SNV IMPACT THAT MATTERS

Veggies 4 Planet & People

Value Chain Study on Traditional African Vegetable in Kenya

Kakamega, Kiambu, Kisumu, Machakos, Murangá, Nairobi, Siaya and Vihiga counties

In partnership with

WorldVeg

With the support of

IKEA Foundation

Correct citation
SNV Kenya. 2022. Value Chain Study on Traditional African Vegetable in Kenya: Kakamega, Kiambu, Kisumu, Machakos, Murangá, Nairobi, Siaya and Vihiga counties. SNV Kenya. Nairobi, Kenya

Report
Value chain study on Traditional African Vegetables in Kenya

Version
January 2023

Address
SNV Ngong Lane, off Ngong Road
P.O. Box 30776-00100
Nairobi, Kenya

Consultant
Agile Consulting

Contributors
Anne Mwatha, Worldveg
Jeremiah Rogito, SNV
Leah Mwaura, SNV
Martin Barare, Worldveg
Ralph Roothaert, Worldveg
Rosina Wanyama, Worldveg

Editing, design and layout
Conrad Mudibo, Ecomedia

Image credits
SNV

CONTENTS

List of Tables

List of Figures

ACRONYMS AND ABBREVIATIONS

ADS	Anglican Development Services
AFA	Agriculture and Food Authority
AFMA	African Farm and Markets
CBO	Community Based Organization
CIM	Christian Impact Mission
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Group Discussion
GAPs	Good Agricultural Practices
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH/Germany Development Agency
Ha	Hectares
ICIPE	International Center of Insect Physiology and Ecology
ITK	Indigenous Technical Knowledge
IPM	Integrated Pest Management
KALRO	Kenya Agriculture and Livestock Research Organization
KES	Kenya Shillings
Kg	Kilogram
KII	Key Informant Interview
NARIGP	National Agricultural and Rural Inclusive Growth Project
NGO	Non-Governmental Organization
PSV	Passenger Service Vehicle
SME	Small and Medium Enterprise
SNV	The Netherlands Development Organization
TAVs	Traditional African Vegetables
USD	United States Dollar
VBN	Vegetable Business Network
WVC	World Vegetable Center

Executive Summary

The Traditional African Vegetable sub-sector in Kenya is on an upward trajectory in terms of the increase of area under TAV production and consumption trends. It has been gaining momentum from the awareness campaigns over the last decade and support through research and policy development by the government. While the supply has been increasing, a deficit is observed because of the high and rising demand. The potential for further growth of the sub-sector still exists.

The Veggies for Planet and People project undertook a value chain analysis on the traditional vegetables in eight counties namely Kakamega, Kiambu, Kisumu, Machakos, Murangá, Nairobi, Siaya and Vihiga. The TAV vegetables in focus included African nightshade, amaranth, collards, Ethiopian kale, cowpea leaves, pumpkin leaves and fruits, slender leave and jute mallow.

The value chain study was conducted using a mixture of qualitative and quantitative data collection techniques. A representative sample of VBN actors from seven counties was interviewed which included 252 farmers, 45 traders, 21 consumers, 6 county government officials, 21 agrodealers and 6 NGOs who also work in the same counties through household surveys, key informant interviews and focus group discussions.

Farmer Demographics

Out of a sample of 252 respondents, 57% of the farmers were women who mostly engaged in vegetable growing, with the remaining respondents being men except for Murang'a and Kisumu, where more men than women (67% and 58% respectively).

35% of the farmers interviewed were youth between 18 to 35 years old, followed by 33% of farmers between 36 and 50 years old, and only 2% of farmers were over 70 years old. Kiambu and Kisumu had highest numbers of young people engaged in vegetable growing at 26% and 17% respectively, while Vihiga and Kakamega had the fewest (6% and 5% respectively).

Majority of farmers had basic education with most of them reporting having completed primary and secondary levels of education (49 and 26% respectively). Only 18 percent of the farmers reported having a tertiary level of education (university and college) with the highest numbers in Kiambu, Kisumu, and Vihiga (25 percent). These counties border major cities, namely Nairobi and Kisumu. A few (6%) farmers lacked any formal education with the highest number in Siaya.

Production

Overall, the most popular TAVs were the African nightshade (76%), cowpeas (63%), and amaranth (53%). Others were spider plant and slender leaf at 39%, pumpkin leaves at 32%, jute mallow at 31%, Ethiopian kale (24%), and vine spinach (6%). *Cucurbita focifolia* (kahurura) was at 2% and its production was limited to the central region of Kenya. Among other vegetables grown, kale is the most popular as reported by 68% of farmers.

The average size of owned land allocated to vegetables was 0.5 acres per household. Some farmers reported leasing land elsewhere for vegetable production especially near the rivers where they could use irrigation during the dry season. The average size of land leased was 0.2 acres per household. Farmers in Kisumu reported the highest land size allocated to vegetable production, both owned and leased land, with each household having an average of 0.84 and 0.46 acres for owned and leased land respectively. Kiambu and Siaya had the lowest land sizes owned at 0.32 and 0.34 acres per household respectively.

57% of the farmers interviewed reported cultivating TAV seeds obtained from informal sources such as from other farmers (11%), farmer saved seed (21%) or from the local market (25%). TAV seeds obtained from informal sources were preferable because they were less expensive, readily available, and catered to the tastes and preferences of the community reported in crops like African nightshade and Slender leaf. 37% of the farmers also purchased seed from agrodealers. Most of the seed were mainly of exotic vegetables such as Tomatoes, Swiss chard, and Onions.

Farmers were interviewed on the awareness and adoption of regenerative technologies. The technologies with the highest awareness level were use of organic manure and crop rotation (94%), followed by mulching (84%), composting (77%), agroforestry (74%), use of cover crops (73%), and micro-irrigation (70%). Bio slurry, bio-fertilizers, vermicomposting, and biochar were less popular amongst the farmers.

The use of the regenerative technologies also varied with crop rotation and use of organic manure at by 96 and 93% respectively. The two practices had over 90 percent adoption rate across all the counties. Mulching, use of cover crops, minimum tillage, and composting were applied by over 70% of the farmers interviewed. The least applied technologies were vermicomposting, soil testing, and post-harvest handling with 25, 28, and 37% adoption rate respectively. This is also reflected by their low levels of awareness on those technologies.

Majority of farmers reported to rely heavily on rainfall for vegetable production with only 27% of respondents irrigating through furrows, flooding, sprinkling or drip. Another 42% use buckets and watering cans while the rest (31%) didn't use any irrigation at all. Within those who had adopted irrigation, Kiambu (32%), Machakos (28%), and Kisumu (22%) had the greatest irrigation adoption rates, while Vihiga and Siaya had the lowest, with one and two percent of respondents, respectively. The higher adoption of irrigation in Kiambu, Machakos, and Kisumu counties can be linked to their closeness to major urban centers (Nairobi and Kisumu), which gives a larger and ready market, resulting in a drive to have year-round output.

The services accessed by farmers include extension and advisory services and financial services. The extension services are mainly sourced from other farmers and NGOs and development agencies working in the counties. To access capital farmers rely on their savings and table banking credit facilities to access capital.

Marketing Channels

On average, farmers interviewed indicated that they sold 60% of the total productio. Most of the vegetables produced in Murang'a, Kiambu, and Machakos were mainly for the market (fully commercialized) with Kiambu and Murang'a counties leading in African nightshade, amaranth, kales, spinach, and tomato sales per household, while onion and cowpeas average sales were highest in Machakos County.

72% of the farmers interviewed sold their produce at farmgate. Overall, the local open-air market retailers and wholesalers/middlemen formed the major vegetable marketing channels as reported by 57 and 33% of the farmers respectively. This was largely attributed to low volumes per farmer considering that the majority sold their vegetables individually.

Vegetable trading was mainly dominated by women (77%). Most of them were middle-aged, between 36 and 50 years, and only 20% of them were youth. Due to the perishability nature of the products coupled with a lack of storage facilities within the markets, most traders reported sourcing vegetables on daily basis (68%) to curb losses. They source the products directly from the farmers (71%) with exception of Nairobi where a majority relied on wholesalers in major markets like Muthurwa/Marikiti, Wangige, and Kangemi.

Data collected from the markets indicated that traders sold a range of TAVs. The African nightshade, amaranth, cowpeas, and kales were the most popular vegetables sold while the least was pepper. Bin addition, the same traders also merchandised other TAV competing products such as Indian vegetables at Nairobi city park and Ngara markets, cabbage, Lake Victoria sardine (Omena), fish, and pulses as well as complementary products including herbs and spices such as coriander, garlic, and ginger, carrots, courgette, among others.

Consumption

Consumption of TAVs has been on the rise in both rural and urban areas. This has largely been driven by increased consumer awareness of the nutritional value of the TAVs, urbanization, and improved consumer incomes. The choice for the specific vegetables was driven by consumer demand and profitability. There was a relatively higher demand for African nightshade, amaranth, cowpeas, and kale as compared to other vegetables and this explains their popularity among the traders. The demand was attributed to availability and nutritional value perceived by consumers. Another factor driving choice was accessibility to the supply points.

In terms of volumes sold, kales and spinach were leading with each trader trading an average of 541 and 320 kg every week respectively. This was closely followed by African nightshade and Amaranth at approximately 308 and 235 kg traded per week per trader respectively. The higher volumes traded for kales and spinach is explained by their relatively heavier weight as compared to the TAVs.

Policies, Rules and Norms

Both formal and informal rules govern the vegetable value chain sector in Kenya. The formal rules exist in the government of Kenya policy and regulatory framework while informal rules are contained in local communities' norms and values. For instance, despite women being mostly engaged in the production and trading of vegetables, they have limited access to land and credit facilities. This is because land is majorly owned by men who are the decision makers on allocation of land to various enterprises. There is also a limitation to the youth in engaging in vegetable farming. In addition to limited land access, the youth also have a negative attitude towards agriculture and would rather engage in other business activities like motorcycle transportation and other non-farm activities which they perceive to have quicker financial returns.

Recommendations

Seed access and quality is a significant challenge in vegetable production. It is therefore recommended that through the support of the project, farmer groups should be supported to carry out seed multiplication, certification, and bulking to ensure accessibility of quality seeds. Market linkages with the formal and informal offtakers is crucial for further development of the traditional vegetables value chain. The level of uptake of regenerative technologies and good production practices is till low. Investing in capacity building of VBNs as well as awareness campaigns on commercial regenerative products and differentiated organic produce is markets may be necessary to promote uptake of the regenerative and circular technologies.

1.0 INTRODUCTION

1.1 Background Information

Traditional African Vegetables (TAVs) are crops whose natural habitat originated in Africa. They represent an important component of Africa's agricultural past, yet they have gradually disappeared from people's diets and fallen into agricultural neglect, leading to huge losses in the diversity of foods available (Wasike *et al*, 2018). The most popular ones include black nightshade (*Solanum spp*.), spider plant (*Cleome gynandra*), amaranth (*Amaranthus spp*.), cowpea leaves (*Vigna unguiculata*), jute mallow (*Corchorus olitorius*), slender leaf (*Crotalaria brevidens*), pumpkin leaves (*Cucurbita pepo*.), African kale (*Brassica carinata*), among others (Abukutsa, 2010). Globally, the use of African leafy vegetables is as old as the man himself. In South Africa for example, some people have used these vegetables for 120,000 years (van Rensburg *et al*., 2007).

