APPENDIX

Interview Guide

Note that only questions relevant to this article are included and that the order and phrasing of questions varied between interviews.

1. Had you heard of "community-supported agriculture" prior to becoming involved in this study? *If yes*: What is it? Where did you hear about it?
2. *Interviewer states that*:
   "Community-supported agriculture involves a local farmer selling produce direct to consumers. Members usually pay in advance for a season's worth of fresh vegetables and fruit. Costs vary depending on how it has been set up. Farmers are guaranteed a reliable market and income, while members receive freshly picked, seasonal, high quality, often organic food weekly."
   An outline of key points about community-supported agriculture is given to participant, which the participant is instructed to read.
3. What do you think some of the benefits of community-supported agriculture could be for:
   (a) Farmers?
   (b) Consumers?
4. What do you think some of the problems with community-supported agriculture could be for:
   (a) Farmers?
   (b) Consumers?
5. Do you think community-supported agriculture would work here in Victoria?
   Why/why not?
6. Would you consider joining a community-supported agriculture farm? Why/why not?
7. *For farmers only*: Could community-supported agriculture help improve farming for:
   (a) Farmers in Australia in general? Why/why not?
   (b) Yourself? Why/why not?

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CONSUMPTION OF TRADITIONAL VEGETABLES IN CENTRAL AND NORTHEASTERN TANZANIA

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The "nutrition transition" has reached developing countries and is contributing to a fast change in food habits there. Traditional vegetables (TV) are thus believed to have a declining importance in consumption. Our results show that the share of traditional vegetable consumption is much higher among poor households than among the wealthy households; and the variety in consumption of traditional vegetables is larger for poor households. Thus, particularly poor households rely on the consumption of traditional vegetables to fulfill their daily requirements of micronutrients, especially vitamin A and iron. More emphasis should be placed on promoting neglected traditional vegetable crops for nutritional health.

KEYWORDS Tanzania, traditional vegetables, consumption, micronutrients

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The "nutrition transition" has reached developing countries and is contributing to a fast change in food habits there (Popkin, 2003). This transition is characterized by a decline in consumption of traditional food crops, and increasing consumption of refined and processed foods, fats, sugars, and animal foods. The changing attitude towards traditional foods, coupled with neglect in research, is affecting the significance of African traditional vegetables (TV) in production systems, contributing to neglect and genetic erosion. This trend is unfortunate, since many TV are valuable sources of energy and micronutrients (Grivetti and Ogle, 2000). Where households lack purchasing power to increase their consumption of animal foods, a decreasing significance of TV in diets may be one factor for increasing rates of nutrition related noncommunicable diseases observed in developing countries. On the other side, there is a continuous high prevalence of malnutrition. For instance, FAO estimates that 33% of the population in sub-Saharan Africa is undernourished (FAO, 2004a). Micronutrient malnutrition is particularly widespread—vitamin and mineral deficiencies afflict nearly 2 billion people worldwide and deficiencies in the three key micronutrients—iron, vitamin A, and zinc—each cause 750.000 to 850.000 deaths annually among children (FAO, 2004b). Micronutrient deficiencies contribute to productivity losses in the range of 5–17% (Weinberger, 2004) and reduced educational attainment (Black, 2003). The global economic burden of micronutrient deficiencies is thus substantial (Behrman, 1993; Horton, 1999; Horton and Ross, 2003). Often, micronutrient deficiencies are dealt with through supplementation and fortification programs. There is, however, concern that results in reducing the prevalence of micronutrient deficiencies will not be sustainable and impact not broad enough if this approach is not underpinned by food-based approaches that aim at dietary diversification (Underwood, 2000). Food-based approaches that focus on foods available to a society have certain advantages as opposed to medical approaches since they are more sustainable and the ideal long-term goal for society (Howson et al., 1998).

The present study was conducted in order to explore aspects (i.e., perceptions, attitudes, and practices) of TV in communities of central and northeastern Tanzania. It aims at highlighting the role that TV play for different groups within the society. It was done with the view of improving food and nutrition security by placing greater emphasis on TV in horticultural research.

