 5.3
Traditional vegetables both cultivated and collected	4	4	3	4

Source: Keller et al. (2006)

The districts of Muheza and Kongwa have higher vegetable diversity and distinct knowledge on traditional vegetables in terms of the mean number of vegetables per village as well as the total number of traditional vegetables identified per district. The geographic location of Muheza may explain this

high vegetable diversity compared with the other districts. The rural Muheza district involves parts of the Eastern Usambara Mountains that are part of the Eastern Arc Mountains belonging to the 26 biodiversity hotspots in the world (Anonymous, 2004a). Villages in Arumeru and Singida districts on the other hand, are closely situated to the towns of Arusha and Singida. It is assumed that this relative proximity to marketing centers as well as access to inputs, knowledge and training have certainly contributed to this diversity decline of traditional vegetables being cultivated and consumed.

Most of the traditional vegetables mentioned have been identified by scientific names; however, some in Arumeru and Singida districts, and more than one-third in both Kongwa and Muheza districts are known by their local or Swahili names only.

Another interesting result was the ratio between cultivated traditional vegetables and those collected from the wild. All vegetables that are collected and not cultivated were regarded as wild even if some of them occurred in cultivated areas and, therefore, should technically be regarded as semi-cultivated. In all four research districts, the number of wild traditional vegetables were consistently greater compared with cultivated traditional vegetables in all focus group discussions. Again, this was especially true for both Kongwa and Muheza districts with exactly three and five times more wild than cultivated traditional vegetables. The lower ratios in Arumeru and Singida vis-à-vis wild traditional vegetables' lower popularity, importance and availability can be attributed to the grade of urbanization and population density, which spares less uncultivated areas as a habitat for wild vegetables. In all districts, only few vegetables are both cultivated and collected from the wild. One example is amaranth as there are different amaranth cultivars or landraces and wild forms available in Tanzania.

The diversity coefficient compares the four districts with regard to their availability of traditional vegetables and how many of the same vegetables they share. A Sørensen coefficient of 100 implies that two districts use exactly the same vegetables, while two districts with a coefficient of 0 would use totally different vegetables.

The two districts with the most similar traditional vegetables (59.6) were Arumeru and Singida district (Figure 2). Villages of both districts are situated close to a town that is a center of education, trade and commerce, and both districts are situated at similar levels of altitude (1000-1600 m asl.). On the other hand, while Arumeru has a rather humid climate, Singida district is characterized by a semi-arid climate suitable for fairly different vegetables. Furthermore, while in Arumeru the culture of vegetable cropping is only about 170 years old and people used to be pastoralists in the past (Gulliver, 1969), in Singida district Nyaturu people have practised agriculture with cattle integrated into the farming system since ancient times (Koponen, 1988). This could suggest a different preference for vegetable species and types as well. However, the influence of the urban center in both Arumeru and Singida district is most likely to be the decisive factor for diversity and species composition.

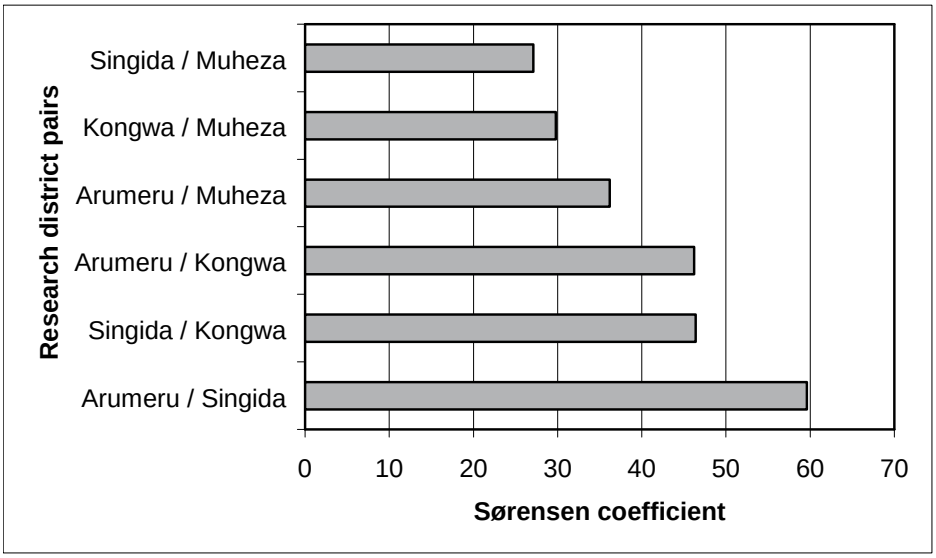


Figure 2. Sørensen coefficient for six pairs of research districts in Tanzania.

Source: Calculated by authors based on 43 focus group meetings conducted in collaboration with HORTI-TENGERU and AVRDC-RCA; formula according to DIERßEN, 1990.

Second in closeness of traditional vegetables used are Singida and Kongwa (46.4) as well as Arumeru and Kongwa (46.2). While the districts of Singida and Kongwa are both situated in central Tanzania with a similar semi-arid climate, which could explain the overlapping of similar traditional vegetables, Arumeru and Kongwa districts are rather different in terms of climate. Furthermore, while Arumeru has an urban center, Kongwa district is situated about one hour car drive from Dodoma town, with several villages being settled even further away. The reason for using similar traditional vegetables in both districts therefore must be found elsewhere.

Muheza differs most from the other districts in terms of traditional vegetable composition (Figure 2). This is obviously due to Muheza being the only coastal district with a humid climate, and light sandy but fertile soils. Moreover, the high natural biodiversity in this region results in a high vegetable diversity and therefore a high number of traditional vegetables that are known only in this district. In fact, the number of common species is highest for Muheza/Arumeru and Muheza/Kongwa, but the high number of traditional vegetables, which occurred in Muheza district only, qualifies this result.

Shannon's (H) and Simpson's (D) diversity indices are used to characterize species diversity in a community and they account for both abundance and evenness of the species present (Beals et al., 1999 and 2000). As for the Sørensen coefficient instead of using vegetable species the number of vegetable units mentioned by farmers is used.

The results show that diversity for Singida district is lowest with a Shannon index H = 2.83, while the highest vegetable diversity occurs in Muheza district with H = 3.84. The districts of Arumeru (H = 2.93) and Kongwa (H = 3.24) show a medium diversity according to Shannon index. Simpson's diversity index D shows a similar trend in vegetable diversity, with Singida (D = 15.70) and Arumeru (D = 16.71) district being quite similar in vegetable diversity but Kongwa (D = 21.87) and especially Muheza (D = 36.18) district holding a much greater diversity of traditional vegetables.

Shannon's evenness increases from Singida district with the lowest value of EH = 0.56 via Arumeru (EH = 0.60) and Kongwa (EH = 0.63) up to Muheza district showing the highest evenness of EH = 0.68. Apparently, evenness increases together with the number of species per district. Therefore, it can be concluded that the higher the vegetable diversity, the more equal is the distribution of vegetable units. However, evenness for all districts is not very high (1 = complete evenness), which is presumably due to only few vegetables being consumed in all villages — quite a number of vegetables are known and used only in individual villages.

Simpson's evenness is even lower and does not differ between the four districts to a great extent. Surprisingly, Kongwa district shows the highest evenness, which suggests that the number of different vegetable species is rather similar within villages in Kongwa than elsewhere. This is, however, unexpected, as in Kongwa district vegetable species differed between villages due to irrigation systems, which are available only in four of the ten villages researched.

Farmers also identified vegetables that were produced and/or consumed in the past but are no longer available. In Arumeru district, the level of genetic erosion of vegetables was fairly high but not as advanced, or at least not observed or mentioned by farmers, as in Singida, Kongwa and Muheza districts. While many wild traditional vegetables have been mentioned to be lost or dwindled in number, this was also observed for several cultivated traditional vegetables. More details and information on genetic erosion of Tanzanian traditional vegetables are discussed elsewhere (Keller et al., 2006). Focus group participants identified six major reasons, in order of importance, for the disappearance of traditional vegetables, the effects of which differ between cultivated and wild plants:

1. Introduction of new or exotic vegetables to the detriment of traditional species;
2. Climate change, especially the augmentation of drought;
3. Change in food habits;
4. Loss of vegetable habitats;
5. Lack of systematic transmission of knowledge from one generation to another resulting in the loss of indigenous knowledge;
6. Politics being responsible, e.g. for farmers resettlement.

4 Important traits in traditional vegetables

Farmers applied their own local classification system when providing the local names for the important vegetables or vegetable varieties, or its characteristics, with local names often having a descriptive meaning. For example, farmers described a vegetable using criteria such as morphology, place of origin, culinary traits and time until harvest.

The most important issues named by farmers concerning the production of traditional vegetables were yield, marketability, availability in general, inputs required, availability and cost of seeds (e.g. no cost when plant was gathered from the wild), as well as drought, and resistance to pests and diseases. In terms of consumption, farmers regarded taste, nutrient content and cooking behaviour to be of importance, although these traits were valued differently by district.

The following subchapters will concentrate on five different traditional vegetables that were most important to farmers in the four research districts. Discussion is divided into two parts. The first part outlines the different species or types of the traditional vegetable that can be found in northeastern and central Tanzania. The second part presents important traits of the traditional vegetables as mentioned and preferred by focus group participants.

4.1 Amaranth (*Amaranthus* spp.)

4.1.1 Overview on species

Amaranth is an important traditional vegetable and is the only traditional vegetable that belongs to the top six important vegetables in all four research districts. Cultivated amaranth species are among the most common leafy vegetables grown in the lowland tropics of Africa (Schippers, 2002). This may be due to the high diversity of the crop which can be divided into several species and subspecies. Moreover, its popularity is also high because of its many positive qualities. Table 4 summarizes the positive and negative traits of different amaranth species in all four districts.

There is still some confusion in the taxonomy of amaranth, especially with the species *A. hybridus*, *A. hypocondriacus* and *A. cruentus*, and it has to be pointed out that local and scientific names may not have been assigned equivocally in one case or the other.

The species *A. graecizans* is common in dry areas (Maundu et al., 1999a), and can be found in Singida and Kongwa districts only and not in the more humid Arumeru and Muheza districts. In contrast, *A. blitum*, which is mainly found in wet areas, waste grounds and cultivated lands (Maundu et al., 1999a) was mentioned in Arumeru and Muheza districts but not in Singida and Kongwa districts.

A. dubius is both cultivated and gathered from the wild only in Arumeru district. In Kenya, this vegetable can be found in most towns especially on cultivated lands, roadsides and flood plains (Maundu et al., 1999a). Most villages in Arumeru district were rather close to Arusha town and, therefore, this could be evidence for the occurrence of *A. dubius*. The species *A. hybridus* ("mchicha mwekundu") ranked between 1 and 2 in all districts and obviously enjoys a high popularity among farmers.

A. spinosus ("mchicha kienyeji") ranked between 2 and 5 and was obviously less preferred among the identified amaranth species. In Kenya, its use is also declining (Maundu et al., 1999a). The spines are a clear drawback during harvest and sorting.

In Arumeru, the local name "mchicha mweupe" (mweupe meaning white) was also used for two different species, namely *A. hypocondriacus* and *A. cruentus*. The color "white" either referred to the light green leaves or to the white or cream-colored seeds. Farmers ranked both species between 1 and 2 or 2 and 5, respectively, equal to *A. hybridus*.

4.1.2 Preferred traits

According to farmers, only *A. blitum*, *A. dubius* are drought tolerant. The other species are usually affected by drought, i.e. they are stunted in case of water shortage. The production of amaranth is favoured to African nightshade because it is sown and not transplanted. Yet, *A. cruentus* requires skill and many inputs, especially water and fertilizer, to cultivate.

