



Vegetable chains in Kenya

Production and consumption of vegetables in the Nairobi metropolis

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Referaat

De consumptie van groenten in Afrikaanse landen zoals Kenia is laag, wat slecht is voor de voedingstoestand van de bevolking en de productie door kleine tuinders. De projectdoelen waren het bepalen van de potenties van consumptie en productie in het metropolitane gebied van Nairobi, het analyseren van de oorzaken van de lage consumptie en het definiëren van strategieën om consumptie en productie te verbeteren. De consumptie van groenten kan worden verhoogd, met name tijdens de droge tijd, wanneer de beschikbaarheid ervan laag is, en ten behoeve van de laag-inkomen groepen. De productie kan worden verbeterd door middel van een aantal technische interventies en scholing. De positie van producenten in de keten moet worden verbeterd, net als de efficiëntie van de keten. Kernelementen zijn: stimulering van stadslandbouw, reductie van de kostprijs in de gehele keten, verbeterde transparantie en verantwoording (accountability) op ketenniveau, kortere ketens met lagere transactiekosten, minder na-oogstverliezen, ontwikkeling van een inkomstensysteem dat de tuinders beter belooft, verbetering van koude opslag en logistiek, verbeterde irrigatie in het droge seizoen, voedselverwerking, en aandacht voor een aantal levensgewoonten. Nederland kan bijdragen in het herstructureren van de keten, bemiddeling tussen partijen, voedselverwerking, consumentengedrag, productie en productkwaliteit (irrigatie, goed zaaizaad, gewasmanagement) en R&D.

Abstract

Vegetable consumption in African countries such as Kenya is low, which has a negative impact on the nutritional condition of the population, and on the production by smallholders. The goals of the project were to determine the potentials for consumption and cultivation in the Nairobi metropolitan region, to analyse the reasons for low consumption and to define strategies to stimulate consumption and production. Vegetable consumption can be increased, especially during the dry season when availability is low, and for low-income groups. Production can be increased through technical interventions and improvement of skills. Important is to improve the leverage of producers in the value chain and the efficiency of the value chain. Key elements are: stimulate urban farming; reduce the cost price throughout the value chain and make the value chain more transparent, accountable, shorter with less transaction costs; reduce post-harvest losses, develop a revenue system that better rewards farmers; improve cold storage and logistics, improve irrigation in the dry season; offer dry-season solutions through food processing; and pay attention to a number of life-style issues. The Netherlands can contribute in the fields of re-structuring the value chain, brokering between parties, food processing, consumer behaviour, production and product quality (irrigation, quality seeds, crop management), and R&D.

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Summary

Vegetable consumption in African countries such as Kenya is low, which has a negative impact on the (micro-) nutritional condition of the population, and on the production by the large number of smallholders. Reasons for this can be many, starting with consumer preferences and habits, logistics, cooling facilities, seasonality of production, land use, functioning of the supply chain, etc. A project was commissioned by the Netherlands Ministry of Economics, Agriculture and Innovation, to:

1. Determine the potentials for vegetable consumption and cultivation in the Nairobi metropolitan region, which serves as an example for African metropolitan regions in general.
2. Analyse the reasons for low vegetable consumption by the urban and rural citizens in the Nairobi metropolitan region.
3. Define strategies to stimulate consumption and production of vegetables.

Potentials

Vegetables form an essential part of a varied human diet, and a shortage leads to micronutrient deficiencies and diseases. Just as in many other parts of Sub-Saharan Africa, the nutritional status in Kenya and its capital Nairobi is insecure. Especially low-income groups suffer from (micronutrient) undernourishment in combination with a high fat intake. The estimated annual consumption in Kenya and Nairobi is too low, although the attitude towards vegetables is positive. From the consumer-perspective, vegetable consumption can be increased, especially during the dry season when availability is low, and for low-income groups.

The vegetable producing farms are located in the arable lands around Nairobi, and produce mainly (96%) for the domestic market. It should be possible to increase production levels, for example through better seeds (either from the informal or formal seed sector), better irrigation, better fertilization, and better pest and disease management. Farms are small, and suffer from decreasing land resources, declining soil fertility, lack of horizontal cooperation, poor infrastructure (roads, telecommunication, electricity), lack of technical skills, and a low leverage in the value chain.

Marketing of vegetables is not optimal. Post-harvest losses are high. Many steps in the value chain can be improved: post-harvest handling, grading and standardization, cold storage, processing, transport. Production would benefit from rewarding farmers for a better quality of the product. The value-chain is dominated by traders who do not sufficiently share information.

Reasons for low consumption

An overview of the most important constraints that were gathered during the desk study, interviews and the workshop is given in Table 16. and Table 17. Three main causes for low vegetable consumption are:

1. insufficient income,
2. low availability, certainly during the dry season,
3. life style, negative attitudes towards vegetables.

Low-income population groups can not afford to purchase sufficient vegetables. This is especially a problem during the dry season, when there is a shortage of fresh vegetables (see below) and when the prices consequently are high.

It appears that during the rainy season, sufficient vegetables are produced. A large part is lost in the value chain, but even so, vegetables appear to be widely available during the rainy season. Also, the variety of vegetables is adequate. However, as a consequence of insufficient availability of irrigation water during the dry season, production of vegetables in that season is much lower than during the rainy season. This is aggravated by a variety of other production-related constraints and constraints that play a role in the value chain between producers and consumers.

Thirdly, a number of life style constraints influence the consumption of vegetables, such as preferences, diversifying eating habits, time availability to purchase and prepare food, and the low status of vegetables.

Strategies

Directly following from the major limitations, the major strategies to stimulate consumption of vegetables should

1. Reduce the price of vegetables and/or increase consumers' income
2. Increase the availability of vegetables during the dry season
3. Modify the life style by promoting a positive attitude and improve knowledge.

Urban farming can make a large contribution in the health of the urban poor by providing them access to higher quality agricultural products with nutritional benefits. As families can grow their own vegetables, vegetables are more easily affordable. Attention to the problems regarding urban agriculture is therefore of great importance.

Consumption of vegetables that are produced in the **peri-urban and rural areas** can be improved by **reducing the cost price throughout the chain**. If **cold storage and logistics are improved**, then losses will be reduced which should in principle reduce product prices for the consumer. Realization of **irrigation in the dry season** will have an enormous impact. Installation of equipment or other activities that makes available water, and enables efficient water application should therefore be seriously considered.

The value chain between the peri-urban and rural producers, and the urban consumer is long and far from optimal. Measures that **make the value chain more transparent, shorter, with less transaction costs**, etc. should result in cheaper and better available vegetables in Nairobi, reduce product prices for the consumer, while maintaining or increasing prices paid to the producers. Reduction of post-harvest losses in itself should result in higher volumes that reach the consumer.

Most pressing is the reduction of post-harvest losses combined with a financial revenue system that rewards farmers for producing more and better products, in combination with increased sales of these vegetables. Trust, transparency, and accountability in the value chain are some of the keywords that apply here. This will not happen automatically, but needs an advance process in which options for changes in the value chain are made explicit in, amongst others, financial terms. A group of stakeholders should take the initiative to implement a value chain that

1. efficiently links consumers to producers
2. ensures that the product prices paid to farmers are sufficiently high year-round
3. ensures that consumer prices are sufficiently low.

Depending on the demand, production in the rainy season can be increased (see also below, food processing). Production increase in the dry season will depend on the availability of water, but also then, production should follow demand and should avoid production peaks. In any case it is best to produce in a water-efficient manner during the dry season, using the appropriate technology level in terms of required investments, maintenance and financial returns.

Given the fact that in the rainy season sufficient vegetables are produced, that the production can be increased with e.g., better irrigation systems, or that lower post-harvest losses can increase availability, and given the fact that during the dry season there is a shortage of vegetables, **food processing** offers extra solutions. Through drying, canning, or freezing, vegetables can be prepared during the rainy season for the dry season.

Although the value of vegetables is generally well-known, **some life style issues** influence the consumption of vegetables. There is some consumer mistrust, especially with regards to low food safety due to washing of vegetables with polluted water (certainly untreated sewage water is unsafe). Not all consumers are aware of preparation methods for African Leafy Vegetables, or do not have sufficient time for purchasing and preparation of food (this is especially a problem for low-income groups). Also, vegetables can have a low status ('poor man's food'), combined with specific preferences for other types of food.

Possible contributions of The Netherlands

The Netherlands, represented by private and public partners, can contribute to increased production and consumption of vegetables in Nairobi and elsewhere in Kenya through the following:

- **Re-structuring of the value chain.** A number of stakeholders has to be brought together that is committed to an efficient and transparent value chain. This may require a number of preliminary steps, such as:
 - o Development of a detailed business case that shows the benefit to all stakeholders
 - o Making available credit facilities.
 - o Developing a realistic business plan
 - o Defining quality standards, a certification scheme, a tracking & tracing system, and a quality control system
 - o Setting up an information system with all data that is needed to realize a transparent chain.
- Improved chain logistics and cold storage, to generate funds that can be (partly) spent on fair payment to growers.
- **Brokering.** Bringing together interested parties on the basis of a viable business plan. Parties may be Kenyan, Dutch, or of other origin.
- **Food processing.**
 - o Drying, canning or freezing of food can increase vegetable availability during the dry season. Issues to be dealt with are consumer prices (must be kept low) and preferences (that currently favour fresh vegetables).
 - o Ready-to-eat and fast foods. To reach many people through numerous sellers and resellers, it requires among others organization, industrialization, stable quality, investments, and planning. Also here, a low price is essential.
- **Consumer behaviour.** The Netherlands can provide support in assessment of, and influencing consumer behaviour that limit vegetable consumption. Especially, the preference for fresh vegetables limits the sale of processed vegetables. Both private and public sector representatives have possess experience that can be utilized.
- **Increased production and product quality,** to ensure adequate supply of vegetables that meet the demands set by the value chain.
 - o Irrigation technology. The Netherlands has wide experience in water and irrigation technology, and can assist in the implementation of water-use efficient technology.
 - o Quality seeds. The Netherlands has a number of international oriented breeding companies that can make available high-quality seeds. An issue to be dealt with is the fact that consumers, and therefore growers, are primarily interested in African vegetables, which may not be part of the portfolio of Dutch companies. After-sales support of Dutch suppliers can play an important advisory role.
 - o General crop management. Crop management practices, comprising pest and disease management, soil management, planting, etc. can be improved. Local knowledge can be combined with knowledge of high-input systems.
 - o Production and distribution of home gardening kits that would, for example, contain high-quality seeds.
- **Research and development.** R&D on vegetables needs more attention, as was indicated during the workshop. Dutch knowledge institutions can contribute here, and for example provide support in linking up private and public initiatives.

1 Background

1.1 Relevance

Vegetable consumption in African countries such as Kenya is low, which has a negative impact on the (micro-) nutritional condition of the population. Reasons for this can be many, starting with consumer preferences and habits, logistics, cooling facilities, seasonality of production, land use, functioning of the supply chain, etc. This is not an isolated urban or rural problem, but a metropolitan problem. A metropolitan region consists of a city plus its surrounding regions with which it interacts. Vegetable production and consumption are interdependent, to be dealt with from a metropolitan, integrative perspective.

1.2 Project goals

The following goals have been determined:

1. Determine the potentials for vegetable consumption and cultivation in the Nairobi metropolitan region, which serves as an example for African metropolitan regions in general.
2. Analyse the reasons for low vegetable consumption by the urban and rural citizens in the Nairobi metropolitan region.
3. Define strategies to stimulate consumption and production of vegetables.

1.3 Methods

1.3.1 Desk study

To determine the potentials for vegetable consumption and cultivation, barriers and opportunities are addressed for consumers and producers, and the intermediate value chain. A literature search was done in scientific literature, reports and available (internet) data. Information sources used are online available studies from local universitie(s) and researchers, as well as from ngo's that have been active in the field of agricultural production and consumption in Kenya and particularly in Nairobi.

Based on the literature search firstly a broad picture of possible barriers and opportunities was described. This picture gave insight in gaps in current knowledge and available data and served as a starting point for the mission to Nairobi.

1.3.2 Fact finding mission

From 13-23 November 2011 a fact finding mission to the Nairobi region took place in which several firms, institutes and organisations were interviewed to collect missing qualitative and quantitative data for the desk study.

1.3.3 Workshop

On November 21, 2011, a workshop was organized in Nairobi, in which several stakeholders of the domestic vegetable chain of Nairobi Metropole participated. This workshop is separately reported by Van der Lans *et al.* (2011).

1.4 Outline report

The Kenyan situation is described in chapters 3, 4 and 5 for respectively consumption, production, and the value chain. Also in each chapter an overview is given of constraints and opportunities found for the specific part of the domestic vegetable chain. Chapter 6 summarizes and discusses the main constraints and opportunities to resolve them, and indicates opportunities for Dutch involvement.

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2 Kenya and Nairobi

2.1 General information

Kenya is situated on the east coast of Africa. The country rises from a low coastal plain on the Indian Ocean to a series of mountain ridges and plateaus which stand above 3,000 m in the centre of the country. It has a land area of 580,000 km² and a population of nearly 40 million residents (Embassy of the Kingdom of the Netherlands, 2011), representing many different peoples and cultures. The country is divided in eight provinces (Figure 1.).

Table 1. Total, rural and urban population in 2009.

	2009 (x1.000)
Total population	38,610
Rural population	26,123
Urban population	12,487

Source: www.countrystat.org



Figure 1. Map of provinces in Kenya (source www.nema.go.ke).

The above map shows these eight provinces of Kenya. The numbers are: (1) Central Province, (2) Coast Province, (3) Eastern Province, (4) Nairobi, (5) North Eastern Province, (6) Nyanza Province, (7) Rift Valley Province, (8) Western Province. Nairobi Province is at the same time also a district and a municipality. The provinces (mikowa) are further divided into 71 districts (wilaya'at). These are divided again into 262 divisions (taarafe). Nairobi Province is the smallest of the eight provinces in Kenya.

Nairobi

The capital city of Kenya is Nairobi, situated in the south of the country and home to an estimated 2,9 million people at an area of 696 km² (which was only 350,000 people at independence in 1963). This city has the largest population in Africa. The urban population is expected to grow enormously. The great influx of people into the city without matched urban planning has continued to result in a wide variety of environmental problems (www.nema.go.ke). Also, the enormous growth makes vegetable and food production an important issue for the coming decades.

The Nairobi Province is with an area of 696 km² the smallest province in area and is entirely urban. It has only one local authority, Nairobi City Council. Nairobi Province was not divided into districts until 2007, when three districts were created. The province is further divided into "divisions" which are further divided into "locations".

Nairobi Province has eight constituencies, which follow same boundaries with administrative divisions (which is not the case on most districts in Kenya). These are Makadara, Kamukunji, Starehe, Langata, Dagoretti, Westlands, Kasarani and Embakasi. The main eight administrative divisions are Embakasi, Makadara, Pumwani, Central, Kasarani, Westlands, Kibera and Dagoreti. Constituency name may differ from the administrative division name, such that Starehe Constituency is equal to Central division, Langata Constituency to Kibera division, Kamukunji Constituency to Pumwani Division in terms of boundaries. The administrative divisions Langata, Westlands, Embakasi, Makadara, Dagoretti, Kasarani are agriculturally important (Nyang'wara *et al.* 2007). The Agro-Ecological Zones range between Lower Highland to Upper Midland for all the divisions.

Most of the upmarket suburbs are situated to the west of Nairobi, where most European settlers resided in colonial times. These include Karen, Langata, Lavington, Gigiri, Muthaiga, Runda and Highridge. Kangemi and Dagoretti are lower income areas. The city's colonial past is commemorated by many English place-names. Most low and lower-middle income estates are located in eastern Nairobi. These include Kariokor, Dandora, Kariobangi, Embakasi and Huruma. Many Somali immigrants have also settled in Eastleigh, nicknamed "Little Mogadishu".

2.2 Climate

Kenya has a tropical climate: hot and humid at the coast, temperate inland and very dry in the north and northeast parts of the country. The average minimum temperature is around 10-14 °C and the maximum temperature between 20-32 °C (differing between the altitudes of the area). There is plenty of sunshine all the year, but in the main horticultural production areas it is usually cool at night and early in the morning. The hottest period is from February to March, the coldest in July to August. There are two rainy seasons in the year: the long rains occur from April to June, the short rains from October to December (Ministry of LNV¹, 2009).

The Nairobi Province has an average annual rain fall of 800 mm per year with a bimodal pattern; in this province the long rains season starts in March ending in May while the short season runs from October to December. The altitude is 1800 metres above sea level and the mean maximum and minimum temperatures are 26° and 18° C respectively (Nyang'wara *et al.* 2007).

1 The previous Ministry of Agriculture, Nature and Food Security (LNV) is currently the Ministry of Economics, Agriculture and Innovation (EL&I).

2.3 Religion

About 80% of Kenyans are Christian, 10% Muslim and 10% follow traditional African religions or faiths (Ministry of LNV, 2009).

2.4 Economy

Kenya traditionally produces tea and coffee. Recently, it has developed a formidable horticultural industry, and has become a major exporter of fresh flowers to Europe. Agriculture contributes 24% of the national gross domestic produce (GDP), industry accounts for 16.7%, and services contribute 59.2% towards Kenya GDP. Export earnings in 2008 from horticulture were USD 763 million (Ministry of LNV, 2009).

Trade industry in Nairobi is also based on an agricultural economy. Tea, coffee, sugarcane, fruits, flowers, dairy and poultry products are the main products around which Nairobi industries have developed. Among the mineral based industries, steel, aluminium, lead, and cement are the predominant ones. In the services sector, Nairobi tourism is the main revenue generating source (<http://www.mapsofworld.com/cities/kenya/nairobi/location-orientation.html>).

Industries in Nairobi are mostly in the small-scale and medium scale sectors. Industries manufacturing batteries, plastic goods, cigarettes, soaps, flour, and vegetable oil fall in this category. Coffee, sugar factories, canned fruit and fruit juice, horticulture, dairy and poultry farming are other industries in the small and medium category. Nairobi industries in the large scale include steel, aluminium, textiles, oil refineries, cement, and ship repairing.

Being a developing nation, Nairobi still has a large number of unemployed and uneducated people. About 75% of the work force is engaged in agriculture, mainly as subsistence farmers. Some 2.5 million people are directly employed in horticulture. Most city residents still retain links with their rural families and leave the city periodically to help work on the family farm (Ministry of LNV, 2009). Since its independence in 1963, Kenya promoted rapid economic growth through public investment, encouragement of smallholder agricultural production and incentives for private (often foreign) industrial investment (Ministry of LNV, 2009).

2.5 Urbanisation and food (in)security of Nairobi

Kenya's population has grown the last decades enormously. The total population was 29 million in 1999 and has risen to nearly 40 million in 2011. Also Nairobi City has undergone a rapid urbanization. The urbanization has been accompanied by inequitable economic growth resulting in increased urban poverty with many low-income households suffering from extremely limited alternative livelihood options and food insecurity. Government statistics show that poverty is shifting from rural to urban areas, with poor people expected to increase to 65% of the urban population by 2015. About 50% of Nairobi's residents are currently poor and hungry, living below the absolute poverty² level of USD 1 per day. Although 75% of the population is currently rural, there was a 90% increase in urban population between 1994 and 1997, creating concern that the focus of poverty reduction had to shift to urban areas (Nyang'wara *et al.* 2007). Urbanisation (as for the whole of Kenya) is mainly poverty-driven: rural population moves to the city, hoping for a better future compared to their situation in the rural areas. Most migrants end up in one of the low-income areas of the city.

2 Absolute poverty is the inability to afford daily minimum basic food and non-food requirements for an adult equivalent.

Box 1. *Nairobi poor people living in slums*

Nowadays more than 60% of the population of Nairobi lives in one of the 146 slums located in and around the city. Kibera slum is one of the slums of the Kenyan capital. It is the second biggest slum in Africa (after Soweto in South Africa). Around one million people are currently living in Kibera and the population is increasing daily. In the slum, landslides are frequent and the unemployment rate is very high.

Source: Pascal and Mwendu, 2009.

Box 2. *History of Urbanisation in Kenya*

Urbanisation in Kenya is not only of recent years. It has a long history with urban agglomeration in the form of trading centers being found along the Kenyan Coast as early as the 9th Century AD. However, the growth of many urban centers can be traced to the pre-independence period when they were used as centres of administrative and political control by the colonial authorities.

Source: Nyang'wara et al. 2007

Consequences for land resources and land use

The growth of the city population has led to an increased demand for both housing and resources required to meet the demand for increased urban food needs. City boundaries are extending continuously, and there is an enormous pressure on land, infrastructure and services as well as on the food supply. The pressure on land has encroaching onto the land that has previously been considered peri-urban. In addition housing is considered to have a higher value when it comes to land use while the urban agriculture is perceived as temporary or transient land use.

Citizens dwelling in slums and peripheral areas that have to deal with limited incomes and poor diets, have resorted to alternative means such as urban agriculture to ensure survival. So, urban agriculture plays a major role in meeting food the food security needs of low-income urban families. Farming activities are realised in backyards (growing food or keeping animals on one's own compound), in public open spaces (along riverbanks, roads, railway lines, industrial areas, under power lines and on reclaimed wetlands) and in the former rural areas that became part of the city due to expansion of the city boundaries.

3 The consumption of vegetables

3.1 Summary

Sub-Saharan Africa has a huge number of undernourished people and faces problems of severe food insecurity and starvation. In this context the promotion of vegetable consumption does not seem urgent for the poorest of the poor, but for a long term healthy diet, both energy, macronutrients and micronutrients are needed. Vegetables can make a significant contribution to micronutrient intake, however, vegetable consumption is generally low in this region and below health recommendations. In Kenya, food insecurity and micronutrient deficiencies are common. In addition, the diet often lacks diversity which is related to co-occurrence of both undernourishment and overweight, both having serious health implications.

At the consumer level vegetable intake is especially related to low income and a high percentage of income spent on food in general and staple foods in particular. In addition consumer behaviours and socio-psychological factors such as attitude, knowledge and social norm influence the importance of vegetables in the diet. At the level of the environment, product characteristics and the government and industry actions are related to vegetable consumption.

Vegetable consumption in developing countries faces the following constraints:

Type of constraints	Specific constraints
Demographics	<ul style="list-style-type: none">• Income• Ethnicity• education
Socio-psychological	<ul style="list-style-type: none">• Attitude<ul style="list-style-type: none">◦ motivations in food choice◦ orientations• Knowledge• (cultural) habits
Food characteristics	<ul style="list-style-type: none">• Accessibility and availability, including seasonality• Information• Convenience• Sensory aspects• Quality, safety and shelf-life• price
Government and Industry	<ul style="list-style-type: none">• Education and information• Intervention and promotion• Law and regulations

Demographic and socio-psychological barriers are also reported for Kenyan vegetable consumption. Income is strongly related to vegetable intake whereas results on educational level are less clear. Additionally, female headed households consume more vegetables and intake is further related to ethnicity. Environmental barriers are also reported, especially barriers of availability and accessibility that are specific for vegetables (short shelf-life, seasonality, safety) and the consumers (money, time, transport, and storage barriers to buy large quantities). Finally, urban dwellers sometimes lack the knowledge on preparation of especially traditional vegetables. Socio-psychological barriers are: vegetables are often not highly regarded, handling and cultivation of vegetables occurs under unhygienic conditions, and cultural beliefs, norms and customs define the choice of vegetables in general or for specific individuals or periods of time as well as their preparation methods.