MATERIAL AND METHODS

Study Area

Tanzania is a highly diverse country in terms of topography, climate, and geology. Mainland Tanzania is divided into 21 administrative regions of which four regions, namely, Singida and Dodoma, located in central Tanzania and Arusha and Tanga, located in northeastern Tanzania, were chosen as research sites. Regions are further subdivided into districts, and one district per region was chosen as a survey site—Arumeru in Arusha, Kongwa in Dodoma, Muheza in Tanga, and Singida in Singida. Arusha is located in the far northeast and borders Kenya. Arusha is one of the four regions in Tanzania classified as suitable for productive agriculture, with volcanic soils mainly of sandy loam and good drainage. Tanga in the coastal zone is characterized by deep sandy to heavy-textured soils, with moderate to high water content, resulting in imperfect drainage. Mean annual rainfall can be as high as 1900 mm. In contrast, the central plateau areas, where Singida and Kongwa are situated, are mantled by sandy loams of low nutrient content and low waterholding capacity and are characterized by low mean annual rainfalls.

Study Population

Tanzania is home to over 120 tribes, of which around 35 are represented through our sample. In Arumeru, the two most prevalent tribes are the Meru and the Arusha, both pastoralist tribes, who colonized land with low agricultural potential after their traditional grazing lands had gradually degraded over several decades (Mbonile, 2005). Kongwa is predominantly inhabited by Gogo and Kaguru. The Gogo are agro-pastoralists, a tribe of cultivating pastoralists. The Kaguru are agriculturalists, cultivating millet, sorghum, and maize, and supplementing their grain-based diet with a variety of vegetables (Meekers et al., 1994). Singida is predominantly inhabited by the Nyaturu, also agro-pastoralists, as are the Sambaa and Bondei of Muheza.

Study Design and Data Collection Methods

The study was conceptualized as research including both quantitative and qualitative approaches of data collection, covering both production and consumption aspects of TV in central and northeastern Tanzania.

The results of the quantitative survey related to consumption of TV are presented here. Data was collected, based on household surveys during July and August 2003. The criteria by which the studied districts were chosen related to having significant differences in a variety of factors such as climate, altitude, ethnic groups, and distance to urban centres. Between 8 and 12 villages were selected by district and in each village between 6 and 18 households were interviewed, covering all sub-villages and based on the snowball approach. A total of 381 rural households participated—71 from Arumeru, 106 from Kongwa and Muheza each, and 98 from Singida. Of these, complete expenditure information was available from only 373 households. The consumption questionnaire comprised a section on socio-economic variables of the household including gender and age distribution within households, a general introduction to consumption aspects of TV, a section of attitude and beliefs concerning TV, and a detailed 24 h food recall recording food consumption for the entire household and including food both eaten in and outside the household. Administration took approximately 40 min. All respondents within this survey were women.

Conversion rates for food items into micronutrients were based on two sources. For TV the location specific micronutrient values discussed in Weinberger and Msuya (2004) were used. For other food values, since a comprehensive database for Tanzania was not available, we used conversion rates from the Kenya food composition table, which is part of the wfood2 database.[1] Since individual food intake figures were not available (the 24 h food recall recorded household consumption only), we estimated total household requirements based on household composition and compared this to actual total intake by the household. Detailed information on gender and age groups within the household was available. Requirements for age groups by gender were estimated based on the FAO/WHO expert consultation of vitamin and mineral intake (FAO and WHO, 2001). Since the diet among respondents was found to be highly dependent of plant products, requirements for iron intake were estimated assuming a general low bioavailability of the diet of 5%. The conversion rate from β-carotene to vitamin A is usually assumed to be 6:1, however, more recent research has challenged this assumption, based mainly on research by de Pee et al. (1998). Using recent findings, IOM (2002) estimated the retinol equivalency ratio for

[1]Available from WWW.nutrisurvey.de

β-carotene from food in a mixed diet including fruits and vegetables to be 12:1 and we apply this conversion rate to the estimation of β-carotene requirements at the household level. For zinc consumption, we assumed a moderate bioavailability of the diet at 30% (FAO and WHO, 2001).