The use of these vegetables is part of cultural heritage, playing a significant role in customs and traditions and in maintaining equity within the family structure since their appearance on the family table depends largely on the work of women (Musotsi *et. al.,* 2018; Abukutsa-Onyango, 2010). Unfortunately, some varieties that were consumed in older times have become extinct. In South Africa, more than 100 species of TAVs have been identified but only a few species are still being utilized (Maseko *et. al*, 2018). According to Abukutsa-Onyango (2010), the introduction of exotic vegetables in the African continent had some negative impacts on the consumption and domestication (cultivation) of TAVs. Although TAVs have been an integral part of agricultural systems in Africa, most African countries have not given priority to the development of the crop (Kebede and Bokelmann, 2017). It is until recently that they have featured in the research agendas of international and local organizations.

Through greater production and consumption of these vegetables, we can eliminate malnutrition and promote healthy diets in Africa. However, there are currently low consumption levels of TAVs in the continent against the minimum recommended level of 73 kg/person per year (Abuktusa-Onyango, 2010). According to Abukutsa-Onyango (2010), statistics indicate that Nigeria is leading at 60kg/per person per year, followed by Kenya, at 40 kg/person annually, while Uganda, Ethiopia, the Democratic Republic of Congo, and Mozambique were identified as countries with the lowest consumption rates of below 20 kg/person annually.

TAVs form part of the horticultural crops in Kenya. They also have been part of diets in Kenya for generations as part of the diverse culture of the people. Initially, upon the introduction of exotic vegetables such as cabbage, spinach, and kales during the colonial period, the TAVs were often referred to as the poor man's diet (Bayesian Consulting Group, 2020). However, despite the alternatives (exotic species), consumption of TAVs is increasing significantly due to growing recognition of higher nutritional value as well as the increased population in both rural and urban areas. While there is a wide range of TAVs in the country, the main types of TAVS prioritized in the V4P&P include; i) African nightshade (*Solanum spp.*)-*Managu;* ii) Amaranth (*Amaranth spp.)- Terere; iii*) Ethiopian mustard (*Brassica carinata*); iv) Cowpea leaves (*Vigna unguiculata*)- *Kunde*; v) Pumpkin leaves and fruits (*Cucurbita moschata*); vi) Slender leaf (*Crotalaria brevidens*)- *Mito; vii)* Jute mallow (*Corchorus olitorius*)- *Murenda.* Other vegetables of importance to the study include kale, spinach, tomato, onion, and pepper.

Black nightshade (*Solanum spp*.)

Spider plant (*Cleome gynandra*)

Amaranth (*Amaranth spp.*)

African kale (*Brassica carinata)*

Cowpea leaves (*Vigna unguiculata*)

Slender leaf (*Crotalaria brevidens*)

Pumpkin leaves (*Cucurbita pepo.*)

Jute mallow (*Corchorus olitorius*)

TAVs are mostly grown in rural areas and support a significant proportion of households (Abel *et al*., 2019). The rural population depend on them both as a source of food and income. These TAVs, account for 30 per cent of all the vegetables marketed in Kenya[1] and the supply does not meet the demand despite increasing production over time (in 2018, the area, volumes, and values for TAVs increased by 20, 31, and 10 per cent respectively). During the period 2016 – 2017, the area under these vegetables increased by 6 per cent from 63,314 ha to 66,879 ha. The yields and value increased from 229,492 tons to 265,267 tons and KES 6.83 billion to KES 8.01 billion, a 16 and 17 percent increase respectively (AFA, 2017). All these factors create an excellent opportunity for V4P&P to apply innovative solutions to transform the sub-sector into a more sustainable, dynamic, and inclusive sector ultimately contributing to increased employment as well improve environmental and human health through the safe production of vegetables.

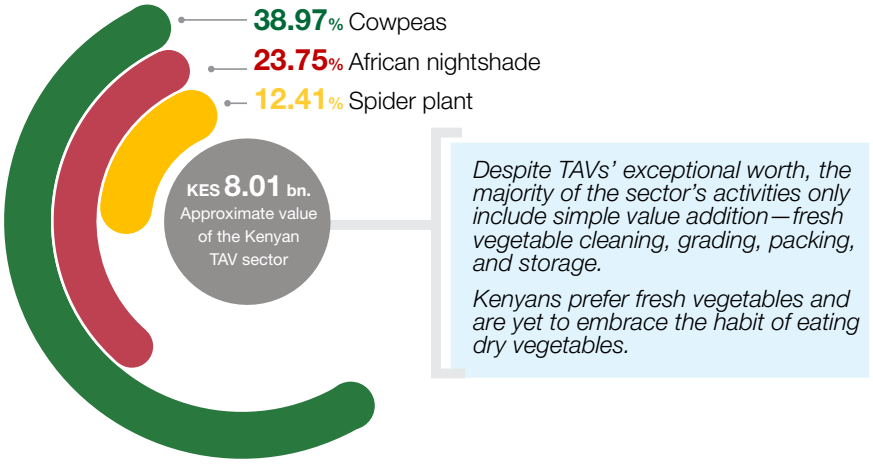
1 Horticulture validated report 2017-2018 – AFA

Most TAVs traded on marketplaces are sold within one to two days due to their perishability to prevent post-harvest losses. Most traders sell in the county or local markets. A few farmers have official market structures where they pool their products and provide them to supermarkets, and businesses like hotels, schools, and hospitals (Chelang'a, Obare, and Kimenju, 2013). This shows that varied TAVs marketplaces are available and reachable. Producers across all counties sell indigenous vegetables in fresh form. The local customer preference for fresh vegetables over dry vegetables is what motivates this. Although it exists, the potential to export TAVs, especially to Kenyans or East Africans residing abroad, has not yet been completely realized (Shiundu and Oniang'o, 2016). Despite this, there has been an increased demand in the diaspora particularly in the United Kingdom (AFA, 2019).

According to AFA (2017), the value of the Kenyan TAV sector is estimated to be KES 8.01 billion (USD 80 million), with cowpeas accounting for 38.97% of this total, with African nightshade at 23.75%, and spider plant at 12.41%. Despite this exceptional worth, the majority of the sector's activities only include simple value addition. These include fresh vegetable cleaning, grading, packing, and storage in a shaded area to prevent withering. This shows clearly that Kenyans prefer fresh vegetables and are yet to embrace the habit of eating dry vegetables. Only a small number of SMEs dry and process these vegetables on a commercial scale, often with export as their primary market. Other small and medium enterprises (SMEs) are involved in processing amaranth flour from the seed. The flour is exported and also used locally as an ingredient in several foods such as nutritious soup and porridge.

Due to rising consumer demand, there has been vast increase in marketing, resulting in TAVs being sold in supermarket chains and other profitable markets, resulting in higher earnings (Mwaura, Muluvi, and Mathenge, 2013). The preference for consumption of TAVs has been increasing in Kenya due to their nutritional value and safety levels as consumers perceive them to have no pesticide residue since very little inorganic fertilizer and pesticides are used during production (AFA, 2017). Consumption-driven forces such as rapid population growth, rural-urban migration, rising incomes, changes in dietary habits, the availability of TAVs in high-valued retail outlets such as supermarkets and green groceries, and demand from institutions and hotels all contribute to the high and rising demand in urban areas. (Gogo, Ulrichs, Huyskens-Keil, and Opiyo, 2016). Supermarkets and green grocery stores are characterized by continuous supply, a broader selection of TAVs, grades, formal packaging, and consistent prices. They also offer greater pricing on comparable terms to established traditional markets. (Jalang'o, Kosura, and Otieno, 2016). However, the current supply does not meet the demand. There is an estimated annual deficit of about 300,000MT annually despite increasing production over time (Bayesian Consulting Group Limited, 2020).

The micronutrient composition of TAVs strengthens the case for their market appeal even further. Vegetables are a vital component of the human diet as they provide essential micronutrients that ensure proper development of the human body and good health (Abukutsa-Onyango, 2010). They contain significant amounts of chemical substances often categorized as antioxidants. These chemical compounds are necessary for scavenging and binding damaging radicals in the body, which if unregulated can lead to diseases such as cancer and diabetes.Research shows that TAVs contain essential vitamins, particularly A, B and C, and minerals (such as calcium and iron) as well as supplementary protein and cal-



ories. Other convincing justifications for TAVs focus on their reported medical benefits and are grown for home consumption

Market research on purchasing patterns of TAVs in low-income areas in Nairobi County (AFMA, 2018) established that nutritional value was the major factor that consumers consider when buying TAVs compared to exotic ones (94per cent). The consumers further explained that the TAVs were highly recommended by health practitioners for their high content of nutrients such as vitamins and minerals. TAVs are well known to have health-promoting properties and to be a significant source of some essential, rare micronutrients, such as iron, vitamin A, and antioxidants (Singh et al. 2012, 2013). In addition, they can be eaten along with starchy staples as part of a balanced diet and help to alleviate some nutrient deficiencies in current diets. TAVs don't contribute to stomach distress and acidity like other vegetables, such as kale. The survey also showed that when choosing which vegetables to buy and where to buy them, customers take into account a variety of factors. Quality, as measured by the vegetables' freshness and cleanliness, was placed highest, followed by accessibility and availability and price. A key factor in determining where the household purchases its TAVs is their freshness.

The age of the crop at the time of harvest is another element that influences consumer demand for TAVs. The majority of vegetables, especially nightshades and spider plants, are favoured at around 8 weeks, whereas for cowpeas 4 weeks is preferred because this is when they are regarded as being soft and delicious. Prolonged growth produces a bitter taste, which decreases consumer demand. Gender, age group, and marital status are socioeconomic factors that affect purchase decisions. Due to the time and expertise required for their preparation, young people rarely purchase traditional vegetables for consumption. As a result, TAVs are primarily consumed in homes where the women have the time and cooking skills to prepare them.

The way in which TAVs are consumed is also influenced by sociocultural values. When compared to other places, some TAVs have more demand since they are thought to be native to particular ethnic groups or geographical areas. In Kenya for instance, consumption of TAVs is particularly high in the Coast, Nyanza, and Western Provinces regions (Gogo et al, 2016). It is noteworthy that consumers in these areas buy multiple types of TAVs and combine or blend them while cooking. For instance, "amaranth is best when blended with cowpeas, sukuma wiki, or spider plant." Some consumers prefer them prepared the traditional way, which is to boil them rather than fry them in cooking oil. They believe that using modern cooking methods like frying destroys the flavor and nutritional value of the food.

TAVs also contribute in a variety of ways to climate resilience and environmental sustainability (Rampa and Dekeyser, 2020). The advantages include short production cycles, adaptation to tough or challenging conditions, lower input requirements compared to other crops, and a reduced need for herbicides and pesticides due to their excellent disease resistance. Although TAVs can withstand and tolerate many stresses, such as pests and droughts, irregular rainfall, and other unpredictable weather, it is difficult to quantify the impact of climate change, pests, and diseases (including the recent locust invasion in East Africa) on TAV production in Kenya.P Thus, preserving TAVS, as traditional knowledge always did, is a coping strategy and their promotion can sustain crop diversity at the level of both individual farms and the larger food system. Additionally, diversification lowers both individual farmers' and collective risks of crop failure brought on by climatic changes, weather-related catastrophes, or the prevalence of pests and diseases. TAV expansion in Kenya has a significant potential to enhance environmental sustainability due to its suitability for intercropping and nitrogen fixation (including staple crops like maize, beans, and other root crops), which results in healthier soils (increasing soil organic matter). However, the widespread use of chemicals and water during the commercial production of TAVs may raise additional issues that could be harmful to the environment.

Regenerative agriculture is an emerging holistic approach to food production that strengthens the ecosystem. In addition to producing good yields of high quality, the management practices also improve soil health, increase biodiversity and contribute to sustainable management of water and waterways (Hagelberg et al, 2020). One of the advantages of regenerative agriculture is carbon sequestration of the soil. Carbon is sequestered in soil by plants through photosynthesis and can be stored as soil organic carbon (SOC).