For vegetable consumption in Kenya the following constraints have been reported:

Type of constraints	Specific constraints
Socio-demographic	<ul style="list-style-type: none"> • income and occupation • female or male headed households • education level • knowledge of the correct choice of foods for a healthy diet or on processing • ethnicity • rural versus urban
Culture, beliefs, norms, customs, habits and attitude relate to:	<ul style="list-style-type: none"> • foods that are essential to the meal • foods that are unacceptable for consumption • specific to individuals (e.g. children) or periods in time (e.g. pregnancy) • sharing and distribution within the family • preparation methods • child feeding practices • vegetables as poor man diet • dirty image due to cultivation and handling during selling
Availability and accessibility	<ul style="list-style-type: none"> • small, regular purchases possible only at open air-market and kiosks • short shelf-life • seasonality
Other	<ul style="list-style-type: none"> • limited time for buying, preparing and cooking • food safety due to growing places and poor handling

We see the following opportunities for increasing vegetable intake in Nairobi:

- Home growing kit; promote small scale urban farming, especially with diversity in crops.
- More use of indigenous vegetables; traditional foods have potential for dietary diversity and increasing household food security but have been relatively low commercialized.
- Education about the importance of vegetables and variety in diet in an integrated approach; combine promotion, education, technical innovations and address daily constraints and barriers.
- Promoting vegetables in fast-foods or street foods; usually these have a small share of vegetables, since many urban dweller rely on these foods there is potential for improvement.
- Better marketing of vegetables; food processing can improve a constant quality of vegetables and provide opportunities for single consumptions at low prices and branded in such a way that they facilitate word of mouth. For example by bundling of different types of vegetables in small portion bags that keep the vegetables fresh or by complementary products such as small packages with herbs and other food components or recipes.

The Netherlands could on a commercial basis become involved in the production and distribution of home gardening kits. It would be most effective to combine this with a distribution system that is based on the fine network of retailers that are frequented by urban households. However, collaborative projects between public partners that deal with indigenous vegetables and commercial breeding companies that deal with other vegetables may be worth exploring, for example in home gardening kits or diversification of the range of vegetables grown by smallholders. Further Commercial opportunities can be found in the areas of ready-to-eat and fast foods, and various ways of food processing. This requires among others organization, industrialization, stable quality, investments, and planning. As a low price is important, so are efficiency and economies of scales.

3.2 Dietary status and vegetable intake

Worldwide almost one billion people suffer from undernourishment according to FAO estimates (Figure 2.). In sub-Saharan Africa live a large number of undernourished people live. Moreover, this region has the highest proportion of undernourished people; 30% in 2010. In the future it is expected that the growing world populations, economic crises, price swings, climate change, and emerging wealth in growing economies will put an even larger claim on the food production and therefore the risk of malnutrition. Moreover, episodes of food insecurity emergencies occur. Such as the current drought-related food crisis in the Horn of Africa that up to now lead to a double number of people in need of emergency assistance compared to early 2011 (website FAO, 2011). In the light of these severe food problems and starvation, the role of vegeta-

bles seems marginal. For the poorest of the poor, it may be unrealistic to even attempt to advise them to increase fruit and vegetable consumption before daily energy requirements are met. Inadequate vegetable and fruit consumption however, is the sixth main risk factor for mortality in the world (Ruel *et al.* 2005). In the long term, micronutrient intake is equally essential to health as energy intake, and vegetables can contribute to this. In addition to micronutrient deficiencies, a dietary pattern with low fruit and vegetable intake is worldwide related to non-communicable diseases *e.g.* cardiovascular diseases, diabetes and some forms of cancer.

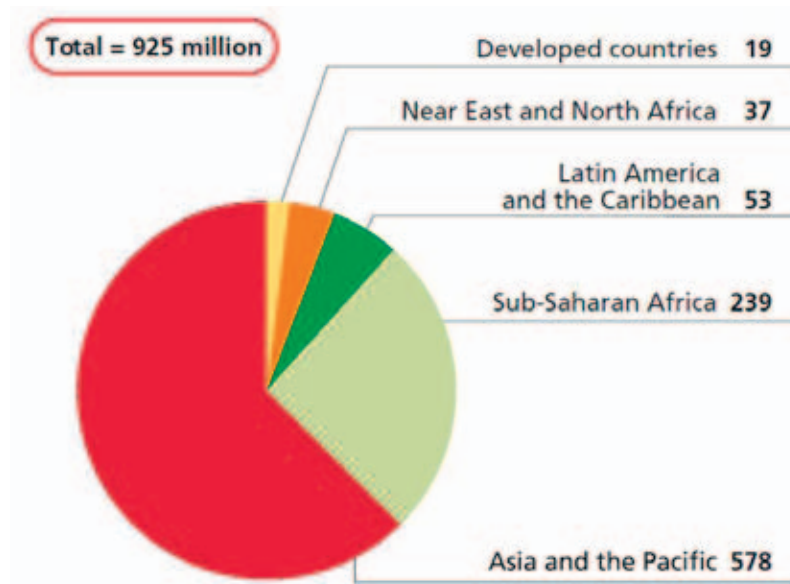


Figure 2. Undernourishment in 2010, by region (millions) (retrieved at http://www.fao.org/hunger/hunger_graphics/en/ on August, 17th 2011).

3.2.1 Health and nutrition

To stay healthy, a balance diet is essential; it should provide enough energy, macronutrients (such as protein and fat) and micronutrients (such as vitamins and minerals). Undernourishment results from consuming too little food over a period of time and is defined as a state of nutrient and energy deficiency whereby an individual is unable to maintain good health (in the sense of being free from avoidable morbidity, risk of premature mortality, etc.) or a desirable level of physical activity. Common dietary problems in low income populations are low energy intake, low protein intake and deficiencies of iron, Vitamin A, iodine and zinc.

Energy and protein deficiencies lead to growth retardation in children and are the most obvious form of malnutrition. Malnutrition is related to decreases in physical growth, cognitive function and school performance, work capacity, and therefore economic development. For children energy deficiency is related to the prevalence of stunted growth (low height for age) and underweight. Micronutrient deficiency, also referred to as hidden hunger, are very common and also have severe impact on health, especially for children and pregnant women. Iron deficiency is probably the most common micronutrient deficiency and is related to impaired mental development, anaemia, reduced immunity, stunting, fetal growth retardation (low birth weight), reduced work performance, and mortality. Vitamin A deficiency can lead to night-blindness or other eye diseases, increased risk of mortality and morbidity from infectious diseases, anemia, and stunting. Iodine deficiency leads to goitre, impaired mental function, and retarded physical development in children. Zinc deficiency results in increased risk of mortality and morbidity from infectious diseases, reduced appetite, growth retardation, delayed sexual and bone maturation, skin lesions, diarrhoea, and the appearance of behavioural changes (WHO, 2004; Latham, 1997).

3.2.2 The importance of vegetables in the diet

Where there is a deficit in the average kilocalorie intake, many people's diets are deficient in more nutrients. When the deficit in energy is moderate, people get enough of staple foods but often lack other foods such as legumes, meat, fish, oils, dairy products, vegetables and fruit that provide essential elements like protein, fat, and micronutrients (Kamau *et al.* 2010c). Vegetables are an important part of the diet, although they provide only a small percentage of the energy intake (4.1%, see Figure 3.), they are an important contribution to micro-nutrient intake. Vegetables provide vitamins, including vitamins A, C and folate, and minerals including, iron and magnesium; proteins and phytochemicals (see Figure 4.). They are also good sources of fibre.

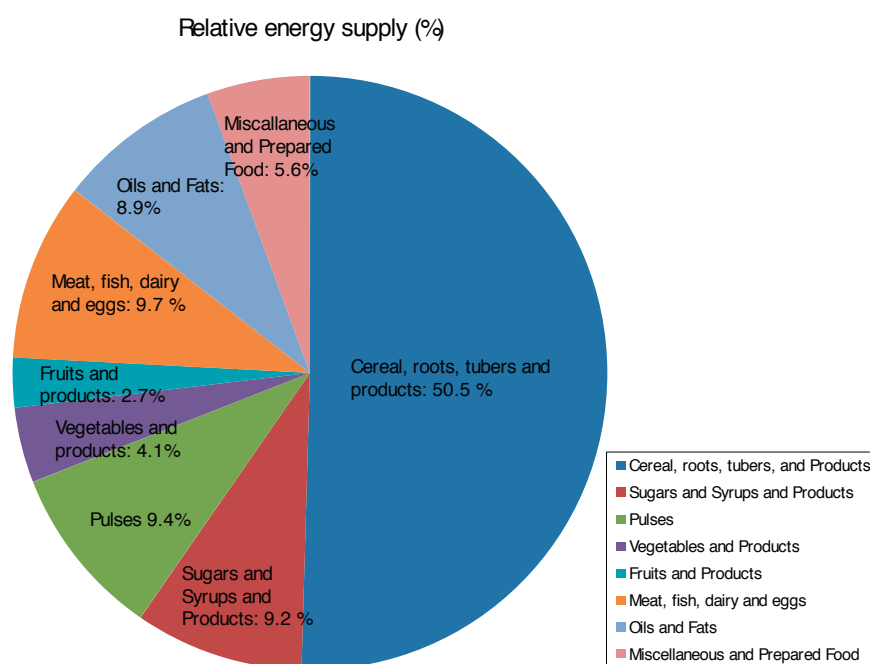


Figure 3. Food supply quantity by food commodity group in Kenya in 2005/06, data from www.countrystat.org.

Table 2. Nutrients in 100 g edible portion of food.

Food	Energy (kcal)	Protein (g)	Fat (g)	Calcium (mg)	Iron (mg)	Vitamin A (µg)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Folate (µg)	Vitamin C (mg)
Carrot	43	1.0	0.2	27	0.5	2813	0.10	0.06	0.9	14	9
Eggplant	26	1.1	0.1	36	0.6	7	0.09	0.02	0.6	18	2
Dark green leaves (spinach)	22	2.9	0.4	99	2.7	672	0.08	0.19	0.7	194	28
Medium-green leaves (Chinese cabbage)	16	1.2	0.2	77	0.3	120	0.04	0.05	0.4	79	27
Light-green leaves (lettuce)	13	1.0	0.2	19	0.5	33	0.05	0.03	0.2	56	4
Onion	34	1.2	0.3	25	0.4	0	0.06	0.10	0.1	20	8
Green pepper	25	0.9	0.5	6	1.3	53	0.09	0.05	0.6	17	128
Red pepper	25	0.9	0.5	6	1.3	530	0.09	0.05	0.6	17	128
Pumpkin	26	1.0	0.1	21	0.8	160	0.05	0.11	0.6	8	9
Tomato, ripe	19	0.9	0.2	7	0.5	113	0.06	0.05	0.6	9	18
Sweet potato leaves	35	4.0	0.3	37	1.0	130	0.16	0.35	1.1	U	11
Amaranth	26	2.5	0.3	215	2.3	292	0.03	0.16	0.7	85	43
Beans, fresh	36	2.5	0.2	43	1.4	375	0.08	0.12	0.5	U	27
Maize, fresh	165	5.0	2.1	2	0.5	28	0.20	0.06	1.7	46	7

Food	Energy (kcal)	Protein (g)	Fat (g)	Calcium (mg)	Iron (mg)	Vitamin A (µg)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Folate (µg)	Vitamin C (mg)
Pulses											
Kidney beans, dry	333	23.6	0.8	143	8.2	0	0.5	0.22	2.1	180	5
Mung beans, dry	347	23.9	1.1	132	6.7	11	0.6	0.23	2.3	120	5
Lentils, dry	338	28.1	1.0	51	9.0	4	0.5	0.25	2.6	U	6
Pigeon peas, dry	343	21.7	1.5	130	5.2	3	0.6	0.19	3.0	100	0
Groundnuts, dry	567	25.8	49.2	92	4.6	0	0.6	0.14		110	0
Soybeans, dry	416	36.5	20.0	277	15.7	2	0.9	0.25	1.6	210	0
Sunflower seeds	605	22.5	49.0	98	6.3	0	1.9	0.14	4.1	U	0
Coconut flesh	376	3.9	36.5	20	2.3	0	0.6	0.80	0.4	U	0

Source: Human nutrition in the developing world, annex 3 http://www.fao.org/DOCREP/W0073e/w0073e08.htm#P14552_1185427.

3.2.3 Vegetable consumption in Sub-Saharan Africa, Kenya and Nairobi

Per capita consumption of fruits and vegetables in sub-Saharan Africa declined between 1986 and 1995 and lags behind that of the other regions. Overall, in developing countries vegetable consumption has increased by 0.92% (to an average of 75.3 kg in 1995), Sub-Saharan Africa showed a 0.19% decline and remained as low as 29 kg of vegetables per capita consumption on average (Ayieko *et al.* 2008). In another report, the consumption of fruit and vegetables in 10 sub-Saharan African countries ranged from 27 kg to 114 kg per person per year, far below the WHO/FAO minimum recommended levels of 146 kg per capita per year (400 g per day, fruit and vegetables combined) (Ruel *et al.* 2005). It is therefore, no wonder that micronutrient deficiency (mainly vitamins and minerals particularly iron, selenium, folate, copper, zinc, iodine and vitamin A) is a serious problem in sub-Sahara Africa (Ayieko *et al.* 2003). Kenya consumers take less fruits and vegetables as compared to FAO/WHO recommendations. Notably, the poorest people are also the lowest consumers of fresh fruits and vegetables.

According to the Kenya Integrated Household Survey of 2005/6, Kenyan households in urban areas spend 21 to 27% of their budget on food, depending on their income level. Data from the Tegemeo's urban surveys (2003 & 2009) showed that on average 21% of the household food budget is spent on fruits and vegetables (Kamau *et al.* 2010). Like in most African communities, people rely on one or two staple crops. Most common in Africa are maize, teff, cassava, yam, sweet potato, plantain and enset. In Kenya, maize meal cooked in boiling water (ugali) is the leading staple food crop, other common staples are rice, maize and wheat flour (chapatis). This provides the bulk of energy intake, and is accompanied by a relish or soup (consisting of beans or groundnuts, vegetables, fats or oils, condiments and spices) and fruits (Oniang'o *et al.* 2003; Kimiywe *et al.* 2007). Eggplant, gourd, green pepper, okra, squash, pumpkin, tomato, chili, amaranth, spinach, leaves from baobab, cassava leaves, cowpea leaves, sweet potato and pumpkin leaves are among the vegetables commonly eaten (Oniang'o *et al.* 2003). In terms of quantities purchased Irish potato, cooking banana and sukuma wiki are the most important vegetables purchased by Nairobi consumers. Mean Irish potato purchases per household purchasing are 23 kg, while cooking banana (plantain) purchases average 13 kg. Among the leafy vegetables, sukuma wiki³ is the leading item purchased by Nairobi consumers, with an average monthly household purchase of 13 kg followed by cabbages.

3 Sukuma wiki is the local name for a green, leafy vegetable of the spinach variety (*Spinacea oleracea*) and also called kales, literally meaning "to push the week". This refers to the importance of the crop for the subsistence dwellers in their daily diet, due to its high yield and low price. People without much earnings can survive on it especially during the week prior to the end of the month ("push the week") when salaries are earned. It is a fast growing crop, especially in the red soil areas in the city, and has a high nutritional value: the high calcium and phosphorus contents are almost comparable with that of whole milk (Sehmi, 1993 in Foeken and Mwangi, 1998). For these reasons, and because it is relatively cheap, sukuma wiki is a typical ingredient in the diet of the poor households, favoured as the usual supplement with the basic ugali dish (stiff maize porridge).

The average tomato and onions purchases are 10 kg and 5 kg respectively. Households spend twice as much on tomato purchases as they spend on onions and sukuma wiki, and about three times as much as they spend on cabbages. Thus among vegetables, tomatoes and Irish potatoes are important in terms of both the percentage of household purchasing and the mean household expenditure, followed by onions and sukuma wiki (Wiersinga and De Jager, 2007). A consumer survey in Nairobi (n = 542) gives an overview of commonly purchased vegetables (see Figure 4.).

Table 3. Food consumption by region in energetic value, proteins quantity, fat quantity and carbohydrates quantity in 2005/06 (based on KIHBS Survey).

	Food consumption (Kcal/capita/day)	Protein consumption (g/1000 kcal)	Fats consumption (g/1000kcal)	Carbohydrates consumption (g/1000 kcal)
Central	2,110	32	28	155
Coast	1,960	30	24	168
Eastern	2,240	28	23	171
Nairobi	2,530	31	20	179
North Eastern	1,460	24	26	171
Nyanza	1,490	29	28	161
Rift Valley	1,600	30	25	166
Western	1,440	28	23	174

Source: www.countrystat.org.

Not just the quantities of vegetable intake are deficient, one of the other main nutritional problems in Kenya is the lack of variety in diet (Figueroa *et al.* 2009). Although a range of vegetables is consumed in Kenya, for Nairobi consumers Irish potato, cooking banana and sukuma wiki are most important in terms of quantities purchased. Some vegetables are thus eaten more often than others, the choice of vegetables depends on demographic and ethnic characteristics of the consumers. In one study for example, in an urban population in Kenya most respondents reported that they consumed only white cabbage and a type of kale locally called sukuma wiki (Biodiversity international, 2006). For a healthy vegetable consumption variation in vegetables is needed, this includes eating dark green leafy vegetables, deep yellow vegetables, beans, tomatoes, and starchy vegetables (Oniang'o *et al.* 2003). In addition to nutritional approaches, such as supplementation and fortification (enriching food with nutrients) an agricultural approach of the problem of micronutrient deficiencies can be applied by including high quality food crops in the farming system (Hillocks, 2011). Hillocks (2011) listed four crop-based options to improve diet diversity:

1. Grow the full range of crops (i.e. cereals, roots, legumes, leafy vegetables and fruit trees).
2. Grow improved (bio fortified) varieties such as orange-fleshed sweet potato and quality-protein maize.
3. Cultivation of underutilized crops.
4. Grow locally available cultivated and wild plants that have a high nutritive value such as African leafy vegetables. More information on green leafy vegetables, orange-fleshed potatoes, and beans and legumes options is described below.

Table 4. Total Kenyan food supply and per capita for some vegetables by year.

	2001		2004		2005	
	Total quantity (tonnes)	Quantity per capita (kg/yr)	Total quantity (tonnes)	Quantity per capita (kg/yr)	Total quantity (tonnes)	Quantity per capita (kg/yr)
Beans	382,000	10	269,000	8	363,000	11
Sweet Potatoes	475,000	16	514,000	15	208,000	6
Onions	52,000	2	68,000	2	61,000	2
Tomatoes	236,000	8	335,000	9	302,000	9

Source: www.countrystat.org.

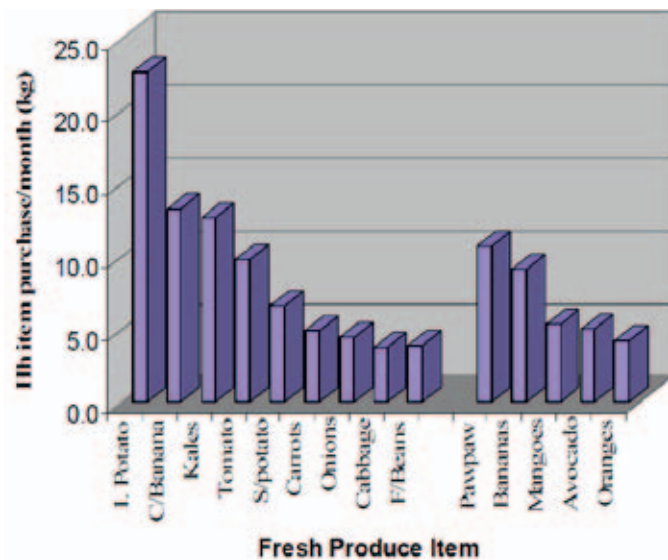


Figure 4. Estimated monthly purchase per household of selected fresh fruits and vegetables in Nairobi, for the households that did purchase the fruits and vegetables (October 2003). Source Ayieko *et al.* 2008. Note There are also households that did not purchase; the share of households that did purchase varied from 16% for French beans to 96% for tomatoes. This Figure therefore provides insight in the relative importance of vegetables, and can not be used to determine the consumption of the Nairobi population.

Green leafy vegetables

Diversity in crops (agrobiodiversity) reduces risk of seasonality and disturbance in growth but also has nutritional benefit and is therefore a powerful contributor to nutrition and food security. However an increase of agrobiodiversity does not necessarily lead to dietary diversity among others due to factors such as dietary habits and taboos (Figueroa *et al.* 2009). Therefore it is essential to increase diversity by using locally accepted and preferred vegetables. Traditional vegetables are indigenous African crops that have been grown for ages mainly for food by the various communities in Africa. Indigenous vegetables contribute to the conservation of biodiversity, income, nutrition and health and are generally cheap. They are more adapted to local environment than exotic ones and therefore more resistant to climate and plant disease related stresses so that they are helpful in improving food security, nutrition and health (Okeno *et al.* 2003).

Some traditional leafy vegetables are widely, not to say daily consumed, and have an important quantitative and qualitative contribution to the diet since they are very nutritious and a cheap source of vitamins and minerals. A number of indigenous vegetables were already reported to be consumed during lunch and dinner, although by a small number of consumers, which are cowpea leaves (4.1%), Jute (2.8%), pumpkin leaves (2%), Amaranthus (5.4%), Bacella alba (2%), spider plant, black night shade (2%), Crotolaria (3.9%) (Kimiye, 2007). They are a significant contribution to intake of micronutrients, particularly vitamin C, iron, and zinc (Onyango *et al.* 2008). Traditional (dark green) leafy vegetables are rich in Beta-carotene (Vitamin A) and Vitamin C (ascorbic acid) and calcium. The vegetable amaranth that is most commonly eaten in Nairobi, has high levels of protein, vitamin C and the minerals iron and zinc that could help in overcoming micronutrient malnutrition at a negligible cost. They also have a high fibre content and hence can serve as a natural source of fibre in the diet. The levels of nitrates, oxalates and lead in the vegetables are not high enough to cause public health concern. In rural Kenya cowpea leaves are the pronominally eaten African Leafy Vegetables and contribute to household Vitamin A intake. The total contribution of vegetables to household vitamin A intake was 43,1% in a study with 814 rural households (Oiyee *et al.* 2009).

The most commonly consumed traditional leafy vegetables in Kenya include pig weed, cowpea leaves, black nightshade, cat's whiskers, pumpkin leaves, and jute. The most popular type of amaranth among consumers in Nairobi is *Amaranthus hybridus*. These vegetables used to be sold mainly in the informal open air markets in most of the urban centers and were therefore presumed to be consumed mainly by the lower socio-economic groups. Recently, however, the vegetables have appeared for sale in increasing quantities in the supermarkets, where the middle and higher socio-economic classes do

their shopping. In supermarkets and green grocers they are sold in bundles of average weight 450 gram with an edible fraction per bundle of 38.9% (Onyango *et al.* 2008). The AVRDC-Regional Center for Africa (RCA) focuses on the promotion of indigenous vegetable crops (such as Amaranth spp., African eggplant, nightshade, Ethiopian kale, jute mallow, spider plant, vegetable cowpea, okra, pumpkin, onion, moringa), high beta carotene vegetables (such as cherry tomatoes) as well as protein-rich crops (vegetable soybean and mung bean) (Chandha and Olouch, 2007).

High beta carotene vegetables, orange-fleshed potatoes

As mentioned earlier, vitamin A deficiencies are widespread. Crops that contribute to both calories and vitamin A would make an important contribution to the diet. Two such crops are palm oil (which is not commonly produced and imported from Malaysia) and sweet potato (Hagenimana *et al.* 1999). Sweet potato is an important crop since it has relatively high productivity, short cropping season and flexible planting and harvesting schedules (Hagenimana and Low, 2000). Currently sweet potato varieties are grown that have white or cream flesh and have a far lower contribution to Vitamin A than the orange-fleshed varieties. Orange-fleshed sweet potatoes can make a considerable contribution to Vitamin A intake and health especially for children and pregnant and lactating women (Low *et al.* 2001). Therefore, the orange-fleshed sweet potatoes are nowadays promoted for example in Kenya, in collaboration with national agricultural research and extension systems, universities and NGOs. Increasing the intake can be taken one step further by not only replacing the sweet potatoes by orange-fleshed varieties but also replacing ingredients (*e.g.* sweet potato flour instead of wheat flour) in commonly eaten products (such as mandazi and chapatis) (Hagenimana and Low, 2000).