Positive traits in terms of preparation are short cooking time and no further need of other ingredients. *A. graecizans* has a good taste even when dried, while *A. cruentus* is only consumed fresh. *A. hybridus* and *A. hypocondriacus* are prepared together with additional ingredients (e.g. onions and tomatoes) to improve the taste. One drawback of *A. hybridus*, however, is its red color which is not attractive to consumers and therefore reaps only low market prices. Further positive and negative traits on production and consumption issues of different amaranth species are listed in Table 4.

4.2 Cowpea (*Vigna unguiculata*)

4.2.1 Overview on types

Many different cowpea types were found in the four research districts. Since it is not assured that the different cowpea crops described by farmers are different cultivars, the term "type" will be used instead.

In Arumeru, Singida and Kongwa districts, farmers distinguished two types according to growth habit. A spreading or prostrate cowpea type "tambaa" (spreading) or "soko" (market) was reported to be drought-resistant (Arumeru and Singida) and is explicitly called "vegetable cowpea." Therefore, it is obviously grown for its leaves (Arumeru).

Table 4. Amaranth species and their positive and negative characteristics as perceived by farmers in four districts, Tanzania

	Amaranth species	*A. blitum*	*A. cruentus*	*A. dubius*	*A. graecizans*	*A. hybridus*	*A. hypocondriacus*	*A. spinosus*
Negative traits	Color not attractive					K, M		
	Lots of oil for cooking needed		A					
	Bitter/bad taste				K	M	M	
	Bad marketability		A			K, M	A, M	
	Cost (for seeds)						M	
	Poor seed availability	A					A	S
	Available only during rainy season				S, K			
	Requires high inputs		S, K					
	Susceptible to damp conditions	M						
	Susceptible to drought		A, S, K		S, K	A, K, M	A, K, M	S
	Susceptible to pests + diseases	M	A, K, M			A, K, M	K	
	Short production period/low yield		A			A, S, K, M	A, K	S
Positive traits	High nutrient content	A, M	A, K	A			K	
	Little oil for cooking needed			A				
	Short cooking time		K			S	A, K	S
	Good taste even when dried				S	S		
	Sweet/good taste	A, M	A, K, M	A	S, K	A, S	K	S
	Good marketability	A, M	K, M	A		A, S, K	S, K	S
	No cost (collected wild)	M			S			
	Good seed availability	M			K	S, M	S	
	Year round availability	A						
	Requires low inputs			A				
	Not/less susceptible to drought	A, M		A		S		
	Not/less susceptible to pests + diseases	A	M	A	K		A	
	Early maturing/fast growth		M			A, S, K	A, S, K, M	S
	Long production period/high yield	A, M	S, K, M	A		K	K	

Districts: A=Arumeru; S=Singida; K=Kongwa; M=Muheza

The second cowpea type called "wima" (erect) or "dakawa" is a variety developed at Dakawa research station of the Ministry of Agriculture and Food Security in Morogoro region. It has an erect plant habit and further distinguishing features (Table 5). This type is not drought resistant, is high yielding, has only one possible harvest (Singida), and is normally used for grains. Farmers in one village of Arumeru reported that this type is used as a leaf vegetable.

In Kongwa district where cowpea is also called "safwe", both the spreading and the erect type have similar characteristics except for the plant height (Table 5). In fact, Schuster (1998) has suggested higher plant habits for the two different cowpea types, namely 30-40 cm for the spreading and 80-100 cm for the erect type. However, these heights were apparently measured under more favorable conditions than in Kongwa district.

Farmers in Muheza district, on the other hand, distinguished more than two cowpea types through different local names. Farmers mentioned six different spreading plant types, which they distinguished according to seed color (e.g. white and big, "nyeupe"; or red/brown and small, "tambaa"), pod shape (long and slender, "nyeupe"; or short, "katumbo ndinga"), color of the plant (light green, "pamba"), or preparation behaviour (cooks fast ("pamba")). Two types, namely "pamba" and "bahau", were mentioned in several villages, yet, their characterization varied. "Pamba" is described to have a spreading plant habit in three villages, while farmers in one village claimed this type to have an erect plant habit. Similarly, "bahau" is said to have an erect plant habit in one village and to be a spreading type in another village. Thus, local names were obviously used for different plant types in different villages.

In general, farmers distinguish different cowpea types according to their grains instead of their leaves. This is possibly due to the fact that cowpea is more important to farmers for its grains and seed-yielding capacity rather than for leaf quality and yield. Actually, international research has focused on cowpea mainly for seed production (Schippers, 2002). Furthermore, farmer acceptability criteria in breeding cowpea, are grain and fodder yield, and quality of large and white

Table 5. Characteristics of two different cowpea types as mentioned by farmers in three districts of Tanzania

	Spreading cowpea type ("tambaa")	Erect cowpea type ("wima")
Leaves	broad, dark green (Arumeru)	narrow, small, light green (Arumeru)
Seeds	big, white, cream or yellow (Arumeru); big, black or red (Singida)	brown, dark green, red, grey or black and white (Arumeru); small, pink (Singida)
Height	about 30 cm (Arumeru); 15-30 cm (Kongwa)	about 30 cm (Arumeru); 30-60 cm (Kongwa)

seeds rather than leaf retention and edible leaves (Kitch et al. 1998). However, cowpea is preferred by most farmers since it is a multi-purpose legume crop (Schippers, 2002) and it is among the top three or four leaf vegetables in many parts of Africa (Barrett, 1990). More research on types and varieties that are grown for their leaves is therefore needed.

4.2.2 Preferred traits

Positive and negative characteristics of all different types are summarized in Table 6. In Arumeru district, both the spreading and the erect cowpea types are accepted, with the erect type being slightly more preferred due to its positive characteristics, namely uniform maturity, soft and fast cooking leaves, and uprooting for harvest. Furthermore, the erect type is washed during rains which minimizes the cleaning process before preparation. The appeal of the spreading type comes mostly from its drought-resistant and prolonged harvest period characteristics. More weight, however, is given by farmers to the softness of leaves and the ease of harvesting than to the latter characteristics.

Farmers from Singida, Kongwa and Muheza districts favor the spreading types due to its positive characteristics. Furthermore, higher yields could be obtained given its longer production period (for leaves), and spreading types are available fresh for a longer period of time. The latter is based on Schippers' (2002) view who considered prostrate, indeterminate cowpea types to be mainly grown for leaves, and erect, determinate and low-branching cowpea types for grain production. Moreover, the spreading or prostrate types have a maturity period of up to 140 days, and leaves can be picked repeatedly, while the grain yield is hardly affected by this as pointed by farmers. On the contrary, the erect types mature in about 80 days and do not produce leaves for a long time, but give a grain crop relatively early. The grain yield of these types, however, is clearly affected by leaf picking, which delays flowering and, therefore, delays the seed harvest (Schippers, 2002).

This was also found in a study on different cowpea accessions in Tanzania. Leafy types of vegetable cowpea were found to have low seed yield. On the one hand, leaf-harvesting reduced both number of pods and seed yield severely. On the other hand, through successive harvests, accessions with high leaf yield ensured a year-round availability of the product. The study suggests, however, further research to optimize frequency and intensity of leaf-harvesting while at the same time not reducing seed yield (Tefera Tolera, 2006).

Table 6. Cowpea types and their positive and negative characteristics perceived by farmers in four research districts of Tanzania

Negative traits	Tough leaves			A			
	Long cooking time			A, K			
	Bitter/bad taste						
	Bad marketability						
	Cost (for seeds)						
	Poor seed availability						
	Available only during rainy season						
	Requires high inputs			S			
	Susceptible to damp conditions						
	Susceptible to drought					S, K, M	
	Susceptible to pests + diseases		M	A, S, K, M		A, S, K, M	M
	Short production period/low yield					A, K, M	
Positive traits	Soft leaves		M			A	
	Little oil for cooking needed						
	Short cooking time		M			A, K	M
	Good taste even when dried						
	Sweet/good taste	M	M	K, M	M	A, K, M	M
	Good marketability			A, K, M		A, K, M	
	No cost (collected wild)						
	Good seed availability					A, K	
	Year round availability						
	Requires low inputs				M	S, K	
	Not/less susceptible to drought						
	Not/less susceptible to pests + diseases			S, K, M	M		
	Early maturing/fast growth			S		K, M	
	Long production period/high yield	M	M	A, S, K, M	M		M
Cowpea type		Nyeupe (spreading)	Pamba (spreading)	Tambaa; soko (spreading)	Bahau (erect)	Wima, dakawa (erect)	Gomesi

Districts: A=Arumeru, S=Singida, K=Kongwa, M=Muheza

4.3 Okra (*Abelmoschus esculentus*)

4.3.1 Overview on species

In general, okra types grown in traditional agriculture are often determined as landraces, which consist of a mixture of *A. caillei* and *A. esculentus* (Siemonsma and Hamon, 2004). Therefore, scientific names of local crops are assumed rather than properly identified. Since *A. caillei* is mainly found in West and Central Africa (Preston, 1998), it is expected that the different okra types described by farmers in Tanzania are primarily types of the species *A. esculentus*. However, some types show rather typical characteristics of *A. caillei* and are, therefore, assumed to belong to this species. The different okra types and their characteristics are summarized in Table 7.

Five different okra types were mentioned by farmers, but two of them were not described in detail in Arumeru district. Only three different types were distinguished in Kongwa district, six in Singida, and ten in Muheza district where diversity of okra types is most significant. Since most okra types have no local name, characteristics to distinguish them are listed.

The most important variety both in Arumeru and Kongwa is called "pusa sawani" or "mwezi mmoja uanze kuchuma" ("one month until beginning of harvest"), belonging to the family of *A. esculentus*. According to Siemonsma and Piluek (1994) and Schippers (2002) "pusa sawani" is an Indian cultivar which has been introduced to East Africa, where it became highly popular. In Singida and Muheza districts, another *A. esculentus* type is also very important.

4.3.2 Preferred traits

The absence of spines in okra fruits is considered a positive characteristic by farmers. Farmers in Arumeru district also prefer okra types that are early maturing and fast growing. The late maturing type is less preferred and at times is not marketable. This applies to the okra type "miezi minne uanze kuchuma" ("four months until beginning of harvest") which has been identified as *A. caillei*. This species is not marketable when "pusa sawani" is available. Nevertheless, it provides fruits and leaves when no other okra type is available since it yields later than the other types and, therefore, bridges a gap in the market.

In Singida district, one positive characteristic of an okra type is its relatively fewer mucilaginous material which is not preferred by consumers in other districts. Moreover, a red okra type is also undesirable to farmers because of the color. An important characteristic in Kongwa district is the prolonged softness of fruits in the field. This is the reason why the *A. caillei* type is less appealing to farmers since its fruit becomes coarse at an early stage (Table 7).

"Pamba" meaning "cotton" is the name for two *A. esculentus* and one unidentified okra type in Muheza district, whose flowers resemble those of cotton plants. Longer plant height of okra and bigger fruit size are considered positive characteristics in Muheza district since only few fruits are needed for a meal. Furthermore, compatibility in recipes with other vegetables, such as amaranth or African eggplant, is also a plus factor.