One of the advantages of regenerative agriculture is carbon sequestration of the soil.

Agroecosystems can degrade and deplete the SOC levels but this carbon deficit opens up the opportunity to store carbon through regenerative aagriculture. The absence of chemical pesticides, agroforestry, biochar, compost, crop residue retention, cover cropping, crop-livestock integration, and reduced tillage are a few examples of activities that are promoted as regenerative technologies. In some areas of Sub-Saharan Africa, regenerative agriculture technologies have improved yields of staple crops. However, the adoption of similar technologies in the vegetable subsector is still low among small-scale farmers.

The primary TAVs planted in central Kenya, in order of importance are African nightshade, amaranth, cowpeas, and Ethiopian kale. These vegetables are mostly grown by the farmers for commercial purposes. They benefit from being close to Nairobi County, which is a significant market for TAVs and is only 50 kilometers away from Kiambu County. Given that the majority of farmers have access to water sources, the irrigated production system is used (AFMA, 2018). This makes it possible for them to have a steady supply for most of the year. The farmers intercrop the TAV on the plot of land since there is a scarcity of land. TAVs like cowpeas are grown alongside food crops including maize, beans, and bananas.

Different TAV varieties – such as African nightshade, pumpkin leaves, cowpeas, amaranth, slender leaf, jute mallow, and Ethiopian kale – are cultivated in Kenya's Western and Nyanza regions, though the extent and level of cultivation varies by community. Despite recent advancements in the commercialization of the value chain, the majority of farmers still cultivate them for subsistence. In addition, the vegetables are grown alongside other food crops like maize, cassava, beans, groundnuts, millet, etc. The majority of the farmers are indigenous people who understand the value of intercropping. Their production is mainly rain-fed with farmers producing them during the long rain season (March to June) and the short rain season (October to December) (Abukutsa-Onyango, 2010). Limited seed quality, pests, and diseases, drought, ineffective marketing strategies, poor market accessibility, ignorance of good agronomic practices, and utilization packages are the main challenges faced.

Though the extent and level of cultivation varies by community, African nightshade, pumpkin leaves, cowpeas, amaranth, slender leaf, jute mallow, and Ethiopian kale are a few examples of these varieties.

Table 1. Trend of TAVs in Area, Volume, and Value in 2017-2018

Crops	2017			2018			Percent of total
	Area (Ha)	Volume (MT)	Value (KSh)	Area (Ha)	Volume (MT)	Value (KSh)	
Cowpeas	31,353	79,345	2,335,372,492	36,745	119,326	2,495,426,701	30.61
African nightshade	4,634	48,643	1,817,129,275	6,849	68,828	2,378,251,829	29.17
Spider plants	3,427	27,299	1,054,324,056	3,758	28,932	1,051,113,259	12.89
Leaf amaranth	2,277	23,079	788,770,073	3,264	31,843	927,658,213	11.38
Pumpkin fruit	1,293	21,993	568,311,788	1,380	24,267	569,098,694	6.98
Slender leaf	521	6,789	294,698,000	767	7,092	302,511,741	3.71
Jute mallow	466	3,996	178,310,930	608	3,971	157,389,227	1.93
Pumpkin leaves	837	5,421	167,604,936	716	4,969	150,877,111	1.85
Grain amaranth	376	974	70,425,400	314	903	68,096,067	0.84
Vine spinach	229	1,687	42,576,000	250	1,708	47,264,377	0.58
Malabor	40	128	2,221,499	38	116	2,182,097	0.03
Russian comfrey	56	105	1,052,500	51	143	1,847,000	0.02
Total	45,508	219,458	7,320,796,948	54,740	292,096	8,151,716,317	100.00

Source: AFA-Horticulture Crops Directorate (2018)

1.1.1 Project Background

The Veggies 4 Planet and People (V4P&P) is a five-year project being implemented by SNV in partnership with the World Vegetable Center (WorldVeg). In Kenya, the project aims to create jobs and income, particularly for youth and women, in the vegetable sector and improve environmental and human health through the safe production of vegetables. This will be achieved by establishing 120 vegetable business networks engaging an estimated 2,400 women and youth in market activities designed to improve their livelihoods and diets.

Accordingly, V4P&P is ultimately meant to lead to the four following outcomes;

a) Identification, assessment, and strengthening of Vegetable Business Networks (VBNs)

b) Promotion of the use of regenerative and circular technologies in vegetable production

c) Building of strong commercial vegetable seed systems

d) Awareness and demand creation for sustainable technologies, business services, seeds, other inputs, and safe vegetables and vegetable products.

1.2 Purpose and Objectives of the Assignment

The purpose of the assignment was to conduct a value chain study that sought to understand production characteristics of producers, availability, and type of markets and the relationship with producers as well as the roles of stakeholders in the enabling environment, rules and regulations, policies, and standards set by the government affecting the vegetable value chain and identification of opportunities for youth and women to increase their incomes.

The specific objectives were to;

a) Select viable vegetable value chains in the regions of focus and analyze their potential in terms of production, irrigation facilities, availability of market, and demand from consumers.

b) Identify existing Vegetable Business Network (VBN) actors, their relationships, and entry points in the development of functional and sustainable VBNs

c) Identify and assess the existing regenerative/circular technologies adopted by producers and practiced and potential ones to be promoted

d) Assess the enabling environment surrounding the vegetable value chain including but not limited to extension providers, government interventions, development partners and their projects, rules and regulations, informal rules and norms, etc.

2.0 Study Approach and Methodology

2.1 Study Approach

The study used a mixed-methods approach utilizing both quantitative and qualitative techniques. Diverse methods were used to gather information to generate rich data that is credible. This involved collecting data from a significant sample of respondents across the prioritized TAVs value chains, and more important, incorporated a range of questions and encouraged participation by all the value chain actors and stakeholders.

2.2 Study Methodology

2.2.1 Study areas, sample size, and sampling techniques

The value chain study took place in Nairobi, Kiambu, Murang'a, Machakos, Kisumu, Vihiga, Siaya, and Kakamega counties (see Figure 1) between the months of June and July 2021. These counties were selected as priority counties for the project implementation. The target respondents were farmers, farm inputs distributors, traders, consumers, county governments agricultural staff, Non-Governmental Organizations (NGOs) and Community Based Organizations (CBOs), seed companies, and research organizations such as the Kenya Agriculture and Livestock Research Organization (KALRO) and the Kenya Plant Health Inspectorate Service (KEPHIS).

SNV provided a list of VBNs / farmer groups for each county. The names of the VBNs in each county were arranged chronologically, and three farmer groups were sampled from the list using systematic random sampling. A total of 18 farmers were sampled from the selected groups with the number allocated proportionately based on the total number of farmers in each group. An additional 18 farmers who did not belong to a farmer group but within the same location were sampled using the snowball technique. In both groups, the process ensured the inclusion of women and youth. A total of 36 farmers were sampled from each county with 50% belonging to the VBNs.

The key informants were identified using the snowballing technique. The categories respondents included:

- Agricultural officers from the county governments
- Representatives from development partners working on TAVs which included the National Agricultural and Rural Inclusive Growth Project (NARIGP)
- NGOs/ CBOs
- Traders and key off-takers
- Consumers
- Stockists and distributors of farm inputs and irrigation equipment
- Seed companies
- KALRO
- KEPHIS

The list of respondents is attached in Annex 2.

In each county, one Focus Group Discussions (FGD) was conducted consisting of 10 TAVs farmersThe selection of the 10 participants made sure that at least 50% of them were women and youth. Table 2 below shows the sampling frame in each county.

Table 2. Sampling Frame

County	Category of respondents	Sample size
Murang'a	Farmers	36
	Traders	3
	Consumers	3
	Input distributors	3
	Ministry of Agriculture	1
	NGO	1
	FGD	1
Machakos	Farmers	36
	Traders	3
	Consumers	3
	Input distributors	3
	Ministry of Agriculture	1
	NGO	1
	FGD	1
Kiambu	Farmers	36
	Traders	3
	Consumers	3
	Input distributors	3
	Ministry of Agriculture	1
	NGO	1
	FGD	1
Vihiga	Farmers	36
	Traders	3
	Input distributors	3
	Ministry of Agriculture	1
	NGO	1
	FGD	1

County	Category of respondents	Sample size
Kakamega	Farmers	36
	Traders	3
	Consumers	
	Input distributors	3
	Ministry of Agriculture	1
	NGO	1
	FGD	1
Kisumu	Farmers	36
	Traders	3
	Consumers	3
	Input distributors	3
	Ministry of Agriculture	1
	NGO	1
	FGD	1
Siaya	Farmers	36
	Traders	3
	Consumers	3
	Input distributors	3
	Ministry of Agriculture	1
	NGO	1
	FGD	1
Nairobi	Traders	30
	Consumers	3

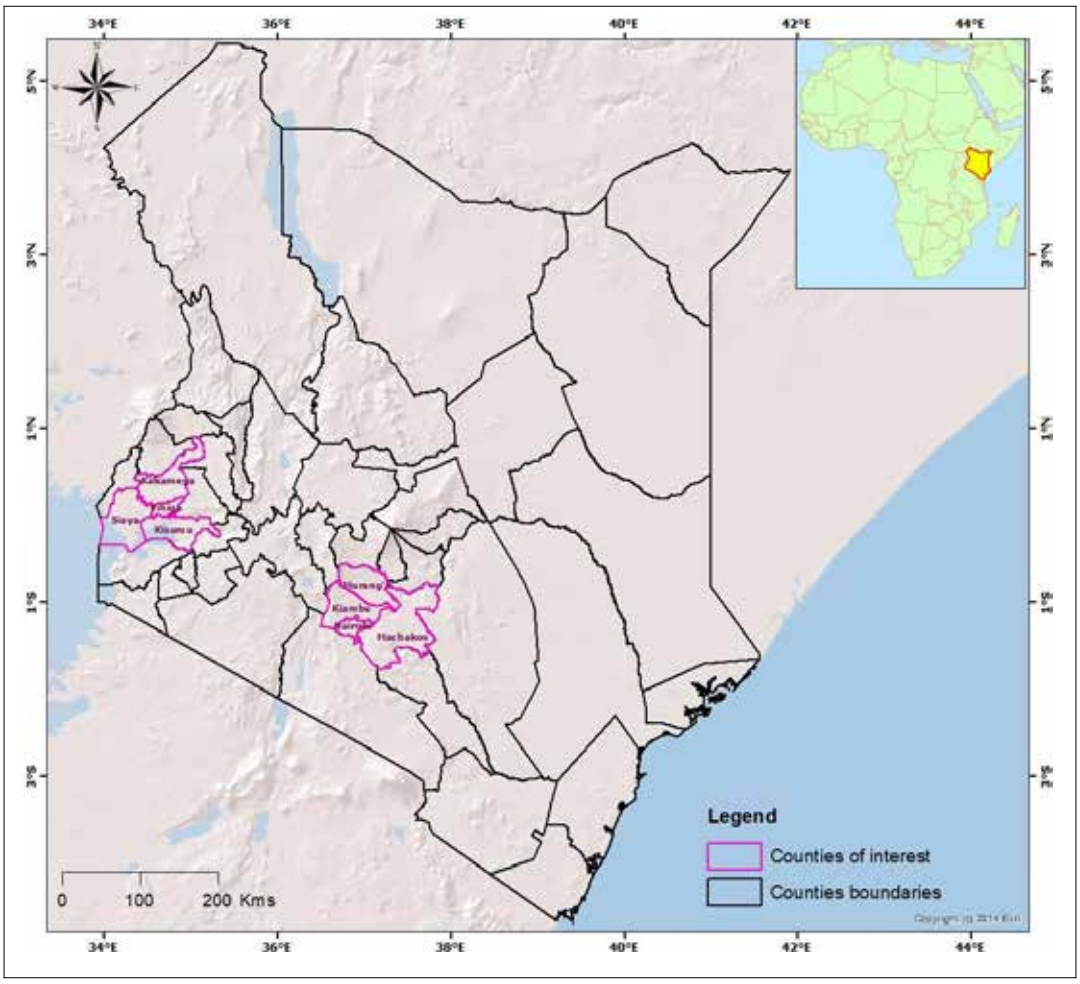


Figure 1. A map of Kenya showing the counties under the study

2.2.2 Data Collection Methods

Both qualitative and quantitative techniques were applied in data collection The qualitative techniques included the use of in-depth surveys, FGD, review of project and contextual literature on ongoing projects of traditional African vegetables, Key Informant Interviews (KII) with actors who have been involved in the value chains, observations, and stakeholder consultations, amongst others.

