

AGRICULTURE

AFRICA

Agricultural Bio-diversity for Better Nutrition, Health and Production Systems in Sub-Saharan Africa

Case Study

HEALTH

PRODUCTION

NUTRITION

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Acronyms

INTRODUCTION AND BACKGROUND

It is well known that hunger and malnutrition are universal problems, facing the majority of the world's poor and needy people, and continue to dominate the health of the world's poorest nations. According to UN Millennium Project (2005), malnutrition and poverty remain at unconscionable levels in most parts of the world, especially in Sub-Saharan Africa, resulting in poor health, high rates of mortality and morbidity, disability, stunted mental and physical growth.

People in many countries in Africa are facing the co-existence of under- and over-nutrition in the same household, community or population of which both can cause malnutrition. Malnutrition also comprises the so-called "hidden hunger" for micronutrients. The most prevalent nutrient deficiencies in the world (also in sub-Saharan Africa) are iron and vitamin A (Persson, Ahmed, Gebre-Medhin & Greiner, 2000; Sankhala, Sankhala, Bhatnagar & Singh, 2004; Stoltzfus, Mullany & Black, 2004). Iron is needed in all tissues of the body for cellular respiration and many other reduction-oxidation enzyme systems, and has particular functions in red blood cells, muscle and the brain, including cognitive development (Stoltzfus et al., 2004). Iron deficiency and its anaemia affect more than 3.5 billion people in the developing world (ACC/SCN, 2000). Vitamin A is an essential nutrient required for maintaining immune function, eye health, vision, growth and survival in humans (Rice, West Jr & Black, 2004). Nearly 250 million preschool children are sub-clinically vitamin A deficient and many more school-age children, pregnant women, and others are affected. Subclinical vitamin A deficiency contributes significantly to raised morbidity and mortality in at-risk populations by increasing the risk of common infectious diseases (McLaren & Frigg, 2001; ACC/SCN, 2000). In children with vitamin A deficiency, the risk of dying from diarrhea, measles, and malaria is increased by 20–24% (Black, Morris & Bryce, 2003). For these reasons many countries adopted strategies for chemical food fortification and supplementation of vitamins and minerals for mothers and children. Many of these initiatives prove to be efficient and successful especially for widespread nutrient deficiency in a population. However, optimal human nutrition in general is not simply a case of consuming enough nutrients. Food also fulfils socio-cultural needs and roles in

communities and there is according to Wahlqvist (2008), increasing evidence for the need of quality (nutrient rich) foods to achieve optimal nutrition. The human body probably needs the greatest variety of foods to maintain in its own short, medium and long-term needs. Wahlqvist (2008) argued that the fact that the human being needs a number of essential nutrients for survival, of which the human body has the ability to make some and the rest should come from different foods, is a clear indication that humans need diversity in diet.

Many have also advocated also other food-based strategies than those mentioned above to achieve optimal dietary requirements to combat micronutrient deficiencies and preserve immunity (Vorster & Kruger, 2006; Faber & Wenhold, 2007; Johns & Eyzaguirre, 2006; Johns & Sthapit, 2004). Such strategies include dietary diversification/modification, diversification of crops, introducing new crops, use of indigenous/local foods, implementation of home gardens to increase household food production and install nutrition security. Johns (2003) reported that the utilisation of the native biodiversity within the socio-cultural context of an area can be a powerful tool for maintaining and enhancing health and nutritional status.

There is no doubt that in most third world countries, more food with special emphasis on nutrient-rich foods should be produced to satisfy the always-growing world population. The industrial revolution led to mass production, also in the field of agriculture, and in some way satisfies this need. However, the emphasis is mostly on higher yields, income, and effectiveness of practices and not necessarily on addressing hunger and hidden hunger which precipitates as malnutrition with high-quality nutrient rich foods.

The Sub-Saharan Africa Scenario: General

Agricultural development has over many years been recognized as a key determinant of food stability, good nutrition status and poverty reduction (Lewis, 1954). Agriculture in Sub-Saharan Africa (SSA) is, according to the FAO (2009), mostly based on subsistence farming and practised by small-scale farmers, mainly women. Commercial farming is mainly to be found in Southern

Africa, while irrigation areas also include production areas in the Niger River basin, along the Nile and in the Sudan. These production areas are dominated by cash crops. Therefore, infrastructure such as passable roads and transport to bring produce to national and global markets are mainly to be found in these areas. Although only five % of SSA land is taken up by commercial and irrigation farming and involves only seven % of the population (FAO, 2009), the effect of industrialisation is already evident by not only agricultural practices but also through the depopulation of the rural areas. In his book "Fatal Harvest: The Tragedy Of Industrial Agriculture", Kimbrell (2002) describes the destructive impacts of the industrial agriculture model developed by the United States of America on Africa and its farmers. Kimbrell describes how these farmers have become more and more dependent on costly solutions, non-renewable resources and personnel needed to run the farm as an economic unit, and the negative effects on health and the environment.

Sustainable food production in SSA is a given need and explains the demand for agricultural intensification in Africa. Challenges for agricultural intensification are recognised by NEPAD (NEPAD, 2003) as being "biases in economic policy and instability in commodity prices" as well as climate uncertainty. An additional factor highlighted by the FAO report (2009) is the frequent wars in Africa and it is stated that "above all, peace must prevail in Africa if the needed intensification of agricultural production is to be achieved". As Devereux (2001) pointed out, "virtually every [African] country that has suffered famine in the past twenty years has suffered a war at the same time".

The health and nutrition transition

It has been observed that with urbanisation and industrialisation in many developing countries, fundamental changes in diet, patterns of work and lifestyle have occurred. These changes have been founded on economic factors, modernisation in agriculture, ecosystem degradation, loss of biodiversity and indigenous knowledge, and the globalisation of markets. Changes in dietary patterns have been described as the nutrition transition and defined by Popkin (2002) as the changes in dietary patterns and nutrient intakes which occur when populations adopt modern lifestyles during economic and social development, urbanisation and acculturation.

The majority (65%) of the poor in Africa are found in rural areas, and 78% of those likely to be chronically poor also live in rural Africa (Egal and Valstar, 1999). Industrialisation generates more job opportunities with higher incomes than traditional farming practices. In this process of seeking more economic opportunities and wealth, more and more people from rural areas migrate

into urban areas even though urban areas may not bring the employment opportunities that migrants had been hoping to find (Van Donk, 2002). In this process of seeking more economic opportunities, increasing numbers of poor start living in urban areas.

Several studies indicate that urbanisation leads to the traditional prudent African diet being replaced over time with a more westernised diet characterised by high fat content and low in high fibre carbohydrates, which has serious health consequences (Bourne, Lambert & Steyn 2002; Vorster, 2002, Popkin 2002).