Table 7. Okra types and their positive and negative characteristics perceived by farmers in four research districts of Tanzania

Okra type	Positive traits										Negative traits								
	Long production period/high yield	Early maturing/fast growth	Not/less susceptible to pests + diseases	Not/less susceptible to drought	Good marketability	Sweet/good taste	Short cooking time	Soft fruit	Soft leaves	Big/long fruit	Short production period/low yield	Susceptible to pests + diseases	Susceptible to drought	Late maturing/slow growth	Poor seed availability	Bad marketability	Bitter/bad taste	Soft fruit only for a short time	Color not attractive
A. esculentus "Pusa sawani"	A	A, K			A, K	A, K		K				A, K	K						
A. esculentus "Bamia ya Moshi"		A			A							A	A		A				
A. esculentus "Mshumaa"	M				M					M									
A. esculentus "Pamba"		M									M								
A. esculentus "Pamba nyeupe"		M				M					M								
A. esculentus (long, slender, green, ribbed, no spines)	S	S			S	S	S		S	S		S							
A. esculentus (light green, no ribs)	K	K			K	K		K				K							
A. esculentus (long, slender, green, no ribs, no spines)	M				M	M													
A. esculentus (short, red, ribbed, with spines)		S	S	S													S		S
A. esculentus (short, broad, green, blunt end, with spines)						S					S	S				S			
A. caillei "Miezi minne uanze kuchuma"	A		A		A	A													
A. caillei (long, slender, green, with spines)	S																		
A. caillei (short, broad, red, no spines)	S			S		S													
A. caillei (long, slender, light green, no ribs, no spines)	M			M		M								M					
A. caillei (long, slender, no ribs, with spines)	M					M	M					M							
A. caillei (red, stout, short, ribbed, with spines)	M									M									
A. caillei (ribbed, with spines)				K	K	K				K	K								

Districts: A=Arumeru, S=Singida, K=Kongwa, M=Muheza

4.4 Nightshade (*Solanum americanum, S. 'eldoretii', S. scabrum, S. villosum*)

4.4.1 Overview on species

For the identification of African nightshade species occurring in northeastern and central Tanzania, the taxonomy of Schippers (2002) was applied. In Table 8, species of African nightshade found in three different districts are listed. While the assignment of scientific names to local names is not assured, the likelihood that these are correct is heavily based on plant descriptions by farmers and due to identification of some plants by Tanzanian fellow researchers.

The yellow-fruited *S. villosum* is the most important African nightshade in Arumeru district, and ranks second in Kongwa villages. This species is rather common in the northern highlands and less so in the southern highlands of Tanzania (Schippers, 2002). *Solanum scabrum* is called "introduced" or "Kenyan" variety in the local language in Arumeru district and ranked second there. The third species in Arumeru, *S.`eldoretii´*, ranked second in the coastal district of Muheza. In Kongwa and Muheza districts, the most preferred African nightshade species was *S. americanum*.

4.4.2 Preferred traits

S. villosum is most important to farmers in Arumeru district due to its good taste, high marketability and high nutrient content. Farmers provided contradicting statements concerning length of production period as well as susceptibility to pests and diseases. Nevertheless, it was stated twice that this species grows especially well under the given conditions in this district. *Solanum scabrum* ranked second in Arumeru because taste and marketability are not as favorable as for *S. villosum*. *S. scabrum* did not occur in the dry Kongwa district, possibly due to the fact that it is normally found in high rainfall areas (Schippers, 2002).

Table 8. Local names of African nightshade species and types

Scientific name	Arumeru	Kongwa	Muheza
S. villosum	"mnavu mwembamba" (narrow); "mnavu wa kienyeji / kawaida" (introduced nightshade); "inyafu" (nightshade in maasai language);	no name;	not cultivated;
S. scabrum	"mpana" (broad); "kisasa" (introduced); "mnavu wa Kenya / kisasa" (nightshade from Kenya / introduced); "Ex-Kenya" or "Ex-Hai" (formerly in Kenya or Hai district, Tanzania); "inyafu" (nightshade in Kimaasai);	not available;	not available;
S. americanum	not available;	no name;	"zinge";
Not identified	-	-	"mnavu kiau / gana"; "puche"

S. `eldoretii´ is not favored by farmers in Arumeru district because of its coarse leaves, non bitter fruit (bitterness was preferred) and the presence of hairs or spines on the stems. In Muheza district, this species is characterized as early maturing and, therefore, available before *S. americanum*. Its taste is also less acceptable.

S. americanum is newly introduced in Kongwa and is not yet accepted by all people. Its popularity is however increasing due to its slightly bitter taste, higher resistance to insect pests, and because it is quick and easy to prepare. In Muheza district *S. americanum* ranks first because it is said to have higher vitamin C content, helps boost appetite, and has medicinal properties of curing malaria (Table 9).

Table 9. African nightshade (Solanum spp.*) types and their positive and negative characteristics perceived by farmers in three research districts of Tanzania*

African nightshade type	Positive traits									Negative traits								
	Long production period/high yield	Early maturing/fast growth	Not/less susceptible to pests + diseases	Not/less susceptible to drought	Good seed availability	Good marketability	Slightly bitter/good taste	Short cooking time	High nutrient content	Short production period/low yield	Susceptible to pests + diseases	Susceptible to drought	Late maturing/slow growth	Poor seed availability	Bad marketability	Not very bitter/bad taste	Long cooking time	Color not attractive
S. americanum	K	K	K			K	K, M	K	M			K		K				
S. 'eldoretii'	K	A, K, M		K		K					K				A	A, M	A	
S. scabrum	A	A			A						A					A	A	
S. villosum				A	A	A	A	A	A	A	A							

Districts: A=Arumeru, S=Singida, K=Kongwa, M=Muheza

4.5 African eggplant (*Solanum aethiopicum, S. anguivi, S. macrocarpon*)

4.5.1 Overview on species

Four and five different types of African eggplant are distinguished by farmers in Arumeru and Muheza districts, respectively. Tanzania's main variety is suggested to be "Tengeru white" (Schippers, 2002) which is a garden egg (Gilo group/*S. aethiopicum*). In fact, "Tengeru white", also called "ngogwe si chungu" (not bitter eggplant) or "mviringo kubwa" (round and big), is cultivated in both districts but ranks first in Arumeru district only. It ranks second after "mshumaa" (also Gilo group/*S. aethiopicum*) in Muheza district.

Further African eggplant types in Arumeru are "Manyire green" (*S. aethiopicum*) and another *S. aethiopicum* type called "ngogwe nyeupe ndogo" (white and small eggplant) or only "ndogo" (small). Muheza farmers identified three types, namely "mviringo" (round, *S. aethiopicum*) "nyeupe" (probably *S. macrocarpon*) and an *S. anguivi* type characterized by its very small, green ribbed and bitter fruits.

4.5.2 Preferred traits

In Arumeru district, "Tengeru white" is preferred due to its high marketability. Other varieties, e.g. "Manyire green" or "ngogwe mshumaa", were reported to be less preferred by consumers when "Tengeru white" is available in the market. This forced farmers to stop cultivation of these varieties when "Tengeru white" is in season. Farmers even uproot these unwanted varieties when they grow in the field by accident to prevent them from crossing with "Tengeru white". However, one good trait of "Manyire green" is that it is less attacked by insect pests compared with "Tengeru white" and "mshumaa".

In Muheza district, the garden egg "mshumaa" is preferred by middlemen who buy vegetables directly from farmers (sometimes even a non-harvested plot) and sell it to marketers. "Tengeru white" ranked only second, possibly due to its short production period. Yet, focus group participants in Muheza also stated that "Tengeru white" in general performed better than other types.

An African eggplant type called "ngogwe nyeupe ndogo" or only "ndogo" in Arumeru district is also inferior to "Tengeru white", e.g. concerning the price it receives in the market. Yet, it matures earlier and could, therefore, be sold in the market when "Tengeru white" is not readily available, thus, bridging a market gap. The type "mviringo" (round) in Muheza had a higher yield and also bigger fruits than "mshumaa", but it is also less favored. Further positive and negative characteristics of African eggplant types are listed in Table 10.

Table 10. African eggplant types (Solanum spp.*) and their positive and negative characteristics perceived by farmers in two research districts of Tanzania*

Negative traits	Color not attractive					
	Bitter/bad taste				A	A
	Bad marketability				A	A
	Poor seed availability					
	Late maturing/slow growth	A				
	Susceptible to drought					
	Susceptible to pests + diseases	A	A, M		A	
	Short production period/low yield				A	
Positive traits	Big fruit	A, M	M	M		
	Attractive shape	A	A			
	Attractive color		M			
	Short cooking time					
	Sweet/good taste	A, M	A, M	M		
	Good marketability	A, M	A	M		
	Not/less susceptible to drought	A	A, M			
	Not/less susceptible to pests + diseases				A	
	Early maturing/fast growth		A		A	A
	Long production period/high yield	A, M	A, M	M		
African eggplant type		*S. aethiopicum* - Gilo group "Tengeru white"; "Ngogwe si chungu"; "Mviringo, kubwa"	*S. aethiopicum* - Gilo group "Ngogwe mshumaa"	*S. aethiopicum* "Mviringo"	*S. aethiopicum* "Manyire green"	*S. aethiopicum* "Ngogwe nyeupe, ndogo"; "ndogo"

Districts: A=Arumeru, S=Singida, K=Kongwa, M=Muheza

5 Cultivation of traditional vegetables

The former chapter has shown the large variety of traditional vegetables that are available in northeastern and central Tanzania. This chapter highlights the economic importance of traditional vegetables by discussing farm production aspects.

The importance of traditional vegetables is often discussed in the context of wild and collected crops (Grivetti and Ogle, 2000, Ogle et al., 2001) that contribute to food safety in times of hunger (Humphry et al., 1993; Lockett and Grivetti, 2000; Zinyama et al., 1990). Studies on the economic value of traditional vegetables are less common although the few studies that are available indicate that the market potential of traditional vegetables is very large. Gockowski et al. (2003) studied the importance of traditional leafy vegetables for employment generation in production and marketing in Cameroon and found that the annual sales of traditional leafy vegetables alone was an estimated US$22 million in 1996, and that including the value of rural consumption, the estimated total market value was more than US$56 million. High and Shackleton (2000) compared economic values of wild and domesticated plants in South Africa and found that wild plants contribute to 31% of the total diet value, as well as to income generation since a share of the surplus is sold. Similarly, Trinh et al. (2003) found that commercialization of traditional vegetables from home gardens contributes to up to 54% of total household income.

5.1 Production aspects

Most farmers cultivate traditional vegetables. A total of 279 farmers (78%) had cultivated traditional vegetables during the preceding production cycle, including 14 different crop species. Most farmers had cultivated one crop (55%), 18% had cultivated two crops and 5% had cultivated three crops. The share of farmers growing traditional vegetables was lowest in Muheza, at only 54%, and ranged from 82% in Singida, 85% in Kongwa to 93% in Arusha. Muheza is the district with the highest number of wild vegetables and with the highest ratio of wild to cultivated traditional vegetables, thus the incentive to cultivate these crops there may be lower (Table 3). Crops most frequently cultivated were cowpea, okra, amaranth and nightshade (Table 11), but it is worth pointing out that in terms of area coverage, more than 50% of all area under traditional vegetables was being cultivated with cowpea. The variety mix is highest in Arumeru, at 1.5 crops per farm, and lowest in Kongwa at 1.2 per farm.

Although the overwhelming majority of farmers are engaged in the cultivation of traditional vegetables, on average only 10.7% of the total cultivated area is allocated to these crops. While there are large differences across regions and by size of operated farms, in general, there is a decreasing trend as farm areas become bigger. On average, 20% of cultivated area is allocated to traditional vegetables in Arumeru district, while only between 7.6 and 8.8% of area are allocated in the other three districts.

Table 12 shows how the share of farmers engaged in cultivation of traditional vegetables differs between districts and across wealth of households. The table shows that, on average, as households become wealthier, the tendency to cultivate traditional vegetables in Arumeru district declines, and increases in Kongwa, while a mixed trend was observed in the other two districts.

A nonparametric regression approach was used to visualize the relationship between land owned and share of cultivated area under traditional vegetables due to the absence of any obvious trend. Results showed that small farms tend to allocate a larger share of their farms to traditional vegetables cultivation (Figure 3). This trend is observed in all four districts, albeit at varying degrees. Small farms may opt to cultivate traditional vegetables on a larger share of their land to minimize risk.