The quantitative techniques comprised of face-to-face interviews that were administered using a structured questionnaire anchored on ODK[2] application.

2 https://docs.getodk.org/collect-intro/

Figure 2. A Focus Group Discussion in session at Matungulu, Machakos County

2.2.3 Data Analysis and Presentation

The quantitative data obtained from the structured questionnaires was analyzed using SPSS[3] (version 25) and Excel. The analysis involved descriptive statistics (frequencies, means, and standard deviations. The outputs of the analysis were presented in tabulation and charts. Qualitative data was analyzed using thematic and content analysis and presented in prose form. Using the analysis, the consultants delivered a comprehensive report documenting selected TAV value chains and differences across the counties, production and marketing characteristics, types of regenerative technologies used, and the existing environment as per the study objectives.

3 https://en.wikipedia.org/wiki/SPSS

3.0 STUDY FINDINGS

This section presents the findings per each objective of the study. It is preceded by a sub-section on demographic characteristics of the respondents who participated in the quantitative survey.

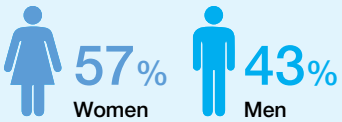
3.1 Demographic Characteristics

3.1.1 Gender

According to the study results, out of a sample of 252 respondents, 57% of the farmers were women who mostly engaged in vegetable growing, with the remaining respondents being men. With the exception of Murang'a and Kisumu, where more men than women were involved in the production of vegetables, this was common in other counties (67% and 58% respectively)

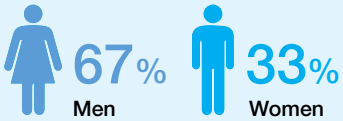
Table 3. Gender distribution of farmers per county

	Variable	Frequency	Percent
Kakamega	Women	22	61
	Men	14	39
Kiambu	Women	19	53
	Men	17	47
Kisumu	Women	15	42
	Men	21	58
Machakos	Women	24	67
	Men	12	33
Murang'a	Women	12	33
	Men	24	67
Siaya	Women	27	75
	Men	9	25
Vihiga	Women	24	67
	Men	12	33

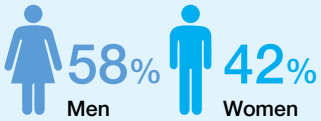


In Kakamega, Kiambu, Kisumu, Machakos, Siaya and Vihiga most farmers engaged in vegetable growing were women

Muranga



Kisumu



In Muranga and Kisumu, more men than women were involved in the production of vegetables

3.1.2 Age

According to the study's overall findings, 35% of the farmers interviewed were youth between 18 to 35 years old, followed by 33% of farmers between 36 and 50 years old, and only 2% of farmers were over 70 years old. In terms of counties, Kiambu and Kisumu had the largest and lowest numbers of young people engaged in vegetable growing, respectively, while Vihiga and Kakamega had the fewest (6 and 5 percent respectively). Figure 3 below illustrates this.

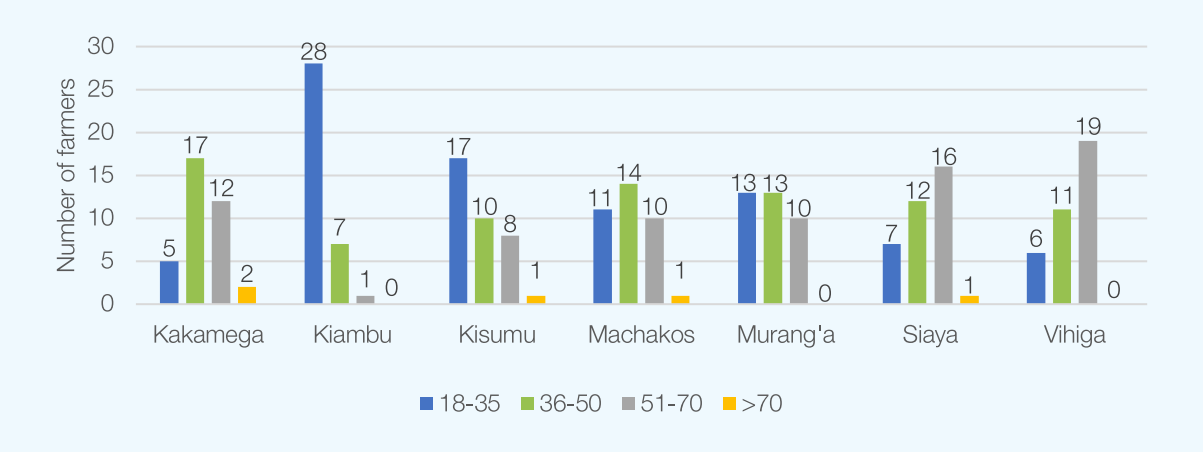
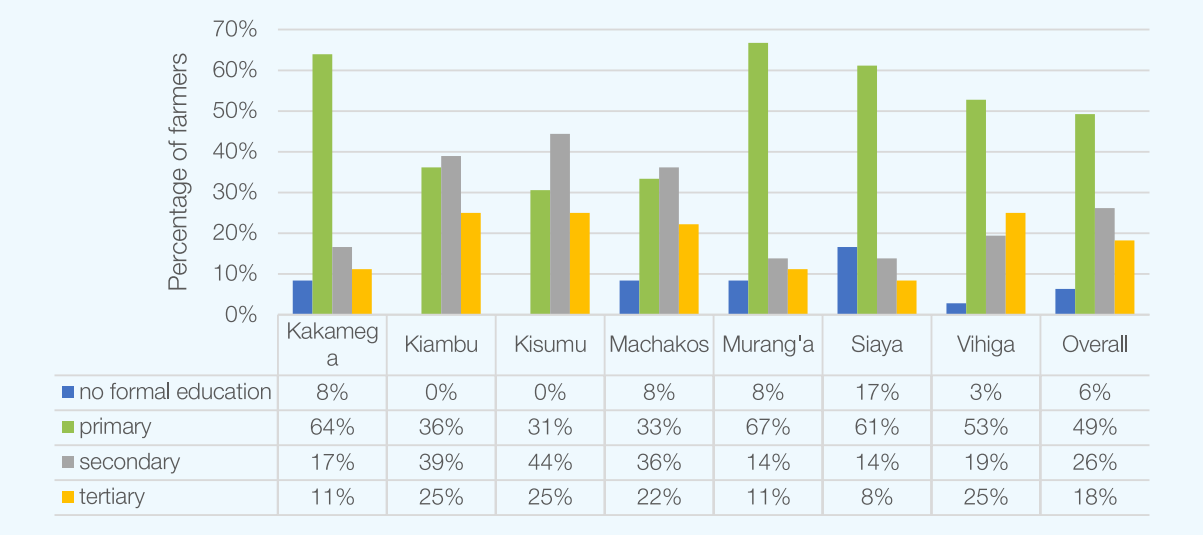


Figure 3. Age distribution of farmers per county

Kiambu and Kisumu had the largest and lowest numbers of young people engaged in vegetable growing, respectively, while Vihiga and Kakamega had the fewest (6 and 5 percent respectively).

3.1.3 Education

Most farmers reported having completed their primary and secondary education levels, and the majority of them had basic education (49 and 26 percent respectively). The areas with the largest percentages of farmers who reported having tertiary education (college and universities) were Kiambu, Kisumu, and Vihiga (25 percent). These counties share borders with two large cities: Nairobi and Kisumu. Six percent of farmers lacked any formal education with the highest number in Siaya (Figure 4 below).



	Kakamega	Kiambu	Kisumu	Machakos	Murang'a	Siaya	Vihiga	Overall
no formal education	8%	0%	0%	8%	8%	17%	3%	6%
primary	64%	36%	31%	33%	67%	61%	53%	49%
secondary	17%	39%	44%	36%	14%	14%	19%	26%
tertiary	11%	25%	25%	22%	11%	8%	25%	18%

Figure 4. Farmers' education level

3.2 Value Chain Map

This value chain map of TAVs consists of several actors from production to consumption. It depicts the relationships existing between different actors in TAVs from production to consumption. Within the value chain map, each actor plays their role in the system. Figure 5 below shows the TAVs value chain map and interactions by the different actors.

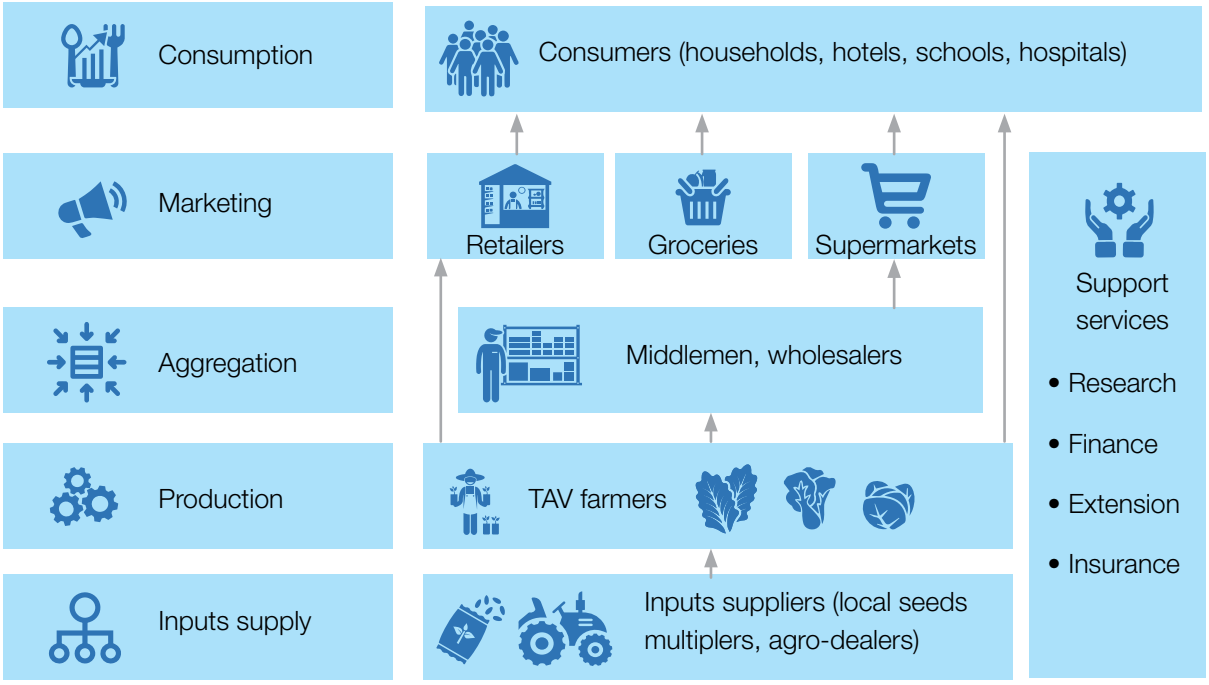


Figure 5. TAVs value chain map

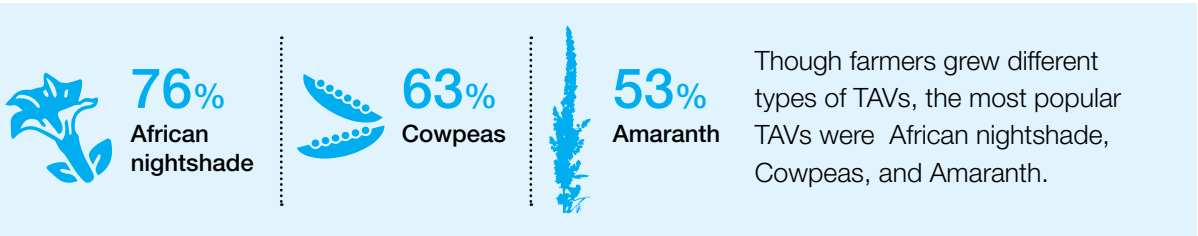
The prices for the respective varieties of TAVs at different stages in the value chain are discussed in section 3.3.4 (demand and supply analysis) and highlighted in Table 12.