Furthermore, a review by Vorster, Kruger & Margetts (2011) indicates that non-communicable, nutrition-related diseases have emerged in sub-Saharan Africa at a faster rate and at a lower economic level than in industrialised countries. Reasons therefor are that the ongoing battle against under-nutrition has not been won yet and that SSA suffers extreme poverty. In many cases the low cost of staples relative to non-staples leads to diets simultaneously adequate in energy but deficient in micronutrients. Consumption of a diet high in energy and low in micronutrients coincides with low energy expenditure and contributes to obesity and malnutrition in the same person (Damman, Eide & Kuhnlein, 2008; Flyman & Afolayan, 2006; Johns & Sthapit, 2004). Given the rapidity with which traditional diets and lifestyles are changing in many developing countries, it is not surprising that food insecurity, under-nutrition and obesity persist in the same countries where chronic diseases are emerging as a major epidemic (Popkin, 2004; WHO/FAO, 2003, Vorster et al, 2011). It was also found that the nutrition transition for growing numbers of population have led to a situation where communicable diseases and under-nutrition exist parallel with chronic diseases, thus creating a "double burden of disease" (WHO/FAO, 2003, Vorster et al, 2011). Healthy diets for populations depend on availability and accessibility of a variety of plant and animal food, within a context that promotes and supports healthy behaviors. Johns & Sthapit (2004) developed a model for improving contemporary food systems by integrating nutrition, reduction of disease risk, income generation, and biodiversity. Furthermore, they stated that "international and national policies that build on the biodiversity and cultural strengths inherent in traditional food systems optimise the chances for vulnerable populations to adapt to changing conditions in a sustainable manner". Therefore, the challenge is to address the problems of the nutrition transition to avoid the "double burden of disease". Apart from this, SSA is suffering an epidemic of infectious diseases such as HIV which brings along its own challenges regarding nutrition demands.

From the above discussions, it is important to note that urbanisation in SSA has in many instances a mixed positive and negative impact on health of

people. A study done by Vorster, Venter, Wissing & Margetts (2005) between 1998 and 2000 showed that urbanization of South Africans in the North West Province has resulted in an improvement in micronutrient intakes and status, but also an increase in overweight, obesity and several risk factors for non-communicable diseases. These findings were confirmed in the elderly with baseline data from the PURE study in 2005 (Kruger, Sebi, Mokgela & Wentzel-Viljoen, 2011). These data showed that urbanisation attributed to higher consumption of fruits, vegetables, animal-derived foods and fats and oils by people living in urban areas compared to those living in rural areas.

Another negative outcome of rapid urbanisation is the degeneration of cultural heritage and loss of knowledge on indigenous biodiversity that traditionally be passed

on from generation to generation (Zobololo & Mkabela, 2006; Vorster, Jansen van Rensburg, Van Zijl & Venter, 2007). Studies from West Africa indicate the shift away from traditional diets (Frison, Johns, Cherfas, Eyzaguirre & Smith, 2005) which included the utilisation of local plant biodiversity. Although biodiversity in many African countries is ignored, a growing body of research has documented the link between biodiversity and nutrition (Frison, 2007; Flyman & Afolayan, 2006; Turan, Kordali, Zengin, Dursun & Sezen, 2003; Hassan & Umar, 2006; Vainio-Mattila, 2000). These studies have confirmed the importance of wild vegetables as sources of micronutrients. Nesamvuni, Steyn & Potgieter (2001) and Faber, Jaarsveld & Laubsche (2007) in South Africa also underscored the significant contribution of wild vegetables as a source of micronutrients.

CASE STUDY

SOUTH AFRICA

A CASE STUDY FROM SOUTH AFRICA

Research setting: North West Province of South Africa

Diversity is the norm in South African farming systems within a country of many diverse cultures and climates. Farming practises vary between subsistence farming, farming for an income and commercial farming.

The North West Province (NWP) of South Africa is approximately 106 512 square kilometres and almost all the rainfall occurs within the summer months between October and April. Rainfall decreases from east to west with a provincial average of 539 mm per annum. The climate in the North West Province is semi-arid and thus harsh. There is a short growing season, between October (last cold) and end April (first frost). During winter there is severe cold and frost and during the summer it is hot. Regular droughts also occur in this province. This all add to the very challenging task of sustainable household food production. Most of the municipal districts (23 out of 26) have poverty rates of over 40% while seven of those situated in the western parts which are less developed, have poverty rates just over or just under 80% (Cilliers, Bouwman & Drewes, 2009). Based on the United Nations Human Development Index (HDI) the North-West province is one of the lowest of all the provinces in terms of quality of life (Tladi, Baloyi & Van Boom, 2002). Three dimensions of human development are used in the HDI, namely life expectancy, knowledge (including literacy) and standard of living (Schwabe, Viljoen & O'Donovan, 2001). Rapid urbanisation also occurs in the Province with mixed impacts on health and food security. Extensive diversity in foods is expensive and might not be necessary to satisfy basic nutritional needs of the poor.

It is against this background that a study was undertaken in the NWP to explore the possibility of more effective utilisation and growth of traditional green leafy vegetables (TLV) as a sustainable source of micronutrient intake. Traditional biodiversity use within the socio-cultural context can be a powerful tool for maintaining and

enhancing health and nutritional status (Johns, 2003; Kuhnlein & Receveur, 1996). By using indigenous knowledge of food plants to improve the current biodiversity utilisation, nutrition and food security of local communities, it might enable us to support the hypothesis of Johns (2003) that the utilisation of native biodiversity, within a socio-cultural context of an area, instead of exotic westernised diets, may be a powerful tool for maintaining and enhancing health and nutritional status.

Aim and objectives

The main aim of the study was to provide empirical evidence of how the role of agricultural biodiversity can be translated into improved health and nutritional status, improved livelihoods and more sustainable production systems in contemporary poor rural and urban communities in the NWP of South Africa.

An overview will be given on the results of the following four objectives within the larger still continuing study:

1. To assess the food plant diversity and management systems of home gardens and natural/semi-natural urban and rural areas.
2. To explore the perceptions of and consumption patterns of local traditional foods as well as how people value biodiversity within a traditional food system.
3. To document evidence-based health benefits of traditional foods and consequently increase indigenous knowledge and dietary diversity.
4. To assess the acceptance of dishes made from local ITF (Indigenous Traditional Foods).
5. To conduct market surveys to identify supply and demand chains and the types of ITF sold for the entire NWP.

The ultimate goal of this research aimed to identify the variety of ITF in this province that could be used as more sustainable food resource, with a longer growing and therefore harvesting season and which are more drought and cold resistant. It also addressed the need for more systematic studies to fill in the gaps in knowledge on the nutritional value of local ITF.