Statistical Methods

We clustered households into different groups depending on their per capita food expenditure. Households were grouped into five groups of similar size, with mean monthly per capita food expenditure ranging from 968 TSH in the first quintile to 10904 TSH in the fifth quintile. A Kruskal Wallis Test was used to test for statistically significant medians across expenditure quintiles and where this test gave a significant result, we tested for differences across groups using Dunn's procedure. To estimate the relationship between food intake and household expenditure, we use a nonparametric regression approach. 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 income (measured by per capita expenditures) is skewed even after a log transformation. Thus, a kernel estimator may not give robust results (at least for the wealthier households where the data density is low) because the fixed band width will have few observations in the upper tail.

Crops Covered

In this study, traditional refers to a crop species or variety genuinely traditional to a region, or to a crop introduced into a region where over a period of time it has evolved, although the species may not be traditional. Crops bred scientifically are excluded from this definition. In contrast, exotic crops are crops that have been imported to a certain region (Engle and Altoveros, 2000). Many more TV were found in the four regions than those covered here (for a complete overview see Keller (2004)). For the purpose of this article, we include only TV that were consumed in

Table 1. Traditional Vegetables Consumed the Previous Day

English Name	Scientific Name
African eggplant	*Solanum spp.*
Amaranth	*Amaranthus spp.*
Baobab	*Adansonia digitata*
Black jack	*Bidens pilosa*
Cassava leaves	*Manihot spp.*
Cow pea leaves	*Vigna unguiculata (L.) Walp.*
Ethiopian mustard	*Brassica carinata*
Hair lettuce	*Lactuca carinata*
Indian mustard	*Brassica juncea*
Jute mallow	*Corchorus olitorius L.*
Lablab bean	*Lablab purpureus (L.) Sweet*
Lady finger	*Abelmoschus spp.*
Nightshade	*Solanum spp.*
Pumpkin leaves	*Cucurbita spp.*
Spider plant	*Cleome spp.*
Sweet potato leaves	*Ipomoea batata*
Swiss chard	*Beta vulgaris*
Water cress	*Rorippa nasturtium – aquaticum*
Wild cucumber	*Cucumis anguria*

households during the preceding 24 h before the survey. An overview on the vegetables consumed is provided in Table 1.

RESULTS

Attitude Towards Traditional Vegetables

Households are well aware of TV. The term "mboga ya asili" in Swahili literally translated into English means "Traditional vegetable." We attempted to assess the attitude that respondents have towards TV by asking a range of yes/no questions (Table 2). Several issues are remarkable. First, while the overwhelming majority of respondents (90%) state that they serve TV crops to visitors, the majority also would not serve TV at special occasions, such as weddings and religious holidays. Also, there is an overwhelming agreement within respondents that TV are an important contribution to the diet when there is food shortage. In most households, adult men eat TV. While virtually all households reported that their children were eating TV, a smaller share reported that they were

Table 2. Attitude Towards Traditional Vegetables (%)

	District				Total
	Arumeru	Kongwa	Singida	Muheza	
Do you offer TVs when visitors come to your home?	93	86	86	95	90
Do you consume TVs at special occasions?	37	40	38	61	45
Are TVs an important contribution to the diet when there is food shortage?	94	94	91	93	93
Do adult males in your household eat TVs?	96	88	94	96	93
Generally, do your children like eating TVs?	100	93	97	96	96
Are you teaching your children how to prepare TVs?	85	80	92	89	86
Is it important to be able to identify TVs?	93	97	84	84	89
Are fewer varieties of TVs to be found nowadays than 20–30 years back?	56	36	64	23	43

Note: Figure represents the share of respondents who answered "yes."
Source: Survey conducted by AVRDC in cooperation with HORTI-TENGERU, 2003. N = 359 households.

teaching their children how to prepare these vegetables. For instance, in Kongwa, 1 out of 5 households do not teach their children how to prepare these food crops. However, if vegetables are not prepared and consumed, this is the first step to their extinction, as farmers themselves are aware of (reported in Keller (2004)). Two-thirds of all households in Singida and slightly more than half of all households in Arumeru agree that genetic erosion within the group of TV is taking place, while only one-third of the households in Kongwa and even less in Muheza (23%) agree.