Protein-rich crops

In terms of bioavailability of nutrients, meat has higher potential to improve nutritional status. It is however expensive and beyond the scope of this study. Legumes and beans also have a high nutritional quality; they are excellent sources of protein, dietary fibre and a number of micronutrients including iron, zinc, calcium, and (for soybeans) isoflavones (although overall protein value is reduced somewhat by their lower digestibility and iron bioavailability from legumes is poor). Consumption of beans and legumes is especially important for people who eat little or no meat (Messina, 1999). From a nutritional point of view, soybeans have a high potential, however, they are not common in Kenya. Legumes and beans as a group have high nutritional potential. To define the most favourable crops, several issues should be considered: local habits and preferences, nutritional value also in relation to other products and the total diet (protein complementary), seasonality and barriers for cultivation.

3.3 Nutritional status in Kenya

3.3.1 Kenya

In 2010 it was estimated that 10% of Kenyan population is food insecure and 30% (3 million people) of the food insecure are located in the urban and peri-urban centres making urban food insecurity and poverty a major concern to policy makers and development agencies (Kamau *et al.* 2010c). For children, malnutrition can be defined by stunting (low height for age) and wasting (low weight for height). The first indicates chronic and the second acute malnutrition. According to the 2003 Kenya Demographic Health Survey, 30% of children are stunted, almost six % of Kenyan children are wasted. Overall, one in five children is underweight. Stunting, wasting, and underweight are most common in rural areas and among families of lower socio-economic status. In Nairobi 6% of children under five were underweight, 19% was stunted, and 5% wasted according to 2003 data. The following problems are reported about the nutritional status of Kenyans: 54% of the population suffers from various levels of iron deficiency anaemia, while almost 70% of pregnant women in Kenya are anaemic. Next to iron, vitamin A, iodine and zinc deficiencies were considered relevant (Kenya Medical Research Institute (KEMRI), 2004). In addition to problems of (micronutrient) undernourishment, people with low incomes have been known to consume unbalanced diets, which are low in fruit, vegetables and fibre and are high in fat. These unhealthy eating habits can have important long term consequences, such as obesity and related health issues (*e.g.* diabetes). The co-occurrence of undernourishment and over-nutrition within communities and even within households, both with serious health consequences, has been named the double burden of malnutrition (Latham, 2006).

Vulnerable groups for nutrient deficiencies are defined by socio-economic status (low income and educational level), age and gender (pregnant and lactating women, children, elderly) and health status (e.g. people who are HIV infected; see Were *et al.* 2008). For the purpose of this study urban and rural differences are also considered.

3.3.2 Nairobi

A cross-sectional survey on 823 households in Nairobi showed that 44% of Nairobi residents were undernourished with up to 20% being ultra-hungry (i.e. daily per capita dietary energy intake is less than 1,600 kcal). Not surprisingly, the majority of the undernourished were in the low income groups (Kamau *et al.* 2010c). Urbanization, together with population growth and higher incomes, contributes to tremendous increases in food demand in the cities. So, in urban areas high numbers of residents are (at risk of) malnutrition. Nevertheless, on average, urban dwellers generally have a better nutritional status than their rural counterparts because of better health coverage and greater diversity in the diet. In Kenya, on average food supply is higher in urban compared to rural areas (see Table 5.). FAO data show that the incidence of child malnutrition, especially chronic malnutrition, is lower in urban areas (Latham, 1997). In the urban diet, fish, fresh vegetables, meat, poultry, milk and dairy products are consumed more often, the diet is higher in variety and shows less seasonal fluctuations (Latham, 1997). However, malnutrition is not only a problem of undernourishment. Especially in urban areas, food habits consist of high consumption of processed foods and snacks that may be prepared and marketed under unhygienic conditions leading to food contamination. Due to the consumption of snacks and fast foods and low quality cheap foods that are high in energy and have a high content of fat and sugar, overweight is also a problem. This double problem is attributed to dietary simplification, the nutrition transition, and inadequate access to quality foods (Biodiversity International, 2006).

Table 5. Food supply in terms of energetic value, proteins and carbohydrates at national, rural and urban level in 2005/06.

	Food supply (Kcal/capita/day)	Protein supply quantity (g/capita/day)	Carbohydrates consumption quantity (g/1000kcal)
National	1,800	30	170
Rural	1,690	29	173
Urban	2,060	30	163
Recommended	2,200		

Source: www.countrystat.org

3.4 Barriers and motives for vegetables consumption and a healthy diet

3.4.1 General

In order to improve the eating patterns of people at risk of (food) poverty it is essential to identify the barriers and motives for healthy food choice. Similarly, the effectiveness of supportive tools should be studied, as these are the ways government and producers can influence food choice. An integrated approach is most successful, since barriers and motives for healthy eating can be on the level of consumers, food product, and environment.

Consumer characteristics

Consumer barriers can be related to demographics, consumer behaviours, and socio-psychological factors, such as attitude, knowledge and social norm. Firstly, poverty and socio-economic status are strongly related to food intake and health. One obvious barrier in food choice is the available money: poor households spend a larger proportion of their income on food and even then are not always able to purchase what they need. Also, since energy density of food is inversely related to costs, energy dense but nutrient poor foods are more often bought when money is short whereas for example fresh fruit and vegetable intake increases with decreasing percentage of income spend on food.

An important socio-psychological factor constitutes food orientations: the attitude towards the position of food in their everyday life such as price orientations (willingness to pay), health orientations (interest), convenience orientations, etc. The norms and values individuals attribute to healthy food and to food in general (for instance focus on taste, health, etc.) has been associated with peoples' age, gender, income level, cultural and demographic background. For example, low income has been related to little knowledge of healthy food and a low motivation to eat healthy food. Finally, habits related to food choice have to be taken into consideration as food consumption is also habitual behaviour (van 't Riet *et al.* 2010).

Food characteristics and environment

Supporting tools that can influence food choice include product characteristics, environment characteristics as well as social and governmental influences. Product characteristics should therefore not just be described in terms of nutritional value but also the more exclusive product qualities such as price, accessibility, availability, information, convenience (easy to buy, easy to prepare, easy to eat, easy to store), sensorial aspects (such as taste, smell, and texture), nutritional quality, shelf life, and safety (pesticide, availability of safe food for acceptable price). As mentioned above, price constitutes one important barrier to healthy food consumption for people with low incomes. Especially for people who live in deprived neighbourhoods, obtaining affordable healthy food can be a problem since fresh vegetables are less available. In addition, social influences on healthy food consumption can be identified. For individuals with low income, internalized social norms and low social support, are inclined to make unhealthy food choices. Finally, government and industry have an influence on food environment. For governments this includes interventions such as laws and regulations, and education. Whereas for producers this includes product development and marketing.

Summarized, vegetable consumption in developing countries face the following constraints:

Type of constraints	Specific constraints
Demographics	<ul style="list-style-type: none"> • Income • Ethnicity • Education
Socio-psychological	<ul style="list-style-type: none"> • Attitude <ul style="list-style-type: none"> o motivations in food choice o orientations • Knowledge • (Cultural) habits
Food characteristics	<ul style="list-style-type: none"> • Accessibility and availability, including seasonality • Information • Convenience • Sensory aspects • Quality, safety and shelf-life • Price
Government and Industry	<ul style="list-style-type: none"> • Education and information • Intervention and promotion • Law and regulations

3.4.2 Kenya

In the previous paragraph general constraints and motives for healthy food consumption were listed. These aspects will be described more specifically for the case of vegetable consumption in Kenya. Firstly socio-demographic differences are described, next social-psychological constraints (culture, habit and attitudes) and finally more practical constrains related to availability and accessibility.

Socio-demographics

As mentioned earlier, income is an important factor in food choice, also for vegetable consumption in sub-Sahara Africa (Ruel *et al.* 2005). Oniang'o *et al.* (2003) also found a relationship between income levels and vegetable intake; they

concluded that vegetables are basically considered a poor mans' diet and as such are more widely consumed among the poor sections of the population. Another study however, found a positive relation between income and vegetable intake. Respondents in Nairobi spent on average 15.3% of their income on fresh vegetables and although there was not a clear pattern of vegetables purchases per income group, the results showed that as income increases, consumers tend to move closer towards WHO/ FAO targets. The respondents were divided into quintiles based in income (per adult equivalent, thus corrected for household size and composition) in the lowest quintile (lowest 20% incomes) the vegetable consumption was relatively high and in the higher quintile (higher 20% incomes) relatively low but from the 2nd to 4th quintile an increasing number of respondents consumed at least the recommended level of vegetables (see Table 6.). In addition to income, also education of the head of household and whether or not the household is female-headed were related to the consumption of fresh produce (Wiersinga and De Jager, 2007).

Table 6. Overall share of vegetables in total household expenditure on “basic Foods” and percentage consumers below the WHO/FAO vegetable consumption levels, by Income/ AE quintile.

Per adults equivalent income quintile	Per adult equivalent income (Ksh)	% share of vegetables in total household expenditure	% of consumers below WHO/FAO recommended level of consumption
1	749	17.1	53
2	1,890	15.8	56
3	3,314	17.3	41
4	5,599	15.2	35
5	23,654	11.0	44
Total	7,039	15.3	46

Numbers adapted from: (Ayieko *et al.* 2003).

Specifically for indigenous vegetables, the following factors were related to consumption: occupation, sex, income and education levels. Consumption was higher for casual labourers and/or non-employed respondents (79%) than those in full time employment and business (21%). Women did consume more vegetables compared to men. The survey also showed no direct relationship between households incomes except for cowpeas leaves with significantly ($P<0.05$) more households with total household income of less than Ksh. 3000⁴ consuming these vegetables. There were neither relationships between education and consumption of indigenous vegetables except for Spider plant and pumpkin leaves with significantly more respondents with informal education and secondary education consuming these foods ($P<0.05$), respectively (Kimiye *et al.* 2007). Similarly, Oniangó *et al.* (2003) found that higher education was unrelated to vegetable consumption. More specifically the lack of knowledge of the correct choice of foods for a healthy diet or on processing on the other hand was associated with the choice for indigenous vegetables (Onyango, *et al.* 2008). Finally, populations living in the rural areas eat more vegetables than their urban counterparts due to accessibility and variety (Oniang'o *et al.* 2003). Also, ethnicity was related to choice and consumption of vegetables. There was a significant difference ($p<0.05$) in type and consumption of traditional vegetables between households with members originating from different tribes and those households with members originating from the same tribe.

Culture, habit and attitude

Socio-cultural beliefs, customs and attitudes towards food have a significant influence on consumption and therefore the dietary status of families. They sometimes concern only specific family members or during a particular period of their lives (e.g. pregnancy). Customs and beliefs can also relate to certain foods that are considered an essential part of the meal or, on contrary, unacceptable for consumption. It may also influence systems of food sharing and distribution within the family, for example the manner of serving the meal and the distribution markedly affects the dietary intake of different family members (Oniang'o *et al.* 2003).

4 1 Euro = approximately 110 Kenyan shilling (December 2011)

Not much is known about the attitude of Kenyans towards vegetables in general and vegetables as part of a healthy diet. The WHO indicates consumer preferences and intra-household decision-making as one of the factors related to vegetable consumption in sub-Saharan Africa (Ruel *et al.* 2005). Attitude also plays a role and in general, vegetable consumption is not highly regarded (Oniang'o *et al.* 2003). A number of studies addressed attitudes towards traditional vegetables. Traditional foods were associated with the poor and backwardness. Some indigenous vegetables have an image problem as it is sometimes cultivated on dump sites, busy roadsides, or the banks of drains carrying sewage and irrigated with water from these drains (Onyango *et al.* 2008; Biodiversity International 2006). Additionally, most of these vegetables sold in open markets or along unclean streets were sold under poor environmental conditions and due to poor handling their qualities were perceived to be poor, and discouraged many potential buyers from consuming these products (Kimiye *et al.* 2007).

Availability and accessibility

Prices and availability have been reported as barriers for vegetable consumption in sub-Saharan Africa (Ruel *et al.* 2005). An additional problem for vegetables is that, once harvested the vegetable has a very short shelf-life (Onyango, *et al.* 2008). Ayieko and colleagues found that in Nairobi traditional marketing channels (i.e. open air-market and kiosk) were preferred by urban consumers for the purchase of fresh fruits and vegetables. They argue that this is because these outlets allow small, regular purchases in places easily reached which is important since less than 20% of consumers in Nairobi own a car or a refrigerator. In addition, some additional services are available at these places, including credit and purchase delivery (Ayieko *et al.* 2003). Also, for many residents, limited available money is a barrier to purchase large quantities. An additional barrier is the time one has for buying, preparing and cooking vegetables; many residents in Nairobi face time constraints for food preparation and therefore for example buy street-foods (van't Riet *et al.*, 2001).

There is ample research on availability and accessibility of traditional leafy vegetables in Nairobi. Kimiywe *et al.* (2007) reported that traditional foods were readily available in urban and peri-urban Nairobi. The availability of traditional foods varied from estate to estate with the highest accessibility in an Eastlands registering. These foods were mainly sold in kiosks, open markets and supermarkets. Another study stated that the production of traditional foods was generally low but still supply was outstripped by the demand, even before promotion (Biodiversity International 2006). The following barriers were mentioned for the consumption of indigenous leafy vegetables: 21.1% of the respondents reported that they lacked time to shop and prepare the indigenous leafy vegetables, 7.5% of them reported that the foods were expensive, 1.1% indicated lacking knowledge on how to prepare them while 41.3% of the respondents did not report access or preparation constraints (Kimiye *et al.* 2007). An additional barrier is the fact that some vegetables being grown on the banks of drains since there is lack of land for agriculture in or close to the urban areas. This results not only, as mentioned earlier, in some consumers having a negative attitude to vegetables, but raises the real risk of contamination by heavy metals and pathogens. Trade in fresh cut amaranth vegetable is, additionally, limited by its short shelf life and would benefit from the development of simple and affordable post-harvest handling practices that extend shelf life (Onyango *et al.* 2008).

Finally, availability and intake of vegetables is influenced by seasonality. Research in especially rural areas, indicates that there are huge differences in general food intake depending on the season. For example, inter-seasonal weight changes are as large as 7% of their bodyweight for men and 3% of their body weight for women were found for elderly in the rural areas in the Kenyan Nakuru district. Energy intake was 22% lower in the lean period compared to the postharvest period (Kigutha *et al.* 1998). More specifically, the consumption and utilization of indigenous leafy vegetables has also been found to be highest when the vegetables were in season and prices were lower (Kimiye *et al.* 2007).

Summarized, for vegetable consumption in Kenya the following constraints have been reported:

Type of constraints	Specific constraints
Socio-demographic	<ul style="list-style-type: none"> • income and occupation • female or male headed households • education level • knowledge of the correct choice of foods for a healthy diet or on processing • ethnicity • rural versus urban
Culture, beliefs, norms, customs, habits and attitude relate to:	<ul style="list-style-type: none"> • foods that are essential to the meal • foods that are unacceptable for consumption • specific to individuals (e.g. children) or periods in time (e.g. pregnancy) • sharing and distribution within the family • preparation methods • child feeding practices • vegetables as poor man diet • dirty image due to cultivation and handling during selling
Availability and accessibility	<ul style="list-style-type: none"> • small, regular purchases possible only at open air-market and kiosks • short shelf-life • seasonality
Other	<ul style="list-style-type: none"> • limited time for buying, preparing and cooking • food safety due to growing places and poor handling

3.5 Options for improvement of vegetables consumption and a healthy diet in the Nairobi metropolis

The government is committed to meeting the Millennium Development Goals which includes halving the population that is in poverty and hunger by 2015. Kenya's Vision 2030 (Republic of Kenya, 2007) provides the policy framework for development and poverty reduction in Kenya. In the previous paragraph, barriers and motives for vegetable consumption in Kenya were described. This part will address more specifically the case of Nairobi: some metropolitan issues, barriers and opportunities that are specific for the urban areas are described and most importantly, possible opportunities in the vegetable chain to enhance intake. Existing initiatives and additional ideas will be discussed. In addition, although it is not easy to change behaviour, once dietary habits are changed, the diet is improved without the need to be repeated (such as for supplementation) or regulated and governed (such as for fortification, that is fortifying common foods with a micronutrient).

Urban farming and home gardening (kit)

Urban farming can be an important additional source of food, especially for vegetables (Foeken *et al.* 2006). Important advantages of home gardening are: it is nearby thus accessible, spare land, recycled water, and organic wastes from the home are used, usually crops are pesticide free, safe and nutritious (Midmore and Venkataraman, 1991, in Chandha and Olouch, 2007). Vegetable production is labour-intensive, therefore farming families with limited space, such as in cities, can make much more income from growing vegetables than staples such as rice or maize (AVRDC). For reasons for both nutrition and risk reduction, it is most preferable to use a mix of crops. For example, in a pilot study in Kenya (among other countries), healthy diet gardening kits with 14 different crops were used which resulted in 170 to 250 kg of vegetables production in 6x6 m plot over a year (Chandha and Olouch, 2007). Such initiatives can also take place on community land or for example in a school garden.

Indigenous vegetables

Traditional foods have been relatively low commercialized and have mainly been utilized for household food supplies, either as supplement, or for emergency. Historically, those crops have been collected from the wild mainly by rural households, but currently some selected ones have been cultivated in rural areas for subsistence and commercial purposes. A number of activities are already going on in Nairobi to promote the use of indigenous vegetables. Since 2003, Farm Concern International (FCI) has implemented various projects aimed at commercialization of traditional foods including African Indigenous Vegetable, Sweet Potatoes, Legumes and Pulses in various areas in Kenya, Uganda and Tanzania. Over the past decade some selected traditional vegetables have been commercialized in East Africa and have been marketed in formal and open air markets. Many species mainly roots, cereals and leafy vegetables are contributing to household income as a result of increasing demand of food in the society. Such projects are needed especially in urban areas. Since youth are migrating to the cities, there is a risk of losing traditional knowledge, changing dietary habits and the increasing indifference to traditions. This may reduce the ability to both cultivate and prepare traditional crops. As mentioned earlier, cultivation of traditional leafy vegetables is easy and flexible, in addition, it is very suitable for small acres of land such as in cities and therefore proven to be a very important commercial crop for women in Africa (FCI, 2011).

Promotion and education, the role of the government

Dietary customs are culture-related and changes in diet such as the promotion of vegetables become difficult if people are unaware of their importance or if practical daily constraints related to the consumption of vegetables are not addressed. A popular approach to improve nutrient intake are the so called "food based strategies" or an integrated approach in which nutrition, education, policies and possibly food fortification are combined. In addition to the focus on matters of nutrition and health, there is also a need for attention to the farmers supplying the cities and market access for vegetables and to researchers and policy makers to ensure a wider impact of promoting activities (Biodiversity International, 2006). The government, health organizations (NGOs), and researchers from the private and public sectors have a crucial role in doing research, providing information and education, communication, and improved food and nutrition policies about the importance of vegetable consumption and diet variety. This will be explained further by the case of the earlier mentioned orange fleshed sweet potatoes and traditional vegetables.

Most countries have supportive but weak, non-specific policies on - for example - the use of traditional foods. Biodiversity international (2006) postulates that there is not enough specific guidance and information on traditional vegetables and how they can contribute to food security by policies and policy implementations. Furthermore, strategies on traditional vegetables for nutrition and health will necessarily involve agriculture, health, and environment sectors, and these cross-cutting platforms and initiatives are yet to be built (Biodiversity International, 2006). FCI in conjunction with AVRDC conducted promotional forums, campaigns, exhibitions of various vegetables and cooking demonstrations of various ALV⁵ recipes, distributed recipe booklets and leaflets to both consumers and producers, and held several consumer and producer awareness clinics. Radio talks on local stations through interactive forums, where the audience calls or sends short messages (SMS) and answers, provided on air were done to create more awareness on nutritive aspects, methods of preparation and preservation (Muhanji *et al.* 2011).

For orange fleshed sweet potatoes, like the promotion of other vegetables, should preferably include nutrition education, training and processing methods, reconciliation of cultural beliefs or patterns by participatory methods, and micro-scale enterprise development (Kurz *et al.* 1998). In this case, practical constraints that should be addressed are financial constraints, time constraints, and cultural constraints such as beliefs, preferences, and pressure for influential relatives (i.e. social pressure) (Hagenimana and Low, 2000). Also attention has to be paid to who the "rights" of the crop belongs. For example, orange fleshed sweet potatoes is considered a women's crop. It means that women are responsible for the production and harvesting OFSP. She determines what part will be used as food for the household and which part will be sold. In the light of the fact that women are usually responsible for ensuring a sufficient food supply for their families, they tend to keep sufficient food for their families and only sell some of their crop to obtain cash. These sales tend to be small and the money earned remains under the control of the female farmers (Hagenimana *et al.* 1999).

5 ALV = African leafy vegetables.

One project aimed to scale up the impact of promoting the consumption of traditional leafy vegetables and Orange-Fleshed Sweet Potatoes by working with larger groups of trained farmers in a “Commercial Village” approach, improve seed systems, develop stronger linkages between smallholders and markets, and evaluate the effectiveness of the scaling up. Sales in Nairobi and peri-urban markets rose from less than 31 tons per month in 2003 to over 600 tons per month after the project in 2006 (AVRDC website, 2011).

Ready-to-eat and fast-foods

A typical effect of urbanization is an increase in the amount of food eaten outside the home (Latham, 1997). In Nairobi, street foods play an important role in the diet of poor households and those with little time to prepare food, because they are cheap and convenient (van 't Riet *et al.* 2001). In many developing countries an informal sector for the sale of food by street vendors and food stalls has developed to provide a cheap source of food and a significant source of income for the vendors, particularly for women (Latham, 1997). In Nairobi, most street food vendors sell cereal-based products. In a study by Mwangi *et al.* (2002) 71 out of 580 interviewed vendors sold cooked cabbage (mboga) and 32 sold sukama wiki. The authors concluded that especially considering urban poor settlements that are highly reliant on street foods, there is a need to improve street food in order to have an adequate nutrient supply. More research on the opportunities and barriers for street food vegetable dishes could provide opportunities for increased intake via this source of nutrient intake.

Marketing opportunities

Over the recent years, the attention for marketing in developing countries has increased. In particular, the attention for relatively poor consumers has increased, often labelled “base” or “bottom of the pyramid”, named after the income pyramid showing that approximately 60% of the world’s population lives on less than US\$2,000 a year (Pralhad & Hammond, 2002). With the traditional markets in Western Europe and Northern America growing more mature, multinational companies started to search for new growth opportunities, which were found among the relatively poor segments in emerging economies and developing countries. These segments are characterized by their size (a relatively large share of the population in these countries lives on less than one dollar a day), the fact that basic needs are relatively more important (notwithstanding that also a market exists for relatively more expensive consumer products such as mobile phones among these consumers), and the fact that they are relatively difficult to reach by traditional media and distribution channels (e.g., Dawar & Chattopadhyay, 2002; London & Hart, 2004; Prahalad & Hammond, 2002; Wright *et al.* 2005; Yunus *et al.* 2010).

The base of the pyramid is reached by multinational companies through the network of sellers and resellers that characterizes the informal sectors of emerging economies. Products are often low in price and size or quantity (e.g., Dawar & Chattopadhyay, 2002). Because people often have no stable incomes, products are typically sold for single occasions. Whereas mass media are less effective, word of mouth is a particularly important means to increase sales among groups that have oral cultures and relatively low levels of literacy (e.g., Dawar & Chattopadhyay, 2002). Low price levels are facilitated by the fact that not much knowledge has been developed yet on efficiency in reaching the base of the pyramid (e.g., Prahalad & Hammond, 2002). Life at the base of the pyramid is therefore often more expensive than in other segments. Most efficient production and marketing systems have always focussed on higher income groups and as a consequence cost-decreasing innovations have been developed for the benefits of the rich rather than of the poor. In order to reach the consumers, multinationals increasingly collaborate with other stakeholders like governmental and nongovernmental organizations (e.g., London & Hart, 2004). These organizations may have objectives that can easily be combined with those of companies (think of poverty reduction or increasing food security). For example, Danone established a yoghurt factory in Bangladesh to produce yoghurt that contains extra nutrients that children generally lack in their usual diets. The firm uses local farmers to supply milk to the factory and existing traders and small-scale retailers to distribute the products, facilitated by a microcredit of the Grameen Bank (Yunus *et al.* 2010). Another example is that marketing of traditional foods was found to be poorly developed and would have a better chance of penetrating the market if they have a better bargaining power, better capital and maintain a constant supply of a certain vegetable. What the farmers needed was training in value adding and basic business skills, plus the establishment or improvement of trading groups (Biodiversity international, 2006).