1 Indigenous leafy vegetables are those that have their natural habitat on sub-Saharan Africa while the traditional leafy vegetables were introduced over a century ago and due to long use, they have become part of the food culture in the sub-continent (Smith & Eyzaguirre, 2007).

METHODOLOGY

METHODOLOGY

Sample population and area

For the food plant diversity study (objective 1), information was drawn from four studies from the same region: the deep rural setting of Tlaskgameng (Molebatsi, Siebert, Cilliers, Lubbe & Davoren, 2010; Molebatsi, 2011), the rural setting of Ganyesa (both in Bophirima district, Kagisano municipality) (Davoren, 2009), and the peri-urban setting of Ikageng (Lubbe, Siebert & Cilliers, 2010, Lubbe, 2011). A fourth study, information from Potchefstroom (Lubbe et al, 2010, Lubbe, 2011), was added as an example of an urban area mainly inhabited by people from European origin (both in Kenneth Kaunda district, Tlokwe municipality). In terms of the plant diversity the rural-urban gradient definitions of Molebatsi et al, (2010) were adopted: deep rural was defined as an inhabited area where tribal authority manages the community and 90% of the inhabitants are subsistence farmers; rural was defined as an inhabited area under municipal management, where less than 50% of the inhabitants are subsistence farmers; and peri-urban was described as an inhabited area on the fringes of a city that falls under the management of a city council, where fewer than 10% of the inhabitants are subsistence farmers.

To reach the aim of objectives 2 and 4, research was conducted in two phases, namely (i) a qualitative phase using focus group discussions based on data saturation principles; and (ii) a quantitative phase, using sensory evaluation. The selection of participants for this study was purposive and based on a defined set of criteria as described by Matenge, van der Merwe, de Beer, Bosman and Kruger (2011) and Matenge S.T.P., Kruger, A, Van de Merwe, D and De Beer, H (2011b). The selection was drawn from rural villages in the Bophirima district (Kagisano municipality) and urban dwellings from Tlokwe municipality (Kenneth Kaunda district). A total of 87 volunteers from black communities aged 20-78 years participated in this sub-study.

The descriptive health profile (objective 3) was done on consumers and non-consumers of TLV and was retrospectively investigated on the baseline data of the participants who are enrolled in the Prospective Urban Rural and Epidemiological (PURE-SA study).² Three rural villages 75km from Vryburg in the Bophirima district, Kagisano municipality and four urban dwellings from Tlokwe municipality in urban Kenneth Kaunda district in the North West Province were included in this study. Rural was defined as communities which have experienced low development and are still living under tribal law, and urban included established households within a developed city area (as defined by Vorster, Wissing, Venter, Kruger, Malan, De Ridder, 2000, and the PURE study). A total of 1 004 urban and 1 006 rural participants were enrolled in the baseline of the PURE study. Of these, a representative sub-selection of participants was made, including 200 rural and 200 urban additional questionnaire on the use of TLVs including. From these 175 were consumers and 221 were non-consumers (Matenge et al. 2011).

For objective 5, a household survey was conducted among black households in the NWP in April and May 2011 to investigate the market and supply chain for indigenous and traditional food crops. In order for the survey sample to be representative for the total population of 815 547 black households in the province, the sample size was determined at 600 households. This sample represents a confidence level of 95% and a standard deviation of four. A total of 601 households in the NWP was surveyed. The sample was stratified according to rural and urban composition of the population and geographical spread in the NWP. This was reflected by surveying 370 households in the rural areas and 231 households in the urban areas where respondents were randomly selected in various neighbourhoods of the above-mentioned areas (Idsardi & Cloete, unpublished data).

2 PURE study: the PURE study track changing lifestyles, risk factors and chronic diseases over a period of twelve years in urban and rural areas of twenty countries in transition. Baseline data for the PURE-SA study were collected in 2005 on 2000 subjects in the North West Province of South Africa. Each of these subjects received a visit from the research team. Ethical clearance number from the North West University: 04M10. The PURE design was published by Teo, Chow, Vaz, Rangarajan & Yusuf, 2009.

Data collection

Data on food plant diversity studies (objective 1) were collected in four of the study areas (Thlakgameng, Ganyesa, Ikageng and Potchefstroom). A total of 359 plots, 20 x 20m in size, were sampled in domestic gardens and in natural/semi-natural areas in and around the settlements (Davoren, 2009; Lubbe, 2011; Molebatsi, 2011). A total floristic survey of entire gardens was also conducted based on presence–absence data to put the sample plot's richness in perspective. Natural areas were not sampled for Potchefstroom, but information collected previously was used (Cilliers, 1998). Plant species of gardens and natural/semi-natural areas were classified as alien or indigenous and the potential value as a food plant (leafy vegetables, fruit, tubers, grain) was determined using Internet searches and the publications of Van Wyk & Gericke (2000) and Van Wyk (2005).

Data collected for objectives 2–4 used a mixed methods approach (Bothma, Greeff, Mulaudzi and Wright, 2010:255) which allowed the researchers to develop a deeper understanding of the dynamics in and around communities. To ensure validity and reliability of the data, a variety of data collection methods was employed such as quantitative measurements according to standard and validated procedures, validated or tested questionnaires and face-to-face interviews with key informants and experts. Drawing on methods deriving from Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA), focus group discussions were held with groups differentiated according to sex and age. A picture guide consisting of most foods available in the communities was prepared and used to help respondents identify the foods and quantities thereof consumed. Furthermore, direct observation of participants and situations was done and systematically recorded in field notes. Digital photo documentation was employed. Dietary assessment tools such as 24-hours

recall and quantitative food frequency questionnaires (QFFQ) were used to assess ITF intake of all adults participating in this study. Furthermore, dishes made from selected TLV were assessed for acceptability by the consumers.

To conduct the market survey (objective 5), questionnaires consisting of 31 questions were filled in by persons responsible for the food supply of the household by local fieldworkers. These fieldworkers were trained, standardised, instructed and overseen by a single fieldwork co-ordinator who was responsible for all fieldwork and data entry of the household survey. A total of 24 fieldworkers were used.

Ethical consideration

Ethical permission was obtained from the ethical committee of the North West University, Potchefstroom campus (04M10 and NWU-00033-09-A1). This ensured anonymity, protection of privacy, dignity and integrity of participants. Participants were informed about the purpose of the research, the expected duration, procedures, and any prospective research benefits. Participation was voluntary and the participants could withdraw at any stage of the research without any consequences. The researchers ensured at all times that the fieldworkers were aware of and familiar with the ethical guidelines that were relevant to the study and their responsibilities.