3.3 Selected Vegetable Value Chains

This section presents findings on selected viable vegetable value chains in the different counties of focus and an analysis of their potential in terms of production, use of irrigation facilities, availability of market, and demand from consumers

3.3.1 Types of Vegetables Grown

According to the survey results, farmers grew different types of TAVs; though, the preference differed across regions. Overall, the most popular TAVs were the African nightshade (76 percent), Cowpeas (63 percent), and Amaranth (53 percent). Others were Spider plant and Slender leaf at 39 percent, pumpkin leaves at 32 percent, Jute mallow at 31 percent, Ethiopian kale (24 percent), and Vine spinach (6 percent). *Cucurbita focifolia (kahurura*) was at 2 percent and its production was limited to the central region of Kenya. Among other vegetables grown, kale is the most popular as reported by 68 percent of farmers (see Table 5 below).



3.3.2 Viable Vegetable Value Chains

The choice and preference for specific vegetables in each region were based on potential in terms of production per unit area of land, level of commercialization and profitability, and consumer/market demand. African nightshade and Amaranth had a high preference in all the counties. In the central region, farmers preferred growing African nightshade, and Amaranth reporting a higher consumer demand. Slender leaf and Jute mallow preference were highest in the western region while in the Nyanza region, African nightshade, cowpeas, and Amaranth are the most preferred TAVs (see Table 5). The study established the top six viable vegetables in each county by considering the TAVs grown by at least 20 percent[4] of the farmers' interviewed. This is shown in Table 4 below.

Table 4. Top six selected vegetable value chains per county

Vegetables / County	African night shade	Amaranth	Spider plant	Ethiopian kale	Cowpea	Pumpkin	Slender leaf	Jute mallow	Kale	Spinach	Tomato
Kakamega											
Vihiga											
Kiambu											
Murang'a											
Machakos											
Kisumu											
Siaya											

4 A Cut off above 30% was limiting the number of popular TAVs per county to below 6 which had been recommended as threshold in the ToR

Table 5. Types of TAVs grown and percentage of farmers per county

TAV s / County	African night shade	Amaranth	Spider plant	Ethiopian kale	Cowpea	Pumpkin leaves	Kahurura	Slender leaf	Jute mallow	Vine spinach	Kale	Spinach	Tomato	Onion	Pepper
Kakamega	89	53	61	28	92	53	0	78	56	8	86	6	11	11	3
Kiambu	53	47	50	31	11	14	11	19	17	0	78	67	11	17	6
Kisumu	56	53	11	3	78	44	0	3	19	0	75	6	31	0	3
Machakos	56	53	11	3	78	44	0	3	19	0	36	39	47	28	8
Murang'a	89	78	0	0	6	8	3	0	0	0	67	36	14	3	3
Siaya	97	44	42	31	89	22	0	58	28	0	56	25	11	11	3
Vihiga	89	78	72	69	97	72	0	89	86	31	75	36	17	17	6
Overall%	76	53	39	24	63	32	2	39	31	6	68	31	20	12	4

3.3.3 Production and Supply Dynamics

Land size

All of the regions surveyed are mostly used for agricultural purposes. Farmers, in general, engage in mixed farming. According to the survey results, each household designated an average of 0.5 acres of land specifically for growing vegetables. Due to the limited growing season for vegetables, some farmers rented property elsewhere to grow vegetables, particularly close to rivers where they could use irrigation during the dry season. Each household leased an average of 0.2 acres of land.

Farmers in Kisumu reported the highest land size allocated to vegetable production, both owned and leased land, with each household having an average of 0.84 and 0.46 acres for owned and leased land respectively. Kiambu and Siaya had the lowest land size owned of 0.32 and 0.34 acres per household respectively (see Table 5).

Table 6: Average land size per household

County (acres)	Kakamega	Kiambu	Kisumu	Machakos	Murang'a	Siaya	Vihiga	Overall
Owned land	0.37	0.32	0.84	0.79	0.44	0.34	0.33	0.5
Leased land	0.27	0.03	0.46	0.17	0.34	0.04	0.11	0.2
Total land	0.64	0.35	1.30	0.96	0.78	0.38	0.44	0.7

Types and sources of seeds

The results show that the majority of farmers surveyed (57%) used seeds from informal sources to grow vegetables. In contrast to agro-dealers, who were mainly the formal sources, local markets, stored seeds, and other farmers are among the informal sources. In the cases of African nightshade and Slender leaf. TAV seeds purchased from unofficial sources were preferred because they were more affordable, more accessible, and had a better flavour. On the other hand, people who cultivated tomatoes and spinach typically bought their seeds from formal sources. Exotic vegetable seeds are mostly bought from formal sources.

The majority of farmers surveyed used seeds from informal sources to grow vegetables.

57%
Informal sources (local markets, stored seeds, other farmers

43%
Formal sources (zagro-dealers)

TAV seeds obtained from informal sources were preferable because they were less expensive, readily available, and tasted better in the cases of African nightshade and Slender leaf. Those that grew tomatoes and spinach, on the other hand, mostly obtained their seeds from formal sources. They made references to the decreased production of spinach and tomato seeds received from informal sources. Additionally, it was found during the FGDs that these farmers routinely bought seedlings from the nurseries of other farmers. It was interesting that these nurseries used formal channels to get their seeds.

TAV seeds obtained from informal sources were preferable because they were less expensive, readily available, and tasted better in the cases of African nightshade and Slender leaf.

Table 7. Sources of seeds for different vegetables

Source of seeds / Type of vegetables	Agro-dealers	Local market	Own-saved	Other farmers	NGO/ community project	Others (KALRO, County govt, One-Acre Fund, grows naturally)
	Percentage of farmers					
African nightshade	42	16	22	10	5	4
Amaranth	37	17	23	15	5	5
Spider plant	34	29	20	7	4	5
Ethiopian kale	25	46	18	5	7	0
Cowpeas	12	65	14	4	3	2
Pumpkin leaves	4	11	65	19	0	1
Slender leaf	9	50	27	9	4	1
Jute mallow	15	29	39	8	3	6
Kale	63	8	9	19	1	1
Spinach	78	7	1	14	0	0
Tomato	86	4	6	4	0	0
Onion	42	16	7	23	13	0
Overall	37	25	21	11	4	2

Sources of vegetable seeds

37% agro-vets

25% local market

21% own-saved seeds

11% from other farmers

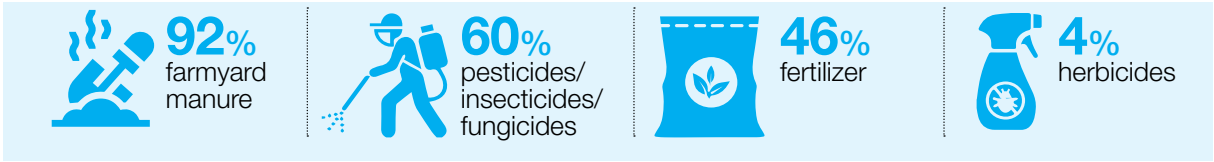
Overall, farmers sourced vegetable seeds from the agro-vets (37 percent), local market (25 percent), while 21% relied on own-saved seeds and 11% from other farmers as indicated in Table 7. The agro-dealers were a common source for tomatoes, spinach, and kales. Cowpeas, slender leaf, and Ethiopian kale seeds were mainly sourced from the local market while a majority of farmers reported using saved seeds from the previous crops in the case of pumpkin leaves and jute mallow. Other sources were buying or borrowing from other farmers and donations from local NGOs and community projects. In the Western and Nyanza regions, KALRO and county governments gave free seeds to some farmer groups while One-Acre Fund sold seeds on credit. It was also common for Amaranth and jute mallow to regenerate naturally after the rains. According to the updated list of certified seed varieties by KEPHIS (August 2020), there is a limited

number of certified varieties available for TAVs, and most of those available were certified in 2016[5].

Figure 6. TAV seeds sources at the local open-air market (left) and agro-vet (right)

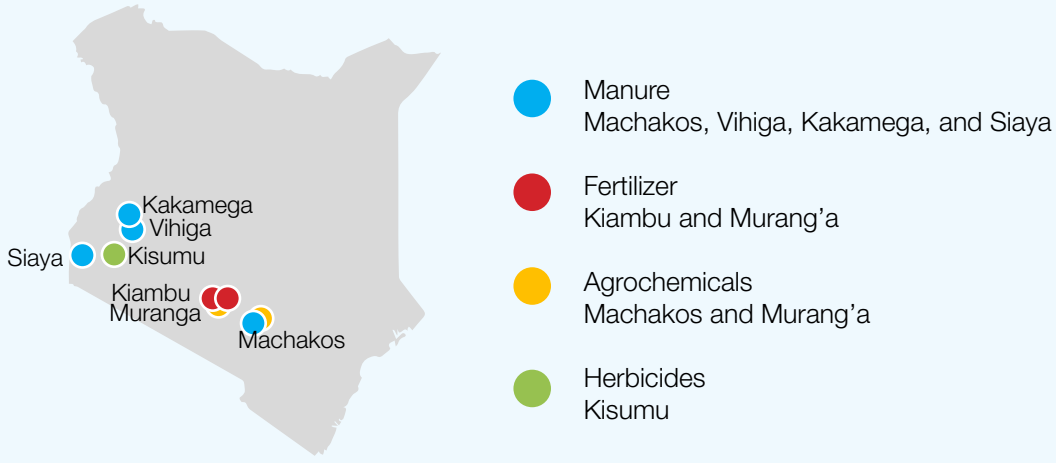
Other inputs used

In addition to seeds, farmers used farmyard manure, organic and inorganic fertilizers, pesticides, insecticides, fungicides, and irrigation in the production of vegetables. The majority of farmers (92 percent) utilized farmyard manure since they also kept livestock and could easily acquire the dung for their farms. This was followed by pesticides/insecticides/fungicides (60 percent) and fertilizer (46 percent), with herbicides being the least used input (4 percent). Herbicide use was uncommon, according to the study, because the quantity of land allotted to vegetables was smaller than other farm enterprises, thus did not require a lot of labour for weeding. This was reinforced during the FGDs, with the majority of farmers reporting pesticide use in other crops such as maize, coffee, and tea, among others.