Table 11. Traditional vegetables most frequently cultivated

English name	Scientific name	Share in	
		plots	area
Cowpea (leaves)	*Vigna unguiculata*	27.9	57.7
Okra	*Abelmoschus* spp.	18.6	13.2
Amaranth	*Amaranthus* spp.	17.0	7.5
Nightshade	*Solanum* spp.	11.2	6.1
African eggplant	*Solanum* spp.	6.9	6.3
Pumpkin (leaves)	*Cucurbita* spp.	6.9	3.4
Sweet potato (leaves)	*Ipomoea batata*	4.3	3.4
Ethiopian Mustard	*Brassica carinata*	4.0	1.0
Others		3.2	1.5
Total		100	100

Table 12. Share of farmers engaged in cultivation of traditional vegetables by district and quintiles of owned area

District	Land owned quintiles					Average
	1	2	3	4	5	
Arumeru	100.0	100.0	85.7	93.8	83.3	92.6
Kongwa	72.7	76.5	92.0	83.3	100.0	84.9
Singida	76.9	84.2	80.6	71.4	94.7	81.6
Muheza	56.3	47.1	59.1	42.1	63.2	53.5
Average	76.5	76.9	79.4	72.7	85.3	78.1

Note: Farm households were ranked into quintile groups according to their total area owned within each district. Farms in group "1" are twenty percent smallest farms in terms of owned area, while farms in group "5" are the twenty percent largest farms per district in respect to owned area. Source: Survey conducted by AVRDC in cooperation with HORTI-TENGERU, 2003. N = 359 households.

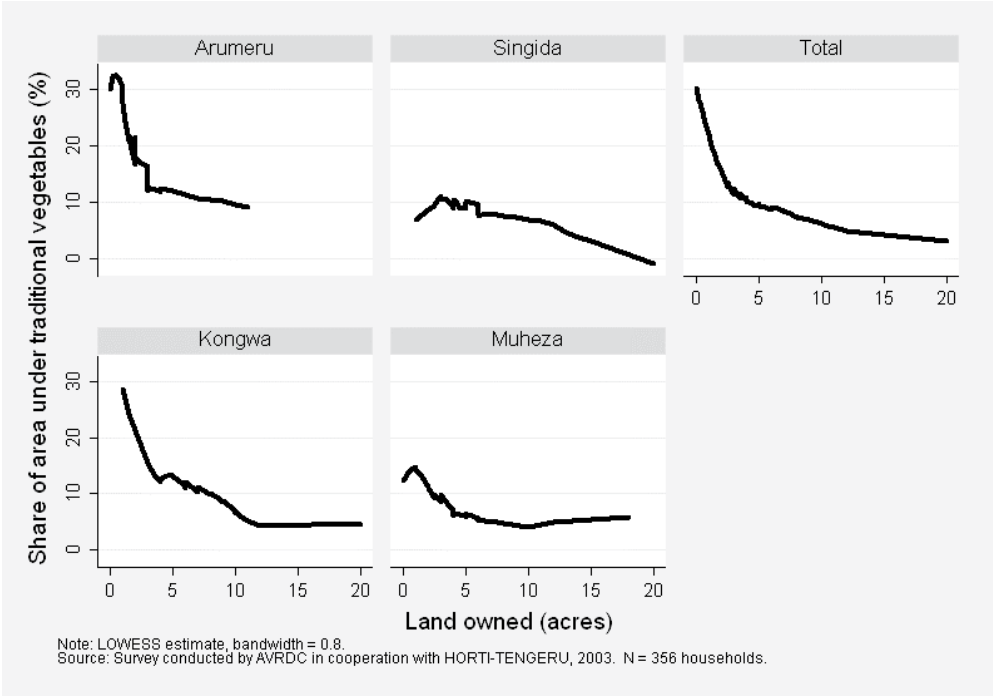
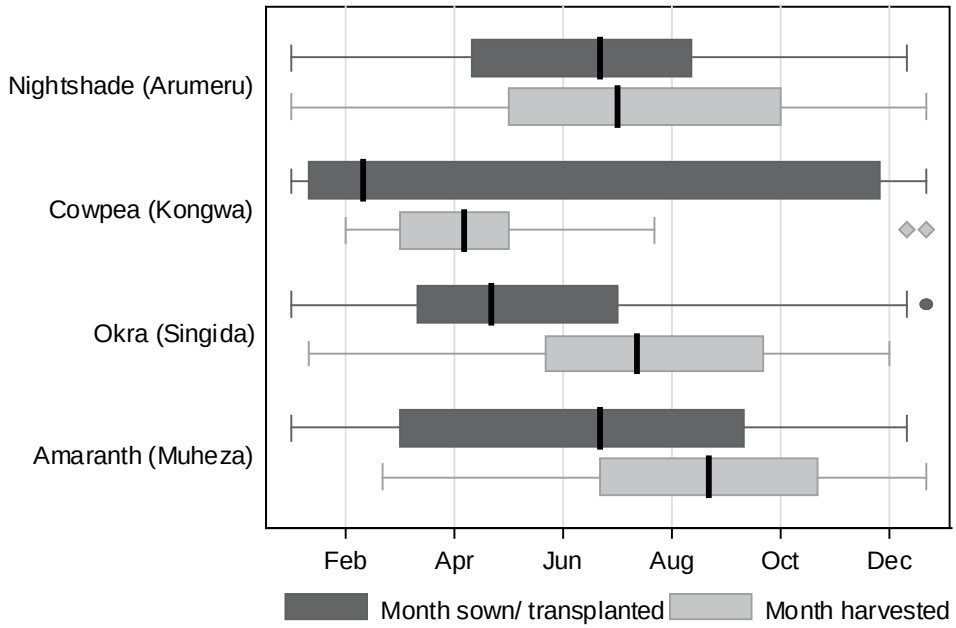


Figure 3. Distribution of share of cultivated area by land owned (LOWESS estimator) and by district.

Among the farmers cultivating traditional vegetables, plot specific information on traditional vegetable production was collected. The four most predominant traditional vegetables found were cowpea (28% of all plots), okra (18.7% of all plots), amaranth (17.1% of all plots) and nightshade (11.2% of all plots). Conveniently, each of these crops is representative for one of the districts, i.e. cowpea in Kongwa, okra in Singida, amaranth in Muheza and nightshade in Arumeru. Thus, in the following, most analysis will concentrate on those four crops.

The production of traditional vegetables is highly variable and follows no uniform cropping patterns (Figure 4). The figure shows the cropping pattern for each predominant crop by district. Neither transplanting/sowing month, nor cropping duration shows uniformity. The same crop may be produced for three months or for eleven months (okra in Singida) although the leafy vegetables are usually cropped for a shorter period than okra and cowpea. Production takes place over the entire year.



Survey conducted by AVRDC in collaboration with HORTI-TENGERU, 2003. N = 152 plots

Figure 4. Cropping patterns for most important crop by district.

Yields, and net return also tend to be highly variable (Table 13), with median values approximately half of mean values for all 4 crops. The median net return per hectare is highest for nightshade (US$ 454/ ha), followed by amaranth (US$ 417/ ha), and okra (US$ 357/ ha) and much lower for cowpea (US$ 152/ ha). Since only a share of all produce is usually sold on the market, non-marketed produce was valued at market price[1]. Considering labor use, nightshade has the highest returns, followed by amaranth and again cowpea has the lowest returns. There is less variation in the value per yield output which is highest for amaranth, followed by cowpea (based on median values). Overall, the median return can be considered comparable to exotic vegetables.

In general, traditional vegetables require less input into production compared to exotic vegetables. Figure 5 shows the cost structure for the most important crop in each district. On average, variable cost constitutes only 14% of all cost. The share is highest for amaranth with approximately 25% variable cost and lowest for okra at 4%. The main component of fixed cost is family labor, valued at the market price. In variable cost, amaranth requires a relatively large share of hired labor as compared to the other three crops, whereas for the other crops the share of input cost for fertilizers and pesticides is highest. This cost structure partly explains why traditional vegetables are particularly attractive to small-scale farmers. Since they require relatively little financial input, the risk of financial losses are much smaller than they are for most of the exotic vegetables, which

[1] Calculated as average regional prices.

Table 13. Mean, median and maximum yield levels and net value of production

		Yield (kg/ha)	Net return (US$)			N
			per ha	per labor hour	per kg	
Cowpea	Mean	512	178.04	0.24	1.47	78
	Median	198	151.99	0.20	0.16	
	Maximum	7413	757.74	0.72	8.20	
	SD	1238	209.55	0.21	2.80	
Amaranth	Mean	3757	968.28	0.46	0.42	47
	Median	1305	417.49	0.30	0.24	
	Maximum	37065	16803.84	2.30	1.76	
	SD	6247	3126.23	0.52	0.43	
Nightshade	Mean	3184	1482.62	0.78	0.30	24
	Median	1661	454.02	0.63	0.12	
	Maximum	12335	19308.76	4.16	1.10	
	SD	3572	3725.35	0.86	0.35	
Okra	Mean	5705	808.85	0.53	0.26	56
	Median	2100	356.95	0.27	0.14	
	Maximum	59304	4957.66	4.66	4.01	
	SD	10379	1164.79	0.87	0.62	

Source: Survey conducted by AVRDC in cooperation with HORTI-TENGERU, 2003. N = 205 plots.

typically require between 50 to 60% variable cost to total cost (Weinberger and Msuya, 2004).

5.2 Marketing

Market integration of producers of fruits and vegetables is usually higher than that of staple crop producers (Weinberger and Lumpkin, 2007). The same holds true for this study. Among the farmers engaged in the production of the respective crops, 88% market traditional vegetables, 98% market exotic vegetables, and all farmers engaged in fruit production market their fruit output, whereas only 49% of farmers market their cereal production. Yet, the degree of commercialization is very different for the different crops. It is highest for African eggplant (four-fifths of all produce is sold), followed by nightshade, okra, amaranth and Ethiopian mustard (approximately two-thirds of the produce are sold). Of all crop produced, nearly half reaches the market and the rest is either consumed at home or given away as gifts. Among the farmers cultivating traditional vegetables, the share of farmers selling in the market is highest in Arumeru (85%) and lowest in Kongwa (22%) (Table 14). It is not surprising that the share is highest in Arumeru, since this district is in close proximity to Arusha which is one of the largest cities in the

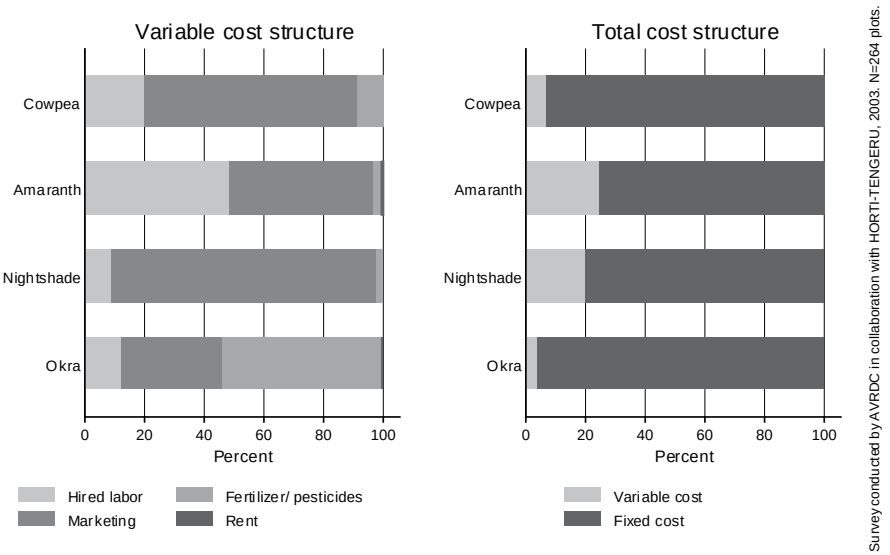


Figure 5. Total and variable cost structure of traditional vegetable cultivation.

country. In general, farmers sell three quarters or more of their produce, and keep the rest for home consumption. In terms of contribution to overall farm income, returns from sale of traditional vegetables contribute an average 15% to total farm income, ranging from 23% in Singida to only 5% in Kongwa. Now we will turn our attention to the question of who markets the traditional vegetables.