Consumption of Traditional Vegetables

Traditional vegetables are a regular part of the diet, albeit at a varying degree within the four districts. In 71.4% of households, TV had been consumed the day prior to the survey, the share being highest in Singida and lowest in Muheza. In total, 19 different TV were found to have been

consumed, ranging from nine different crops in Arumeru to 16 different crops in Kongwa (Table 3). There are marked differences among the districts. In Singida, jute mallow and wild cucumber are most prevalent, both crops that are collected but cultivated. In contrast, nightshade, amaranth, and African eggplant (in Arumeru) are all cultivated crops. Concerning the variety of TV consumed within household diets, this 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 one. The results reported here stand in some contrast to those reported by Keller (2004), who estimated various diversity indicators and who found that Muheza had the greatest diversity in TV, and that Singida had the lowest diversity. A greater variety in TV 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 1). While the majority of all exotic vegetables consumed was purchased on markets (65.4%), the majority of TV consumed is produced in their own field or collected from the bush. However, there are also marked differences across different households.

Table 3. Most Popular Traditional Vegetables

Region	N	Traditional Vegetables			Households That Had Consumed TV		
		Count		Most Frequently Consumed	Share	Number of TV Consumed	
		Not Weighted	Weighted			Mean	Maximum
Arumeru	71	9	12	nightshade, amaranth, African eggplant	67.6	1.3	3
Kongwa	106	16	14	Jute mallow, amaranth	80.2	1.4	3
Singida	98	10	9	Jute mallow, wild cucumber	78.6	1.8	4
Muheza	106	11	10	amaranth, hair lettuce	58.5	1.1	3
Total	381	19	19	Jute mallow, amaranth	71.4	1.4	4

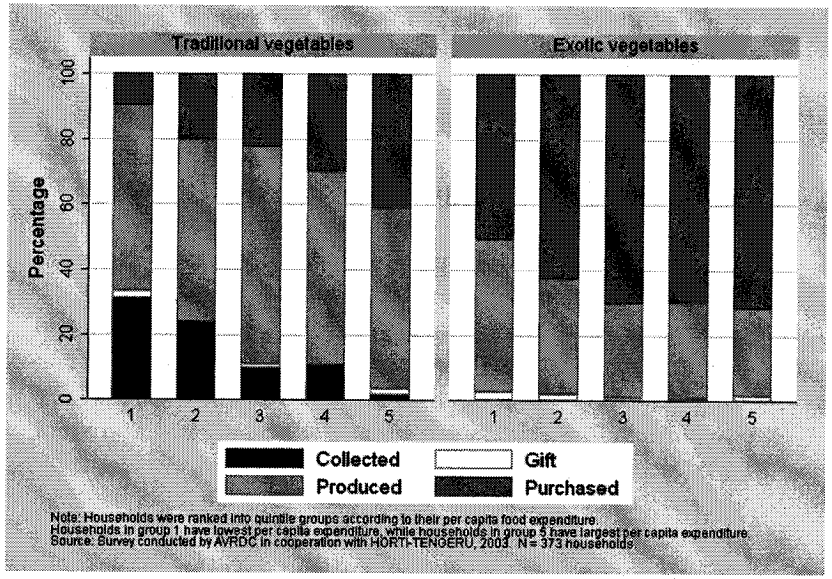

Figure 1. Source of vegetables.

To assess the role that TV play in consumption for different groups within a society, we clustered households into expenditure quintiles. A larger share of TV produced in poor households (first quintile) tend to be obtained through collection (30%), while it is the middle class (third quintile) that consumes the largest share of TV produced in their own fields. As would be expected, it is the wealthiest group (fifth quintile) that purchases the largest share of TV 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 1).