The use of manure was highest in Machakos, Vihiga, Kakamega, and Siaya while fertilizer use was largely in Kiambu and Murang'a. The highest use of agrochemicals to control pests and diseases was highest in Machakos and Murang'a while herbicides use was highest in Kisumu as shown in Figure 7.

Highest use of inputs in value chain study areas by county



5 https://www.kephis.org/images/pdf-files/UPDATED%202020%20August%20NATIONAL%20VARIETY%20LIST1.pdf

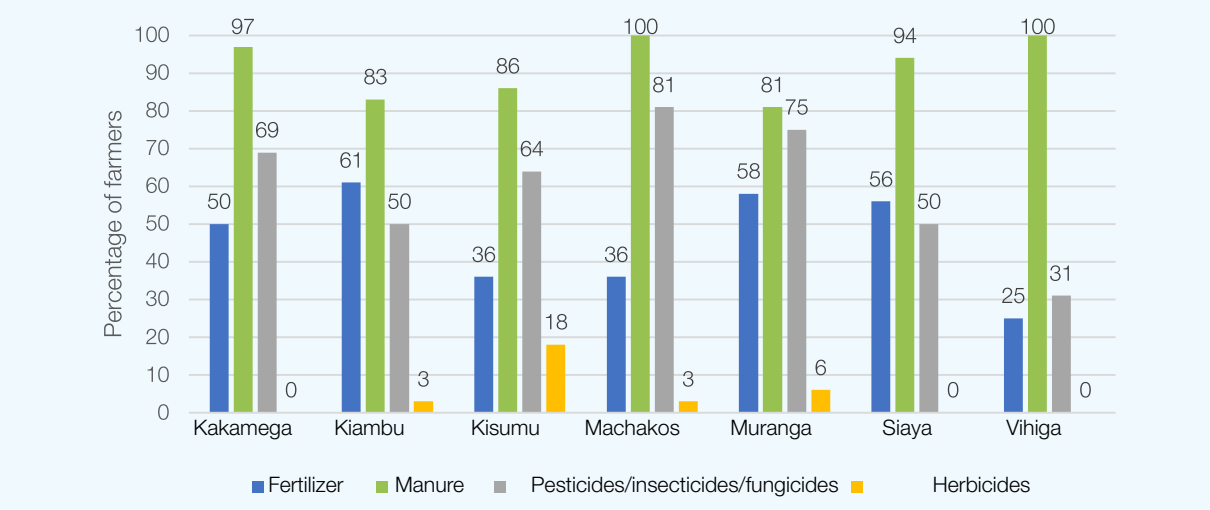


Figure 7. Other inputs used in vegetable production

Use of irrigation technology

According to the survey, just 27% of respondents (n=68) irrigate by furrows, flooding, sprinkling, or drip, with the majority of farmers relying on rainfall for vegetable production. The remaining 31% did not use any irrigation at all, while another 42% used buckets and watering cans. The highest rates of irrigation adoption were found in Kiambu (3%), Machakos (2%), and Kisumu (2%), while the lowest rates were recorded in Vihiga and Siaya, with one and two percent of respondents, respectively. The greater use of irrigation in the counties of Kiambu, Machakos, and Kisumu can be attributed to their proximity to important urban centres (Nairobi and Kisumu), which provide larger and ready markets and encourages a drive for year-round production.

27% **of farmers used furrows, flooding, sprinkling, rainfall or drip irrigation**

31% **did not use any irrigation at all**

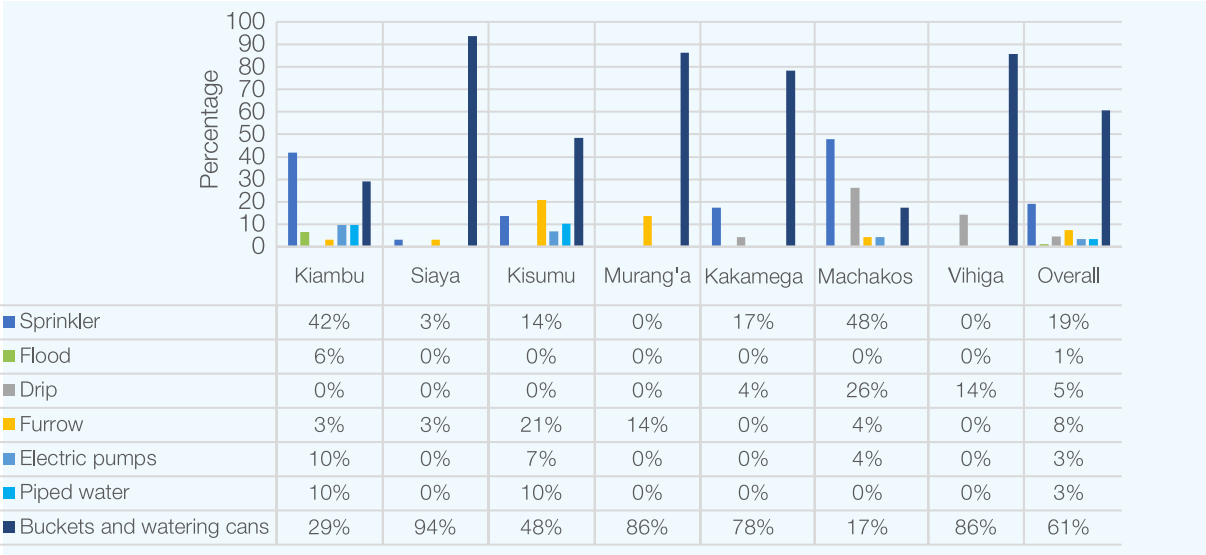
42% **used buckets and watering cans**

Types of irrigation systems and equipment used

According to the survey findings, 19% of the farmers used sprinklers to irrigate their crop, (8%) applied furrow irrigation and 5% used drip irrigation. Flood irrigation received the least number of responses, accounting for only 1% of the total. As indicated in Figure 8, drip irrigation was exclusively implemented in the counties of Kakamega, Machakos, and Vihiga. The study also discovered that most farmers (61 percent; n=105) used simple ways to irrigate vegetable farms, such as use of buckets and watering cans, because of the difficulty of obtaining irrigation equipment due to the high cost.

Due to the fact that the majority had constructed piped water systems on their farms, the bulk of the farmers who used sprinkler irrigation were from Machakos and Kiambu. The majority of farmers in Murang'a used the furrow irrigation system because their farms were located near rivers, although in Kiambu and Kisumu, electric pumps were frequently used (see Figure 8).

None of the farmers reported the use of solar pumps. This was explained by the relatively expensive purchase and installation costs when compared to using electric pumps. With assistance from the Kayata farmers Sacco, farmers in Machakos' Kayata farmers group adopted a drip irrigation system. The farmers have to be SACCO members in order to use the drip irrigation system. For new members, the membership fee was Kshs 200,000 and Kshs 100,000 for those whose parents were already members. Following discussions with the group members, it was determined that the funds were utilized to create a drip irrigation system on the farm and maintain the water canal on a regular basis. Additionally, each participant was only permitted to irrigate a single acre of land.



	Kiambu	Siaya	Kisumu	Murang'a	Kakamega	Machakos	Vihiga	Overall
Sprinkler	42%	3%	14%	0%	17%	48%	0%	19%
Flood	6%	0%	0%	0%	0%	0%	0%	1%
Drip	0%	0%	0%	0%	4%	26%	14%	5%
Furrow	3%	3%	21%	14%	0%	4%	0%	8%
Electric pumps	10%	0%	7%	0%	0%	4%	0%	3%
Piped water	10%	0%	10%	0%	0%	0%	0%	3%
Buckets and watering cans	29%	94%	48%	86%	78%	17%	86%	61%

Figure 8. Types of irrigation systems and equipment used

County	Main preferred Irrigation methods
Kiambu	Sprinkler, buckets and watering cans
Siaya	Buckets and watering cans, sprinkler
Kisumu	Buckets and watering cans, furrow
Murang'a	Buckets and watering cans, furrow
Kakamega	Buckets and watering cans, sprinkler
Machakos	Sprinkler, drip
Vihiga	Buckets and watering cans, sprinkler

Water for irrigation was sourced from a variety of sources, the most popular being rivers/streams/lakes (n=85). Others were farm ponds (n=34), boreholes (n=22), wells (n=18) and harvested rainwater (n=16). The least common sources of water were water pans which were common in Machakos, tap water was common in Kiambu, and dams which were only found in Siaya County (see Figure 9).

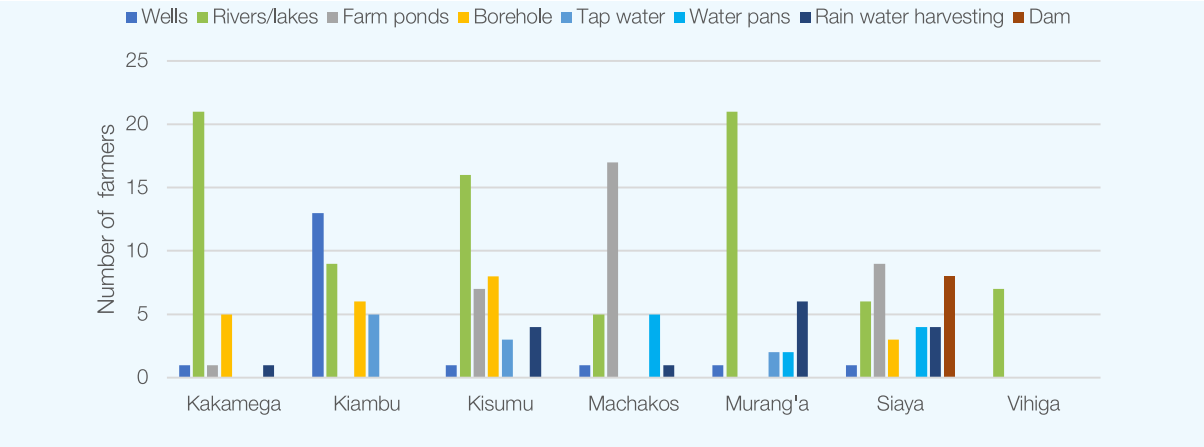


Figure 9. Sources of water for irrigation

Challenges and opportunities of irrigation technology

The challenges associated with irrigated farming were the high cost of labor especially when using buckets and watering cans; which meant farmers could only irrigate a small plot of land, and insufficient water from the rivers and streams mainly during the dry season. Additionally, the expense of purchasing irrigation equipment, such as water pumps, was exorbitant, which led to the use of buckets and watering cans.

Along with the high cost of power and/or fuel, the frequent breakdown was recognised as a major challenge for those who use electric pumps. Farmers in Kiambu recommended support for solar installation to lower the cost of production, which presented a significant problem. On a 0.25-acre plot of land, farmers typically spent Kshs 7,000 to Kshs 10,000 (USD 7 to USD 10) per season pumping water. Farmers in the Kayata neighbourhood of Machakos had little control over how much water was used since water utilization was controlled by the SACCO.

Farmers recognized certain benefits to using irrigation in the production of vegetables despite these obstacles. These included year-round production, increased productivity, better home food and nutritional security, and increased household income.

The amount of land under irrigation as a percentage of total land was approximately 29 percent overall, with Kiambu County having the highest adoption of irrigation methods out of the 68 farmers that use furrows, flooding, sprinkling, or drip irrigation (77%). This was ascribed to the fact that the majority of farmers had made investments in reliable water sources such wells and boreholes, allowing for the year-round cultivation of vegetables. Machakos, Kisumu, and Murang'a came in second, third, and fourth, with 36, 31 and 24 percent respectively. According to Figure 10 below, Siaya and Vihiga had the least amount of land under irrigation, at 8 and 5 percent, respectively.