FINDINGS

Production systems and food plant diversity

A total of 525 plants species that have the potential to be used by humans for various purposes were recorded from all four study areas, of which 101 were regarded as food species. Most of the food species were harvested for their fruit (57 species), while the variety of leafy vegetables was lower (30 species), as can be seen in Figure 1. Food plant species can occur in the gardens or in the natural/semi-natural areas surrounding the settled areas. This indicates, for example, that there is still a large variety of useful leafy vegetables (Table 1) available in natural and semi-natural areas (Figure 3). This is especially so for rural areas, such as the Vryburg district, where many native leafy vegetables may be collected from the wild. Food plants with useful fruit is an exception in that fewer than 10% of the species in gardens also occur in natural and semi-natural areas, indicating that most of the fruit species are cultivated

aliens. In accordance with our findings (Figure 3), Molebatsi et al, (2010) have shown that deep rural and rural home-gardens have a higher percentage of native useful plant species than the peri-urban gardens, in which alien species dominate.

An alarming finding in this study is the few Tswana households that still grow a vegetable garden. Although more households in the rural area had some sort of vegetable garden, they were still fewer than 70% of the sampled households. Molebatsi et al (2010) have also shown that Batswana people have a garden layout in deep rural and rural areas, called the *tshimo* garden, which is culturally driven. In peri-urban areas this layout was rarely present and was replaced by a typical westernised garden layout similar to those in urban areas. One can also expect that indigenous knowledge applied in the *tshimo* garden layout will be absent from the westernized garden layout. For instance, the *lebala* concept (regularly swept bare soil) that keeps the yard

Figure 1: Main categories of edible plants and the number of species recorded from gardens or natural areas. Th=Thlakangeng; Ga=Ganyesa; Ik=Ikageng; Po=Potchefstroom.

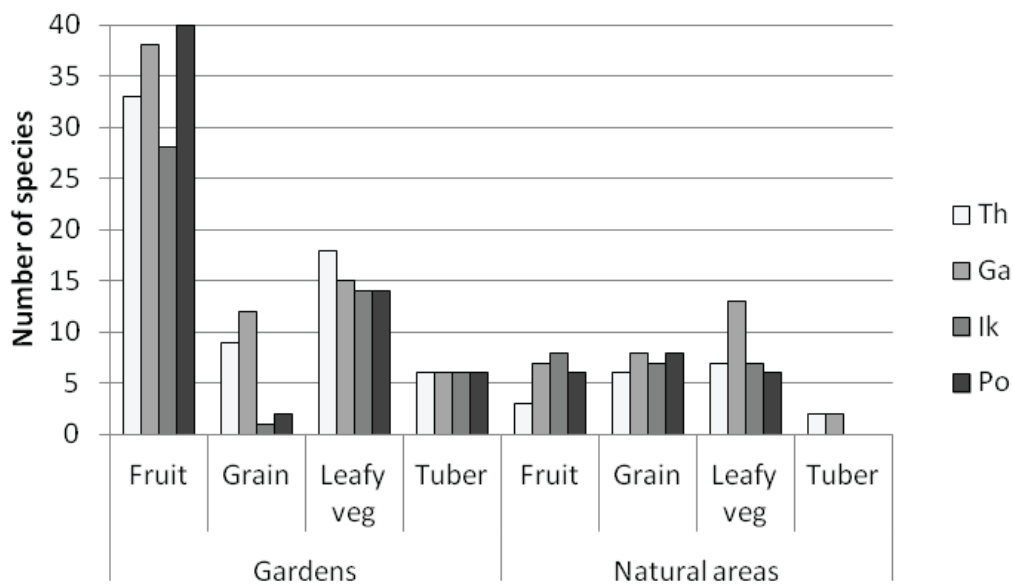
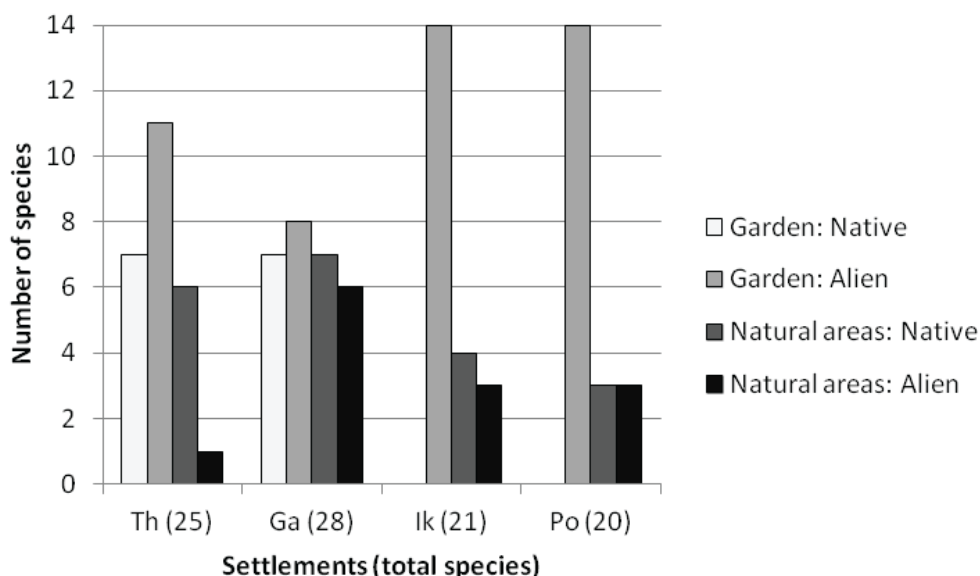


Figure 2: Alien and native leafy vegetables recorded per garden and per natural area for each of the four study sites.³ Th=Thlakgameng; Ga=Ganyesa; Ik=Ikageng; Po=Potchefstroom.



free of pests and diseases, is not very fashionable in urban settings, where a green lawn is highly regarded and seen as a form of prosperity.

Molebatsi et al (2010) define a *tshimo* (home garden) as a “land-use form on private or communal land surrounding an individual house (*ntlo*) with a definite fence as border around the yard (*patlelo*), in which several useful tree species are cultivated (intercropped) with crops and other useful plants, often with the inclusion of small livestock”. The garden layout of a typical Tswana *tshimo* is based on the occurrence of micro-gardens (orchard, vegetable garden, medicinal garden, flower beds, containers with plants, lawn, windbreak, shade tree, hedge, open space (*lebala*) and semi-natural area (*naga*) in similar positions in more than 50% of the homegardens sampled (see Figure 3 in Molebatsi et al. 2010).