Figure 6 shows the share of harvest sold by land owned. There are clear differences between the smallest 40% of farms, the middle 40-60% of farms, and the largest 40% of farms. While among the largest 60% of farmers approximately half do not sell any output at all, this share drops to a quarter among the 40% smallest farms. In terms of proportion, selling output is more important for the smaller farms than for the larger farms. In terms of absolute value that marketing of traditional vegetables contributes to farm income, the relationship takes a U-distribution (Figure 7). It is high for small farms (around US$ 60), drops to a minimum point for farms around 2 acres and then rises to slightly over US$ 70 for farms larger than 12 acres. These results indicate that both in absolute and relative terms, traditional vegetables are an important source of income for small farms.

Table 14. Marketing of traditional vegetables

	Share of farmers selling		Share in farm income	
	%	N plots	%	N farmers
Arumeru	84.8	79	16.1	41
Kongwa	21.6	88	5.1	58
Singida	74.7	95	22.7	61
Muheza	83.0	47	16.7	29
Total	63.4	309	14.9	189

Source: Survey conducted by AVRDC in cooperation with HORTI-TENGERU, 2003. N = 309 plots.

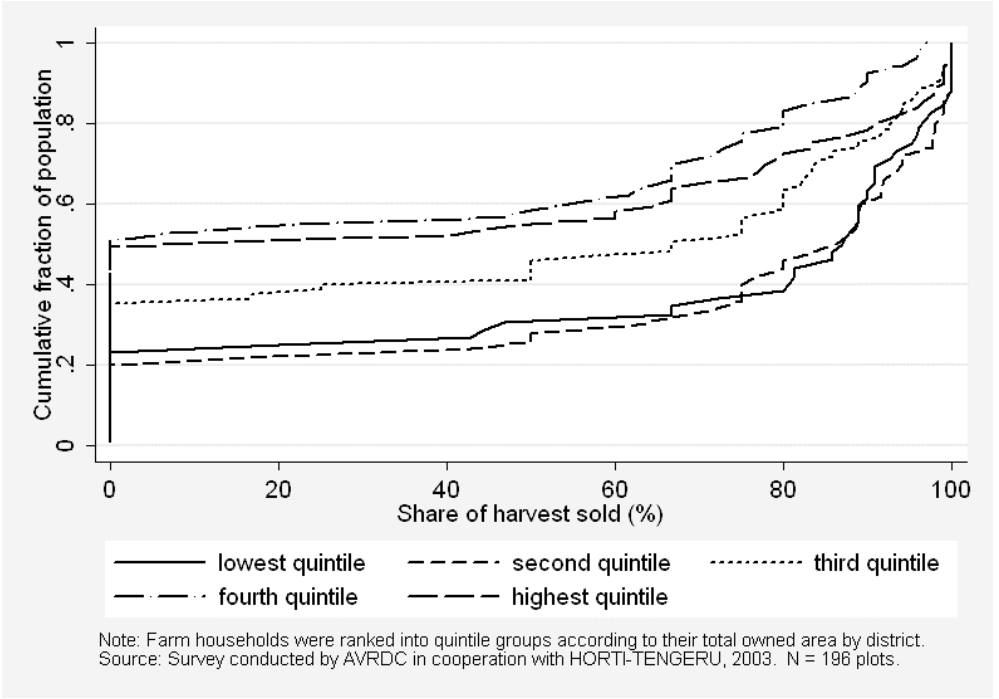


Figure 6. Share of harvest sold by farm groups.

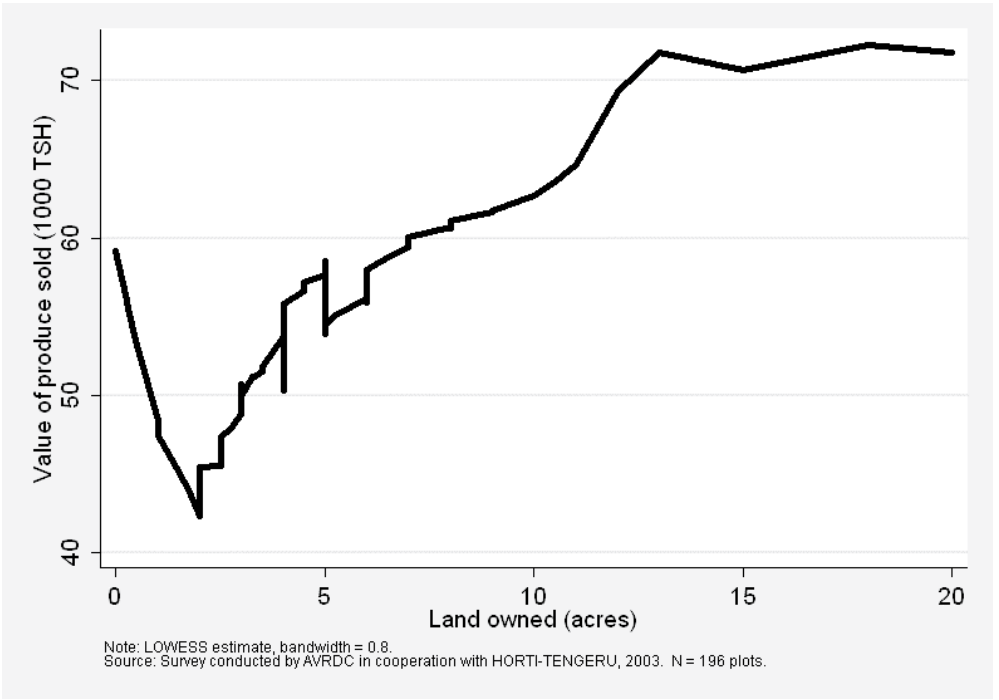


Figure 7. Distribution of value of produce sold by land owned (LOWESS estimator).

6 Consumption of traditional vegetables

6.1 Significance of traditional vegetables in consumption

For the purpose of the following section, we include only traditional vegetables that were consumed by households during the preceding 24 hours before the survey. These crops are listed in Table 15.

Table 15. Traditional vegetables consumed the previous day

English name	Scientific name
African eggplant	*Solanum aethiopicum* L., *S. macrocarpon L.*, *S. anguivi* Lam.
Amaranth	*Amaranthus blitum* L., *A. cruentus* L., *A. dubius* L., *A. hybridus* L., *A. spinosus* L., *A. graecizans* L.
Baobab	*Adansonia digitata* L.
Black jack	*Bidens pilosa* L.
Cassava leaves	*Manihot esculenta* Crantz, *M. glaziovii*
Cowpea leaves	*Vigna unguiculata* (L.) Walp.
Ethiopian mustard	*Brassica carinata* A. Braun
False sesame	*Ceratotheca sesamoides* Endl.
Hair lettuce	*Lactuca carinata / Launaea cornuta* (Oliv. & Hiern) Jeffr.
Indian mustard	*Brassica juncea* (L.) Czern.
Jute mallow	*Corchorus olitorius* L., *C. tridens* L., *C. trilocularis* L.
Lablab bean	*Lablab purpureus* (L.) Sweet
Lady finger	*Abelmoschus esculentus* (L.) Moench, *A. caillei* (A. Chev.) Stevels
Nightshade	*S. americanum* Miller, *S. scabrum* Miller, *S. villosum* Miller
Pumpkin leaves	*Cucurbita pepo* L., *C. Moschata* (Duschesne ex Lam.) Poir.
Spider plant	*Gynandropsis gynandra* (L.) Briq., *Cleome gynandra* L., *C. hirta* (Klotzsch) Oliv.
Sweet potato leaves	*Ipomoea batata* L.
Swiss chard	*Beta vulgaris* L.
Water cress	*Rorippa Nasturtium aquaticum* (L.) Hayek
Wild cucumber	*Cucumis* spp.
Wild simsim	*Sesamum angustifolium* (Oliv.) Engl.

Traditional vegetables are a regular part of the diet, albeit at a varying degree within the four districts. Approximately three-fourths of the households consumed traditional vegetables the day prior to the survey, the share being highest in Singida and lowest in Muheza. In total, 19 different traditional vegetables were found to have been consumed, ranging from nine crops in Arumeru to 16 crops in Kongwa (Table 16). There are marked differences among the districts. In Singida, jute mallow, false sesame, wild simsim and wild cucumber are most prevalent and all crops are collected. In contrast, nightshade, amaranth and African eggplant (in Arumeru) are all cultivated crops. The variety of traditional vegetables consumed within household diets is highest in Singida, where on average nearly two different vegetables had been consumed the day before, while in Muheza, the mean was close to 1. The results reported here stand in some contrast to chapter 3 that reports that Muheza had the greatest diversity in traditional vegetables while Singida had the lowest diversity. A greater variety in traditional vegetables available does not appear to imply that all these vegetables are consumed, and vice versa.

Traditional vegetables are usually obtained from different sources as compared to exotic vegetables (Figure 8). While the majority of all exotic vegetables consumed were purchased in the market (65.4%), the majority of traditional vegetables consumed were produced in their own fields, or collected from the fields as volunteer crops. However, there are also marked differences across different households. To assess the role that traditional vegetables play in consumption

Table 16. Most popular traditional vegetables

District			Households that had consumed traditional vegetables	Number of traditional vegetables consumed	
	Count	Most frequently consumed	Share	Mean	Maximum
Arumeru	9	nightshade, amaranth, African eggplant	67.6	1.3	3
Kongwa	16	jute mallow, false sesame, wild simsim, amaranth	80.2	1.4	3
Singida	10	jute mallow, false sesame, wild simsim, wild cucumber	78.6	1.8	4
Muheza	11	amaranth, hair lettuce	58.5	1.1	3
Total	19	jute mallow, amaranth	71.4	1.4	4

for different groups within a society, households were clustered into different groups depending on their per capita food expenditure. Five groups of similar size were created with mean monthly per capita food expenditure ranging from 968 Tanzanian Shillings (TSH) in the first quintile to 10904 TSH in the fifth quintile. A larger share of traditional vegetable produce in poor households (first quintile) tends to be obtained through collection (30%) while it is the middle class (third quintile) that consumes the largest share of traditional vegetables produced in their own fields. As would be expected, it is the wealthiest group (fifth quintile) that purchases the largest share of traditional vegetables in the market (40% of all produce). For exotic vegetables, purchasing is more important than home production for all expenditure groups, but it is less important for the first and second quintile as compared to the other three quintiles (Figure 8).

It is well established in the literature that diversity of food intake increases with increasing food expenditure (Ruel, 2003, Thiele and Weiss, 2003). In this study, diversity in total food and total vegetable intake also increases with increasing food expenditure (Table 17, column 2 and 3). But in contrast, diversity of traditional vegetable intake is higher for the poorest group of households than for any of the other quintile groups (Table 17, column 4).