Although the purchasing power of consumers in this group is often relatively low on an individual level, the purchasing power of the group as a whole makes it an attractive segment for companies to invest in (e.g., Prahalad & Hammond, 2002). Because the group as a whole has been labelled “base of the pyramid” and because products targeting this segment still focus on relatively basic needs, consumers within this group are sometimes assumed to be homogeneous in their wants and needs (Wright *et al.* 2005). A recent study shows however that even for basic food products like staple foods, considerable differences exist between countries (Ghana and Benin) and between the rural poor and urban poor, depending on how these groups have been approached in the past by food security products (Opoku 2011).

In the absence of a large middle class, the only other group that can be distinguished in most emerging and developing countries is the upper class. This group is often characterized by a preference for expensive and exclusive brands of a foreign origin (Burgess and Steenkamp, 2006; Steenkamp and Burgess, 2006). They shop for their groceries in the modern supermarkets that are being established in these countries. Marketing strategies that aim to increase the consumption of vegetables should therefore be different for this group as compared to the group at the base of the pyramid. This group can be used, however, to introduce new brands that thus require some recognition and can subsequently be introduced (in different products) at other market segments in the country.

In summary, marketing strategies that aim to increase the consumption of vegetables should take the specific characteristics of this segment into account. Because marketing channels consist of numerous sellers and resellers, offering a constant quality of vegetables is relatively difficult without food processing. Food processing represents also an opportunity because units can be developed for single consumptions at low prices and branded in such a way that they facilitate word of mouth. Another opportunity pertains to collaboration between private and governmental or nongovernmental organizations. More simple ways of processing is the bundling of different types of vegetables in small portion bags that keep the vegetables fresh. This increases the accessibility and trade-ability of the vegetables and brings new types of vegetables under the attention of the consumer. Another approach is not to focus on the marketing of vegetables themselves, but rather on the marketing of complementary products such as small packages with herbs and other food components that describe a simple recipe that requires consumers to search for the vegetable themselves. For example: governments may stimulate urban gardening by facilitating seeds that can be planted in small plots of land in urban areas. The home-grown vegetables can be consumed by the family or sold in small market stalls at the road side to increase the family income.

Netherlands involvement

The Netherlands could on a commercial basis become involved in the production and distribution of home gardening kits. Ingredients could be: proper amounts of seed, fertilizers, simple manuals, sticks, ropes and other materials, etc. It would be most effective to combine this with a distribution system that is based on the fine network of retailers that are frequented by urban households.

Whether indigenous vegetables are of interest to a commercial company, remains to be seen. The market is very scattered in terms of crops and varieties. Breeding companies may not find it interesting to include indigenous vegetables in their portfolio. However, collaborative projects between public partners that deal with indigenous vegetables and commercial companies that deal with other vegetables may be worth exploring, for example in home gardening kits or diversification of the range of vegetables grown by smallholders.

Commercial opportunities can be found in the areas of ready-to-eat and fast foods, and various ways of food processing. As the target is to reach many people through numerous sellers and resellers, it requires among others organization, industrialization, stable quality, investments, and planning. As a low price is important, so are efficiency and economies of scales.

3.6 Conclusions

Vegetables are essential for a healthy diet and in Kenya average vegetable consumption is below health recommendations. Since food insecurity and micronutrient deficiencies are common, improving vegetable consumption has a potential in improving the health status of the Kenyans. On the whole, there appears to be a positive consumer's attitude towards fresh vegetables in Kenya, however, socio-demographic (including income) and cultural and habitual factors may for particular social groups negatively influence vegetable consumption. Also, due to lack of land, higher proportion of small families, and urban lifestyle some specific urban problems occur such as unhygienic production and processing, greater dependence on ready-to-eat foods, and lower knowledge of (a variety of) vegetables and their preparation. Awareness programmes can focus on a varied and balanced diet, preferably in combination with product development and marketing addressing the barriers of consumers. Specific interventions such as home growing kits, promotion of small-scale urban farming and promotion of indigenous vegetables as well as improving marketing can increase vegetable intake. A serious problem is the availability of fresh vegetables during the dry season. Either this is solved by increased production during the dry season (see Chapter 4), or through drying, canning or freezing (see Chapter 5) and making available such products. If the latter route is followed, consumer acceptance of processed food must be increased.

Commercial opportunities especially lie in the field of ready-to-eat and fast foods, and food processing (drying, freezing, canning) of fresh vegetables in combination with retail activities that make available processed food to the consumer. Supporting programmes will have to convince consumers, possibly combined with nutrition and health education in an integrated approach. Critical will be the costs of the product, as income is an important barrier. The product and the marketing should be tailored to the consumers and their daily constraints, for example by offering small portions or providing a hygiene and safety guarantee.

4 The production of vegetables

4.1 Summary

Vegetable production in Kenya mainly takes place in the enlarged circle around and/or triangle of Nairobi, Lake Naivasha and Mount Kenya. Only 20% of the total land area in Kenya is arable land, the rest (80%) is arid or semi-arid land. The total area used for vegetable production is estimated at around 100,000 ha. Vegetables are mainly grown for domestic consumption. In 2003 Kenya grew 4.35 million tons of horticultural products of which 6-7% was processed and only 4% was exported. A wide range of vegetables is produced throughout Kenya. Main products are cabbages, kales, tomatoes, garden peas and traditional vegetables. For export production French beans, snow and snap peas, and Asian vegetables dominate the list.

The growth and development of the Kenyan horticultural sector has been mainly private sector driven. The government's level of intervention has been minimal and has allowed Kenyan and foreign investors to take the initiative without public sector interference. The number of people working in the sector is somewhere between 2.5 to 4.5 million people. Most of them are smallholders who cultivate up to 80% of the horticultural produce (fruits and vegetables).

Besides rural vegetable production, vegetable production also takes place within the city of Nairobi. Here small-scale subsistence growers grow a variety of crops on their small plots. The large majority of them grow the basic staples as maize, beans and sukuma wiki. Chemical inputs are used only by a small minority of these farmers, because most cannot afford them. Irrigation is also quite rare. Also small-scale market-oriented crop growers are active within the city. They grow on very small plots seedlings, notably of vegetables, which are sold to farmers (including the rural areas).

The majority of the urban farmers are women and are migrants from neighbouring districts. For new migrants it is hard to get access to a piece of land to grow food. One major constraint is that almost all of the Nairobi farmers are completely left on their own and get no assistance or advice of any sort, as roadside, riverside and sewage-line farming are not recognised by the officers. Seed is retrieved by the growers from either the formal or the informal seed systems. Formal seed is more expensive, but is of better quality and therefore most used for export production. For domestic production informal seed (local varieties and vegetables) is most used.

Constraints and associated opportunities with highest priority are:

- Water availability in the dry season
- Quality seed and planting material
- More and/or better use of fertilizers
- Research and extension
- Formulation and implementation of policies
- Collectiveness
- Pest and disease management
- Control of hygiene and food safety

However, production increase requires an efficient and transparent value chain that absorbs the extra produce without resulting in falling prices for the producer (see Chapter 5). The Netherlands could on a commercial basis be involved in the development and supply of seeds and planting materials, certainly of the crops that are planted to a relatively large acreage, and for which a formal seed sector exists. However, good seeds and planting materials pays off only if other production factors are also well developed. For that reason, support to development and dissemination of knowledge is needed. Credit facilities are considered as a limitation for investments. The Dutch banking sector could become actively involved with the development of a profitable vegetable sector in Kenya. Water is an important issue, and good water management is essential to the Kenyan horticultural sector. Tailor-made interventions at the farm level, or at the level of farmer groups where they collaborate, by specialized companies can result in a more sustainable use of water resources.

The growth and development of the Kenyan horticultural sector has been mainly private sector driven. Unlike other agricultural sectors the Government's level of intervention has been minimal and has allowed Kenyan and foreign investors to take the initiative without public sector interference.

Estimates of the number of people working in the sector vary from 2.5 million (HCDA, 2005) up to 4.5 million people (EVD, 2009). Most of these are smallholders who cultivate up to 80% of the horticultural produce (fruits and vegetables).

Table 7. Main production regions for the domestic market of Nairobi. For all regions, the main crops are cabbage, carrot, potato, kale and onion.

Region
Kiambu (Limuru), Machakos, Nairobi (outskirts of Nairobi-Githunguri, Kitengela)
Baringo, Nakuru, Nyandarua
Embu, Kirinyaga, Meru, Murung'a, Nyeri

4.2.1 Crops and acreages

Table 8. Annual production quantity of most important primary crops in Kenya (million tonnes).

Crop	2006	2007	2008	2009	2010
Irish Potato	2,692,950	2,789,160	2,176,012	2,550,128	3,148,213
Beans*			610,428	960,705	689,376
Tomato	503,730	567,780	402,070	526,923	590,137
Cabbage	518,376	609,292	461,129	627,603	588,432
Kales	426,885	423,750	378,791	356,861	502,058
Cowpeas*			148,157	124,302	168,273
Pigeon Peas*			195,959	118,167	158,746
Green peas	40,375	59,045	45,472	75,404	151,522
Carrots	49,490	62,790	89,134	82,257	90,501
Spinach	48,919	47,684	76,219	50,539	76,571
French beans	61,540	67,330	92,095	46,496	55,841
Sweet Potatoes*			62,785	77,821	42,312
Nightshade				21,860	30,355
Peas, green*			9,814	11,025	23,439
Snow pea	12,582	14,766	11,563	14,267	21,050
p/fruit	6,165	10,020	12,283	18,973	20,769
Cabbages*			19,138	14,783	18,614
Egg plant	17,220	15,780	18,860	12,766	15,171
Bell pepper	10,270	9,900	12,013	13,357	17,160
Leaf amaranth				31,965	15,752
Butter nut	2,097	2,100	5,337	6,968	9,194
Onions*			7,892	6,934	.
Courgettes	1,970	1,030	4,986	6,398	7,034
Babycorn	960	1,648	1,774	5,662	6,457
Green beans*			4,616	3,336	3,810
Carrots*			3,485	3,165	4,844
Spinach*			3,910	2,595	4,047

Crop	2006	2007	2008	2009	2010
Okra	6,672	4,384	5,024	4,246	3,180
Cucumber	850	660	1,325	3,020	2,796
Watermelons*			1,493	2,033	2,325
Broccoli	439	517	3,090	1,856	2,028
Lettuce	1,212	1,504	2,011	1,475	1,965
Cauliflower	2,346	1,190	852	994	1,540
Dudhi	2,268	2,290	1,556	2,154	1,086
Karella	4,512	3,288	3,219	1,026	925
Chillies, green peppers*			1,244	1,179	672
Garlic*					195
Cucumbers, gherkins*			68	173	153
Lettuce*			181	186	152

Source: HCDA, 2010

*Source: www.countrystat.org

A wide range of vegetables is produced throughout Kenya. Table 8. gives an overview of the production levels for several primary crops for the period 2001-2010. The harvested areas for these crops are given in Table 9.

Beans, peas, Irish and sweet potato are the most commonly grown crops, both in terms of production and acreage. Those apart, prominent among the produced vegetables are cabbages, kales, tomatoes, onions, carrots, french beans, garden peas and traditional African leafy vegetables, both in terms of area and total output. Cabbages, tomatoes and kales have predominated in vegetable production for at least the past decade. Trends in production show a slight increase for most vegetables, except for cabbages and carrots: cabbages showed a sharp drop in 1993 and stagnation since that time, and carrots show steady decline in output, with partial recovery in production in 2001. Kales, tomatoes and traditional vegetables showed steady increases in output (Wiersinga and De Jager, 2007).

Table 9. Harvested area (ha) for several primary crops by year.

Crop	2006	2007	2008	2009	2010
Beans*			610,428	960,705**	
Cowpeas*			148,157	124,302**	
Pigeon peas*			195,959	118,167**	
Irish Potato	120,754	121,724	91,778	108,199	131,047
Sweet potato*			62,785	77,821**	
Kales	28,459	28,250	25,182	25,122	28,119
Green peas	8,075	11,809	9,814	11,024	23,776
Tomato	19,542	18,926	16,400	17,182	18,981
Cabbage	21,559	24,892	19,138	14,782	18,829
Carrots	3,535	4,462	3,485	3,165	4,881
French beans	6,154	7,733	4,616	3,336	4,840
Spinach	3,763	3,668	3,910	2,596	4,263
Nightshade				3,140	4,245
Snow pea	2,097	1,754	2,472	2,648	3,601
Leaf amaranth				3,724	1,892
Bell pepper	1,027	990	1,414	1,272	1,614
Egg plant	861	789	1,020	815	1,045
p/fruit	316	359	583	888	979
Courgettes	197	103	457	724	796

Crop	2006	2007	2008	2009	2010
Babycorn	120	206	294	588	702
Butter nut	108	101	289	532	650
Okra	834	548	545	633	455
Lettuce	115	138	174	186	190
Cucumber	76	52	68	174	153
Karella	376	274	267	161	141
Cauliflower	138	70	61	112	140
Dudhi	168	163	152	175	120
Broccoli	56	72	147	28	49

Source: HCDA, 2010

*Source: www.countrystat.org

** : estimate

Also the range of vegetables produced for export is very broad, with French beans, snow and snap peas, Asian vegetables (such as karella, chillies, aubergines and okra) dominating the export list (Ministry of LNV, 2009). On the whole, these vegetables are not for local consumption, not being an element of the traditional diet. In Annex 1 these data are shown for some of these primary crops by administrative level. Producers' prices for these crops can be found in Table 10.

Table 10. Producers' prices for some primary crops by year (KSh/tonne).

	2001	2005	2007	2008
Beans	30956	27778	48889	50000
Pigeon Peas	26,667	31,111	33,333	35,556
Cowpeas	17,778	22,222	32,222	34,444
Sweet Potatoes	15,021	14,500	17,500	16,500

Source: www.countrystat.org

4.2.2 Rural farming

Smallholder farms

Locally consumed vegetables are primarily produced by smallholder farmers. These smallholder farms are characterized by less than around 2 acres (0.9 ha), and mainly produce cabbage, kales, onions, tomatoes, carrots. Most labour is done by the family, but in a few cases labour is hired by the smallholder farmer.

Box 3. *Kabaru District as example of rural farming*

The Kabaru District in north central Kenya consists of relatively recent settlements (Waraza, Kirima, Himakuri, Ndathi, Island Farm, and others) on land previously owned and farmed by colonialists. The government's purpose was to put this land into production. Estimations in 2004 were that in this District between 1700 to 2000 small-scale farms are spread throughout the area supporting about 16,000 people and covering 10 km². Small scale farms average 3 to 4 ha in size. Family size is 4 to 5 individuals per family. Horticultural vegetable crops grown for sale include cabbage, carrots, garden peas, snow peas, Swiss chard (spinach), kale, string or French beans, onions, potatoes, garlic, ginger and other usually temperate crops. Asia vegetables (snow peas, sugars snaps) are produced for export and for consumption in large cities with a significant Asian population (e.g. Nairobi). Water for production is obtained from the watershed and rivers on Mount Kenya.

Box 4. *Tomato production*

Tomato is one of the major vegetable crops. Tomato production is a major farming business in Kirinyaga district. Out of the average 5 acres of land, tomato occupies more than a third of the cultivated area. Furrow irrigation is common although known to favour insect and other arthropod pests besides mechanical transmission of soilborne diseases such as the prevalent bacterial wilt. Tomato produce is usually sold in boxes of 60 kg each. The average output price per 60kg box was KShs 800 during high season and KShs 2000 during low season. The average amount of tomato harvested by each farmer was 100 boxes per acre.



Figure 6. Vegetable cultivation in Nakuru.

Export farms

Most production in the rural area is carried out by small scale farmers, with approximately 0.5 -2.5 ha of land each (Wiersinga and Jager, 2007). Vegetable production for export takes place in four different production systems, which are:

1. Backward integration; exporter has its own production.
2. Product segmentation; products which require full traceability are grown on own farms, products with less demanding requirements are sourced from contracted smallholders.
3. Modified extension; combination of own production and outgrower/smallholder production.
4. Higher intensity outgrower systems; most of the vegetables are procured from outgrowers/smallholders.

The largest part of the export of vegetables goes to the UK. Netherlands and France are the other main importers of Kenyan vegetables (Ministry of LNV, 2009).

4.2.3 Urban farming in Nairobi

Part of the vegetable production takes place within the city of Nairobi. Four farming systems can be distinguished in this city:

1. Small-scale subsistence crop cultivation (dominant)
2. Small-scale livestock production
3. Small-scale market-oriented crop production (in the south western part of the city)
4. Some large-scale commercial farming.

Nairobi has, just like the rest of Kenya, a bimodal rainfall pattern. The long rainy season is from April to June, the short rains from late October to early December. In 'normal' years, two harvests are possible, though maize — which is the staple food — is mostly cultivated during the long rains only. The long-term average is 880 mm of rainfall annually, but the seasonal pattern tends to be quite irregular. This makes agriculture more difficult, as Kenyan agriculture is predominantly of the rain-fed type.

Small-scale subsistence crop cultivation concerns a variety of crops on the farmers small plots. The large majority of these farmers grow the basic staples as maize, beans and sukuma wiki. Maize is usually intercropped with beans. They also grow crops such as kale (sukuma wiki), tomatoes, beans, cowpeas, Irish potatoes, sweet potatoes, arrow roots and bananas among others. Chemical inputs are used only by a small minority of farmers, because most cannot afford them. Also irrigation is quite rare.

Box 5. Kibera slum as vegetable production area

The Kibera slum reaches with a population between 250,000 and 800,000. It is the largest informal settlement in Nairobi and is located not far from the city centre. Most of the mud and wattle dwellings are located along a wide slope opposite the Motoine River and Nairobi Dam. Many of the food producers in Kibera have their plots in a large open space across from the river and dam. This open space includes slopes ranging from gentle to moderate and several soil types. Maize is generally grown during the long rains but some fast maturing varieties can be grown during the short rains. Beans are grown during both seasons. Aside from these two crops, sweet and Irish potatoes, kale, and cowpeas are common crops. Flood-prone areas are planted with cocoyam, bananas, and sugar cane. High value crops such as onion, tomato, and Swiss chard are rarely seen because they are well liked by thieves. A small number of producers irrigate their plots with sewage water. At the lower reaches of the river there are many small-scale vegetable farms especially along the rivers and sewer trunk mains. In the residential areas of Umoja and Kayole, there are large maize and bean farms especially in the furrow grounds between the two estates. Along the trunk sewers, there are large vegetable farms of tomatoes, Irish potatoes, kales (sukuma wiki) arrowroots and plant nurseries that are irrigated using the sewer. The farmers block the trunk mains using stones and use the overflowing wastewater for irrigation.

Small-scale market-oriented crop cultivation concerns seedlings, notably of vegetables, grown on very small plots. Seedlings are sold to farmers including the rural areas. In Kibera slum, for example, seeds for leafy African vegetables such as amaranth, spider plant and African nightshade are produced for the commercial vegetable rural farmers who supply the Nairobi city with these high-demand commodities (Karanja *et al.* 2010). The areas in the outskirts of the city seem have reasonably large parcels of land. The yields from these urban grown crops are substantial. For example it is estimated that 50,000 bags of maize and 15,000 bags of beans are produced in Nairobi annually (Njenga, 2004 in: Nyang'wara *et al.* 2007).

The majority of the urban farmers are women. The large majority of urban farmers is not born in Nairobi; most of the migrants come from neighbouring districts, in particular the ones in Central Province. But, they have been living in Nairobi for quite a long time. New migrants do not come to the city to practise agriculture, but they look for formal employment. Not succeeding in this, many try to get access to a piece of land to grow food, but because they are not firmly settled in the city, they have not the right network to acquire land (Foeken and Mwangi, 2000).

Almost all of the Nairobi farmers are completely left on their own and get no assistance or advice of any sort; as roadside, riverside and sewage-line farming are not recognised by the officers, the Ministry of Agriculture does not provide extension to them.

4.2.4 Indigenous leafy vegetables

In addition to a growing export market the demand for indigenous leafy vegetables in Kenya is increasing rapidly, both at urban and rural markets. Nearly all the main chain supermarkets are currently stocking these greens, alongside the commonly consumed vegetables such as leaf cabbage, known in Kenya as 'sukuma wiki'. While the cabbages are produced in large quantities, the supply of indigenous leafy vegetables is rather inadequate, especially during the dry season (Ministry LNV, 2009).

Box 6. *Indigenous vegetables*

Research shows that indigenous vegetables now account for some 30 per cent of all the vegetables marketed in Kenya, with the percentage growing due to their high nutritional value.

Food experts say indigenous vegetables contribute to micronutrient consumption in a way that exotic vegetables do not, estimating that for poorer households, half of pro-vitamin A and one third of iron requirements are now being met by indigenous vegetables. Indigenous vegetables also contain non nutrient substances called phytochemicals, which help protect people against non-communicable diseases.

Source: Koigi, unkwon date

4.2.5 Seed industry

Seed and planting materials are important inputs in agricultural production (Muyanga *et al.* 2005, in Ayieko and Tschirley, 2006). Improved seed may play an important role in increasing agricultural productivity and thereby reduces other production input costs.

Two seed systems exist in Kenya: the formal and informal seed systems. The formal seed system is an important source of high quality certified seed, but is not able to meet the farmers' demand. The majority of farmers therefore relies on the informal seed system for seed and planting material for most agricultural commodities. Formal seed is more expensive, but is of better quality and therefore most used for export production. For domestic production informal seed (local varieties and vegetables) is most used (Ayieko and Tschirley, 2006).

The challenge for Kenyan agriculture is to develop seed production and delivery systems that encourage wider use of quality seed throughout the marketing chain. Therefore, one of the six fast-track activities for Kenya's Strategy for Revitalization of Agriculture (SRA) is to improve access to quality inputs and financial services (Republic of Kenya, 2004).

Local and international seed companies find it unprofitable to make the investment required to provide the quantity, quality and variety of seed needed to support an expanding agricultural base (Ayieko and Tschirley, 2006). A small section of export vegetable growers make use of quality seeds, which are imported by local companies or are obtained from local branches of seed multinationals. Seeds are imported from United States, Great Britain, Japan and South Africa. Most of the planting material comes from Holland, Israel, USA with a limited supply from South Africa (Ministry LNV, 2009).

Box 7. Seed industry for indigenous vegetables

Projects exist to bring farmers into seed production to accelerate the rise in production and sales of indigenous crops. An example of such a project is a pilot project by the Centre for Agriculture and Biosciences International (CABI) funded by Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA). CABI initially partnered with the Kenya Seed Company to train farmers that the company had contracted to grow indigenous seeds for them. CABI trained the farmers in farm management, minimal pesticide use, harvesting, seed extraction and in finding marketing channels for their seeds. Farmers also received specific training in seed multiplication, after being supplied with foundation seed, which they then multiplied under the supervision of extension workers. The trained farmers recorded a 60 per cent to 70 per cent increase in yields after the initial training, prompting moves to extend the program further.

In collaboration with the Kenya Agricultural Research Institute (KARI), KEPHIS and the Arusha-based World Vegetable Centre, which supplied farmers with foundation seed, CABI ran demonstrations across 11 districts in Nyanza and Western Kenya, teaching farmers best practices in seed handling, controlling weeds and pests and packaging. The farmers now sell their seeds to the Lagrotech Seed Company, which has been approved to package the seeds for sale.

For a farmer to be a seed supplier, officials from KEPHIS have to test the foundation seed for its known and accredited source. The foundation seed is used to multiply other seeds for farming. KEPHIS then visits the farm where the seed will be grown to check the land history and ensure that no similar crops have been planted in the farm previously, which raises chances of the new seeds getting diseases. KEPHIS also visits farms to inspect the crop before and after the flowering stages, to monitor the growth of the crop and identify any undesired growth in the crop.