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 4, column 2 and 3). But in contrast, diversity of TV intake is higher for the poorest group of households than for any of the other quintile groups (Table 4, column 4).

Table 4. 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	All Vegetables	TV	TV Produce	Share TV in Total Value	
	TSH	N	N	N	g	g	TSH	TSH	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1[a]	968	10.8[b,c,d,e]	3.5	1.4[b,c,d,e]	154[d,e]	50	672	8.0[b,c,d,e]	74
2[b]	2401	12.3[a,e]	3.6	1.0[a]	152[d,e]	36	490	4.8[a,e]	75
3[c]	3958	12.3[a,e]	3.4	1.1[a]	168[e]	46	437	4.8[a,e]	75
4[d]	5972	13.0[a,e]	3.8	0.9[a]	243[a,b,e]	36	428	3.6[a]	75
5[e]	10904	14.1[a,b,c,d]	4.1	0.8[a]	317[a,b,c,d]	61	497	2.7[a,b,c]	74
Average	4835	12.5	3.7	1.0	207	46	504	4.8	373

Source: Survey conducted by AVRDC in cooperation with HORTI-TENGERU, 2003.

N = 373 households.

The superscripts imply that the values are statistically significant with the corresponding food expenditure quintiles at $P \leq 5\%$ level (Kruskal-Wallis and Dunn's procedure).

Total vegetable consumption tends to increase with higher total food expenditure. Households in the highest expenditure quintile consume approximately double the amount of vegetables (317g) consumed in the lowest expenditure quintile (154g) (Table 4, column 5). The WHO recommends an average intake of 200g per capita for a healthy diet (WHO, 2003). While this level is met for the average population, poor groups within the population (first to third quintile) meet only approximately three-quarters of recommended intake levels.

The per capita intake of TV by expenditure quintile shows no obvious trend (Table 4, column 6). Thus we use a nonparametric regression approach to visualize the relationship between food expenditure and intake of TV. The results are shown in Figure 2. The curve has two maximum points. Intake of traditional vegetables is highest among the group that spends the least on food items and then decreases. It reaches another maximum in the highest food expenditure quintile before it decreases again. Clearly, TV are an important contribution to the diet in households with low purchasing power, but they are also in demand by households with high purchasing power, who may increasingly turn

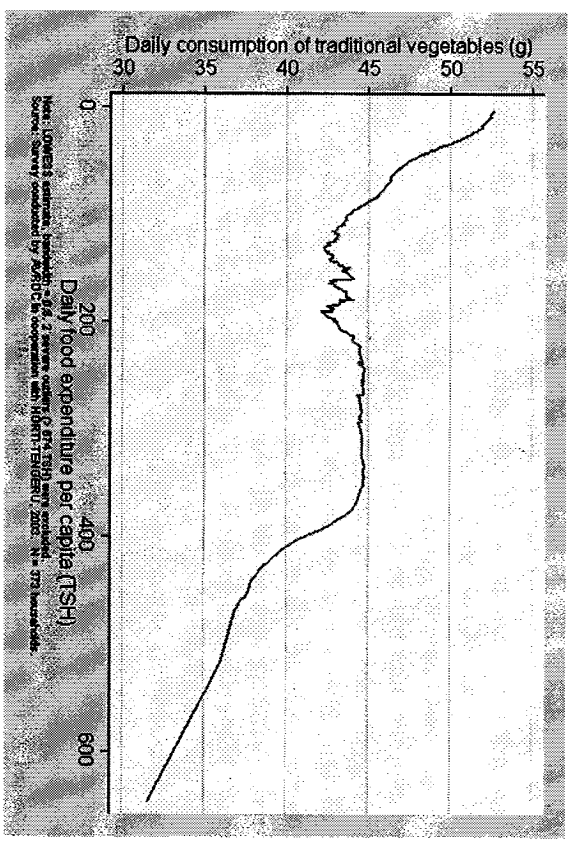

Figure 2. Lowess smoothing – consumption of TV and food expenditure.