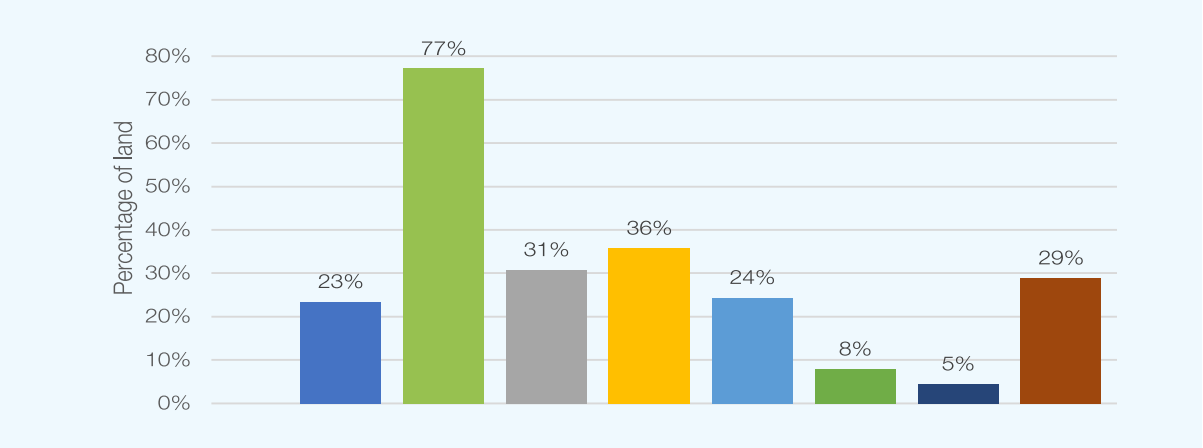


Figure 10. Proportion of land under irrigation (exclusive of watering cans and buckets)

Agronomic practices

High-quality TAV production depends on effective agronomic practices. The common approaches used in this study were nursery setup, planting, fertilizer and manure application, watering, and harvesting, which could involve leaf plucking or thinning.The nursery's main crops were kale, spinach, tomatoes, and onions. The bulk of the TAVs were planted using the broadcasting method, the majority of them were harvested by uprooting at the first harvest especially the spider plant, and Ethiopian kale, which consumers prefer when young. Most farmers used their own saved seeds to cut production costs and preserve local variations since they frequently extended the production time for a portion of the crop to allow seed formation.

In the majority of places, vegetable production takes place throughout the prolonged rainy season. Due to the small area of the field and the desire for the maize crop because it is a staple food crop in Kenya, it is noteworthy that farmers frequently intercropped cowpeas with maize. TAV production is especially widespread in the western region during the brief rains that follow the harvest of maize crops.

Supply and production trends

African nightshade, kales, cowpeas, and amaranth were the most widely produced vegetables, per the survey results. Others were onions, spinach, tomatoes, jute mallow, spider plants, and slender plants. However, the popularity of these vegetables varied by county. Consumer demand, nutritive and medicinal value, and profitability influenced consumer preference.

April through August, which is the middle of the long rainy season, saw the highest supply throughout the areas for various TAVs, while December through March, which is typically the dry season of the year, saw lower supplies. For African nightshade, amaranth, spider plant, and Ethiopian kale, the highest supply months were found to be June to August, while the highest cowpea output months were recorded to be April to July. These results concurred with agro-dealers' reports that the three months with the highest demand for vegetable seeds were March, April, and August. The production calendar for the various varieties of vegetables is shown in Table 8 below.

Table 8. Vegetable production calendar for different TAVs

Month	Availability											
TAVs	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Nightshade												
Amaranth												
Spider plant												
Ethiopian kale												
Cowpeas												
Pumpkin leaves												
Slender leaf												
Jute mallow												
Kale												

Low Medium High

According to the survey results, Murang'a County led in average annual production per acre of African nightshade, amaranth, and tomatoes at 3,501, 2,005, and 5,905 kg while kale and spinach production was recorded highest in Kiambu (4,760 and 5,263 kg respectively) as shown in Table 9 below. The average production of spider plants and Ethiopian kale was highest in Kisumu County while Machakos led in the production of cowpeas, slender leaf, jute mallow, and onion. Table 9 shows the annual production per acre for the different vegetables per county.

County	**Preferred crop**
Murang'a	African nightshade, amaranth, and tomatoes
Kiambu	Kale, spinach
Kisumu	Spider plant, Ethiopian kale
Machakos	Cowpeas, slender leaf, jute mallow, and onion

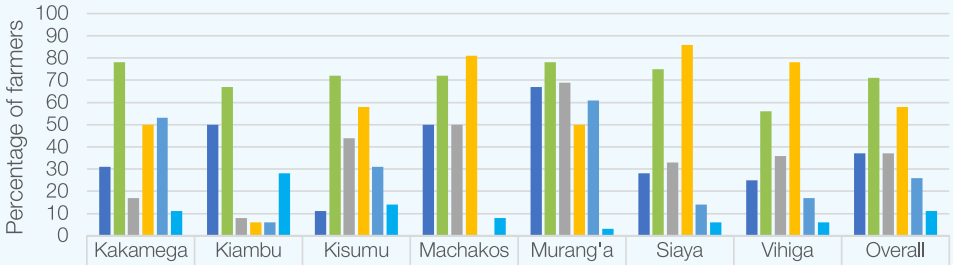
Table 9. Average annual vegetable production per acre (kg)

County	Kakamega	Kiambu	Kisumu	Machakos	Murang'a	Siaya	Vihiga
Type of vegetable	Production (Kg)						
African nightshade	1237	1073	840	876	3501	672	523
Amaranth	366	913	293	733	2005	867	498
Spider plant	297	347	548	77	0	312	300
Ethiopian kale	224	472	728	29	0	216	327
Cowpeas	686	363	696	901	271	394	785
Pumpkin leaves	47	294	76	165	15	104	150
Pumpkin fruits*	43	69	27	123	48	139	174
Slender leaf	258	257	205	770	0	154	215
Jute mallow	101	122	302	491	0	145	197
Kale	1899	4760	436	603	3372	2406	1217
Spinach	105	5263	464	659	1842	651	133
Tomato	486	3156	1409	1472	5905	1106	705
Onion	270	27	0	697	43	106	93

*- Production is in units

Challenges related to vegetable production

At the production stage, the prevalence of pests and diseases was the issue that was reported the most (71 percent of the time). Aphids, nematodes, and mites were the most prevalent pests, and bacterial wilt was the most frequently reported disease. Drought (58 percent) followed next, especially in Machakos and Siaya because those two counties are located in a semi-arid region. In Murang'a, Kiambu, and Machakos, the high cost of certified seeds was seen as a prevalent problem. This may be explained by the farmers' typical seed sourcing behavior, which was to buy from agro-dealers. In Kakamega and Murang'a, flooding and hailstorms were viewed as problems. Post-harvest losses, which accounted for 11% of challenges, were the least problematic. This was due to the fact that the majority of farmers sold their produce directly from the farm rather than storing it. In addition, people who sold in the neighborhood markets kept leftover produce fresh until the next day by laying it out on the floor overnight or by sprinkling them with water.



	Kakamega	Kiambu	Kisumu	Machakos	Murang'a	Siaya	Vihiga	Overall
High cost of certifed seeds	31	50	11	50	67	28	25	37
Pests/diseases	78	67	72	72	78	75	56	71
Inadequate agronomic knowledge	17	8	44	50	69	33	36	37
Droughts	50	6	58	81	50	86	78	58
Floods/hailstorms	53	6	31	0	61	14	17	26
PHL	11	28	14	8	3	6	6	11

Figure 11. Vegetable production challenges

3.3.4 Markets and Demand Dynamics

Marketing channels

According to the study results, a majority of farmers sold their produce at the farm gate (72 percent). This was attributed to the potential high transactional cost arising from the low supply levels per household coupled with unstructured marketing as well as the poor road network in some areas. The average distance from the farm to the nearest market was estimated at 4.5 kilometers.

72% farmers sold their produce at the farm gate attributed to the potential high transactional cost arising from the low supply levels per household

4.5% average distance from the farm to the nearest market

Overall, the local open-air market retailers and wholesalers/ middlemen formed the major vegetable marketing channels as reported by 57 and 33 percent of the farmers respectively.

The study results showed that there is hardly vegetable aggregation processes taking place spearheaded by the farmers nor collective marketing. The farmers across all the regions sold their vegetables individually. In Vihiga County, there were efforts by the county government through the NARIGP to federate local vegetable farmers into an umbrella marketing body- the "Vihiga County African Leafy Vegetables Farmers' Cooperative Society". The Cooperative aims at improving the marketing of TAVs through aggregation and linking farmers to markets that will enable them to fetch better prices.

Overall, the local open-air market retailers and wholesalers/middlemen formed the major vegetable marketing channels as reported by 57 and 33 percent of the farmers respectively. This was largely attributed to low volumes per farmer considering that the majority sold their vegetables individually. These traders, therefore, played the role of aggregating the products and providing the market to the farmers. The retailers sold the vegetables in the local markets while the middlemen transported them to other towns within or outside the counties.

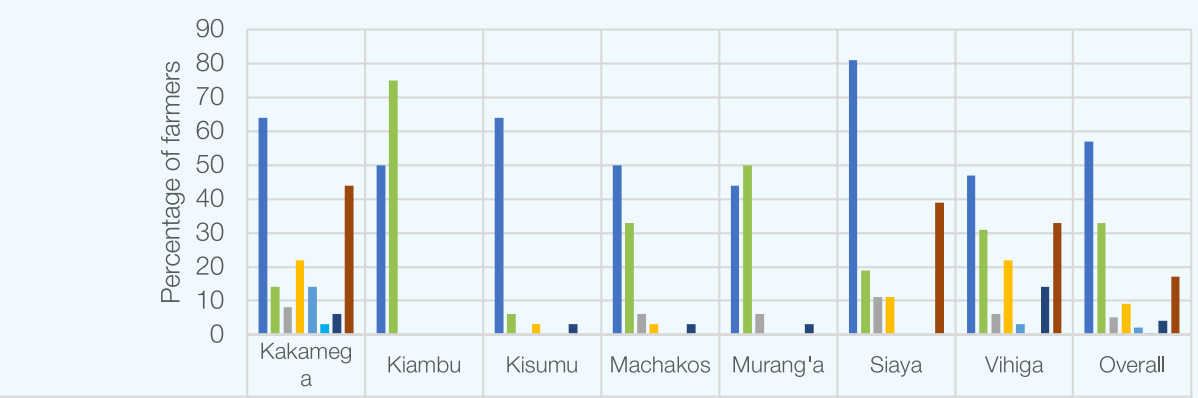
Direct selling to household users created a sizable market for the TAVs in the western and parts of Nyanza regions, as depicted in Figure 13. The farmer groups were the least used channels. Only in Kakamega, at Khwisero, where farmers reported selling jointly to Mace Foods in Eldoret, were attempts at collective marketing made. The Anglican Development Services established a connection between them and the Mace Foods (ADS). Nevertheless, a comprehensive conversation with the group leader revealed that the contract was short-lived. The buyer only picked up the produce twice before withdrawing because of the erratic and insufficient supply.