Source: Koig, unknown date

4.2.6 Organizations

Several grower or producer organizations can be found in Kenya. Below an overview is given of these organizations.

Kenya National Federation of Agricultural Producers (KenFap)

This organization started in 1946 as the Kenya National Farmers Union (KNFU). It was formed then to serve the interests of the large-scale white settler farmers. After independence in 1963, the small-scale farmers agitated for the formation of their union, a process that was concluded in 1973. During this period, the Union became a very strong lobby group, agitating for price control measures and equitable distribution of land resources.

The need to rejuvenate the federation's identity in 2002 stemmed from the realization that the members required better services. In addition the Union adopted a business-like approach, in order to generate its own funds. The leadership began conducting membership recruitment drives and changed its name to the Kenya National Federation of Agricultural Producers (KENFAP). The last decade, the federation focused on a long term strategic focus. Vision of KENFAP is "Empowered Kenyan farmers with a strong voice".

KENFAP has the mission "to empower its members to make informed choices for improved sustainable livelihoods". The following objectives are set for KENFAP:

- To promote unity, co-operation and dialogue among its members and between its members and other actors in the agricultural sector;
- To ensure timely intervention in the resolution of issues affecting the agricultural sector;
- To ensure effective representation of the farming community and expression of its views to government and the public at large;
- To encourage effective networking and collaboration with national and international associations which share the Federation's objectives and aspirations;
- To offer professional consultancy services as an income generating activity of the organization at subsidized/ concessionary rates for the members and at commercial rates for the non-members;
- To conduct and document research into problems affecting agricultural production, marketing, value addition and policy;
- To encourage collaboration between members of the farming community and any other legitimate entity whose actions are in the interest of the farming community.

More information on KENFAP can be found at their website: www.kenfap.org.

Kenya Organic Agricultural Network (KOAN) is a national coordinating body for Organic Agricultural activities in Kenya. KOAN emerged from a consultative process where organic practitioners agreed to come and work together to achieve the synergy required to develop the organic sub sector. It is a membership organization with members across the country and unites producers, exporters, traders, NGOs and other like-minded individuals and organizations in promoting Organic Agriculture in Kenya. The organization represents over 35,000 farmers and works with partner organizations throughout the country. KOAN aims to coordinate, facilitate and provide leadership and professional services to all members and other stakeholders in the organic agriculture industry in Kenya. KOAN has the target to develop competencies, skills and strategies in the following areas of the organic industry:

- Marketing : to help organic producers in finding markets for their produce both locally and internationally;
- Certification and standards : to improve standards and get out producers properly certified to constantly improve the standards of Kenyan organic produce;
- Training : to train producers so that they will be able to meet the Organic Standards;
- Extension and information exchange : to provide growers with the latest information;
- Networking - to organize activities that allow Kenyan Organic producers to meet potential customers both locally in Kenya and abroad;
- Policy and advocacy;
- Production - to share information with Kenyan Organic producers on advancements that are being made locally and internationally.

More information can be found at the website of KOAN: www.koan.co.ke.

East African Growers is an export oriented organization of growers, processors, packers and exporters of vegetables, fruits and flowers located in East Africa to markets within Europe. More information can be found at the website of East African Growers: www.eaga.co.ke.

Fresh Produce Exporters Association of Kenya (FPEAK) is Kenya's premier trade association representing growers, exporters and service providers in the horticulture export industry. FPEAK was formed in 1975. Since then, the association has grown to become Kenya's foremost sector trade association. Members of the Association are involved in growing and/or exporting fresh cut flowers, fruits, and vegetables. FPEAK supports growers and exporters by providing technical and marketing information and training, act as an information centre, and run active lobbying and advocacy programmes to enhance the sector's competitiveness. The vision of FPEAK is to make Kenyan horticulture the Global choice.

Her mission is to develop, unite and promote the Kenyan horticultural industry in the global market with due regard to safety, good agricultural practices, social, ethical and environmental responsibilities. FPEAK has set the following strategic goals:

- Update and implement Kenya Gap to recognized international standards;
- Influence enactment of a facilitative environment for the horticulture industry;
- Create awareness in the horticulture industry on market requirements, changes and regulations;
- Undertake continuous identification of market opportunities.

More information can be found at the website of FPEAK: www.fpeak.org.

Other organizational structures

The major function of the agricultural boards and committees is to advise the government on all matters of agricultural policy in regard to agricultural development. They may be used effectively to spearhead agricultural projects and programmes that could lead to food security, alleviation of poverty and improvement of farmers' livelihoods. The Nairobi Provincial Agricultural Board (PAB) in particular has the responsibility of promoting policies that support UPA in consultations with the relevant stakeholders. Specifically, it should promote policies for food security, produce/ product marketing and environmental conservation. It is expected to chart the way forward on most major issues requiring redress for a flourishing UPA in Nairobi.

4.3 Constraints in vegetable production

An extensive overview of constraints is given in Annex 2, where a distinction is made between constraints for the entire country, and constraints specifically for the peri-urban region of Nairobi. Annex 2 is summarized in Table 11. and Table 12. The list is long; during the workshop (see paragraph 1.3.3, Van der Lans *et al.* 2011) the following constraints were given highest priority:

- The lack of quality seed and planting material
- The lack of fertilizer
- Research
- Appropriate formulation and implementation of policies
- Collectiveness
- Pests and diseases

The issue of seasonality, driven by water availability, should be added here. Production during the rainy season is on the whole sufficiently high to serve consumer needs during the rainy season. If production is increased, which is certainly possible, then sells must also be increased. Although very accurate data are hard to obtain, it seems that sells to consumers in the rainy season will not substantially increase. Also, export of indigenous vegetables is not easy as for example European customers desire different products. Increased production during the rainy season is therefore only useful if vegetables can be processed in the form of canning, drying or freezing, if a retail organization exists that makes these products available to consumers in the dry season, and if consumers accept processed vegetables.

Production increase in the dry season is limited by the availability of water (either surface or ground water) and of irrigation equipment. If water is available, and if irrigation is technically possible, fresh vegetables can be easily sold on the consumer market, as demand exceeds current production levels.

Table 11. Constraints in vegetable production in Kenya.

Type of constraints	Specific constraints
Infrastructure constraints	<ul style="list-style-type: none"> • Poor (rail)road network, especially in rural areas (results in high transport costs and high post-harvest losses). This even worsens in rainy seasons. • Unavailability or limited means of transport to reach the markets, which lead to high wastage. Also often delay and subsequent quality loss during transportation and distribution processes. • Limited (or no) electric services (which is needed for continuous postharvest storage or processing facilities, but also influences possibility for telephone or internet communication with clients) • Limited telecommunication network • Poor building and farm infrastructure
Production constraints	<ul style="list-style-type: none"> • Lacking of year round water supply / low and variable rainfall • Minimal access to irrigation facilities • Poor availability of farm inputs to small scale farmers (among others seed supply) • Lack of high quality seeds and high yielding varieties for crops for domestic consumption and of quality planting materials • Declining soil fertility / low use of inputs • Decreasing land resources • Vegetable pests and diseases (aphids and cutworms, leaf and root diseases, blights) • Steep and rocky terrains that make cultivation cumbersome and inconsistent
Business and economic constraints	<ul style="list-style-type: none"> • Financial: <ul style="list-style-type: none"> o Due to seasonality of production large fluctuating supply on markets and large fluctuation of prices o High costs of inputs o Not enough capital to invest in good quality inputs o Poorly managed credit programmes • Market <ul style="list-style-type: none"> o Insufficient insights in marketing and channels, and consumer behaviour, lack of market information o Local markets are small compared to high number of vegetable producers o Poor (wholesale) market infrastructure (cool store, packing, handling grading) o Limited awareness on market access or market standards o Traders dominate the value chain; smallholders have no voice, which reflects in price setting o Chain fragmentation (multiple, non-transparent and long) o Lack of market-based production o Fragmented farming, low economic use o Opening up of other production areas o Poor record keeping • Product <ul style="list-style-type: none"> o Inadequate quality control system, grading and packing of fresh produce in the domestic markets o Product quality is not rewarded in the value chain o Lack of packaging and processing capacity • Insecurity • Consumer mistrust
Educational and Research constraints	<ul style="list-style-type: none"> • Limited farmer institutions/centres for specific training and information channelling related to horticulture • Education farmers • Education extension workers • Lack of communication and applied research • Research agenda: marketing, processing, vegetables • Research funding
Cultural / community constraints	<ul style="list-style-type: none"> • Community related consumption of specific ALVs, due community habits. This limit marketability of some species • Insufficient horizontal cooperation among farmers (e.g., organized collection of produce)

Table 12. Constraints in vegetable production in the peri-urban region of Nairobi.

Type of constraints	Specific constraints
Legal constraints	<ul style="list-style-type: none"> • Farming activities are not properly planned or regulated and therefore often illegal
Institutional and social constraints	<ul style="list-style-type: none"> • Urban agriculture is excluded from support services like extension services and credit access • Lack of support from local authorities • Poor transport
Economic and financial constraints	<ul style="list-style-type: none"> • Lack of credit and investment opportunities • Lack of market opportunities for the products • Lack of sustainable income • Negative consumer attitudes
Environmental constraintst	<ul style="list-style-type: none"> • Environmental conditions are not favourable <ul style="list-style-type: none"> o limited water availability, especially during dry seasons o environmental conditions are of health concern o due to the use of polluted river water or sewage water to wash farm produce, danger for health of consumers (including farmers family)
Production constraints	<ul style="list-style-type: none"> • Lack of tools and equipment • Insecure land tenure
Others	<ul style="list-style-type: none"> • urban problems, as: <ul style="list-style-type: none"> o theft of crops o lack of inputs/capital o plot used as toilet o threat of destruction of the farm or land • Poor leadership • Illiteracy • Lack of support from neighbours

4.4 Options for improvement of vegetable production

Production increase

Purely from a production point of view, the main physical factor that limits year-round production of vegetables is water, which is very scarce in the dry season as most vegetable farmers do not have access to water resources such as lakes and rivers. But even if water is in the vicinity, getting it to the crop needs investments in irrigation facilities. Also, better inputs in the form of quality seeds, planting material, and fertilizers can increase productivity of (indigenous) vegetables. From a purely technical perspective, barriers and solutions seem relatively clear. However, a technical approach (alone) will not do.

Firstly, it appears (although precise data are difficult to obtain) that during the rainy season production is currently sufficient. Therefore production increase in the rainy season without further actions will result in lowered prices and possibly discarded produce. Farmers will not profit.

Secondly, increased production during the dry season through for example the introduction of irrigation introduces the danger of peak production and therefore also low prices.

This imperfection of the domestic market can only be solved through an integrated approach in which a number of parties collaborate, resulting in a stable demand-supply relation. The farmers are currently an underlying party in the value chain with very difficult access to vital information on product demand, pricing, etc. As value chains further develop, and consumer demands with regards to product quality increase, the value chain should reward, with financial incentives, the efforts of the farmers. This issue will be further discussed in Chapter 5.

Also, the enabling environment for vegetable farming should be improved. Credit facilities enable farm investments (e.g., tools, irrigation equipment, storage facilities). A well-organized and focused research, training and extension service facilitates the practical application of skills and knowledge (e.g., pest and disease management), and improved organization among neighbouring farmers strengthens their position in the value chain, which is traditionally weak.

In a second phase, once the market imperfection has been removed, it becomes worthwhile to invest in production increase. The important issues to deal with are summarized in Table 12.

Part of the small farmers produce for the export sector in an outgrower-scheme (e.g., East African Growers). Although this is somewhat beyond the scope of this study, which focuses on the domestic vegetable value chain, it offers for example mechanisms for knowledge transfer at the communal or regional level.

Resource use efficiency

Water can be a scarce commodity in Kenya, certainly in summer and for farmers without irrigation facilities. Chemical pesticides and fertilizers are expensive and harmful to the environment. It is therefore best to produce the maximum amount of vegetables with the minimum amount of inputs. Crop management measures support each other: for example, if the production increases because of better pest management, then the amount of vegetables produced per liter of water will also increase. On the whole, the resource use efficiency increases as the control over the production system increases. Strategies may vary - causing a discussion among farmers, scientists, politicians and others involved. Small-scale farming systems can be characterized by a high level of control, whereas large-scale production systems can profit from standardization and mechanization. Both systems call for a serious investment in knowledge transfer, in which the public and private sector should effectively collaborate.

Netherlands involvement

The Netherlands could on a commercial basis be involved in the development and supply of seeds and planting materials, certainly of the crops that are planted to a relatively large acreage, and for which a formal seed sector exists.

However, good seeds and planting materials pay off only if other production factors are also well developed. For that reason, support to development and dissemination of knowledge is needed. The Dutch involvement with the newly established Practical Training Centre in Thika is an example of this. In addition to this, after-sales support of Dutch suppliers can play an important advisory role.

Credit facilities have been mentioned (Van der Lans *et al.* 2011) as a limitation for investments. The Dutch banking sector could become actively involved with the development of a profitable vegetable sector in Kenya.

Water is an important issue. Without wanting to call for large-scale irrigation schemes, good water management is essential to the Kenyan horticultural sector. 'More Crop Per Drop' is the theme of the Netherlands Partners For Water programme. Tailor-made interventions at the farm level, or at the level of farmer groups where they collaborate, by specialized companies can result in a more sustainable use of water resources. As this requires financial investments, credit facilities should be in place.

4.5 Conclusions

From a purely technical perspective, barriers and solutions seem relatively clear. Tailor-made interventions to make better use of the limited amount of water, goods seeds and planting materials, good fertilizers, good pest and disease management, and improvement of other crop management measures are needed to increase both production levels and resource use efficiency.

However, a technical approach (alone) will not do. The market is imperfect: increased production during both the rainy and dry season will likely result in reduced prices. And in the absence of market incentives, farmers will not invest in improvements. Therefore, an integrated approach is needed, that is based on a more rewarding integration of the farmer in the value chain.

Having said this, at some point production levels and resource use efficiency must be improved. Commercial opportunities at the farm level lie in the field of tailor-made water management and irrigation, development and supply of seed and planting materials (especially for the larger crops), and knowledge transfer.

5 Marketing channels in Nairobi

Even though export gives higher prices for commodities, the local market is dominant in Kenya. For the past decade, over 90% of all fruit and vegetable production was consumed domestically, either on-farm or through domestic markets. This is also reflected at the farm level: over 90% of smallholder farmers in all regions (except arid regions) of Kenya produce horticultural products, less than 2% do so directly for export (Bawden *et al.* 2002, in Wiersinga and De Jager, 2007; Ministry of LNV, 2009; Pegasys, 2010). In paragraph 5.2 the Kenyan vegetable chains are described, and in paragraph 5.3 the barriers in the chains are summarized.

5.1 Summary

Small-scale producers access the domestic market through brokers. Transport and market information are provided by the broker. A very small number of small growers own a truck or have access to transportation. In such cases, the farmer (or group of farmers) can sell directly to traders at the wholesale market. Medium-scale producers also access the domestic fresh market through brokers. They also sell directly to traders at the wholesale market if they have their own transportation or access to transportation. Plantations tend to concentrate on the export market only, selling the lower quality produce that did not meet the export standards in the local market.

Domestic chain

Over 90% of all fruits and vegetables production is consumed domestically in Kenya. Vegetable production for the Nairobi market takes place primarily within 150 km of the city. The most important vegetables and fruits that enters are Irish potatoes, cabbages, tomatoes, carrots and bananas. Vegetables sold on the domestic market account for 52% of the farm production, followed by on-farm consumption (36%) and vegetables sold on the export market (12%). Local chains are characterised by high transaction costs and inefficient post-harvest handling and marketing arrangements.

The main traders in the regional markets are the wholesalers who collect and sell most of the products through one of the wholesale markets before making its way to retail market. Important wholesale markets are Wakulima market and Gikomba market. The system has become more decentralized in recent years, driven by congestion and lack of maintenance of the market, and increasing populations on the periphery of the city. Nevertheless, it is expected that urban wholesale market places will continue to play a key role in the domestic horticultural marketing.

Fresh vegetable channels

The domestic market chains for fresh produce can be classified a rural and urban part category. The structure of the rural market is informal, and is mainly supplied by small and medium-scale producers through brokers. Retail outlets are either covered market facilities in larger villages, and - most common - the open-air markets (Figure 7.). The urban market is more complicated, with four retail segments: up-scale green grocers, supermarkets, formal constructed markets, and street hawkers. The green grocer channel is relatively recent, but has experienced very spectacular growth, to the extent that it threatens the survival of the open air retail markets which use to be the main market outlets to consumers. Supermarkets in Kenya are large locally owned markets dominated by Uchumi and Nakumatt, independent mini-supermarkets, small family business-sized stores; and foreign-owned multinational market chains such as Metro Cash & Carry and Woolworth. The major urban supermarkets are Uchumi, Nako Mart, and Metro Cash and Carry. Supermarkets have attempted to expand their participation in horticultural markets over the past three years, but their market share remains quite low (4% of Nairobi's fresh produce). Another channel is that of open air markets and green kiosks. These are the most important channels in the urban areas accounting for 55% and 33% of sales respectively. Products are sold mainly to retailers, green grocers, supermarkets and institutional consumers. Quality in the street/road side markets is usually lower than in the constructed markets. Convenience is a key factor in determining where consumers buy their groceries. Hotels, safari lodges, and up-scale restaurants require the highest quality.

Processed vegetables

Important processed products in the domestic market include canned tomatoes and tomato products, canned French beans, fruit juices and juice concentrates, sauces and chutneys, and jams. There is a small frozen food processing segment, focusing mainly on beans, peas and pre-fried potatoes (chips). A wide range of fruit and vegetable processing facilities exists in Kenya. These range from modern, fully integrated plantation processors to micro-enterprises. The processing industry can be broken into four segments: integrated plantation processors, modern mechanized processors, cottage industry processors, and micro-enterprises.

Export chain

The export market is served by a few large-scale own company farms, an increasing number of contracted commercial horticultural farms, and a declining but still significant number of contracted smallholder farms. Smallholder production is purchased by brokers and co-ops, then sold to the exporters, from them to the importers and wholesalers, and finally arrive at the retailers, and sometimes from them to restaurants and caterers. The export chain can be divided in a fresh produce segment and a processed produce segment.

Netherlands involvement

Most pressing is the reduction of post-harvest losses combined with a financial revenue system that rewards farmers for producing more and better products, in combination with increased sales of these vegetables. Trust, transparency, and accountability in the value chain are some of the keywords that apply here. This will not happen automatically, but needs an advance process in which options for changes in the value chain are made explicit in, amongst others, financial terms. Preferably, this is done in close collaboration with stakeholders along the value chain that show a positive interest. Implementation could be started small-scale in which the model is tested, evaluated and improved. If successful, up-scaling processes should follow.



Figure 7. Open-air market scenes.

5.2 Vegetable chains of Kenya

Figure 8. gives an overview of all domestic, regional and international marketing channels for fresh horticulture product in Kenya. The rural consumers are served by independent smallholder farmers, either directly or through rural assemblers and purchasing agents. International consumers are served by company farms, contracted smallholder farmers and commercial farmers, through international exporters. The groups of urban consumers in Kenya is served through a diversity of channels that end at open-air retail markets, kiosks, high-end green grocers, supermarkets and hotels. In addition (but not in the figure) food is reaching customers through for instance canteens at schools and factories.

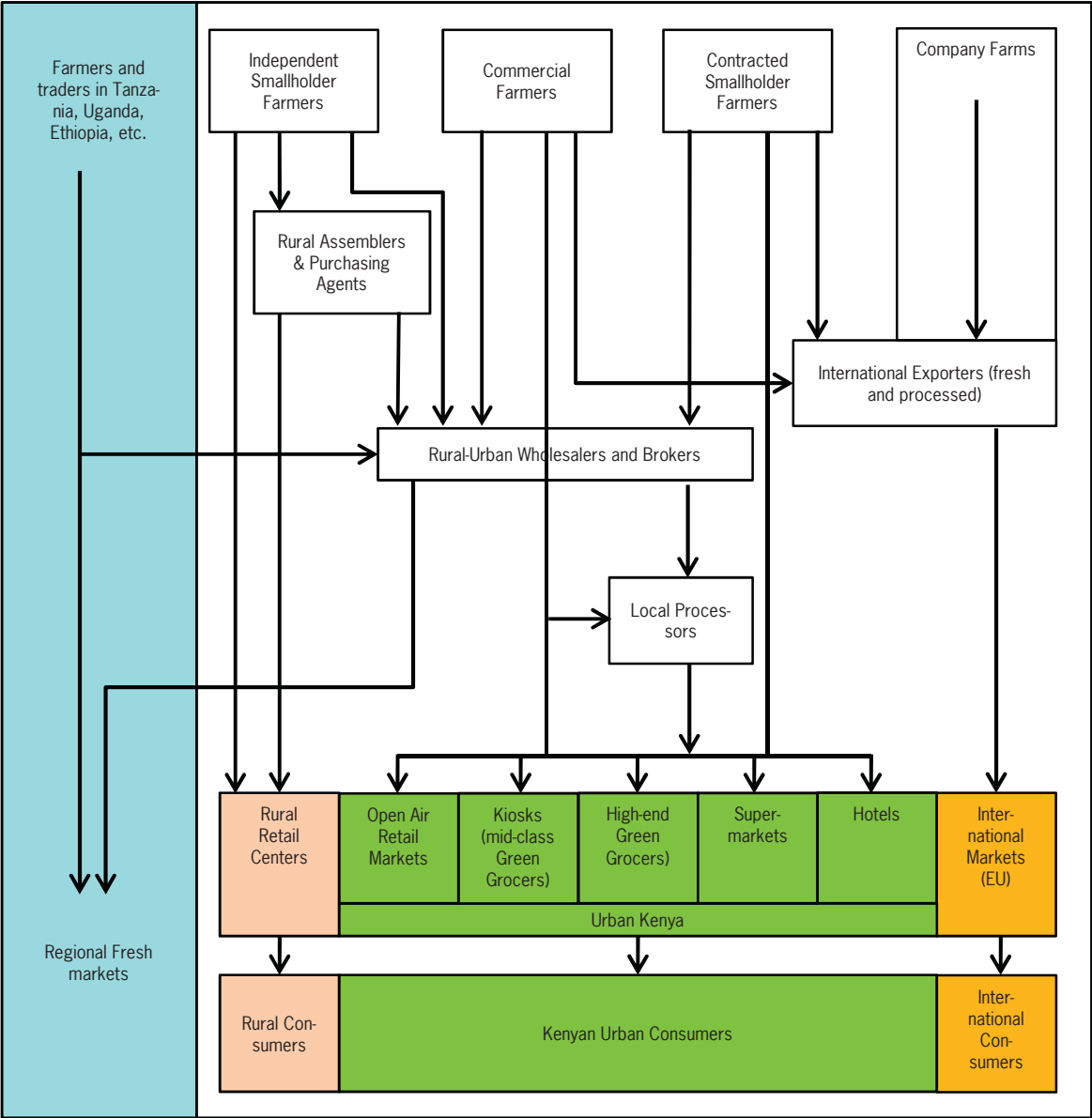


Figure 8. Domestic, regional and international marketing channels for fresh horticulture product in Kenya (Source: Tschirley, 2004, in Wiersinga and Jager, 2007).

5.2.1 Domestic chain

Fresh produce flows into Nairobi from over 45 districts plus Tanzania and Uganda. Vegetable production for the Nairobi market takes place primarily within 150 km of the city, in an arc running from the north-eastern Narok district to the northwest of Nairobi, through Kirinyaga district to the northeast (see also Section 4.2). Within this area, the top 5 of districts is responsible for 84% of the vegetable trade into Nairobi (see Table 13.). The most important vegetables and fruits that enter Nairobi are shown in Table 14; the most important fresh produce items entering Nairobi are Irish potatoes, cabbages, tomatoes, carrots, and bananas. Vegetables sold on the domestic market account for 52% of farm production, followed by on-farm consumption (36%) and vegetables sold on the export market (12%) (Muendo and Tschirley, 2004, in Pegasys, 2010). The average mark-ups of these different market categories were 150% for the domestic market and 300% for export vegetables. Local chains are characterised by high transaction costs and inefficient post-harvest handling and marketing arrangements (Ministry LNV, 2009).