Total vegetable consumption tends to increase with higher total food expenditure. The amount consumed by households in the highest expenditure quintile is twice the amount of vegetables (317g) consumed in the lowest

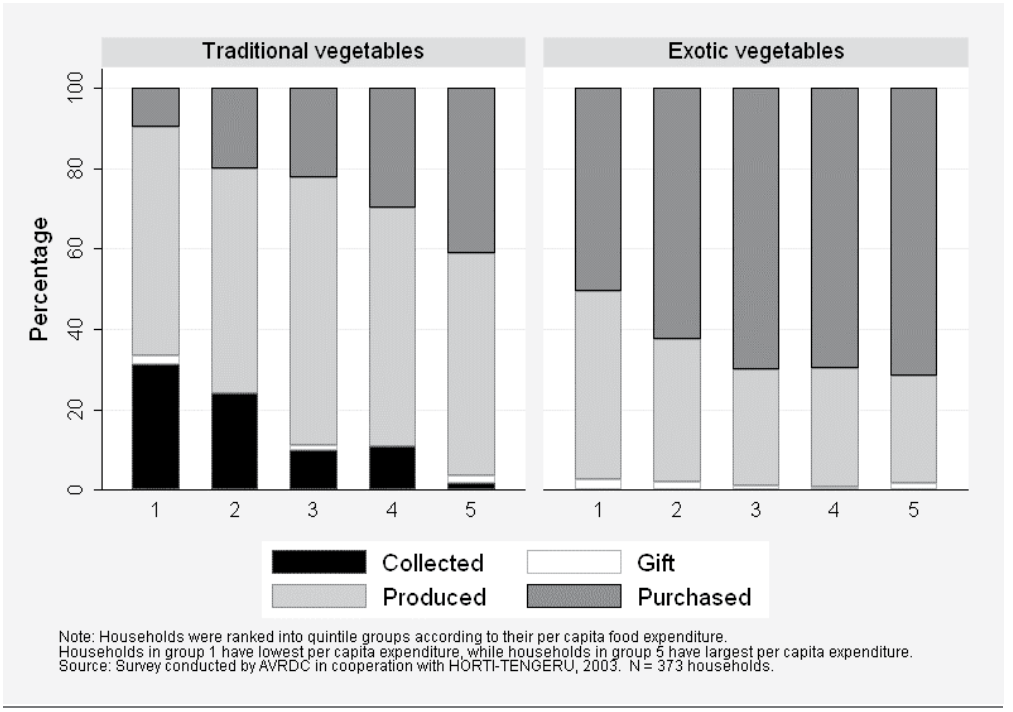


Figure 8. Source of vegetables consumed the previous day.

expenditure quintile (154g) (Table 17, column 8). The WHO recommends an average daily intake of 400g of fruits and vegetables per capita for a healthy diet (WHO, 2003). If it is assumed that at least half of this amount are vegetables, i.e. 200g, this quantity is only met by the average population while the poor households (first to third quintile) are able to meet approximately three-fourths of this recommended intake level only.

There is no observable trend for the per capita intake of traditional vegetables by expenditure quintile (Table 17, column 6). A nonparametric regression approach (LOWESS) was then used to visualize the relationship between food expenditure and level of intake of traditional vegetables. Figure 9 shows the results. The curve has two maximum points. Intake of traditional vegetables is highest in the group with little food expenditure, and decreases as food expenditure rises. It reaches another maximum in the highest food expenditure quintile before it decreases again. Clearly, traditional vegetables are an important component in the household diets of both low-income and high-income groups. High-income groups may increasingly turn towards traditional vegetables as health foods as what is already happening in some Asian countries like Malaysia where these vegetables are believed to be free of pesticides (Hoe and Siong, 1999). Ogoye-Ndegwa and Aagaard-Hansen (2003) similarly reported that traditional vegetables regarded by the Luo of Kenya as having low status can be found in big hotels.

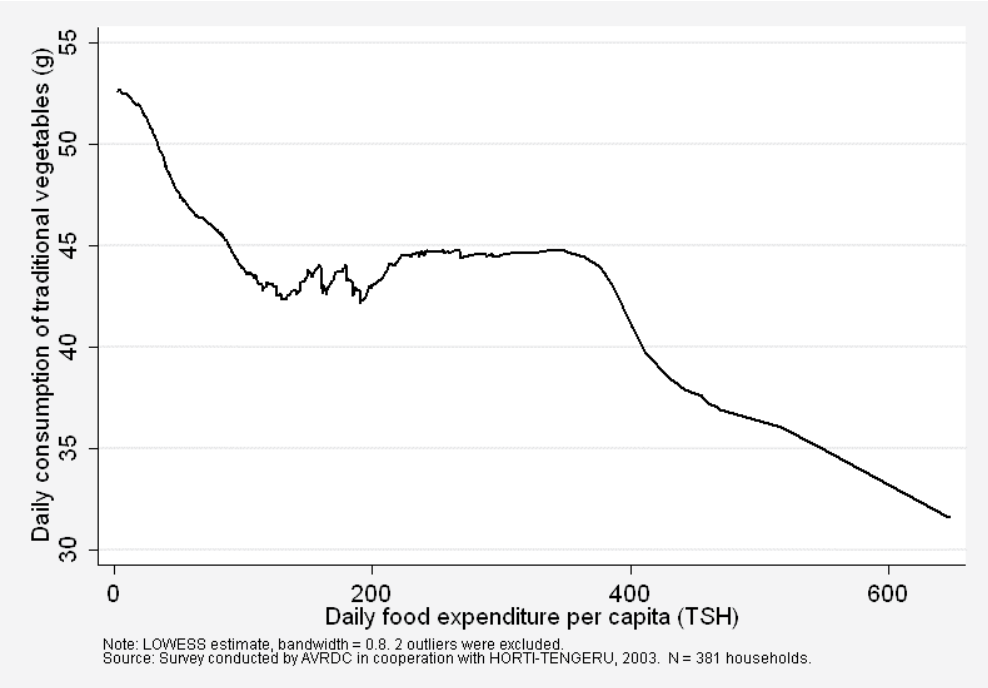


Figure 9. Lowess smoothing - consumption of traditional vegetables and food expenditure.

Since a large share of all food items consumed is either produced at home or collected, the opportunity costs of these products were computed based on either the average village level price, or the average district level price if the former is not available. Column 9 in Table 17 shows the value of traditional vegetables and the share (column 10) in total food value (as opposed to actual food expenditure). Both absolute value and the share in total food value decrease for wealthier groups (albeit taking an upward turn in terms of absolute value for the wealthiest group). The value of traditional vegetables is approximately 8% of the value of all food consumed for poor households, and only 2.7% for the wealthiest households. Clearly, poor households rely more on traditional vegetables than wealthier households do.

6.2 Food preparation and preservation

Traditional vegetables are used in diverse forms and many of them can be considered multi-purpose crops. Many parts of almost all vegetables mentioned by farmers are used (Table 18). Leaves of all traditional vegetables are utilized except for African eggplant. Within this crop group, farmers stated to use only the leaves of *Solanum anguivi*. Among the list, three vegetables are used only for their leaves, while a minimum of two plant parts are used from all the others

Table 17. Consumption parameters

Food expenditure quintiles	Monthly food expenditure per capita	Number of different food items consumed				Daily per capita consumption			Monthly food value per capita		N
		All	Vegetables	Traditional vegetables	Exotic vegetables	Traditional vegetables	Exotic vegetables	All vegetables	Traditional vegetables produce	Share traditional vegetables in total value	
	TSH	N	N	N	N	g	g	g	TSH	TSH	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	968	10.8	3.5	1.4	2.1	50	104	154	672	8.0	74
2	2401	12.3	3.6	1.0	2.6	36	116	152	490	4.8	75
3	3958	12.3	3.4	1.1	2.3	46	122	168	437	4.8	75
4	5972	13.0	3.8	0.9	2.9	36	208	243	428	3.6	75
5	10904	14.1	4.1	0.8	3.4	61	257	317	497	2.7	74
Average	4835	12.5	3.7	1.0	2.7	46	161	207	504	4.8	373

crops. Aside from human consumption, some traditional vegetables are also fed to animals (e.g. stems of African nightshade in Arumeru) or eaten by free-ranging animals in the wild (e.g. the mlenda types in Singida).

At first glance, traditional vegetables serve as food only, as a component in meals besides starch and protein, as important suppliers of vitamins and minerals and as taste improvers. Different preparation methods have been summarized by Oomen and Grubben (1978). Side dishes are prepared from leaves to supplement the main food, ensuring that fair quantities of vegetables for every meal are consumed. Leaves are also used in soups and sauces; however, quantities consumed are rather small since leaves are mainly added to improve taste. A third method is to prepare vegetable as part of the main food, i.e. mixing leaves with the starch component prior to cooking. However, one disadvantage of this preparation method is that the color of the whole meal may not be very acceptable (Oomen and Grubben, 1978). Furthermore, the cooking time for leaves is extended since e.g. tubers require more time than leaves, which lead to greater nutrient loss. The fourth method, which was not observed in the research districts of Tanzania, is edible packing material. Meat dishes are packed and steamed using vine, nightshade or cabbage leaves which considerably increases the carotene intake (Oomen and Grubben, 1978).

Table 18. Plant parts used of traditional vegetables in four different districts of Tanzania

Traditional vegetables	Plant part used								Location
	leaves	stem	root	tuber	fruit	flower	pod	seed	
African eggplant	X*				XX				AM
African nightshade	X	X			X**				A
African spiderflower	X								K
Amaranth	X	X							A, S, K, M
Bitter lettuce	X	X							M
Cassava	X		X						S, K, M
Cowpea	XX						X	XX	A, MS, K
Ethiopian mustard	X								A
Okra	X				X				A, S, M
Pumpkin leaves	XXX				XXX	X		XX	SKM
Sweet potato leaves	X			X					S, K, M
Wild cucumber	X				X				S

Districts: A = Arumeru; S = Singida; K = Kongwa; M = Muheza;
* Leaves were only used from *Solanum anguivi*.
** Ripe yellow fruits only of *Solanum villosum* were eaten especially by children.

Common preparation methods for traditional vegetables in Tanzania are boiling, steaming, frying and roasting (the latter for African eggplant in Muheza district only) (Table 19). Vegetables in Arumeru are often fried in oil, while in Muheza, these are usually boiled or steamed in water. It is not, however, clear whether farmers in Muheza district do not use oil on a regular base due to its unavailability or because it is not part of their culture. Frequently, ingredients used by farmers are locally available. For instance, coconut milk is used in the coastal Muheza district where coconut palms are growing. Likewise, groundnuts are a common ingredient in Singida and Kongwa districts due to its abundance in the area. In Arumeru district, recipes include exotic ingredients like carrots, sweet pepper, tomatoes, onions as well as meat, fish or fresh milk due to the presence of animal husbandry in this area. The number of different recipes for one vegetable species is lowest in Arumeru, where only a maximum of three recipes per vegetable are available, while in the other districts, four or even five (Singida) different dishes were named.

In Arumeru, drying of vegetables is not practised since fresh vegetables are available all year round. In Muheza, only amaranth and cowpea leaves are conserved, while in Singida and Kongwa districts, all traditional vegetables are preserved for the dry season using two methods. Commonly, drying is usually done under direct sunlight for one or two days depending on the temperature. A solar dryer is also used, yet, in only one village of Singida. Open drying methods are, however, prone to dust and dirt contamination, attacks by birds, rodents and insects, and re-wetting of the drying material by rain. At the same time nutrient loss especially of vitamins is high through sun-drying (FAO, 2001).