Food plants, such as leafy vegetables, are harvested from the vegetable garden and semi-natural area (*naga*) within the domestic garden, and also the natural areas surrounding settlements. *Naga* is a form of indigenous management system for food resources, as this semi-natural area is kept in the yard for various reasons such as short-term grazing for livestock and harvesting of wild leafy vegetables and fruit (Molebatsi et al. 2010). It can also act as a push-pull system that protects the cultivated vegetable crops and orchards against pests (Midega, Khan, Van den Berg, Ogol, Dippenaar-Schoeman, Picket & Wadhams, 2008).

Figure 3: General garden layout of a Tswana tshimo (home garden) (Molebatsi et al., 2010).



LEGEND: A, position of the house; B, front door of house; C, main entrance gate; D, livestock holding pen; 1.1, orchard; 1.2, vegetable garden; 2, medicinal garden; 3.1, flower bed; 3.2, container; 3.3, succulent container; 3.4, lawn; 4.1, windbreak; 4.2, fire screen; 4.3, shade tree; 4.4, hedge; 5, open space (*lebala*); 6, natural area (*naga*). Drawing not according to scale.

3 Different plant species are referred to as:

- Native = species occurring naturally in immediate surroundings of study area
- Indigenous = species occurring naturally in other parts of South Africa, but not in the immediate area
- Exotic = species from other countries, including other countries in Africa
- Naturalised = not indigenous to South Africa, but occurs in the study area, where it sustains self-replacing populations outside of cultivating without direct intervention by people (Molebatsi et al, 2010)

Table 1: List of leafy vegetables recorded from the four study sites. Alien species are indicated with *.

Species	Vernacular name	Occurrence
<i>Allium cepa</i> *	Onion	Garden
<i>Allium porrum</i> *	Leek	Garden
<i>Amaranthus deflexus</i> *	Perennial Pigweed	Garden/natural area
<i>Amaranthus hybridus</i> *	Common Pigweed	Garden/natural area
<i>Amaranthus spinosus</i> *	Spiny Amaranth	Garden/natural area
<i>Amaranthus thunbergii</i>	Thunberg's Amaranth	Garden/natural area
<i>Amaranthus viridis</i> *	Slender Amaranth	Garden/natural area
<i>Armoracia rusticana</i> *	Horseradish	Garden
<i>Asparagus laricinus</i>	Wild Asparagus	Natural area
<i>Beta vulgaris</i> *	Chard	Garden
<i>Bidens bipinnata</i> *	Spanish Blackjack	Garden/natural area
<i>Bidens pilosa</i> *	Blackjack	Garden/natural area
<i>Boerhavia erecta</i> *	Erect Spiderling	Natural area
<i>Brassica oleracea</i> *	Cabbage	Garden
<i>Brassica rapa</i> *	Turnip Mustard	Garden
<i>Cleome gynandra</i>	Spider Wisp	Garden/natural area
<i>Corchorus asplenifolius</i>	Fern-leaved Corchorus	Garden/natural area
<i>Lactuca sativa</i> *	Lettuce	Garden
<i>Pergularia daemia</i>	Trellis Vine	Natural area
<i>Portulaca oleracea</i> *	Purslane	Garden
<i>Saccharum officinarum</i> *	Sugar Cane	Garden
<i>Sesamum alatum</i>	Wing-seeded Sesame	Garden/natural area
<i>Sesamum triphyllum</i>	Wild Sesame	Garden/natural area
<i>Spinacia oleracea</i> *	Spinach	Garden
<i>Talinum arnotii</i>	Porcupine Root	Garden/natural area
<i>Talinum crispatum</i>	Kalahari Butterweed	Garden/natural area
<i>Tropaeolum majus</i> *	Nasturtium	Garden
<i>Chenopodium album</i>	Goose Foot	Garden/natural area
<i>Momordica balsamina</i>	Balsam Apple	Natural area
<i>Vigna unguiculata</i>	Cowpeas	Garden

Figure 4: Ornamental garden planted with *Zinnia elegans* (Garden zinnia), *Tagetes erecta* (African Marigold), *Cosmos bipinnatus* (Cosmos) in the foreground and *Zea mays* (Corn) at the back. (Photo: S.J. Siebert)



Figure 5: Orchard of *Opuntia ficus-indica* (Prickly pear). (Photo: L.Y. Molebatsi)



Figure 6: Vegetable garden planted with *Zea mays* (corn), *Cucurbita spp.* (pumpkin) and *Brassica oleracea* (cabbage). (Photo: S.J. Siebert)



Figure 7: Leaves and fruit of the Wild water melon (*Citrullus lanatus*) is harvested from natural and semi-natural areas. (Photo: S.J. Siebert)



Figure 8: Common Pigweed (*Amaranthus hybridus*) is cultivated for its leaves (*morogo*) and is often harvested from natural and semi-natural areas where it grows as a weed (Photo: L.Y. Molebatsi).



Demographic and socio-economic profile

A descriptive demographic and socioeconomic profile of the consumers and non-consumers of TLF representative of the NWP is drawn from the data collected in the market survey (611 participants) (Idsardi & Cloete, unpublished data) and from the sub-sample of 200 PURE participants (Matenge et al, 2011) and is given in Table 2. The independent T-test⁴ was applied to analyse whether these differences between the consumers and non-consumers groups were statistically significant. The results of this test shows that these two groups differ significantly with regard to the head of the household, the person in the household who determines the expenditure on food, the geographical area, the size of the household and the source of income. Hence, the

4 Levene's test for equality of variances was performed to determine whether the conventional Independent T-test or the Welch's T-test was appropriate.

non-consumers are prominently headed by a household member other than the father and the person who determines the expenditure on food is mostly a member of the household other than the mother. Furthermore, the non-consumers are significantly more rural based and more reliant on pensions and government grants for their respective household income. Thus the two groups are homogeneous with regard to the other demographic factors.

It is important to note that in the NWP there is still a large percentage of people consuming traditional foods and that many of them live in urban areas. However, the large portion of rural participants who were recorded as non-consumers of TLV needed a more in-depth approach to identify reasons for consumption thereof.

Possible link between indigenous and traditional foods and health

The health profile was explored between consumers and non-consumers of TLV because of the reported high content of some nutrients in these vegetables

(Nesamvuni, Steyn & Potgieter (2001) and Faber, van Jaarsveld & Laubscher (2007) on 200 subjects from the PURE-SA participants. However, no information on the bio-availability of these nutrients is available. The health profile included a blood sample to determine risk factors for non-communicable disease (such as cardiovascular disease and diabetes mellitus), blood pressure and anthropometric measurements, and total dietary intakes by means of a quantitative food frequency questionnaire and is shown in Table 2.

Results demonstrated that there was no significant difference ($p>0.05$) between the selected micronutrient intakes or the risk markers for non-communicable disease between consumers and non-consumers of TLV in rural and urban communities. Most alarming from these results is the insufficient consumption of nutrient rich foods in both the consumers and non-consumers of TLV. It is also important to note that the participants from the urban settings consumed more nutrient rich foods as evident from the nutrient bio-markers, however, still less than the recommended daily allowances for these micronutrients (Whitney and Rolfes, 2008).