towards TV as a health food as is happening in some countries of Asia, i.e., Malaysia, where TV are believed to be produced without pesticide use (Hoe and Siong, 1999). Weinberger and Msuya (2004) also found among urban consumers in Tanzania a frequent belief that indigenous vegetables are healthier than exotic vegetables because of a lower fertilizer and pesticide regime. Ogoye-Ndegwa and Aagaard-Hansen (2003) report that while the Luo of Kenya consider some of their TV as having low status, the same vegetable can be found in big hotels.

Since a large share of all food items consumed is either home-produced or collected, in order to value them we attributed an opportunity cost to those products, either at the average village level price, or if not available, at the average district level price. Column 7 in Table 4 shows the value of TV and the share (column 8) in total food value (as opposed to actual food expenditure). Both absolute value and share in total food value decrease for wealthier groups (albeit taking an upward turn in terms of absolute value for the wealthiest group). For poor households, the value of TV is approximately 8% of the value of all food consumed. Among the wealthiest group of households, this reduces to 2.7%, respectively. Clearly, poor households rely more on TV than wealthier households.

Micronutrient Contribution of Traditional Vegetables

Micronutrient malnutrition is widespread; and particularly iron, zinc, and vitamin A deficiency affect millions of poor people worldwide (SCN, 2004). Food-based approaches are often regarded as a viable instrument to improve micronutrient consumption, especially where infrastructure for supervision of supplementation and fortification is absent (Allen and Gillespie, 2001). However, since the bioavailability of iron from plant sources is low, efficacy of such food-based approaches is usually assumed higher for vitamin A than for iron. We will now assess the role that TV consumption plays for fulfilment of daily dietary needs.

The contribution of TV to fulfilment of the overall requirements of the household is shown in Table 5. The table shows that particularly poor households rely on the consumption of TV to fulfill their daily requirements of micronutrients, particularly vitamin A and iron. In poor households, approximately one-quarter of all vitamin A requirements and 11% of iron requirements are consumed through TV. This share declines among wealthier households, but on average 10% of all iron

Table 5. Contribution of Traditional Vegetables to Fulfilment of Daily Fe, Zn, and β-Carotene Requirements of Household

Expenditure Quintiles	Contribution of Traditional Vegetables to Daily Household Requirements (%)		
	Iron	Zinc	β-Carotene
1	11.1	2.3	24.2
2	10.3	1.7	16.5
3	11.2	2.0	18.1
4	8.4	1.6	18.8
5	8.3	1.7	15.7
Average	9.9	1.9	18.6
Mean contribution of exotic vegetables	1.5	0.5	3.0

Source: Conversion rates based on Weinberger and Msuya (2004) and on values provided by the Kenya food composition table by wfood2.

Survey conducted by AVRDC in cooperation with HORTI-TENGERU, 2003. N = 373 households.

requirements and 19% of all vitamin A requirements are fulfilled through consumption of TV. Traditional vegetables contribute only marginally to required intake of the third micronutrient under consideration, zinc. Here, the average contribution is only 1.9%.

The share is much lower for exotic vegetables. On average, only 1.5% of all iron requirements, 0.5% of all zinc requirements, and 3% of all β-carotene requirements are fulfilled.

Figure 3 shows the cumulative contribution of the three micronutrients under consideration (β-carotene, zinc, and iron) to overall requirements, as a simple sum of the percentage contribution to overall household requirements and by expenditure quintiles. Clearly, the lowest expenditure quintile, which is represented by the far right line, relies strongly on TV as a source for micronutrients, while the highest expenditure quintile, which is represented by the line on the far left, relies least on this source for fulfilling daily requirements. The figure also shows that among the poorest households only about 20% had not consumed any micronutrients through TV the day preceding the survey, while among the two highest expenditure quintiles the share of such households is higher than 40%.