Table 19. Methods of preparing traditional vegetables in four different districts of Tanzania

Traditional vegetable	Preparation method
African eggplant	boiling and frying (A); boiling, frying and roasting (M);
African nightshade	boiling, steaming and frying (A); mixed with green maize, banana and milk (A);
African spiderflower	boiling (K);
Amaranth	boiling, steaming or frying (A, S, K, M);
Bitter lettuce	boiling (M);
Cassava leaves	boiling and frying (S); boiling (K, M);
Cowpea leaves	boiling, steaming and frying (A); boiling and frying (S, K); boiling and steaming (M);
Ethiopian mustard	steaming and frying (A);
Okra	boiling and frying (A, S); boiling and steaming (M);
Pumpkin leaves	steaming and frying (S); boiling and steaming (K, M);
Sweet potato leaves	boiling and frying (S, K, M);
Wild cucumber	boiling and frying (S);

Districts: A = Arumeru; S = Singida; K = Kongwa; M = Muheza;

6.3 Medicinal value

Most traditional vegetables in Tanzania are not only consumed but are used for their preventive and curative medicinal properties as well (Table 20). Amaranth (Arumeru) and pumpkin leaves (Kongwa) are eaten, because they have high vitamin A content. Jute mallow, amaranth (Kongwa), African nightshade and okra (Arumeru) are consumed due to their contribution to good eyesight as explained by farmers. Moreover, farmers believe that cassava leaves (Muheza) help "increase blood" and is beneficial to anaemic people. About 40% of traditional vegetables are considered medicinal in all districts, except in Muheza where up to 70% of vegetables are used for their medicinal properties.

By simply eating fruits of the bitter African eggplant types (leafy group), farmers believe that one can overcome problems of high blood pressure, eyesight and diabetes. The fruit is eaten fresh or boiled without any other ingredients. This method of treating eyesight problems suggest that fruits contain a significant amount of vitamin A. Furthermore, the fruit may also contain substances that relieve the body from excess salt and water and eventually reduce the volume of blood. This was supported by Lester and Seck (2004) which stated that roots and fruit of *S. aethiopicum* could treat high blood pressure.

Farmers maintain that only African nightshade grown without industrial fertilizers can be used as medicinal plants. Moreover, only mature leaves can be used for treatment. In fact, plants produce more biomass when fertilizer is applied, while high nitrogen levels reduce the dry matter content of the plant and further increase the level of unwanted nitrates in the leaves (Fontem and Schippers, 2004). Consequently, certain components probably responsible for its medicinal effects, are no longer available in sufficient quantities or possibly inhibited by other nutrients.

Bitter lettuce, a wild vegetable, is good for lactating women when their milk is "watery". Leaves are burned and pounded into powder. Then, the skin of the upper top of the breast is cut and the ash-powder is applied into these cuts (Muheza).

Some medicinal treatments with vegetables are used by women only. One example is a certain okra dish in Arusha which is said to treat stomach problems. This dish contains okra fruits cut into small pieces, and okra or pumpkin leaves boiled in water with salt for 7 to 10 minutes. Since only women eat this meal, it can be concluded that this dish particularly treats women's specific disorders, e.g. dysmenorrhoea.

The knowledge of the medicinal values of certain vegetables is usually indigenous knowledge. However farmers from Arumeru and Kongwa districts reported some clinic doctors encouraging them to supply their children with amaranth for health improvement in general.

Table 20. Measures to treat certain illnesses with traditional vegetables perceived by farmers in four districts of Tanzania

Traditional vegetable	Illness	Measure
African eggplant	"mashilingi/punye" (ringworm, skin disease on head of children) (A)	rub leaves between hands and squeeze juice on the skin / external application (A)
	scabies (A)	like for "machilingi" (A)
	malaria (A)	boil leaves and add little salt, eat leaves and drink boiled water (A)
African nightshade	anaemia (A)	just eat (A)
	high blood pressure (A)	eat fresh or boiled fruit without any further ingredients (A)
	diabetes (A)	like for high blood pressure (A)
	problems of sight (A)	like for high blood pressure (A)
	peptic ulcers (A)	eat boiled fruits with little salt (A)
African spiderflower	ear problems (A, K, M)	rub leaves and put liquid into ears (A, K, M); or use flowers & leaves (M)
	headaches (A, S)	rub leaves between fingers and smell (A)
	easy conception (S)	
	cold (K)	just eat the prepared vegetable (K)
	continuous lactation (K)	just eat the prepared vegetable to stop permanent milk flow (K)
	stomach pain (M)	squeeze leaves and drink liquid (especially for children) (M)
	high fever ("degedege") (M)	squeeze leaves and drink liquid (especially for children) (M)
Amaranth	anaemia (K, M)	boil leaves and drink boiled water (K, M)
Bitter lettuce	stomach ache (M)	squeeze leaves and drink the liquid (M)
	malaria (A, M)	like for stomach ache, or boil leaves and drink boiled water, 1 cup in the morning, 1 cup in the evening (M) or 1/2 glass 3 times a day (A), or eat the leaves after boiling (M)
	measles (A, K, M)	boil leaves for 15 min. and drink boiled water and bathe in the water (A, K, M)
	hookworms (M) "ascaris"	boil leaves and drink boiled water (M)
	"safura" (A)	boil the leaves, drink boiled water and eat as a vegetable, must be bitter (A)
Black jack	anaemia (M)	boil leaves and drink boiled water (M)
	prevention of growing of "false" teeth (A)	rub leaves and put on teeth/in mouth of children (A)
	wounds (M)	rub leaves between hands and squeeze liquid into wound to accelerate healing process (M)
Cassava leaves	anaemia (K, M)	just eat (K, M)
	diarrhoea (K)	pound fresh leaves, add little soda and water, stir, leave particles to settle, drink the water (K)
	nosebleed ("kambaku") (M)	rub leaves and smell (M)
	snake bites (M)	chew leaves and swallow liquid only as a first aid, e.g. when in the field (M)
Cowpea leaves	anaemia (M)	boil leaves and drink boiled water to increase the haemoglobin level (M)
	skin irritation /abscesses (swellings, "jipu") (A, M)	cover skin for 1-2 days with a paste from crushed and pounded cowpea grains soaked in water (A,M)
Okra	stomach upset (A)	eat one bowl of a meal with boiled okra fruit, pumpkin leaves, onions and tomatoes (women only) (A)
Sweet potato leaves	anaemia (M)	boil leaves and drink boiled water (M)
	burns (S)	rub soft leaves between hands and put on the skin/wound (S)
	wounds that occur due to worms under the skin (S)	wilt broad leaves over fire and put on affected skin (S)
	asthma (M)	rub the leaves between hands, add water until water becomes slimy, sieve and drink the water, or squeeze leaves and mix the liquid with water and drink (M)
Tikini (Asystasia gangetica, A. mysorensis)	bleeding wounds (M)	flick leaves between fingers and put them on wound to stop the bleeding (M)

Districts: A = Arumeru; S = Singida; K = Kongwa; M = Muheza;

6.4 Food taboos

Food taboos or restrictions identified by farmers in Tanzania are summarized in Table 21. Except in Singida where only 10% of vegetables are related to any food taboo, around 50 to 60% of vegetables are occasionally not consumed by specific population groups in the other districts. Most vegetable taboos concern people with certain diseases, pregnant or lactating women, and even gender in general. In Arumeru, men would not eat green leafy vegetables. This can be traced back to their history as pastoralists. For pastoralists, meat and fresh blood mixed with milk are important food items (Maundu and Imbumi, 2003) while green plants are regarded as animal fodder only, and therefore not suitable for human consumption.

Other taboos may have been created by trial and error or doctor's suggestions. Thus, it is important to carefully distinguish between the concept of taboo from that of simple avoidance, whereby the latter is usually based on empirical common sense (Fieldhouse, 1995). In general, most food taboos or restrictions were mentioned in Muheza district, followed by Arumeru and Kongwa districts, and Singida with only two.

In Muheza, examples of food taboos which inhibit the consumption of okra are as follows: (a) okra is believed to cause stomach pains (or general pain in the abdomen) for women who had just given birth during the first 40 days after delivery; (b) okra is believed to counter the healing effects of traditional healing methods for people bitten by snakes; and (c) okra is believed to diminish power of strong and powerful men. Another interesting taboo in Muheza, according to farmers, is that people with peptic ulcers must refrain from eating African eggplant because it generates more acid. People from Arumeru district, however, believe otherwise. Presumably, different landraces with different chemical compositions are available in the two districts.

It is assumed that these food taboos may contribute to the malnourishment of people, especially vulnerable groups of a community such as women and children. Magandi (1997), however, reported that in Iramba district, located in the northern part of Singida district, the nutritional status of women and children is affected not by beliefs and taboos but by community habits. For instance, the patriarchal system enforced during family meals where husbands or males generally receiving the best parts of the dishes, can influence the nutritional status of these vulnerable groups (Magandi, 1997).

Table 21. Vegetable taboos in four different districts of Tanzania

Traditional vegetable	Taboo
African eggplant	not consumed by people with peptic ulcers and asthma (M)
African nightshade	not consumed by old and conservative men in former times (A) and lactating women (A)
Amaranth	not consumed by old and conservative men (A) not consumed by some children (S)
Bitter lettuce	not consumed by lactating women, babies and children with high fever (convulsion/degedege) (M)
Cassava leaves	not consumed by people with skin infection (K) not consumed by people who fear to get head aches due to cyanides (M)
Cowpea leaves	not consumed by old and conservative men (A)
Okra	chopped fruits not consumed by men - too mucilaginous (A) not consumed by women after giving birth and by powerful men (M)
Pumpkin leaves	not consumed by women after giving birth as this will cause "stomach" problems (K, M)
Sweet potato leaves	not consumed by people with hernia (M)

Districts: A = Arumeru; S = Singida; K = Kongwa; M = Muheza;

7 Conclusions and recommendations

Diversity of traditional vegetables. As Tanzania comprises nine different agro-ecological zones (Anonymous, 2004c) and hosts one of 25 hotspots of biodiversity in the world (Anonymous, 2004b), it was expected to find also a high diversity of traditional vegetables in this country. In fact, it was not a question of vegetables being available but rather which and how many vegetables were indeed used by farmers. Actually, vast differences in number of traditional vegetables used occurred between the different districts of Tanzania investigated. While the overall vegetable diversity with 103 different traditional species and types found in the four districts researched was fairly high, only 12 traditional vegetables were available in all four districts. These were mainly cultivated vegetables, while those gathered from the wild were rather unique to individual districts.

It was shown by Shannon's and Simpson's diversity indices that both vegetable diversity and evenness were different between districts. Thereby, less difference between the urban districts of Arumeru and Singida was observed, while rural Kongwa and more so rural and coastal Muheza district showed a much higher vegetable diversity. The Sørensen coefficient was fairly low and ranged from about 27% of common vegetables between Singida and Muheza to nearly 60% of common vegetables between Arumeru and Singida districts. The fact that Muheza differed to such an extent from the other districts in terms of vegetable composition can be traced back to its totally distinct coastal climate and its great biodiversity in general (Anonymous, 2004b). Furthermore, it was by far the most rural district with villages farthest from urban centers and, in general, not easy to access. The equality of Arumeru and Singida districts was explained with their urban centers being responsible for a certain degree of infrastructure, resulting especially in terms of marketing and information systems, in a similar limited set of vegetable species and types used by farmers. Thereby, climatic conditions as well as soil properties were rather negligible, while the degree of urbanization and the availability of infrastructure were decisive. This can also be stated for the general shortage of food, which is not due to natural conditions such as drought but to man-made forces (Rosset, 2001).

Besides infrastructure including knowledge from "outside", indigenous knowledge on how to collect, cultivate and prepare traditional vegetables and their variable taboos and applications e.g. as medicines, was also of high importance. Unfortunately, it was recognized that indigenous knowledge was getting lost in Tanzania. For example, in Muheza district, where vegetable diversity was highest, names of many wild traditional vegetables and their uses were often only known by elderly women, yet, this knowledge was not with the young generation. This can be considered a main factor for genetic erosion of traditional vegetables.