Table 13. Vegetable trade into Nairobi (December 2004 - March 2005) (Source: Tschirley and Ayieko, 2008).

Top 5 Districts	Volume Share	Value Share
Nyandarua	.37	.34
Meru	.19	.26
Narok	.22	.17
Nakuru	.12	.09
Kirinyaga	.07	.12
Nyeri	.06	.11
Total share of top five	0.84	0.83
Tons per day	594	
Value per day ('000 Ksh)	7,871	

Source: Computed by authors from Tegemeo's monitoring of wholesale markets in Nairobi.

Table 14. Top fresh produce items entering Nairobi (December 2004-March 2005).

Item	Volume (tons day-1)	Volume share	Value per day (x 1,000 Ksh)	Value share
Irish potatoes	348	0.51	2,787	0.28
Cabbage	59	0.09	1,699	0.17
Tomatoes	50	0.07	1,207	0.12
Carrots	43	0.06	870	0.09
Bananas	38	0.06	1,142	0.11
Onions	36	0.05	718	0.07
Green maize	31	0.05	234	0.02
Mango	28	0.04	555	0.06
Sukuma Wiki	16	0.02	237	0.02
Watermelon	10	0.01	86	0.01
Oranges	8	0.01	272	0.03
Pineapples	6	0.01	53	0.01
Sweet Potato	5	0.01	80	0.01
Plums	5	0.01	.	0.00
Spinach	3	0.00	38	0.00
Avocado	1	0.00	19	0.00
Total	387		9,997	

Source: Computed by authors from Tegemeo's monitoring of wholesale markets in Nairobi.

Box 8. Wholesale markets in Nairobi

Wakulima market is the most important wholesale market for horticultural products in Nairobi. *Wakulima* also includes a retail market. It is located in the city centre which means that all commodities have to be transported through the traffic of Nairobi. *Wakulima* market has two roofed areas providing shelter for traders during rain. The market place is owned by the Nairobi City Council (NCC) and civil servants are in charge of collecting the market fees on a daily basis. The market authority does not perform any quality assurance or standard control of the products being sold. There are two kinds of market fees. One is the fee traders or retailers pay for market entry and their stall, the other one is the fee paid by intermediaries per unit of commodities traded on the market. Those fees are important for the city council's budget. With the growing population and increasing demand for fruit and vegetables, the market reached the limits of its capacity. Currently app. 3,000 wholesalers and retailers do business on a daily basis, far more than the market was designed for. Therefore, wholesale trade moved partly to other retail markets in town resulting in a loss of wholesale shares at *Wakulima*. Wholesale trade at some of these market places is set up illegally and without a licence from the NCC.

Gikomba market is located near *Wakulima*. It is one of the markets that emerged because of the limited space at *Wakulima*. The market actually developed on the streets when the traders started their business in New Pumwani and Quarry Road. This is also the reason why *Gikomba* market has no infrastructure, no paved roads and no buildings. *Gikomba* does not provide adequate facilities in terms of hygiene, security and shelter against rain and sun. The traders and retailers are still operating from the roadside. According to NCC the traders are not supposed to sell there, however business people have to pay a market fee to the NCC, receiving little in the way of service in return. Wholesale trade takes place in the morning from 4 a.m. until 8 a.m. on New Pumwani Road. At 8 a.m. the wholesalers have to vacate the place. From 8 a.m. onwards the same place is used for retail activities. *Gikomba* market is both wholesale and retail market.

Thika is located 20 km north of Nairobi. It is an important market for the northern region around Nairobi. The new market where onions and tomatoes are mainly traded, has little infrastructure, providing no shelter and no regular garbage collection.

Two further local markets in the production regions were considered. *Karatina* market is a big local market in Nyeri North. It has a fenced area for retail but no proper place for wholesale. There is no infrastructure such as sanitary facilities, roof or store provided by the city council at this place. In *Kutus* in Mwea Division wholesalers operate right outside the market from 7 to 9 am. Inside the market fence retail is carried out all day long.



Gikomba Market in Nairobi
Source: Koenig et al. 2008



Kutus Market in Kenya

5.2.1.1 The role of wholesalers

The main traders in the regional markets are the wholesalers. They collect the vegetables and sell primarily in the urban wholesale market. Collecting wholesalers travel long distances to purchase commodities in spot markets from the producing areas and towns. To facilitate this, collecting wholesalers frequently employ purchasing agents who work in the production areas on their behalf. Purchasing agents reduce costs by identifying produce for sale, carrying out the negotiations, accumulating, assembling and carrying the produce to a nearby earth road for ease of collection. Once enough produce is obtained, collecting wholesalers then transport the commodities to the main cities/towns (Wiersinga and de Jager, 2007).

Most of these products are sold through one of the wholesale markets (distributing wholesalers) before making its way to retail market stall and kiosk owners, along with a small amount that goes to hawkers, dukas, and green grocers, supermarkets, and hotels. These wholesale markets are Wakulima market, Gikomba market, Kangemi market, and Kibera market. Wakulima market has the a majority share in wholesale transactions in the city. Overall, Wakulima carries an estimated 56% of value and 67% of volume flowing into wholesale markets in the city. Gikomba is in second place with 23% of value and 16% of volume. Wakulima dominates the flow of Irish potato, carrots, onion, mango, watermelon, and oranges, with shares of nearly 80% or higher on each. Gikomba dominates tomato, banana, green maize, and sukuma wiki, with a nearly 60% - 70% share in each. Kangemi and Kibera trail in all products, though Kangemi has meaningful shares in cabbage, tomato, green maize, and sukuma wiki, and Kibera is also strong in the latter (Wiersinga and Jager, 2007).

The system has become more decentralized in recent years, driven by congestion and lack of maintenance at this market, and increasing populations on the periphery of the city. Key actors in the supply chain include small and medium farmers, rural assembler/ wholesalers who bulk product in rural areas and transport it to Nairobi, urban wholesalers operating primarily within the city, and market stall and kiosk owners selling at retail (Tschirly and Ayieko, 2008).

Despite this decentralization, it is expected that urban wholesale market places will continue to play a key role in the domestic horticultural marketing system as the dominant source of supply for open-air retail markets, kiosks, and small stores. The two largest supermarkets are attempting to by-pass these markets. Each relies primarily on brokers and secondarily on direct procurement with an assortment of contracted commercial farmers and some organized small- and medium-sized farmers (Wiersinga and de Jager, 2007).

5.2.1.2 Fresh vegetables

The domestic market chains for fresh produce can be classified into two categories: rural and urban (Harris *et al.* 2001).

Rural market

The structure of the rural market is informal. Mainly small (small holder subsistence farmers) and medium-scale producers supply this market. Most commonly, producers sell their produce to brokers who then sell to a retail trader at a local market. The number of times produce changes hands depends on the capacity (access to transport, etc.) and specialization (time and knowledge constraints) of the different actors. In some cases, farmers with their own transport may sell directly to a trader at a local market. Because of time constraints and lack of experience, farmers rarely act as traders, selling directly to consumers at local markets. Most farmers do not own a truck, so transport is provided by the broker who may also relay some market information. Some brokers own their own trucks for transport. Others hire a truck to provide transportation. There are two types of rural "retail" outlets. First, in larger villages there may be a covered market facility with fruit and vegetable stalls. Second, the most common form of retailing is street or roadside, open-air markets. In some cases traders may have wooden kiosks or tables and in other cases, the produce is laid out on the ground on a piece of cloth, paper, plastic, or directly on the ground.

Urban market

The urban market is more complicated with fruit and vegetable retailing taking place in a range of environments from road-side selling to up-scale green grocers. There are four retail segments in the urban market: up-scale green grocers, supermarkets, formal constructed markets, and street hawkers.

Green grocers

This channel constitutes sale of fruits and vegetables through green grocers, general shops (mainly catering for medium to high income consumers), and roadside kiosks (*Kibanda*). The highest quality products are found at up-scale green grocers. These grocers usually source their products from small, medium and large-scale producers via informal market agreements. Some of them are also involved in vertically integrated production. They import produce that is not grown locally or when they cannot get the necessary quality locally. This channel is relatively more recent but has experienced very spectacular growth, to the extent that it threatens the survival of the open air retail markets which use to be the main market outlets to consumers. According to survey by the Tegemeo Institute in 2003, this channel was the source for fruits and vegetables for 38% of those interviewed, with kiosk accounting for 33%, hawkers for about 3% and green grocer and general shops for 1% each (Harris *et al.* 2001; Wiersinga and de Jager, 2007).

Supermarkets

Based on size of floor space, variety of products sold and volume of businesses handled, categorizes of supermarkets in Kenya can be summarized as follows: (a) Large locally owned hyper/supermarket chains dominated by Uchumi and Nakumatt; (b) Independent mini-supermarkets; (c) Small family business-sized stores; and (d) Foreign-owned multinational hyper/supermarket chains such as Metro Cash & Carry and Woolworth. There are three major urban supermarkets: Uchumi, Nako Mart, and Metro Cash and Carry.

Except for Nakumatt, Uchumi and the Pioneer branch (Nairobi) of Tusker Mattresses, the rest of the supermarkets do not (regularly) deal in fruits and vegetables. Even where this occurs, it is occasional and in very insignificant scale (Wiersinga and de Jager, 2007).

In 2007, 209 supermarkets and 16 hypermarkets were in Kenya (Wiersinga and de Jager, 2007). Uchumi and Nakumatt each have 35% of the market. Supermarkets pay the highest wholesale prices for high quality product, sometimes 40% higher than traditional retailers, and they also pay a stable price across the year. The high segment market requirements in Kenya consist of quality, quantity and timely supply. The supermarket requires large volumes per supplier. Supermarkets import produce, such as apples and dates that are not produced locally. Local grown produce they procure from a variety of sources: direct buy from medium and large-scale producers and plantations through market reciprocity agreements and spot market transactions; from brokers who purchase from small and medium-scale farmers; and sourcing of pre-packaged vegetables (specifically French beans and Asian vegetables) from exporters. They require the producers and brokers to deliver the produce to individual stores or to a central distribution center. Uchumi supermarket was incorporated in 1975 and currently has one distribution centre and 10 operational branches in Nairobi. The supermarket procures from farmers (60%) and brokers (40%). Other high segment markets competing for urban vegetable consumers include Nakumatt (with quite a different procurement system), Tuskys and Ukwala supermarkets (Wiersinga and de Jager, 2007).

Supermarkets have attempted to expand their participation in horticultural markets over the past three years, but their market share remains quite low. The two major chains - Uchumi and Nakumatt - each carry upwards of 80 horticultural products in the produce section of their Nairobi stores, including fresh whole produce from Kenya, imported produce, and prepared vegetables ready for cooking. Each has ambitious expansion plans, with Uchumi planning to reach 50 stores within five years from 30 currently (Weatherspoon *et al.* 2003 in Wiersema and de Jager, 2007). However, as of March 2003, these plans appeared to be stalled due to financial difficulties that this firm is having (Wiersema and de Jager, 2007).

Covered, constructed markets

Fruit and vegetable retail traders sell to consumers in covered, constructed markets or in street/road-side markets. These traders obtain produce from the wholesale market or brokers, both of which are predominantly supplied by small and medium-scale producers. There is a large fruit and vegetable wholesale market in Nairobi where farmers with access to transportation and brokers sell produce to retail traders and other brokers. There are similar wholesale markets in other cities and larger towns.

Small-scale producers access the domestic market through brokers. Transport and market information are provided by the broker. A very small number of small growers own a truck or have access to transportation. In such cases, the farmer (or group of farmers) can sell directly to traders at the wholesale market. Medium-scale producers also access the domestic fresh market through brokers. They may also sell directly to traders at the wholesale market if they have their own transportation or access to transportation. Plantations tend to concentrate on the export market only, selling the lower quality produce that did not meet the export standards in the local market. An interesting exception is Del Monte. Del Monte sells fresh pineapples to the local market, mainly through its own kiosks.

Street markets

This channel consists of both open air fresh produce wholesale/retail markets and green kiosks. The main urban markets include Nairobi (which account for about 40% of urban consumption); Mombasa, Nakuru, Kisumu, Nyeri, Eldoret and Meru. Both wholesale/retail markets and kiosks are the most important channels in the urban areas accounting for 55% and 33% of sales respectively (Tschirley *et al.* 2004). Sourcing of produce in this channel mainly constitutes purchases directly from farmers by traders or through their local or regional brokers, for onward sale mainly to retailers, green grocers, supermarkets and institutional consumers.

Quality in the street/road side markets is usually lower than in the constructed markets. Often the discarded produce from these markets is sold to street traders, but some very good quality produce also reaches the street/road side markets. At the same time, the hygienic conditions vary from fairly good to poor in the covered markets, usually decreasing with the income level of the neighbourhood in which the market is located. The hygienic conditions of the street/road-side markets are poor.

Open-air markets (56%) and kiosks (36%) have a dominant role in the fresh produce market (Table 15.). Together they account for more than 90% of the fresh fruit and vegetable market share (Ayieko *et al.* 2005; Tschirley *et al.* 2004; Tschirley and Ayieko, 2008). Supermarket chains have only 4% of Nairobi's fresh produce market, according to data from late 2003. Even if supermarket market shares have doubled over the past five years, this would still leave the traditional sector with about 90% of the market. It should be noted that it is not realistic that this share of the supermarket chains have been doubled or will grow the coming years, as this is a selling point that is mainly visited by the upper income groups, that will not grow very much in the urban areas.

Table 15. Fresh Food and Vegetables (FFV) market shares of various retail outlet types, by quintile of income per Adult Equivalent.

Per Adult Equivalent Income Quintile	Mean Income per Adult Equivalent (Ksh)	Market Outlet							
		Supermarket Chain	Small Supermarket Chain	Duka	Open Air Market	Kiosk	Hawker	Green Grocer	Total
		% of total FFV expenditure							
(lowest)	749	0.0	0.1	0.2	54.7	41.5	3.6	0.0	100.0
	1,890	0.0	0.0	1.3	60.6	34.4	3.7	0.0	100.0
	3,314	0.4	0.7	0.0	60.7	36.4	1.8	0.0	100.0
	5,599	1.7	0.1	0.3	59.5	38.0	0.4	0.0	100.0
(Highest)	23,654	13.7	0.4	1.3	47.8	32.6	2.4	1.7	100.0
Overall	7039	4.4	0.3	0.7	56.1	35.9	2.2	0.5	100.0

Levels of consumer awareness and concern about quality and safety issues is presumably highly varied among the population, but no data were identified which described the amount of variation or the correlates of the variance (e.g., income, education, location). Presumably the ability to act on quality and safety issues declines with buying power (disposable income). Very often convenience is a key factor in determining where consumers buy their groceries. One place where consumer demands for quality are a factor is in the up-scale green grocers. The food service segment is also quality segmented with the hotels, safari lodges, and up-scale restaurants requiring the highest quality. Lower-end restaurants and institutions do not set high quality standards (Harris *et al.* 2001).

5.2.1.3 Processed vegetables

The most important processed products in the domestic market for processed fruits and vegetables include canned tomatoes and tomato products, canned French beans, fruit juices and juice concentrates, sauces and chutneys, and jams. There is a small frozen food processing segment, focusing mainly on beans, peas and pre-fried potatoes (chips) (Harris *et al.* 2001). This is a relatively small market channel as compared to the fresh market channel. Total processed fruits and vegetables amounted to about 400,000 MT in 2003 of which about 260,000 MT was consumed domestically (Wiersinga and de Jager, 2007).

A wide range of fruit and vegetable processing facilities exists in Kenya. These range from modern, fully integrated plantation processors like Del Monte to micro-enterprises (very small home/street operations). The processing industry can be broken into four segments: integrated plantation processors, modern mechanized processors, cottage industry processors, and micro-enterprises (Harris *et al.* 2001).

Integrated plantation processor

The major integrated plantation processor in the Kenyan market is Del Monte. The Del Monte plantation and processing plant in Thika produces a range of canned pineapple products and juices. Historically, less than 1% of the production was sold in the local market. However, this has increased to 10% in recent years due to local pressure.

Modern mechanized processors

Modern mechanized processors produce a large volume of processed goods for the domestic market. These processors, about 30 large industrial processors in number (Wiersinga and de Jager, 2007), source products from small and medium-scale producers through spot market transactions, informal market agreements, forward market contracts, and production contracts. They also source produce from brokers who buy produce from small and medium-scale producers. Contracts with small-scale producers are often through producer groups.

Processors sell their products through a variety of channels. First, they sell ingredients, like juice concentrate and dried vegetables, to re-manufacturers. Second, they sell products directly to the supermarkets. Third, they provide products to wholesalers. Wholesalers then sell products to the supermarkets, small general grocers, grocer kiosks, and food service customers.

“Cottage industry” processors

Small “cottage industry” processors produce products like sauces, jams, pickles, and chutneys, with traditional cooking methods (open fire) and hand packing and labelling. These processors source most of their products directly from small and medium-scale producers through spot market transactions and informal market agreements. They also buy produce from brokers. These processors sell their products in the usual mainstream channels. They sell directly to the food service industry, especially hotels, and supermarkets in addition to selling to wholesalers.

Micro-enterprises

Micro-enterprises are generally operated out of individuals’ homes. They make products like juice drinks, sauces, and chutneys. They source raw materials from the wholesale market and from brokers who buy from small and medium-scale producers. Products are sold through street hawkers and in kiosks and small grocers. This is a very informal segment without any apparent quality standards or enforcement of hygiene standards.

5.2.2 Export chain

The export market is served by a few large-scale own company farms, an increasing number of contracted commercial horticultural farms, and a declining but still significant number of contracted smallholder farms (Dijkstra and Magori, 1995, in Wiersinga and de Jager, 2007). Smallholder production is purchased by brokers and co-ops, then sold to the exporters, from them to the importers and wholesalers, until finally arriving at the retailers, and sometimes on from them to restaurants and caterers. The export chain can also be divided in two segments, fresh produce and processed (Ministry of LNV, 2009; see also Sections 5.2.1.2 and 5.2.1.3).

5.3 Constraints

Lack of cooperation

The degree of cooperation between all actors of the vegetable chains is low (Koenig *et al.* 2008). Actors prefer to operate individually and not to rely on self-help groups or contractual business relations. For example, cooperation among farmers is low in case of travelling to the cities to buy input supply or to sell products. Co-operation is based on family or friendship relations. This is the same regarding cooperation between farmers and other actors of the vegetable chain.

Contract farming is not applied in most chains. Some supermarkets cooperate closely with a limited group of farmers. Nukumat Supermarket and Uchumi supermarket are examples of this. The vegetables at Nakumatt are delivered by Fresh ‘N Juicy, which functions as a wholesaler in the Nakumatt chain. In some cases farmers depend on the input supply of brokers or other “donors” and thereby undertake to sell their yield to this specific person. The price is then set by the supplier and often ranges below the market price. But normally they only grow what they can afford to and sell to whoever comes first or offers the best price. In most vegetable chains the farmers depend on the traders for transport to the markets and the selling price is dictated by the traders.

At the trade level knowledge about prices, buyers and markets is essential. But most traders (brokers, wholesalers and intermediaries) do not cooperate on a regular basis. They profit from their own knowledge or receive relevant information from fellow traders. The relation between wholesalers and retailers as well as between retailers and consumers are spot-

market ones. Especially the latter occur mostly incidentally. Regarding the power relation for buying, retailers depend more on the wholesalers who normally set the prices. Only in some instances does the retailer channel the prices he or she has to pay on the wholesale market back to the customers.

There is hardly any cooperation, neither at the retail level, nor outside the retail markets. Here again information is exchanged only between friends and family members. In contrast to the purchasing price, when setting the selling price most retailers are in a strong bargaining position.

The same picture of poor cooperation can be found among the transporters whether lorry owners, handcart drivers or carriers. But as lorry owners are generally in a better bargaining position, handcart drivers and carriers often depend on the goodwill of their employers.

Low quality criteria

The majority of Kenyans lack the income to buy regularly in supermarkets. As a consequence supermarket market share will remain low. A 10-20% maximum share is estimated in FFV (fresh food and vegetables) market in ten years time. Supermarkets cater mostly to the expatriate community and a small upper class that are their major clients (Koenig *et al.* 2008).

Most supermarkets use the same wholesale channels as the classic market or street retailer. That makes that the products they buy are of the same quality as the ones on the street. Exceptions from this are only the really big chains like Nakumatt and Uchumi in Nairobi (Kenya). These supermarkets have contracted or at least regular suppliers. This might be important in terms of consistent quality but this also only relates to the appearance of the produce and not for non-visible aspect, as none of the supermarket chains checks for chemical residues or other non-visible aspects (Koenig *et al.* 2008).

Other constraints

Besides the constraints of low cooperation and low quality criteria, also the following problems are reported in literature for the domestic vegetable sub-sector (Ministry LNV, 2009; Ayieko *et al.* 2008):

- Poor wholesale market infrastructure (cool store, packing, handling grading)
- High waste (20-50%)
- Very poor hygiene; non-compliance to food safety laws
- Traders dominate the value chain (high asymmetry of information); lacking market information
- Product quality is not rewarded in the value chain
- Fragmentation from production to and of the chain (multiple, non-transparent and long)
- Consumer mistrust
- Inadequate quality control system, grading and packing of fresh produce in the domestic markets
- Lack of transparent grades and standards
- Lack of processing capacity
- No public market information
- Poor infrastructure (telecommunication network, roads, buildings, (cold) storage, transport
- Payment of fines

Summarized, the domestic marketing channels face the following barriers:

Type of constraints	Specific constraints
Chain organisation constraints	<ul style="list-style-type: none"> • Traders dominate the value chain (high asymmetry of information) • Lack of cooperation throughout the chain: <ul style="list-style-type: none"> o Low degree of cooperation between all actors of the vegetable chains, for example to buy input supply or to sell products o Restrictions to sell horticultural products to the suppliers/ brokers/ donors; price is set by the supplier. o Traders (brokers, wholesalers and intermediates) do not cooperate on a regular bases. Regarding the power-relation for buying, wholesalers set the prices and retailers follow. o Hardly any cooperation at retail level and outside the retail markets. Information is exchanged only between friends and family members o Poor cooperation among transporters (lorry owners, handcart drivers and carriers). Lorry owners are generally in a better bargaining position. Handcart drivers and carriers often depend on the goodwill of their employers. • Fragmentation from production to and of the chain (multiple, non-transparent and long)
Infrastructure constraints	<ul style="list-style-type: none"> • Poor wholesale market infrastructure (cool store, packing, handling grading) • Lack of processing capacity
Quality and quality criteria	<ul style="list-style-type: none"> • Quality (criteria) of vegetables in the supermarkets are of the same quality as on the street (Nakumatt and Uchumi are exemptions in this) • Although Nakumatt and Uchumi have quality requirements, this only relates to the appearance of the produce and not for non-visible aspects (like chemical residues or others non-visible aspects) • Product quality is not rewarded in the value chain • Inadequate quality control system, grading and packing of fresh produce in the domestic markets
Others constraints	<ul style="list-style-type: none"> • High waste (20-50%) • Consumer mistrust

At the stakeholder workshop (see paragraph 1.3.3), especially post-harvest losses, the poor market infrastructure, and the poor information structure were identified as constraints.

5.4 Opportunities

A good value chain links in an efficient manner consumer demand to farmer production, and rewards the producer for the efforts made. This implies that financial incentives must be in place to realize higher production and better quality, and also that these finances are generated in the value chain. Assuming that the greatest difference between demand and production is in the dry season, the value chain must be re-organized such that this mis-match is solved. However, it appears that the level of chain cooperation to achieve this for the vegetable value chains in Keny is insufficient. Therefore, actions must be undertaken that increase mutual trust and profits of various chain players.