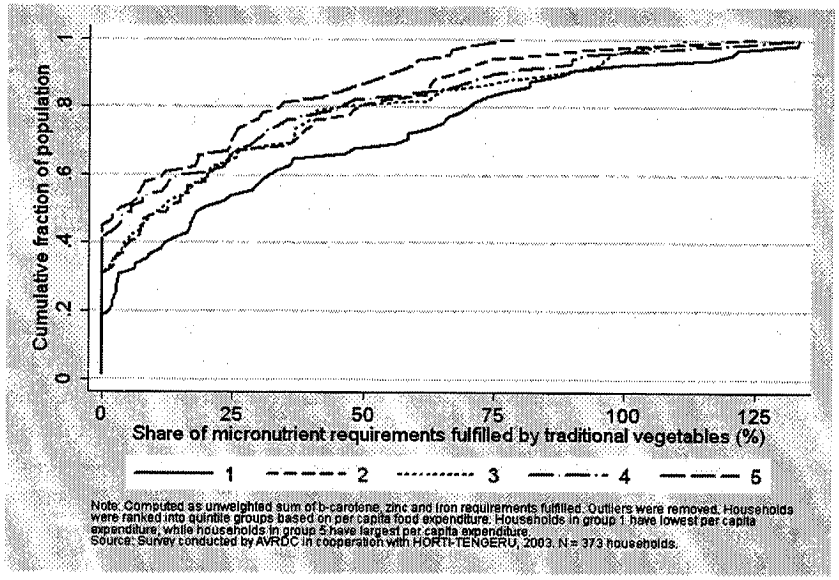

Figure 3. Micronutrient requirements fulfilled through consumption of TVs by expenditure quintiles.

DISCUSSION

Among the rural population of central and northeastern Tanzania, only about one-quarter of all vegetables consumed are traditional, the remaining are exotic vegetables. However, traditional crops continue to be an important contribution to the diet, particularly so in the rainy season, when they are readily available. The share of TV consumption among all vegetables is much higher among poor households (approximately one-third) than among the wealthiest households (approximately one-fifth) and also the variety in consumption of TV decreases as households become wealthier, while at the same time the variety in consumption of exotic vegetables increases. By valuing collected TVs produced in local gardens, we found that in the poorest group of households approximately 8% of all food consumed are TV. The average share for all households is only 4.8%.

Poor households particularly rely on the consumption of TV to fulfill their daily requirements of micronutrients, especially vitamin A and iron. In poor households, approximately one-quarter of all vitamin A requirements and 11% of iron requirements are consumed through TVs. Thus, while TVs

cannot be considered a panacea for the elimination of micronutrient deficiencies, these results show that TVs do have an important role to play for maintaining adequate levels of micronutrient consumption in poor societies.

It would be wrong, however, to believe that TVs are a purely subsistence crop for poor consumers. Traditional vegetables may offer good opportunities for commercialization if properly exploited, since approximately 40% of all produce consumed by wealthy households is acquired through the market. For instance, African eggplants have now acquired a commercial status in Arusha and produce from there is sold in supermarkets and also transported to markets as far away as Dar-es-Salaam. Traditional vegetables can be harvested over a longer period of time compared to exotic types. Under good management, African eggplants and amaranth selections can be harvested for over a year and this is very beneficial in case of price fluctuations. Input requirements for TVs are comparatively low compared to exotics. Pesticides are rarely used in the production of TVs but they are necessary in the production of exotic vegetables. In order to tap the potential of TVs for the benefit of small and resource poor farmers, it will be essential that future research incorporates the needs of these small 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 (IVs) enjoy the advantage of being produced with relatively small inputs and thus 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. More emphasis also needs to be placed on providing small farmers with quality seed. Private seed companies have little interest in traditional varieties because domestic markets for such vegetables are perceived to be small.

In conclusion, this study reveals the importance of IVs in resource poor communities; thus, preserving biodiversity and indigenous knowledge on production and consumption while improving varieties and cultivation practices of IVs in Tanzania will contribute to the well-being of thousands of poor farmers by enabling them to participate in markets.

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