Table 2: Demographic and socioeconomic profile of participants

	Consumers (n=640)	Non-consumers (n=258)
Rural*	60.5%	77.8%
Person in the hh** responsible for the food supply	Mother: 56.1% Father: 23.9%	Mother: 47.2% Father: 11.1%
Average age of respondent	44 years	44 years
Average hh size	5	4
Ethnicity of the respondent	Tswana: 78.8% Sotho: 5.5%	Tswana: 72.2% Sotho: 13.9%
Average monthly hh income***	R2 518	R2 353
Average monthly expenditure on food (% of income)	R694 (27.6%)	R664 (28.2%)
Contributors to hh income	Mother: 56.6% of hh Father: 41.4% of hh	Mother: 47.2.8% of hh Father: 36.1% of hh
Highest level of education of respondent	Lower than grade 12: 40.9% No formal education: 24.1%	Lower than grade 12: 30.6% No formal education: 38.9%
Main source of income:	Salary (employed): 45.3% Pension: 22.5%	Salary (employed): 27.8% Pension: 30.6%
Head of hh	Mother (52.0%)	Mother/father (36.1%)

* Provincial composition: rural hh 62.2%, urban hh 37.8%

** hh: Household is defined as a group of persons who live together, and provide themselves jointly with food and/or other essentials for living, or a single person who lives alone (a household member is a member of a household if the person spends on average four nights a week in that household).

*** household income includes: salary (employed and self-employed), grants, transfers, farm income.

Table 3: Indicators for the health profile of consumers and non-consumers of TLV

Nutrient intakes	RDA/ day*	Consumers (n=139)	Non-consumers (n=59)	Consumers (n=28)	Non-consumers (n=169)
Iron (mg)	18	11.4 (8.6; 14.4)	11.2 (9.1; 15.7)	16.5 (9.9; 20.6)	14.1 (10.2; 18.9)
Calcium (mg)	1000	216.8 (138.2; 313.2)	173.4 (128.4; 320.9)	410.6(248.4; 597.6)	368.2 (272.7; 539.3)
Zinc (mg)	15	8.2 (6.32; 10.2)	8.1 (6.4; 10.3)	12.8 (7.9; 14.3)	10.9 (8.2 ; 15.2)
Vit C (mg)	60	12.8 (9.6; 19.5)	11.2 (7.9; 15.7)	37.0 (8.6; 18.6; 64.3)	38.1 (18.9; 59.2)
Risk markers for non-communicable disease		Consumers (n=139)	Non-consumers (n=60)	Consumers (n=28)	Non-consumers (n=169)
Systolic blood pressure (mmHG)		129.5 (115.5; 145.5)	129.0 (116.0; 140.0)	135.0 (118.0; 152.0)	137.0 (124; 126)
Diastolic blood pressure (mmHG)		87.0 (77.5; 97.0)	87.0 (73.0; 94.0)	91.0 (80.0; 95.0)	90.0 (81.0; 99.0)
Total cholesterol (mmol/L)		4.8 (4.1; 5.8)	4.9 (4.1; 5.8)	4.8 (3.7; 5.4)	5.1 (4.3; 6.2)
HDL cholesterol (mmol/L)		1.4 (1.1; 1.9)	1.3 (1.1; 1.9)	1.3 (1.1; 1.9)	1.5 (1.1; 1.9)
Triglycerides (mmol/L)		1.0 (0.8; 1.4)	1.2 (0.9; 1.7)	0.9 (0.8; 1.5)	1.2 (0.9;1.7)
Fasting glucose (mmol/L)		4.7 (4.4; 5.2)	4.8 (4.4; 5.1)	4.7 (4.2; 5.5)	4.9 (4.3; 5.5)
Serum ferritin (mmol/L)		14.4 (10.2; 18.9)	16.4 (11.6; 22.4)	17.3 (11.8; 23.5)	17.6 (12.6; 24.4)
BMI ^ (kg/m ²)		23.7 (20.3; 28.5)	23.0 (19.1; 29.6)	22.1 (19.2; 31.7)	24.3 (20.6; 29.8)
Waist circumference (cm)		78.5 (70.8; 88.9)	77.3 (73.1; 91.8)	84.1 (68.3; 95.0)	81.2 (73.9; 89.2)

Note: Values are presented as medians (lower quartile; upper quartile).*RDA, Recommended Daily Allowances as defined by Whitney and Rolfes, 2008. ^Body Mass Index.