The following opportunities exist:

- Improve the logistics (rural electrification, rural road network, motorbikes, cars) and cold storage will reduce post-harvest losses and shorten delivery time. The reduction of post-harvest losses results in more produce of better quality to be traded, which should generate extra finances that can be used for better product prices and for further investments in the logistics of the post-harvest chain.
- This process needs to be started by somebody, for example a supermarket that sees a market opportunity on the basis of consumer demand, a group of farmers, or - preferably - a coalition of stakeholders that wants to move forward.
- It is crucial that the extra revenues are somehow shared among the chain actors, and invested in the value chain. This requires improved chain transparency, organization and cooperation. All parties will benefit from this, and the delivery of vegetables from farmers to consumers can be optimized on rational grounds.

- Incentive-based change of behaviour by growers (= a higher price for a better product, or more product) has the great advantage that better farming is directly rewarded. Better farming can be defined in terms of less pesticide use, higher visible product quality, use of more sustainable practices, a speciality crop, etc. It generates a cash flow towards the farmers that can be invested in better inputs and tools, and also in knowledge. A system in which the value of good and relevant knowledge is acknowledged is in terms of continued skills improvement better than 'training-for-free'.
- Major opportunities lie in the consumer acceptance of processed vegetables in the dry season. It is easier to increase vegetable availability during the wet season (reduced post-harvest losses will already have a major impact) than increasing production during the dry season. This will not be very easy, as the process of drying, canning or freezing will may result in price increases for the consumers, and as many consumers are poor. Also, the social acceptance of processed vegetables is much lower than that of fresh vegetables. Therefore, awareness raising with consumers through public-private partnerships are required to increase the acceptance of (different) vegetables, and vegetables in a different form.
- Alternatively, vegetable production during the dry season can be improved, provided this is done in a water-efficient manner (see Chapter 4).
- Although it is wise to organize the value chain well, this can be combined with the advantages of flexibility in the value chain. For example:
 - o Involve large and small-scale cottage industries with food processing.
 - o Link domestic and export networks.

Netherlands involvement

Most pressing is the reduction of post-harvest losses combined with a financial revenue system that rewards farmers for producing more and better products, in combination with increased sales of these vegetables. Trust, transparency, and accountability in the value chain are some of the keywords that apply here. This will not happen automatically, but needs an advance process in which options for changes in the value chain are made explicit in, amongst others, financial terms. Preferably, this is done in close collaboration with stakeholders along the value chain that show a positive interest.

Implementation could be started small-scale in which the model is tested, evaluated and improved. If successful, up-scaling processes should follow.

5.5 Conclusions

The value chain for vegetables in Kenya is diverse and long, and characterized by high transaction costs, low transparency, and a poor connection of consumers with farmers. This affects the availability and price of vegetables in Nairobi. Consumer behaviour and demands are not translated in financial incentives for the farmer. A wide range of actions must be taken to change this:

- reduction of post-harvest losses
- increased transparency, fewer stakeholders, better cooperation, lower transaction costs, lower dominance of the wholesaler
- a functional reward system for growers that stimulates changes in farming behaviour, leading to higher production, better product quality, greater sustainability, and acquisition of knowledge and skills.
- Increased availability of vegetables during the dry season through 1) processing of vegetables harvested during the wet season, and 2) water-use efficient cultivation of vegetables during the dry season where this is in terms of sustainability possible.

6 General discussion

The project had the following goals:

1. Analyse the reasons for low vegetable consumption by the urban and rural citizens in the Nairobi metropolitan region.
2. Determine the potentials for vegetable consumption and cultivation in the Nairobi metropolitan region, which serves as an example for African metropolitan regions in general.
3. Define strategies to stimulate consumption and production of vegetables.

6.1 Reasons for low vegetable consumption

An overview of the most important constraints that were gathered during the desk study, interviews and the workshop is given in Table 16. and Table 17. The constraints are organized along the value-chain, to which R&D has been added as an overall element. A very wide range of constraints to production and consumption of vegetables have been identified, and consequently, a similarly wide range of actions should be taken to stimulate the production and consumption of vegetables. One isolated action will most likely not be sufficient. Three main causes for low vegetable consumption can be identified:

1. insufficient income,
2. low availability, certainly during the dry season,
3. life style, negative attitudes towards vegetables.

Low-income population groups can not afford to purchase sufficient vegetables. This is especially a problem during the dry season, when there is a shortage of fresh vegetables (see below) and when the prices consequently are high.

It appears that during the rainy season, sufficient vegetables are produced (although information is not completely conclusive on this). A large part is lost in the value chain, but even so, vegetables appear to be widely available during the rainy season. Also, the variety of vegetables is adequate. However, as a consequence of insufficient availability of irrigation water during the dry season, production of vegetables in that season is much lower than during the rainy season. This is aggravated by a variety of other production-related constraints and constraints in the value chain between producers and consumers.

Thirdly, a number of life style constraints influence the consumption of vegetables, such as preferences, diversifying eating habits, time availability to purchase and prepare food, and the low status of vegetables.

Table 16. Overview of constraints.

Actors	Constraints	
R&D	<ul style="list-style-type: none"> • Limited applied research • Market research • Processing research • Research prioritization • Dissemination / extension /advocacy 	<ul style="list-style-type: none"> • Classification of vegetables to give a chance to all others • Low governmental funding • Seeds, planting materials, equipment, applications
Inputs	<ul style="list-style-type: none"> • Poor access to <ul style="list-style-type: none"> o inputs o financial services o water (management) o high quality plant material/seeds • Poor infrastructure (roads, telecommunication, electricity) 	<ul style="list-style-type: none"> • Insufficient quality of extension services (urban agriculture) • technical information • Information flow towards extension services • Procurement - high costs • Decreasing land resources

Production	<ul style="list-style-type: none"> Poor quality of produce Disease and pest infestation Declining soil fertility Lack of horizontal cooperation Only packages for supermarkets contain nutrition information Standards Lack of market based production 	<ul style="list-style-type: none"> Fragmented farming - no economic use Smallholders voice in value chain e.g., pricing Open up into other production areas Low production Poor record keeping Lack of technical skills Unreliable climate conditions
Collection/ Processing	<ul style="list-style-type: none"> Inefficient post-harvest handling leading to high post-harvest losses Lack of grades and standards Theft of crops 	<ul style="list-style-type: none"> (Cold) storage facilities Lack of processing capacities Lack of organized collection Packaging for transportation
Distribution	<ul style="list-style-type: none"> Infra-structure (telecommunication network, roads, buildings, (cold) storage, transport) Seasonality of the production (surplus during the rainy season, shortage during the dry season) 	<ul style="list-style-type: none"> Payment of fines High wastage Controlling position of the middle men Lacking market information Packing, handling, grading
Wholesale	<ul style="list-style-type: none"> Infra-structure (cold) storage Poor market infra-structure (storage, waste disposal, hygiene) High wastage 	<ul style="list-style-type: none"> Traders dominate the value chain Product quality is not awarded Payment to growers
Retail	<ul style="list-style-type: none"> Poor market infra-structure Low quality criteria High waste 	<ul style="list-style-type: none"> Poor storage conditions Lack of hygienic conditions for markets Non-compliance to food safety laws
Consumer	<ul style="list-style-type: none"> Seasonality Lack of skills to prepare African Leafy Vegetables Price of vegetables related to income Limited variation in vegetable intake Food safety / hygienic handling Low status of vegetables (poor man's food) Time available for buying and preparing vegetables 	<ul style="list-style-type: none"> Shelf life (from harvest to consumption) Lifestyle Preference, likes and dislikes Family economy Diversifying eating habits Poor/lack of information on nutrition and health benefits from a public health perspective

Table 17. Overview of cross-sectional constraints.

Actors	Cross-sectional constraints	
R&D		
Inputs		
Production		
Collection/ Processing	<ul style="list-style-type: none"> Lack of joint transport and selling 	<ul style="list-style-type: none"> Illegality of urban agriculture Insufficient insight in marketing channels consumer behaviour, accepting low quality fragmentation throughout the vegetable chain - loose supply chain arrangements- lack of vertical cooperation between the different links within the chain market prices limited technical and marketing support services
Distribution		
Wholesale	<ul style="list-style-type: none"> Poor hygienic situation leading to waste 	
Retail		
Consumer		

6.2 The potential for vegetable consumption and cultivation

Consumption

Vegetables form an essential part of a varied human diet. A shortage leads to micronutrient deficiencies ('hidden hunger') and diseases such as cardiovascular diseases, diabetes and some forms of cancer. Inadequate vegetable and fruit consumption is the 6th main reason for mortality in the world (Ruel *et al.* 2005). Just as in many other parts of Sub-Saharan Africa, the nutritional status in Kenya and its capital Nairobi is insecure. Especially low-income groups suffer from (micronutrient) undernourishment in combination with a high fat intake. This is named the double burden of malnutrition (Latham, 2006).

It is recommended that a person consumes 146 kg per person per year of fruits and vegetables (Ruel *et al.* 2005). In sub-Saharan countries, including Kenya, per capita consumption is (far) below this level.

The attitude of Kenyans, including the inhabitants of Nairobi, towards vegetables is positive. The awareness of the dietary importance of vegetables is widespread and there is a wide range of traditional (leafy) vegetables. Where purchasing vegetables is not possible, urban horticulture has emerged to provide households with vegetables nevertheless.

Therefore, from the consumer-perspective, vegetable consumption can be increased, especially during the dry season and with low-income groups. As many inhabitants of Nairobi are poor, this, however, has to be realized at low costs of vegetables.

Cultivation

The vegetable producing farms are located in the arable lands around Nairobi, and produce mainly (96%) for the domestic market. The sector development has been mainly private-driven, and it can therefore be assumed that production would increase if demand and possibilities would enable this.

From a purely technical perspective, it should be possible to increase production levels, for example through better seeds (either from the informal or formal seed sector), better irrigation, better fertilization, and better pest and disease management. Farms are small, and suffer from decreasing land resources, declining soil fertility, lack of horizontal cooperation, poor infrastructure (roads, telecommunication, electricity), lack of technical skills, and a low leverage in the value chain.

Given increasing environmental concerns with the general public domestically and world-wide, attention to the sustainability of vegetable cultivation is required. More advanced value chains have certification schemes that value efficient use of water, chemicals and nutrients, amongst others. To achieve this, production systems, whether they are small or large-scale, have to be developed with care, ensuring the careful use of resources.

In addition the enabling environment for vegetable farming should be improved. Credit facilities enable farm investments (e.g., tools, irrigation equipment, storage facilities). A well-organized and focused research, training and extension service facilitates the practical application of skills and knowledge (e.g., pest and disease management), and improved organization among neighbouring farmers strengthens their position in the value chain, which is traditionally weak.

The value chain

However, without first resolving existing market imperfections there is great danger of price collapse if production is increased. Farmers are not likely to profit in the current situation from increased production during the rainy season as long as the extra produce is not absorbed by a more efficient value chain that caters to an increased consumer demand. Also, increased production during the dry season through for example the introduction of irrigation introduces the danger of peak production and therefore also low prices.

Re-organization of the entire value chain system in Kenya will be an enormous task. It is therefore advisable to re-organize or newly develop vegetable value chains that are transparent, efficient and deliver vegetables as cheap as possible to the consumers. Such a process should start at the consumer's end with the guarantee that vegetables are indeed absorbed by the market. It is important to financially reward growers for their efforts to produce more vegetables and/or vegetables of better quality.

6.3 Strategies to stimulate consumption and production

Directly following from the major limitations, the major strategies to stimulate consumption of vegetables should be:

1. Reduce the price of vegetables and/or increase consumers' income, while maintaining product prices for farmers.
2. Increase the availability of vegetables during the dry season.
3. Modify the life style.

Any strategy should work primarily with traditional African vegetables. Export vegetables such as French beans are not a major part of the Kenyan diet.

6.3.1 Urban farming

Urban farming can make a large contribution in the health of the urban poor by providing them access to higher quality agricultural products with nutritional benefits. As families can grow their own vegetables, vegetables are more easily affordable. Attention to the problems regarding urban agriculture is therefore of great importance.

An important problem for urban farming is insufficient knowledge regarding optimal production of vegetables. An extra handicap in this is that urban farmers are excluded from extension services by actual policy. Not only the knowledge about production is insufficient, the same holds for the knowledge regarding consumption of vegetables (both the preparation of vegetables, as the importance of a good diet). Production costs can be reduced by formation of farmers' cooperatives, which enable them to reduce transaction costs, create economies of scale and develop greater negotiating power.

Home gardening kits that include for instance good seeds and appropriate fertilizers can stimulate year-round urban production.

6.3.2 Peri-urban and rural farming, and the value chain

The value chain between the peri-urban and rural producers, and the urban consumer is long and far from optimal. A number of issues is given in Table 16. and Table 17. Measures that make the value chain more transparent, shorter, with less transaction costs, etc. should result in cheaper and better available vegetables in Nairobi. If cold storage and logistics are improved, then losses will be reduced which should in principle in larger volumes that reach the consumer, reduce product prices for the consumer, while maintaining or increasing prices paid to the producers. However, arrangements should be such that the lower transaction costs are indeed to the benefit of both consumers and producers, and not to the tradesmen who normally make sufficient profit.

Most pressing is the reduction of post-harvest losses combined with a financial revenue system that rewards farmers for producing more and better products, in combination with increased sales of these vegetables. Trust, transparency, and accountability in the value chain are some of the keywords that apply here. This will not happen automatically, but needs an advance process in which options for changes in the value chain are made explicit in, amongst others, financial terms. Preferably, this is done in close collaboration with stakeholders along the value chain that show a positive interest.

Implementation could be started small-scale in which the model is tested, evaluated and improved. If successful, up-scaling processes should follow.

A group of stakeholders should take the initiative to implement a value chain that

1. efficiently links consumers to producers
2. ensures that the product prices paid to farmers are sufficiently high year-round
3. ensures that consumer prices are sufficiently low.

A money-generating first action could be the reduction of post-harvest losses through the improvement of logistics and cold storage. Perhaps, credits are required, and farmer cooperation will strengthen the bargaining position of farmers and enable them to supply larger and more stable amounts of vegetables. It is important that the value chain rewards farmers for their greater and qualitatively better production - this in contradiction to the current situation in which a greater production leads to price reduction. If the value chain is financially more healthy, then it is worthwhile for growers to invest in inputs such as seed, fertilizer, tools, and also knowledge.

Depending on the demand, production in the rainy season can be increased (see also below, food processing). Production increase in the dry season will depend on the availability of water, but also then, production should follow demand and should avoid production peaks. In any case it is best to produce in a water-efficient manner during the dry season, using the appropriate technology level in terms of required investments, maintenance and financial returns. This will vary between small-scale farms and large-scale industrial farms.

6.3.3 Food processing

Given the fact that in the rainy season on the whole sufficient vegetables are produced, that the production can be increased with e.g., better irrigation systems, or that lower post-harvest losses can increase availability, and given the fact that during the dry season there is a shortage of vegetables, food processing of vegetables that are produced in the rainy season offers extra solutions. Through drying, canning, or freezing, vegetables can be made available for the dry season.

Additional benefits are for instance a higher farmer income, and employment. Some initiatives are known (e.g., canning, drying), but room for further initiatives certainly exist. This will require processing technologies, managerial capacities and organizational structures, and awareness raising with the consumers who prefer fresh vegetables.

6.3.4 Life style

Although the value of vegetables is generally well-known, some life style issues influence the consumption of vegetables. There is some consumer mistrust, especially with regards to low food safety due to washing of vegetables with polluted water (certainly untreated sewage water is unsafe). Not all consumers are aware of preparation methods for African Leafy Vegetables, or do not have sufficient time for purchasing and preparation of food (this is especially a problem for low-income groups). Also, vegetables can have a low status ('poor man's food'), combined with specific preferences for other types of food.

Awareness campaigns are one of the mechanisms to avert life style related problems with vegetable consumption.

6.3.5 Possible contribution of The Netherlands

The Netherlands, represented by private and public partners, can contribute to increased production and consumption of vegetables in Nairobi and elsewhere in Kenya through the following:

- **Re-structuring of the value chain.** A number of stakeholders has to be brought together that is committed to an efficient and transparent value chain. This may require a number of preliminary steps, such as:
 - o Development of a detailed business case that shows the benefit to all stakeholders
 - o Making available credit facilities.
 - o Developing a realistic business plan
 - o Defining quality standards, a certification scheme, a tracking & tracing system, and a quality control system
 - o Setting up an information system with all data that is needed to realize a transparent chain.
- Improved chain logistics and cold storage, to generate funds that can be (partly) spent on fair payment to growers.
- **Brokering.** Bringing together interested parties on the basis of a viable business plan. Parties may be Kenyan, Dutch, or of other origin.
- **Food processing.**
 - o Drying, canning or freezing of food can increase vegetable availability during the dry season. Issues to be dealt with are consumer prices (must be kept low) and preferences (that currently favour *fresh* vegetables).
 - o Ready-to-eat and fast foods. To reach many people through numerous sellers and resellers, it requires among others organization, industrialization, stable quality, investments, and planning. Also here, a low price is essential.
- **Consumer behaviour.** The Netherlands can provide support in assessment of, and influencing consumer behaviour that limit vegetable consumption. Especially, the preference for fresh vegetables limits the sale of processed vegetables. Both private and public sector representatives have possess experience that can be utilized.
- **Increased production and product quality,** to ensure adequate supply of vegetables that meet the demands set by the value chain.
 - o Irrigation technology. The Netherlands has wide experience in water and irrigation technology, and can assist in the implementation of water-use efficient technology.
 - o Quality seeds. The Netherlands has a number of international oriented breeding companies that can make available high-quality seeds. An issue to be dealt with is the fact that consumers, and therefore growers, are primarily interested in African vegetables, which may not be part of the portfolio of Dutch companies. After-sales support of Dutch suppliers can play an important advisory role.
 - o General crop management. Crop management practices, comprising pest and disease management, soil management, planting, etc. can be improved. Local knowledge can be combined with knowledge of high-input systems.
 - o Production and distribution of home gardening kits that would, for example, contain high-quality seeds.
- **Research and development.** R&D on vegetables needs more attention, as was indicated during the workshop. Dutch knowledge institutions can contribute here, and for example provide support in linking up private and public initiatives. The Dutch involvement with the newly established Practical Training Centre in Thika is an example of this.

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Annex I Some production data per administrative level

Table 18. Production quantity, harvested area and production level for several primary crops by administrative level, product and year.

	2006			2008			2010		
	Production quantity (M tonnes)	Area harvested (ha)	Production level (kg/ha)	Production quantity (M tonnes)	Area harvested (ha)	Production level (kg/ha)	Production quantity (M tonnes)	Area harvested (ha)	Production level (kg/ha)
Central									
Cabbages	241,025	9,641	25	251,910	9,330	27	188,842	7,492	25
Kales	101,070	6,738	15	90,176	5,636	16	240,573	6,897	35
Tomatoes	111,000	3,700	30	117,000	2,600	45	171,600	3,796	45
Carrots	27,552	1,968	14	41,725	1,669	25	59,600	2,886	21
French beans	42,820	4,282	10	65,200	3,260	20	16,526	2,384	7
Spinach	18,330	1,410	13	31,220	1,561	20	51,708	2,329	22
Garden peas	27,730	5,546	5	31,055	6,211	5	82,594	15,003	6
Coast									
Cabbages	2415	161	15	3,600	200	18	2,041	124	16
Kales	7,440	496	15	8,730	582	15	15,559	588	26
Tomatoes	32,880	1,096	30	36,200	905	40	92,176	2,274	41
Carrots	210	15	14	414	23	18	302	16	19
French beans	-	-	-	-	-	-	320	44	7
Spinach	858	66	13	1,926	107	18	1,800	100	18
Garden peas	20	4	5	25	4	6	60	30	2
Eastern									
Cabbages	41,225	1,649	25	34,175	1,367	25	35,376	1,426	25
Kales	23,790	1,586	15	17,400	1,450	12	10,440	922	11
Tomatoes	45,960	1,532	30	26,400	880	30	28,685	1,134	25
Carrots	2,520	180	14	11,375	455	25	8,936	894	10
French beans	12,620	1,262	10	12,160	608	20	33,596	1,768	19
Spinach	1,040	80	13	4,680	312	15	5,643	376	15
Garden peas	2,660	532	5	2,172	543	4	2,822	603	5
Nairobi									
Cabbages	1,080	36	30	1,410	47	30	413	28	15
Kales	2,025	135	15	2,055	137	15	1,837	176	10
Tomatoes	2,040	68	30	3,160	79	40	1,715	70	25
Carrots	280	20	14	60	3	20	57	5	11
French beans	70	7	10	60	3	18	-	-	-
Spinach	884	68	13	1,638	91	4	983	119	8
Garden peas	25	54	0.5	16	4	4	16	4	4

North Eastern									
Cabbages	-	-	-	-	-	-	-	-	-
Kales	285	19	15	450	45	10	548	69	8
Tomatoes	11,520	384	30	18,400	460	40	14,391	320	45
Carrots	-	-	-	-	-	-	-	-	-
French beans	-	-	-	-	-	-	-	-	-
Spinach	-	-	-	-	-	-	-	-	-
Garden peas	-	-	-	-	-	-	-	-	-
Nyanza									
Cabbages	63,040	3,152	20	29,980	1,449	21	28,600	1,430	20
Kales	132,930	8,862	15	115,350	7,690	15	80,593	7,984	10
Tomatoes	141,480	7,074	20	143,370	6,495	22	166,140	5,538	30
Carrots	3,360	240	14	7,260	363	20	3,500	175	20
French beans	-	-	-	-	-	-	-	-	-
Spinach	-	-	-	75	5	15	2,880	148	19
Garden peas	-	-	-	-	-	-	52	14	4
Rift Valley									
Cabbages	160,825	6,433	25	129,234	6,154	21	294,360	7,359	40
Kales	128,550	8,570	15	95,925	6,395	15	96,438	7,477	13
Tomatoes	135,270	4,509	30	143,220	4,774	30	77,004	4,131	19
Carrots	14,868	1,062	14	26,580	886	30	15,560	778	20
French beans	6,030	603	10	14,000	700	20	4,419	546	8
Spinach	27,495	2,115	13	35,080	1,754	20	12,157	1,121	11
Garden peas	9,940	1,988	5	12,204	3,051	4	65,874	8,107	8
Western									
Cabbages	-	-	-	-	-	-	-	-	-
Kales	30,795	2,053	15	48,705	3,247	15	56,070	3,738	15
Tomatoes	23,580	1,179	20	57,690	1,923	30	38,426	1,718	22
Carrots	700	50	14	1,720	86	20	2,546	127	20
French beans	-	-	-	-	-	-	980	110	9
Spinach	312	24	13	1,600	80	20	1,400	70	20
Garden peas	-	-	-	-	-	-	105	15	7

Source: HCDA, 2010⁶.

6 We (the authors) have also tried to use data from www.countrystat.org, however, these data show wide variation over time in production areas, and were therefore considered less reliable.

Annex II Constraints and opportunities in vegetable production

An extensive overview of constraints and opportunities in vegetable production is presented in this paragraph. The text starts with a brief overview of reported constraints for Africa and Asia, which is followed by constraints and opportunities for Kenya as a whole, and for metropolitan vegetable production in particular.

1.1 Constraints in Africa and Asia

Companies in developing countries face specific constraints related to limited access to (technical and market) information and reduced borrowing opportunities (Harris-White, 1999, in Ruben, Slingerland and Nijhoff, 2006). In the last two decades several studies have been conducted in which the barriers and constraints for the development of vegetable production in a specific region have been inventoried. The constraints can be many.

We consider social constraints, organizational constraints, constraints in technology transfer, and economic constraints (following Samantaray, Prusty and Kaj (2009) on a vegetable study in India villages in India), and input constraints, production constraints, and chain constraints.

Social constraints refer to lack of community awareness, lack of co-ordination among farmers, group forming in village, low adoption by neighbours, traditional norms and adverse socio-political system in the villages. These constraints do not permit farmers to adopt new technology in vegetable farming (Samantaray, Prusty and Kaj, 2009).