Another significant factor for genetic erosion of traditional vegetables in Tanzania was the introduction of exotic vegetables. The introduced new vegetable

varieties or species were usually marketable or fetched a better market price. They were higher yielding, fast growing and less perishable. In fact, some of them, such as onions and tomatoes, diversified the meals of people and were rather used as spices and mixed with traditional vegetables and were irreplaceable already. However, others, such as kales and cabbages stood in for traditional leafy vegetables, yet, they were often less nutritious and more expensive than traditional ones (IPGRI, 2003). While these qualities, especially nutrient content, were rather "long-term" qualities, and would not influence people directly, the positive qualities of exotic vegetables mentioned above were "short-term" qualities and had a direct impact e.g. on farmers income. If one was in an unfavorable situation, one would of course choose a path with short-term impacts to change living standards rapidly. As low living standards are prevalent in Tanzania, with 19% of the population living below the food poverty line and 36% living below the basic needs poverty line (Anonymous, 2001), exotic vegetables creating cash income rapidly became highly popular.

Besides positive long-term effects in terms of nutrition and adapted growth, the usage of traditional vegetables also presents a conservation of genetic material through utilization. This is an important key to preserve genetic diversity for future generations and to prevent crop failures due to large-scale monocropping. Plant genetic diversity represents an immense pool of different genetic characteristics such as resistance, taste and nutrient content, adapted to different requirements, cultures, lifestyles and regions. This diversity is needed for different growing conditions and to ensure that new combinations and new ideas can evolve (Lachkovics, 2001).

Recommendations. While investment in infrastructure and especially education and advanced training in vegetable cropping and marketing is needed, at the same time indigenous knowledge must not be neglected. For example, in this study it was learned that especially wild traditional vegetables played an important role while others initially identified by the project did not. Thus, to identify farmers' knowledge and needs was absolutely necessary, as it was done in this study. Genetic erosion in terms of traditional vegetables already occurs in Tanzania and should be focused on if genetic diversity is to be maintained for future generations. While some traditional vegetables may vanish since they are not longer preferred by consumers, others should receive similar attention in research and development as exotic vegetables to get a chance within the competition.

Important traits in traditional vegetables. The four most predominant traditional vegetables cropped by farmers were cowpea in Kongwa, okra in Singida, amaranth in Muheza and nightshade in Arumeru. However, when farmers were asked which vegetable they prefer for both production and consumption it coincided only in Kongwa where cowpea was favored most and in Arumeru where African nightshade was the most important vegetable. In both Muheza and Singida vegetables gathered from the wild were most important to farmers, bitter lettuce in Muheza and the mlenda types (false sesame, wild simsim and jute mallow) in Singida.

Important traits in traditional vegetables differed for the different vegetable types and between districts. In terms of production aspects drought resistance and easy cultivation, i.e. no transplanting, was especially important for amaranth, while fast growth and early maturing was more important for okra and a long production period and high yield for vegetable cowpea. African nightshade and African eggplant were mainly favored for their good marketability and some African eggplant types also for their pest and disease resistance. In terms of consumption some amaranth types were preferred because of their short cooking time and that no other ingredients are needed to prepare a satisfying dish. For okra and African eggplant fruits, the bitter taste and the amount of mucilaginous material as well as softness of fruit was central. A sweet and good taste was an important trait for vegetable cowpea leaves while African nightshade was chosen for its bitter taste and medicinal properties.

The most important constraints in the production of traditional vegetables were pests and diseases affecting the crops, followed by water stress and lack of irrigation facilities. Additional constraints were weighed differently in the various districts and in individual villages some constraints were perceived as burning issues and outstanding while others were not a problem. Consequently, each district needs its own approach and while e.g. the availability of vegetable seeds must be improved in Singida district, vegetable marketing should be enhanced in Kongwa and Muheza districts. Similar constraints, such as pests and diseases, lack of good market prices, lack of seeds and lack of cash for inputs, were mentioned by farmers to decrease production in a study on Kenyan traditional leafy vegetables (Maundu et al., 1999b).

Many more different traditional vegetables were collected from the wild instead of being cultivated. Moreover, some of these wild plants were also recognized as the most important vegetables for one district, such as bitter lettuce in Muheza. Wild traditional vegetables are advantageous since they are often more resistant to pests, easy growing, and acceptable to local tastes (AVRDC, 2003). Furthermore, it is mainly women who select, propagate, gather, and market these wild food resources (Price, 2003). As wild vegetables were seldom marketed in Tanzania they contributed mainly to the daily domestic consumption. This contribution is highly important especially in terms of vitamins and minerals, yet, historically wild food plants, belonging to the women's field of responsibility, were often overlooked since men's activities received much more attention in research (Price, 2003).

Recommendations. Though research on integrated pest management in vegetables is already carried out at HORTI-Tengeru and AVRDC, the knowledge did not yet reach the farmers sufficiently, especially in the districts of Singida, Kongwa and Muheza. As pests and diseases were named as a main constraint, this problem should be examined with a focus on traditional vegetables in particular. Water availability is a general problem for agriculture in Tanzania, with crops usually being rainfed. At the same time it is believed that irrigation holds the key to stabilize agricultural production (Anonymous, 2004c), yet, in 1997 only 4% of Tanzania's cropland was irrigated (Millstone & Lang, 2003). As it is not

sure how fast this broad challenge on water distribution and availability can be solved, crops should be adapted to their environment and the more drought-resistant varieties and types should be chosen for cultivation. For example, in Kongwa district an introduced okra type (*Abelmoschus esculentus*) was preferred due to its fast growth, early maturing and soft fruits, but it was susceptible to drought. At the same time, a local type (*A. caillei*) was drought-resistant but not liked by people since it was late-maturing, developed coarse fruits very soon and had spines. Consequently, more research is urgently needed in traditional and indigenous crops and, in fact, it is argued that the value for money would be greater when research is invested in indigenous vegetables than on already well-established exotic vegetable crops. Furthermore, it is likely that research on traditional vegetables will lead to new findings and will contribute not only to science, but also to people's general well-being and food security (Schippers, 2002).

Cultivation of traditional vegetables. Traditional vegetables are cultivated by the majority of farms, and farmers with a smaller land area allocate a larger share of their land to traditional vegetables than larger farmers. Approximately 40% of farmers who cultivate small plots of land are engaged in the cultivation of traditional vegetables, while only 25% of relatively large-scale farmers are engaged in the cultivation of traditional vegetables. This may be because of less risk associated with the production of traditional vegetables, since these are less capital intensive. It would be wrong to believe, though, that traditional vegetables are a purely subsistence crop. Several traditional vegetables are highly commercialized, and some of them can nowadays be found in supermarkets and convenience stores. Thus, it appears that there is a good market potential for these crops, both in the high-price segment, as well as in the low-price segment. Commercial seed companies are also recognizing this potential and are entering the market of traditional vegetables crop seeds (Weinberger and Msuya, 2004).

Recommendations. In order to tap the potential of traditional vegetables for commercialization while ensuring that small and resource poor farmers can benefit, it will be essential that future research incorporates the needs of small-scale farmers into the agenda. In particular this relates to the selection of improved varieties with traits that are important for small-scale farmers. Indigenous vegetables enjoy the advantage of being produced with relatively small inputs and with low capital risk and it is unlikely that farmers would change this production pattern. Thus, selecting varieties that require an intensive input regime will probably be less attractive to farmers. Furthermore, farmers are interested in early maturing varieties that allow for multiple harvesting over a long production cycle.

Consumption of traditional vegetables. In Tanzania, different parts of traditional vegetables were consumed, usually more than one part, e.g. leaves and fruits or seeds. Between 50% and 60% of traditional vegetables were recognized as taboo foods and not consumed by specific population groups in all the study districts except for Singida district, where only 10% of traditional vegetables were recognized as taboo. About 40% of traditional vegetables had both food and

medicinal value in all districts but Muheza, where 70% of traditional vegetables had medicinal uses. The medicinal value of tranditional vegetables was not restricted to the ability to heal an illness but also to increase general health due to their vitamin and other nutrient content.

In fact, it is acknowledged that the primary food sources of vitamin A are dark green vegetables, and dark yellow vegetables and fruits (Tontisirin et al., 2002). Moreover, traditional vegetables were found to contain much more vitamin A and other micronutrients than introduced exotic vegetables. For example, amaranth has 57 times more vitamin A precursor than green cabbage, about 13 times more iron, and nearly 9 times the calcium (IPGRI, 2003). In Bangladesh, for example, the key food group with respect to micronutrient consumption is vegetable. There, vegetables provide nearly 95% of vitamin A, 75% of vitamin C, and 25% of iron intake, and are also the least expensive source of all these nutrients (Bouis & Novenario-Reese, 1997).

One of Tanzania's main nutritional problems include iron deficiency anaemia (IDA) affecting 32% of the general population, especially pregnant women and children under five (Kavishe, 1993; in: Lyimo et al., 2003). Since some traditional vegetables are a potentially important source of iron, such as jute mallow (*Corchorus tridens*) with content of up to 7.7 mg/100g, consumption of these vegetables in adequate amounts may help to overcome nutritional problems (Lyimo et al., 2003). In general and as a long-term approach, a food-based strategy with emphasis on increasing the variety of foods consumed, is presumably the best approach to improve micronutrient malnutrition sustainably (Tontisirin et al., 2002).

Preparation methods for traditional vegetables in Tanzania were mostly steaming, boiling or stir-frying in combination with other vegetables such as onions and tomatoes. Especially, the preparation methods of steaming and stir-frying were satisfactory in terms of nutrient preservation and, in fact, they are desirable for increasing micronutrient bioavailability. To facilitate the absorption of provitamin A, foods containing provitamin A-rich sources should be mixed with appropriate quantities of fat or oil (Tontisirin et al., 2002) which was usually done in all districts, whereby fat was used in the form of vegetable (sunflower) cooking oil (Arumeru, Singida), groundnuts or sunflower oil (Kongwa) and coconut milk or palm oil (Muheza). Only a few exceptions of cooking for too long were observed in Tanzania, for example boiling bitter lettuce (Launea cornuta) in water for up to 40 minutes (Muheza).

Sun-drying leaves is an inexpensive and effective method of preserving surplus micronutrient-rich foods (Tontisirin et al., 2002). However, the amount of light-sensitive micronutrients will be significantly reduced through sun-drying, while a photo-protected solar drier could retain a much higher amount of, for example, beta-carotene (Mgoba, 1993). As in Tanzania, in Burkina Faso, the common drying method is also to spread e.g. surplus vegetables on the roof of a hut or on straw mats on the ground in the direct sun. However, since vegetables are exposed to dust and insect attacks a local NGO has been working on a solar-drying program

in the country. Their aim was to utilize seasonal overproduction of vegetables in a sensible way, so that farmers do not have to sell it below cost or even waste it. The promoted solar drier is reliable and assures a sufficiently good quality, so that products even can be sold on the market (Legay, 2004).

Recommendations. The pattern of preference for traditional vegetables was fairly unequal between the four districts researched. For example, in Arumeru district some vegetables low in iron content such as African nightshade (No. 1) and African eggplant (No. 3), were popular, while others rich in iron, such as sweet potato leaves (No. 7) and cassava leaves (No. 9) were less preferred. Similarly, in Muheza district okra (No. 2) and hair lettuce (No. 3), having a low iron content, were favored, while cassava and cowpea leaves, rich in iron, ranked only No. 7 and No. 8, respectively. Consequently, it is suggested that people should be educated about the nutritional benefit of certain vegetables on the one hand. On the other hand, variability in nutritional quality due to genotypes used and environmental conditions of cultivation sites may require further research.

Though a number of recipes was named in each district they were fairly similar and mainly differed between the four districts. To make preparation of traditional vegetables more diverse and popular and to provide greater recognition to traditional vegetables, a cookbook for traditional vegetables, as it was supplied by IPGRI in Kenya (Woomer, 2002), could help to introduce these plants and preparations to a wider audience of consumers and cooks.

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