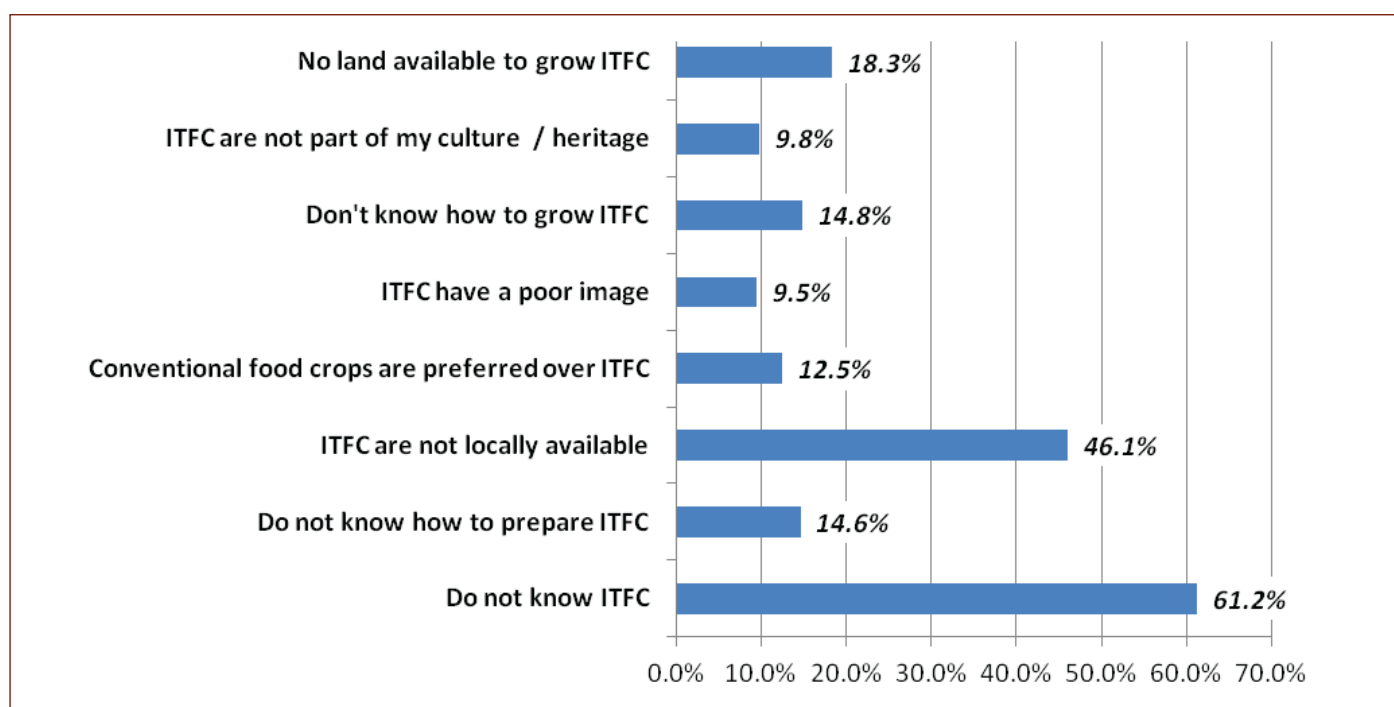
Consumption patterns

As indicated in the methods section, a mixed-methods approach was followed to find an in-depth understanding of the reasons why ITF are consumed or not. From the focus group discussions, thematic analysis identified three major themes in relation to ITF consumption. These were: benefits of ITF consumption; barriers to ITF consumption; suggestions on how to increase ITF consumption.

Factors related to consumption

In this study good taste was one of the main reasons for consumption. However, there was a marked difference between the older and younger generations. More older than young participants find the traditional way of preparing TLV appealing and important for

general health. The younger participants associated ITF with “a lifestyle that was too traditional and old fashioned”. There was also a difference in opinion between working people and those at home responsible for food preparation. Differently from those working, convenience, reflected by easy to prepare and availability on the market, was not seen as an important motivation for consumption. Other important reasons for consuming ITF were the affordability and that some of the food crops can be obtained free of charge in the fields. The latter implies that the crop can be collected from the veld and thus does not need to be bought from a formal or informal market. This motivation for consumption is especially applicable to TLV and for the less commonly consumed more seasonal crops such as roots. This is an important finding, given the fact that in large areas of the NWP, the people suffer low income, high unemployment rates and high dependability on government grants (evident from Table 2).

Figure 9: Reasons for not consuming ITF

Factors related to non-consumption

The lack of knowledge of how to grow and prepare TLV was seen as the main barrier to consumption by participants of all ages (Figure 9). Some elderly people blamed this on urbanisation and modernisation and on a lack of interest in indigenous knowledge from the youth; “Modernisation and urbanisation have brought a lot of changes in terms of the eating habits of our children. They now refuse to eat traditional foods (female aged 60+, rural)”.

Availability of produce on local markets was the second important reason for non-consumption of ITF. This finding is not due to a lack of markets, but rather to the seasonality of the crops and the fact that so few participants were growing these crops, as will be indicated in the next section, on infrastructure.

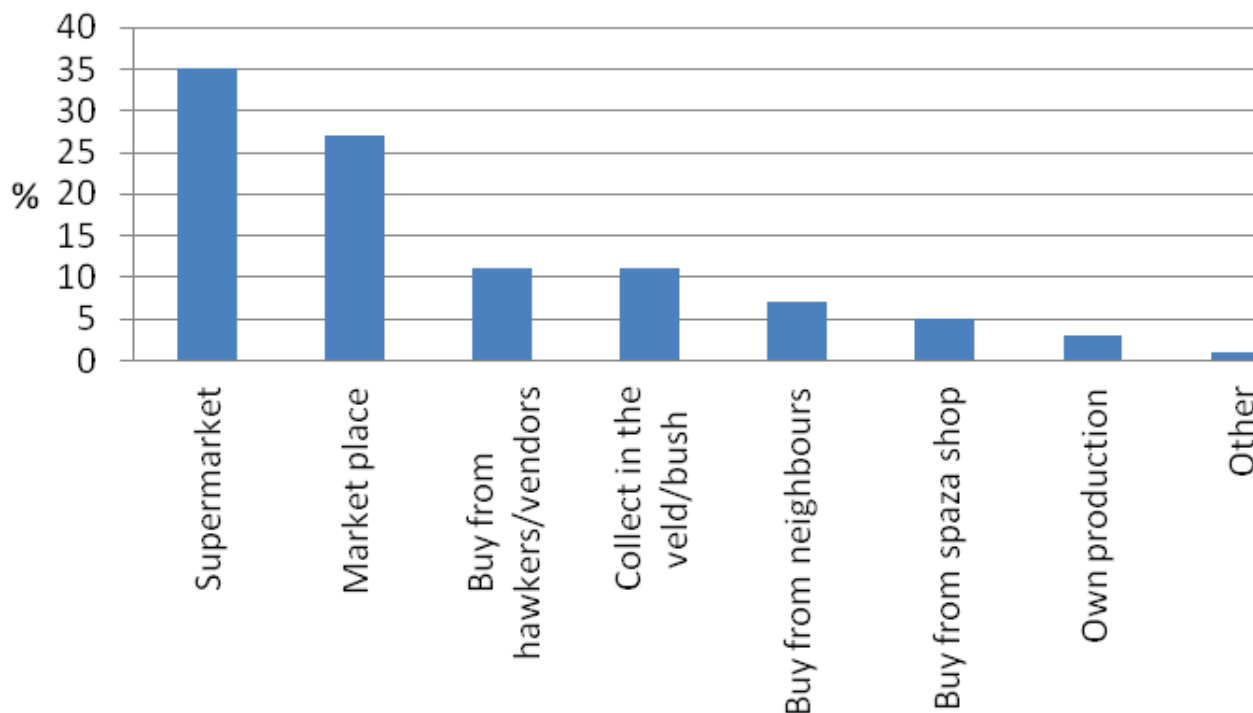
Although only 9.5% of the participants reported ITF to have a poor image, it is important to note that in general, younger consumers found ITF rather revolting and undesirable and they see it as a humiliation to consume, while older consumers’ reported positive views. This finding supported findings from other in this regard (Damman et al, 2008). The negative views by younger consumers can be related to their unfamiliarity with these food products, since familiarity is a factor shown to influence traditional food consumption behaviour positively (Pieniak, Verberk, Vanhonacker, Guerrero & Hersleth, 2009).