Organizational constraints concern poor co-ordination and co-operation among grass root level extension worker, low credibility of extension worker, lack of timely advice and guidance by extension personnel, non-availability of production inputs timely, irregular visit of extension worker, lack of effective supervision (Samantaray, Prusty and Kaj, 2009).

Constraints in technology transfer are lack of land consolidation, absence of proper post-harvest technology, inadequate training programme, lack of approach to demonstration and non-communication of location specific recommendations, low-level of technical know-how, non-exposure to mass media and lack of soil testing facilities (Samantaray, Prusty and Kaj, 2009).

Economic constraints refer to the absence of storage facility, poor economic status, low risk bearing capacity, high cost of technology, poor marketing facility and non-availability of credit (Samantaray, Prusty and Kaj, 2009).

Devarre (1995) mentions a number of major constraints for the development of the vegetable sector in Asia, and from several sector studies for the eastern Africa, Visser (2009) derived constraints that restrict the development of the sector.

Input constraints refer to the limitations due to lack of seed, fertilizers, capital, labour, etc. The availability of adequate varieties (both hybrids and open-pollinated varieties) that respond to specific production constraints are not always available. Moreover, there is never enough quality seed available.

Production constraints refer to limitations during cultivation and harvest of the crop, for example climatic conditions, water availability, crop management, pest and disease management, etc. One particular factor is the seasonality of the production, which is caused by the climate, and which influences availability of vegetables, price fluctuations and profitability (Devarre, 1995).

Chain constraints are related to the post-harvest value chain. Post-harvest losses up to 40% of the produce is occur (Devarre, 1995).

For eastern Africa, Visser (2009) identifies the following factors that restrict development:

- Quality issues (poor handling and inappropriate varieties);
- Good quality seed and varieties adapted to African conditions
- Seasonality & prices (high fluctuation in supply between the dry and rainy seasons resulting in high price fluctuations; lack of some commodities; artificial supply and price distortions caused by brokers)
- Purchasing power, sales and profits (low purchasing power in domestic market and low returns due to high competition)
- Traditional vegetables (lack of indigenous vegetables while demand increases)
- Transport issues (high cost of transport due to poor road conditions and associated spoilage of produce)
- Capital (lack of capital among the small farmers and traders);
- Markets/ market Facilities (high congestion, unhygienic conditions, and insecurity at main market centres);
- Standards, food safety & traceability (poor and not-standardized packaging of produce delivered to wholesale markets);
- Lack of marketing organizations and information
- Lack of sufficient processing capacity
- Lack of awareness on the nutritional value

Summarized, vegetable production in Africa and Asia face the following constraints:

Type of constraints	Specific constraints
Social constraints	<ul style="list-style-type: none"> • Lack of community awareness • Lack of co-ordination among farmers • Group forming in village • Low adoption by neighbours • Traditional norms and adverse socio-political system in the villages. • These constraints do not permit farmers to adopt new technology in vegetable farming.
Organizational constraints	<ul style="list-style-type: none"> • Poor co-ordination and co-operation among grass root level extension worker • Low credibility of extension worker • Lack of timely advice and guidance by extension personnel • Non-availability of production inputs timely • Irregular visit of extension worker • Lack of effective supervision
Constraints in technology transfer	<ul style="list-style-type: none"> • Lack of land consolidation • Absence of proper post-harvest technology • Inadequate training programme or facilities • Lack of approach to demonstration and non-communication of location specific recommendations • Low-level of technical know-how • Non-exposure to mass media • Lack of soil testing facilities • Lack of bilateral and multilateral cooperation between national research institutes to exchange research results
Economic constraints	<ul style="list-style-type: none"> • Absence of storage facilities • Poor economic status • Low risk bearing capacity • High cost of technology • Poor marketing facility • Non-availability of credit
Input constraints	<ul style="list-style-type: none"> • Lack of quality seed hybrid seed adapted to African conditions • Lack of capital among the small farmers and traders • Low purchasing power in domestic market and low returns due to high competition
Production constraints	<ul style="list-style-type: none"> • Seasonality of vegetable production due to temperature, water shortages during dry seasons, etcetera, resulting in high price fluctuations;

Chain constraints	<ul style="list-style-type: none"> • Lack of indigenous vegetables while demand increases • Post-harvest losses due to poor handling, difficult transport, storage, and many other problems through the various stages in the marketing chain • High cost of transport due to poor road conditions and associated spoilage of produce • High congestion, unhygienic conditions, and insecurity at main market centres Poor and unstandardized packaging of produce delivered to wholesale markets • Lack of marketing organizations and information • Lack of sufficient processing capacity • Lack of awareness on the nutritional value of specific vegetables • Lack of some commodities; • Artificial supply and price distortions caused by brokers
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1.2 Constraints and opportunities for vegetable production in Kenya

Here, we summarize a number of studies on vegetables in Kenya. Results overlap, and an overall picture is presented at the end of this chapter.

Morris (2004) identified for the Kabaru District (north Central Kenya) the following barriers in production and marketing:

- *Infrastructure barriers:* The road network is poor and results in high transport costs and post-harvest losses. There are limited (or no) electric services, which are needed for continuous postharvest storage or processing facilities, and for telephone or internet communication with clients) and a limited telecommunication network.
- *Production barriers:* The most mentioned barrier is the lacking of a year round water supply, which results in a serious lack of available water during the dry season. Also of importance is the lack of high quality seeds for crops for domestic consumption.
- *Business and economic barriers:* There is not enough capital to invest in good quality inputs, and insufficient information on and insight in marketing and channels, and consumer behaviour.
- *Educational and Research barriers:* Education of both farmers and extension workers were reported. Applied research is not sufficient.

Wasilwa (2008) mentions that the major factors contributing to the decline of agricultural productivity in sub-Saharan countries the poor soils, decreasing land resources, minimal access to irrigation (only 4% of the land used for agricultural production is under irrigation) and drought which affects 33% of crops produced for food slightly and another 25% severely. Major constraints facing Kenyan horticulture smallholder farmers include:

- high inputs costs
- insecurity
- poor building, farm and road infrastructure
- inadequate extension support services
- limited awareness on market access or market standards
- limited farmer institutions/centres for specific training and information channelling related to horticulture hence minimal capacity building particularly in production

Joshephat and Moi (2010) conducted a study to map the constraints for vegetable production and marketing in Kenya. In this study the farmers indicated that the greatest challenge they faced from planting through harvesting to sale, were vegetable pests and diseases. Major vegetable pests were aphids and cutworms, while diseases noted were leaf and root diseases and blights. Other constraints included steep and rocky terrains that made cultivation cumbersome and inconsistent with environmental recommendations. Farmers also complained of a “shallow market” that could not absorb all vegetables produced. This could be drawn from the fact that nearly everybody produced vegetables and since the markets were local, buyers were limited. Only few farmers (1.6%) reported vegetable loss through rotting due to lack of markets. This could be attributed to the low production levels of the vegetables in the region.

According to Wainwright and Labuschagne (2009) improving production and market development are important to enable the smallholder to obtain a better return.

In a study of 2008 (Ssejjemba, 2008) regarding a value chain analysis for fresh tomatoes produced in Kenya the constraints and opportunities in Table 19. were concluded.

In a study by Wiersinga and De Jager (2007) among farmers in the Kirinyaga district (in the Central Province of Kenya), regarding the development of commercial field vegetable production was noted that “production conditions in Kenya is usually rain-fed and takes place at almost one point in time. Most farmers also lack knowledge and skills on production techniques. This has resulted in low yields compared to other world producers as well as frequently low quality produce.” One of the farmers’ groups in the study mentioned problems like transportation, seeds, shortage of capital, increasing price of fertilisers, no outlet of low quality and no direct contract with the trader (i.e. Maina). Farmers in this study were not interested in organising transportation themselves. Wiersinga and De Jager also reported that knowledge of the farmers’ management strategies was scarce and was fully dependent upon pesticides for pest control. About 40% of the interviewed farmers reported rejection of their produce by buyers, mainly due to glut leading to poor market prices (22%), pests and diseases⁷ (19%), unmarketable small sizes of fruits (12%) and some other reasons Most of the farmers (77%) in this study did not keep any record of their production; spraying or sales of tomato (only 23% did so).

Table 19. Constraints and opportunities in Kenyan value chain.

Actor	Constraints	Opportunity
Farmers	<ul style="list-style-type: none"> • Raising right varieties by farmers (use of substandard seeds/ varieties) • Lack of training sites for farmers on propagation of right planting materials • Diseases, pests and high cost to combat them • Limited funds to improve farmer productivity • Dependency on rainfall which leads to seasonality in production • Lack of information on market prices • High perishability • Many farmers do not have access to effective transport to distant markets at the required time 	<ul style="list-style-type: none"> • Support through research and provision of extension services • Training entomologists and virologists in areas of detection, identification and characterization of whitefly transmitted viruses, white flies and their natural enemies, as well as training in epidemiological research methodologies • Fostering organization of farmers to access financial services and distant markets • Access to irrigations schemes • Distribution of market information to farmers • Strengthening of the tracing and tracking structure to enhance EU accreditation and certification • Investing in cold chain facilities
Traders, retailers	<ul style="list-style-type: none"> • Poor infrastructure i.e. poor roads, lack of space, storage facilities, bad hygienic situation leading to waste • Payment of irregular fines or bribes 	<ul style="list-style-type: none"> • Improvement of infrastructure
Processors	<ul style="list-style-type: none"> • These are quite a few 	<ul style="list-style-type: none"> • Investment in processing facilities • Tapping the regional markets like Rwanda, Sudan, Congo and Burundi

Source: Ssejjemba, 2008.

Onduru *et al.* (2002) reported the following major crop production constraints and options for increased food production in Mbeere District in Kenya.

Major constraints:

- Limited access to high yielding varieties;
- Low and variable rainfall;
- Declining soil fertility (low use of inputs);
- Exacerbation of pests and diseases;
- Poor market infrastructure.

⁷ In common the knowledge of insect pests, diseases and weeds was good because farmers were able to identify and name them. For some farmers this aspect was a constraint in production.

Major options and opportunities:

- Increasing land under cultivation;
- Community bulking of high yielding seed varieties (seed bank);
- Addressing soil fertility constraints: recycling of manure, use of crop residues, use of green manures and cover crops and adoption of agroforestry. Use of combinations of organic and inorganic inputs;
- Efficient water use: timing of planting, water harvesting and soil moisture retention techniques;
- Land intensification through irrigation where possible;
- Farm mechanization through increased use of oxen draught power to reduce labour demands for land preparation and weeding;
- Enhanced skills in integrated crop management (good farming practices, pest management, soil fertility management etc.).

Shiundu and Oniang'o (2007) conducted a study on challenges and opportunities regarding the marketing of African Leafy Vegetables (ALV). They reported the following constraints for ALV marketing and farming in Kenya:

- *Seasonal constraints:* ALV farming (like other agricultural activities in Kenya) relies mostly on rain-fed agriculture. This leads to fluctuating supply of ALVs on the markets. In the remote parts of the country where production of ALV's takes place and most small-scale farmers lack means to transport their produce to far-distant and lucrative markets in the urban centres, this constraint was pronounced often. These smallholders are open to exploitation by middlemen. This constraint can be addressed through value adding processes, particularly solar drying and proper packaging.
- *Physical infrastructure constraints:* The poor state of the infrastructure, particularly roads, found in most of the rural areas where ALVs are cultivated worsens during the rainy season. There is much wastage because of unavailability or limited means of transport to reach the markets at such time. Even those vegetables that manage to get to the markets are poor in quality due to delay and subsequent biological deterioration during transportation and distribution processes.
- *Community related consumption of species:* The nature of ALVs is that each community tends to have a number of species, which they have been exploiting over many years or even centuries. In this regard, some species are only consumed in particular parts of the country. This in a way limits the marketability of some species across the communities, regions, across generations and even gender.

Shiundu and Oniang'o (2007) also reported some opportunities:

- *Irrigation:* Reliance on rain-fed agriculture in production of ALVs has been one of the major obstacles in expanding their production. There is always overproduction of the vegetables in the rainy season and this obviously depresses their prices, and in turn occasioning great losses to farmers and traders. Use of irrigation to produce ALVs during dry season is extremely useful in optimizing farmers' returns when the supply is low in the market. Similarly, irrigation production ensures continued supply, which ensures stability in the prices of vegetables in the market and enabling even the low-income groups to access them.
- *Co-operative structures:* In areas where ALVs is a major economic activity like Kisii region and western province, there have been efforts to mobilize farmers to form groups. The level of organization is still basic. The farmers need to collaborate in order to have a strong voice and a united position as they negotiate for favorable prices for their produce. It is then also easier to transport in bulk if farmers agree on the logistics hence avoid falling victims to the middlemen. This approach may also reduce the transactional cost for farm inputs and aggregate demand for services such as training and advisory services.
- *Export market:* There are possibilities to consider exporting the vegetables. Kenyans in diaspora would relish identifying themselves with the vegetables. The Asian vegetables are a major component of the Kenya's horticultural industry, because of the people of Asian origin who reside in United Kingdom and other parts of Europe. The possibility of exporting ALVs to Africans, East Africans or Kenyans living abroad, is worth investigating for possible action.
- *Capacity building in marketing and business skills:* Public education and promotion of ALVs needs to support the marketing component. Farmers need to be taken through marketing and business skills to enable them maximize output as well as income from their farms. This can be done through workshops and seminars. Farmers can also have exchange-visit programmes to familiarize with marketing concepts, especially those that work.

- *Use by public institutions:* Many public institutions are yet to incorporate the indigenous vegetables - in the wider context, traditional foods- in their dietary systems. Boarding schools and colleges, prisons and hospitals have an opportunity to vary and improve their dietary contents with the highly nutritious indigenous vegetables. Few institutions use these vegetables, and where they do, it is very occasional.
- *Research and extension:* The future of ALVs is dependent on increased research on nutrition and crop genetics, and to improve seed storage facilities, processing and marketing. It is not enough to encourage local farmers to grow their traditional crops. Also successful marketing is important in the effort of creating sustainable livelihoods.
- *Nutritional and toxic properties:* The issue of toxicity is very important, hence the need to develop and apply standard scientific methods to evaluate the nutritional and toxic properties of the ALVs. Further, it is critical to educate the public on the nutritive values of ALVs and possible associated toxicity. This will promote user confidence and increase vegetable consumption.

In the Agricultural Sector Development Strategy 2010-2020 (Republic of Kenya, 2010) the Kenyan Government addressed among others the following key constraints and challenges:

- *Pre- and post-harvest crop losses.* There have been high levels of waste due to pre- and post-harvest losses occasioned by pests and diseases, and lack of proper handling and storage facilities. Smallholder farmers are unable to control pests and diseases due mainly to lack of information.
- *Low and declining soil fertility.* The rising population density has contributed to the subdivision of land to uneconomically small units. In addition, the reduction of fallow periods and continuous cultivation have led to rapid depletion of soil nutrients, declining yields and environmental degradation.
- *Inadequate infrastructure.* Poor rural roads and other key physical infrastructure have led to high transportation costs for agricultural inputs and products. This has reduced farmers' ability to compete. In addition, electricity in rural areas is often not available or is expensive, leading to reduced investment especially in cold storage facilities, irrigation and processing of farm produce.
- *Insufficient water storage infrastructure.* The high variability of floods and droughts is likely to increase with global climate change. Water harvesting and storage infrastructure need to be expanded to store the run-off for livestock watering points, irrigated agriculture and fish farming.
- *Inadequate storage and processing facilities.* Inadequate storage facilities constrain marketability of perishable goods such as fish, dairy products, beef and vegetables. Lack of fish-processing facilities close to Lake Victoria and the coastal area (Mombasa) has limited the extent of exploiting fish resources.
- *Inadequate markets and marketing infrastructure.* While Kenya's agriculture is better developed than that of most countries in Sub-Saharan Africa, the domestic market is too poorly organized to take advantage of the regional market. The local marketing information system has recently been established but has not been well utilized.

In a study conducted by the Dutch Ministry of Agriculture the following problems were reported in the domestic vegetable sub-sector of Kenya (Ministry LNV, 2009):

- Poor wholesale market infrastructure (cool store, packing, handling grading);
- High wastage (20-50%);
- Traders dominate the value chain (high asymmetry of information);
- Product quality is not rewarded in the value chain;
- Fragmentation from production to and of the chain (multiple, non-transparent and long);
- Consumer mistrust;
- Inadequate quality control system, grading and packing of fresh produce in the domestic markets;
- Lack of quality planting materials and seeds;
- Lack of processing capacity.

A very recent concept report of the Embassy of the Kingdom of the Netherlands (2011) mentions water as the main constraint for vegetable production, both the amount of water as the insecurity of water. Increasing water insecurity threatens investments in agricultural production. Often the access to water is a source of conflict between agriculturalists, pastoralists and wildlife. This report also mentions the bad availability of farm inputs to small scale farmers (among others seed supply), losses due to post-harvest inefficiencies (storage, transport and marketing), poorly managed credit

programmes for smallholder farmers, agro-dealers and other players, poor land policy and poor rural infrastructure (roads/railway, energy, market sheds).

Summarized, for vegetable production in Kenya the following constraints have been reported:

Type of constraints	Specific constraints
Infrastructure constraints	<ul style="list-style-type: none"> • Poor (rail)road network, especially in rural areas (results in high transport costs and high post-harvest losses). This even worsens in rainy seasons. • Unavailability or limited means of transport to reach the markets, which lead to high wastage. Also often delay and subsequent quality loss during transportation and distribution processes. • Limited (or no) electric services (which is needed for continuous postharvest storage or processing facilities, but also influences possibility for telephone or internet communication with clients) • Limited telecommunication network • Poor building and farm infrastructure • Insufficient water storage infrastructure. Water harvesting and storage infrastructure is needed to store the run-off for irrigation of crops.
Production constraints	<ul style="list-style-type: none"> • Lacking of year round water supply / low and variable rainfall • Insecurity of water availability • Bad availability of farm inputs to small scale farmers (among others seed supply) • Lack of high quality seeds and high yielding varieties for crops for domestic consumption and of quality planting materials • Declining soil fertility / Low use of inputs • Decreasing land resources • Minimal access to irrigation • Vegetable pests and diseases (aphids and cutworms, leaf and root diseases, blights) • Steep and rocky terrains that make cultivation cumbersome and inconsistent
Business and economic constraints	<ul style="list-style-type: none"> • Due to seasonality of production large fluctuating supply on markets and large fluctuation of prices • Not enough capital to invest in good quality inputs • Insufficient insights in marketing and channels, and consumer behaviour, lack of market information / local markets small compared to high number of vegetable producers • High inputs costs • Insecurity • Poor (wholesale) market infrastructure (includes cool store, packing, handling grading), which leads to post-harvest crop losses • Limited awareness on market access or market standards • Traders dominate the value chain • Fragmentation from production to and of the chain (multiple, non-transparent and long) • Product quality is not rewarded in the value chain • Consumer mistrust • Inadequate quality control system, grading and packing of fresh produce in the domestic markets • Lack of processing capacity • Poorly managed credit programmes
Educational and Research constraints	<ul style="list-style-type: none"> • Limited farmer institutions/centres for specific training and information channelling related to horticulture • Education farmers • Education extension workers • Lack of communication and applied research
Cultural / community constraints	<ul style="list-style-type: none"> • Community related consumption of specific ALVs, due community habits. This limit marketability of some species

1.3 Constraints and opportunities for vegetable production in Nairobi

Foeken and Mwangi (2000) have conducted a research among Nairobi urban farmers. They reported two type of problems among the farmers. The first type of problems is natural, which means that they are not specific for urban farmers. These problems are drought, flooding, poor soil, destruction by animals and pest/diseases. The second type of problems are the so called urban problems, which concerns problem as theft of crops, lack of inputs/capital, plot used as toilet, and threat of destruction of the farm or land (farmers farm on land of others). Especially theft is a serious problem for the urban farmers.

In a study regarding low-income producers' organizations Nyang'wara *et al.* (2007) noted that the existence and practice of urban and peri-urban agriculture by low-income producer groups faces a number of constraints, namely:

- *Legal constraints:* Farming activities in the urban and peri-urban areas of Nairobi are not properly planned or regulated. Legally, urban farming can only be practiced under certain conditions and restrictions. There is absence, inadequacy and inconsistency in policies, legislation and institutional arrangements for regulating the Urban and Peri-Urban (UPA) sub-sector and constraints facing the low-income producer groups. There is need to harmonize the legal, regulatory and institutional frameworks affecting the agriculture sector.
- *Institutional and social constraints:* Kenyan urban planning and management regulations exclude urban agriculture from of the urban land uses. This implies that urban agriculture is an activity that does not receive the critical support services like extension services and credit access. Institutions that would promote UPA are hampered by lack of clear policies. The socio-cultural biases against urban agriculture are often strong, some arising from lack of information sharing among the groups and the consumers. An organized farmer association is required to advocate for recognition and support of UPA.
- *Economic and financial constraints:* UPA lack credit and investment opportunities. The exclusion of UPA from the urban land use system means that the urban farmers cannot benefit from special agricultural promotion credit schemes. Private financiers are reluctant to support urban farmers that are not commercially recognized.
- *Environmental constraints:* The majority of the low-income producer groups live in informal settlements where environmental conditions are not favourable. In these settlements, water is limited and even sometimes lacking and the environmental conditions are of health concern (livestock diseases, missing protective material for people that handle various types of waste, no connection to the city sewerage system). Due to scarcity of water, most of these farmers rely on rainfall while others on riverbanks use the polluted river water or sewage water for farming. It has been observed that some of these farmers use the polluted water to wash their farm produce, which could be dangerous to their health and to other consumers. The bimodal rainfall pattern for Nairobi, just like the rest of Kenya, is a constraint for agricultural production. The long rainy season is from April to June, the short rains from late October to early December. In 'normal' years, two harvests are possible, though maize — which is the staple food — is mostly cultivated during the long rains only. The long-term average is 880 mm of rainfall annually, but the seasonal pattern tends to be quite irregular. This makes agriculture more difficult, as Kenyan agriculture is predominantly of the rain-fed type. The garbage heap in low-income producer residential areas in Nairobi can be of potential use for UPA if managed properly. For instance 1% of organic waste in Nairobi is used for production of compost for use as a bio-fertilizer. The opportunity for waste recycling has not been exploited due to lack of space for waste recycling activities.

Nyang'wara *et al.* (2007) reported from a study among producers/groups in Nairobi city as greatest challenges the lack of tools and equipment (62.5%) and insecure land tenure (54.2%). Other challenges include lack of market opportunities for their products (45.8%), lack of sustainable income (45.8%), and lack of support from local authorities (29.2%), negative consumer attitudes (20.8%), poor transport (26.1%) and illiteracy (20.8%). Less mentioned constraint include lack of support from neighbours (8.3%), lack of extension services (8.3%) and poor leadership (8.3%).

Summarized, for vegetable production in the peri-urban region of Nairobi the following constraints have been reported:

Type of constraints	Specific constraints
Legal constraints	<ul style="list-style-type: none"> • Farming activities are not properly planned or regulated and therefore often illegal
Institutional and social constraints	<ul style="list-style-type: none"> • Urban agriculture is excluded from support services like extension services and credit access • Lack of support from local authorities • Poor transport
Economic and financial constraints	<ul style="list-style-type: none"> • Lack of credit and investment opportunities • Lack of market opportunities for the products • Lack of sustainable income • Negative consumer attitudes
Environmental constraints	<ul style="list-style-type: none"> • environmental conditions are not favourable <ul style="list-style-type: none"> o limited water availability, especially during dry seasons o environmental conditions are of health concern o due to the use of polluted river water or sewage water to wash farm produce, danger for health of consumers (including farmers family)
Production constraints	<ul style="list-style-type: none"> • Lack of tools and equipment • Insecure land tenure
Others	<ul style="list-style-type: none"> • urban problems, as: <ul style="list-style-type: none"> o theft of crops o lack of inputs/capital o plot used as toilet o threat of destruction of the farm or land • Poor leadership • Illiteracy • Lack of support from neighbours