Infrastructure

In an attempt to determine the existing infrastructure for the supply base of ITF in the NWP, we looked at who the producers of ITF are and where their produce is marketed. Results from these analyses also showed that only a very small number of households actually produce ITF themselves and an even smaller number are selling them to any of the market outlets. The analysis revealed that only 7% of the respondents in this study produce one or more of the ITF themselves in their households. Sorghum, cowpeas, sweet potatoes, and amaranth are among the ITF that are most frequently consumed and are mainly produced commercially by commercial farmers and small farmers in the NWP. The major retail outlets (see Figure 11) for these ITF are supermarkets (formal market) and the so-called marketplaces (see Figure 10) that are part of the informal market.

From the market analyses it is evident that household production is mostly of a subsistence nature and that the small amount that is produced commercially is destined for the smaller informal market outlets such as hawkers/ vendors and spaza shops and supermarkets. However, the low level of household utilisation/consumption of ITF suggests that smaller market outlets source ITF from the formal market as well. It is remarkable that the supermarket has such a significant share in the sales of some indigenous traditional food crops (ITFC) (figure 11); this underpins the growing importance of supermarkets in the South African food supply chain. In 2003, Weatherspoon Reardon stated that urbanisation and the rise of the middle class in countries such as

Figure 10: Market outlets for all Indigenous and Traditional Food Crops



Markets

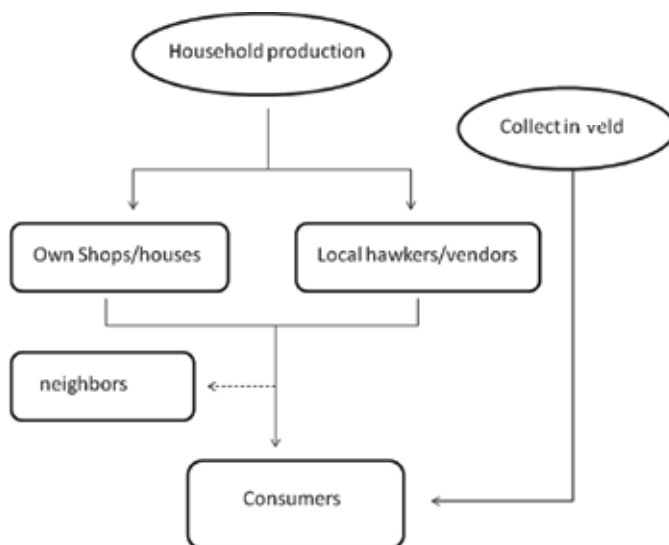
Kenya and South Africa are drivers for the development of supermarkets, but also do not deny the importance of the informal market chain (Weatherspoon Reardon, 2003). These authors also emphasised the importance that the retail food sector can play when small farmers can sell their produce in order to escape from poverty.

Figure 11: A typical marketplace



A schematic representation (Figure 12) is based on the results from the survey of a generic supply chain for ITF produced by households in the province. It is evident from the figure that the informal market is the main outlet for households that produce ITFC.

Figure 12: Generic supply chain for ITFC produced by households in the North West Province



Consumers of ITF tend to buy from the household producers that sell to neighbours or through their own houses and rely on their own and/or public transportation. They therefore go for the nearest and cheapest option. The producers of ITF are also dependent on their own and/or public transportation, that is they carry produce from the point of production to the market. The average travel time for those making use of public transport in this study was 10 minutes.

CONCLUSIONS

STUDY

CONCLUSIONS OF THE STUDY

The main aim of the study was to provide empirical evidence of how the role of agricultural biodiversity can be translated into improved health and nutritional status, improved livelihoods and more sustainable production systems in contemporary poor rural and urban communities in the North West Province of South Africa. Results in this regard reveal the following:

- Of the wide variety of potential eatable ITFs in the NWP, only a few are consumed to some extent by the households in the NWP; mostly sorghums, cowpeas, and sweet potatoes are consumed by more than half of the households. A large share of the investigated ITF is never consumed by the households in the NWP.
- The consumption of traditional leafy vegetables is very low and therefore no evidence of varying health benefits could be found between consumers and non-consumers of TLV.
- Reasons for not consuming potential eatable ITFs are predominantly due to unfamiliarity with the crops by the households and the poor availability of the crops in the veld or market. It also seems that the consumption of most commonly consumed ITF is on the decline as many households indicated that they used to consume them in the past.
- For all the ITF, the good taste of the respective crop was an obvious and major driver of consumption. Other reported drivers for consuming ITF were self-reported health aspects, availability in the market place and affordability, free availability in the veldt.
- Household vegetable gardens are limited and if available, the production of ITF is very small; it is mainly grown in backyard gardens at a subsistence level. However, most of the respondents still managed to sell a small percentage in their neighbourhoods via their own houses/shops or to local hawkers/vendors.
- Household producers are normally within close proximity of their respective markets, (neighbourhoods, local hawkers/ vendors, thus the informal market), as transport costs are expensive and public transport is scarce and unreliable.

RECOMMENDATIONS

RECOMMENDATIONS (SPECIFIC TO THE NORTH WEST PROVINCE)

1. This study reveals a gap in knowledge on the nutrient content and bio-availability of nutrients in ITF that needs to be addressed.
2. The socioeconomic status of the study area is low. Therefore, agricultural management and infrastructural aids should be provided to enhance the food production within settlements.
3. Study sites where the in-depth data were collected are located within an area with an erratic annual rainfall of less than 600 mm per annum. Hence, crops are not guaranteed high production and can often fail. Most houses have corrugated iron roofs which provide an opportunity to fit gutters to channel water to water storage tanks. This will buffer gardening systems against short-term droughts.
4. Soils of the study sites are often infertile, marginal land which is not taken up by the commercial farming sector. Composting of organic household waste and kraal manure could increase the fertility of small vegetable patches around the house. The eco-circle approach could be applied where compost is limited. This involves a circular hole being dug and filled with compost and soil, after which it is planted with vegetables. Sustainable mentoring and assistance in this regard is needed.
5. Fruit trees are often limited to households that can afford hardy, high yield cultivars. Agricultural extension should advise households on suitable fruit trees that can be grown from seed and establish nurseries where such species are made available at a minimum cost. As fruit trees take a while to mature, gardeners should be advised and mentored on the best care to enhance this process.
6. Cultivated shade trees are often invasive aliens that consume more water than other species. Through education programmes and distribution of “water-friendly” alternatives, the micro-habitat of the domestic garden can be greatly improved, which will enhance the production of crops.
7. More programmes should be launched to investigate methods of successfully cultivating ITF. Currently only a few of the leafy vegetable species can be cultivated with ease. If the availability of these leafy vegetables increases, they will most probably be more regularly cultivated and not only be opportunistically harvested (as they appear in gardens and other areas).
8. Simultaneously, markets should be developed for these foods. One way of achieving this is to invest in product development acceptable to the consumer of ITF. Consumer demand is a forceful economic driver.


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