Other marketing channels such as supermarkets, online markets, and vegetable processors have not been adequately explored by the farmers interviewed. Supermarkets, for example, were not preferred due to the fact that most farmers noted the nature of operations where they only get paid once the goods have been sold. Since vegetables are perishable, there were possibilities that they may go bad before payment, resulting in losses. At the time of the investigation, there were no vegetable processors purchasing vegetables. Though farmers were aware of vegetable processing, a major obstacle to the full exploration of value addition for TAVs was consumers' low demand for processed vegetables. The marketing channels used are presented in Figure 12.

Demand and supply analysis

Even though there is a year-round demand for vegetables, there are seasonal variations. The months of December through March, which are associated with the dry seasons and a period of relatively low vegetable supply, are those of high demand. Higher prices and higher returns for the value chain actor are characteristics of higher demand seasons. According to the type of TAV and the area, this price rise was estimated to be between 50% and 100%.

When selling TAVs, bundles were the common unit of measurement. In some marketplaces, green vegetables were also sold in bags or sacks of 50 and 90 kg in addition to handfuls. Other commodities like tomatoes and bulb onions were sold in crates and kilograms, respectively (the wooden crate weighed 60 kg while the plastic one was 30 kg). The size of the bunches offered for sale differed with the type of vegetable, the buyer along the supply chain, and the seasonality. For instance, the bunch was bigger for kales as compared to spinach, african nightshade, amaranth, and cowpeas and smallest for spider plants, slender leaf, and jute mallow. The bunch size was also one and a half to two times smaller during the low supply season. When selling to traders, the size of the bunch was also slightly higher as compared to direct consumers. The middlemen transporting vegetables to other major towns packaged the vegetables



	Kakamega	Kiambu	Kisumu	Machakos	Murang'a	Siaya	Vihiga	Overall
Retailers	64	50	64	50	44	81	47	57
Wholesalers	14	75	6	33	50	19	31	33
Hotels	8	0	0	6	6	11	6	5
Schools	22	0	3	3	0	11	22	9
Hospitals	14	0	0	0	0	0	3	2
Farmer groups	3	0	0	0	0	0	0	0.4
Groceries	6	0	3	3	3	0	14	4
Household consumers	44	0	0	0	0	39	33	17

Figure 12. Traditional Vegetable marketing channels

Figure 13. Vegetables at Muthurwa (left) and Kangemi (right) markets

in 50kg and 90kg bags before loading them into motorbikes, pull-carts, trucks, passenger service vehicles (PSV), or private vehicles.

In Kiambu, Murang'a, and Machakos, large traders bought the vegetables at the farm gate and transported them to major wholesale markets in Nairobi such as Wangige, Muthurwa, Kawangware, and Githurai markets. Kangemi market was also a destination market, especially for vegetables from the western and Nyanza regions.

Nairobi City Park market and Ngara market sourced the vegetables from the wholesalers. These traders then sold to hotels and household consumers. Other major target markets for wholesalers were Nakuru and Mombasa markets.

Volumes sold by households

The majority of farmers surveyed reported selling 60% of their total production. Therefore, it can be concluded that the majority of farmers have turned to TAV farming as a commercial venture.

Most of the vegetables produced in Murang'a, Kiambu, and Machakos were primarily for the market (fully commercialized) with Kiambu and Murang'a counties leading in African nightshade, amaranth, kales, spinach, and tomato sales per household, while onion and cowpeas average sales were highest in Machakos County (see Table 10).

Due to a lower level of commercialization of the value chains and the majority of vegetables being consumed at the household level, the Western and Nyanza areas recorded significantly lower sales. Pumpkin leaves, which were sold at 43%, were the least popular vegetable. Some farmers believed that pumpkin leaves should not be sold, but rather distributed to friends and neighbors as a subsistence crop.

Table 10. Average annual sales per household in kilograms

County	Kakamega	Kiambu	Kisumu	Machakos	Murang'a	Siaya	Vihiga
Type of vegetable				Sales (Kg)			
African nightshade	603	293	818	833	1745	193	142
Amaranth	180	214	306	675	989	255	121
Spider plant	173	90	600	67	-	116	97
Ethiopian kale	110	130	873	18	-	63	95
Cowpeas	349	90	654	806	181	116	203
Pumpkin leaves	12	40	50	65	1	18	25
Pumpkin fruits*	20	2	-	109	8	43	53
Slender leaf	160	60	217	670	-	51	78
Jute mallow	48	28	202	420	-	44	58
Kale	1001	1360	502	580	2221	727	434
Spinach	62	900	267	608	1149	201	44
Tomato	193	460	1537	1269	3980	427	261
Onion	89	5	-	575	-	37	15

**-Units*

Farmgate prices

Farmgate prices varied by county and TAV type. The most expensive items on average were jute mallow and pumpkin leaves, which sold for 61 and 50 KES per kilogram. Cowpeas and kale, which cost 25 KES per kg, were the least priced TAV. African nightshade cost the most in Murang'a and the least in Machakos, whereas amaranth cost the most in Kisumu and the least in Machakos. In Kakamega, slender leaf and jute mallow were the most expensive (see Table 11)

Women heavily dominated in the vegetable trade (77 percent). Only 20% of them were youth, with the majority of them being between the ages of 36 and 50. Due to the perishable nature of the produce and a lack of storage space in the markets, the majority of traders (68 percent) reported obtaining vegetables daily to reduce losses. With the exception of Nairobi–where the majority relied on wholesalers in major markets like Muthurwa/Marikiti, Wangige, and Kangemi–they source the products directly from the farmers (71%).

Table 11. Farm gate prices for different TAVs per kg

TAV type	Kakamega	Kiambu	Kisumu	Machakos	Murang'a	Siaya	Vihiga	Average
African nightshade	30	24	36	20	39	22	36	30
Amaranth	31	26	35	24	29	23	31	28
Spider plant	14	47	44	35	-	37	49	38
Ethiopian kale	32	20	36	27	-	25	37	29
Cowpeas	31	24	33	21	13	22	29	25
Pumpkin leaves	87	50	60	36	67	20	33	50
Pumpkin fruits*	68	53	33	85	33	27	78	54
Slender leaf	66	36	42	14	-	53	57	45
Jute mallow	93	53	52	55	-	47	61	61
Kale	24	11	26	34	36	21	22	25
Spinach	19	21	56	21	30	33	65	35
Tomato	26	14	46	29	16	28	52	30
Onion	33	53	-	44	-	54	33	44

*Units

Traditional African Vegetable Traders preferences

Data collected from the markets indicated that traders sold a range of TAVs. The African nightshade, amaranth, cowpeas, and kales were the most popular vegetables sold while the least was pepper as shown in Figure 14. Besides, the same traders also merchandised other TAV competing products such as Indian vegetables at Nairobi city park and Ngara markets, cabbage, Lake Victoria sardine (Omena), fish, and pulses as well as complementary products including herbs and spices such as coriander, garlic, and ginger, carrots, courgette, among others.

The choice for the specific vegetables was driven by consumer demand and profitability as reported by 94 and 75 percent of the traders across different markets. There was a relatively higher demand for African nightshade, amaranth, cowpeas, and kale as compared to other vegetables and this explains their popularity among the traders. The demand was attributed to availability and nutritional value perceived by consumers. Another factor driving choice was accessibility to the supply points. In terms of volumes sold, kales and spinach were leading with each trader trading an average of 541 and 320 kg every week. This was closely followed by African nightshade and Amaranth at approximately 308 and 235 kg traded per week per trader respectively. The higher volumes traded for kales and spinach is explained by their relatively heavier weight as compared to the TAVs.

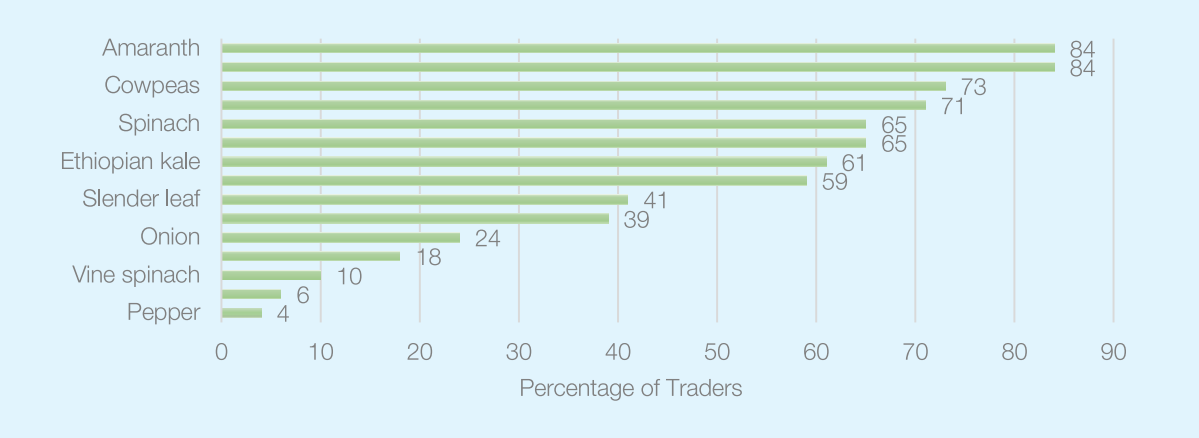


Figure 14. Preference of vegetables sold at the markets

On average, jute mallow, slender leaf, and pumpkin leaves fetched the highest price per kg explained by their relatively smaller weight per volume. The average price was highest in Nairobi due to slightly higher demand and wider market as compared to market opportunities within the counties. The table below shows the distribution of margin across the various actors in the value chain.

Table 12. Distribution of margin along the value chain for different vegetables

TAV type	Farmgate (Average prices/kg)	Wholesale market	Retail market
African nightshade	30	35	50
Amaranth	28	35	50
Spider plant	38	45	60
Ethiopian kale	29	35	45
Cowpeas	25	30	45
Pumpkin leaves	50	60	70
Pumpkin fruits*	54	70	100
Slender leaf	45	60	70
Jute mallow	61	70	80
Kale	25	30	40
Spinach	35	40	50
Tomato	30	40	60
Onion	44	50	70

*-Units

Marketing challenges

At the farmer level, various challenges affect the marketing of vegetables. The major challenges include poor and fluctuating prices due to exploitation by some middlemen and the seasonality of vegetables. Some farmers reported middlemen picking the produce on credit with a promise to send money via Mpesa but failed to pay. Other marketing challenges raised were lack of aggregation centers, inadequate market information, and effects of the covid-19 pandemic which negatively affected consumers' purchasing power hence lowering demand.

At the traders' level, the challenges mentioned include; unavailability of TAVs due to seasonality in vegetable production, poor road conditions leading to high transportation costs, inadequate sales space at the markets and poor and/or inadequate storage facilities which compounded the challenge of post-harvest losses especially where the market cannot be accessed immediately and competition with cheaper vegetable varieties. The study further established that the covid-19 pandemic largely affected vegetable trading after the closure of schools and most of the hotels, considering that these institutions form a significant market for the traders both in the local trading centers and in large markets. The pandemic was also associated with the loss of jobs which affected consumers' purchasing power.

Consumer demand

Consumption of TAVs has been on the rise in both rural and urban areas. This has largely been driven by increased consumer awareness of the nutritional value of the TAVs, urbanization, and improved consumer incomes. According to the survey findings, tomatoes, onions, african nightshade, kale, and amaranth were the most consumed vegetables (see Figure 15). Onions and tomatoes form the basic ingredients for most meals explaining the higher level of consumption. The higher consumer demand for African nightshade, kale, and amaranth on the other hand was driven by availability both on the farms and in the local markets. Consumption of TAVs is also driven by cultural dietary practices and thus not a common part of the traditional diets of certain communities. This was reported as a challenge hindering consumption in Machakos.

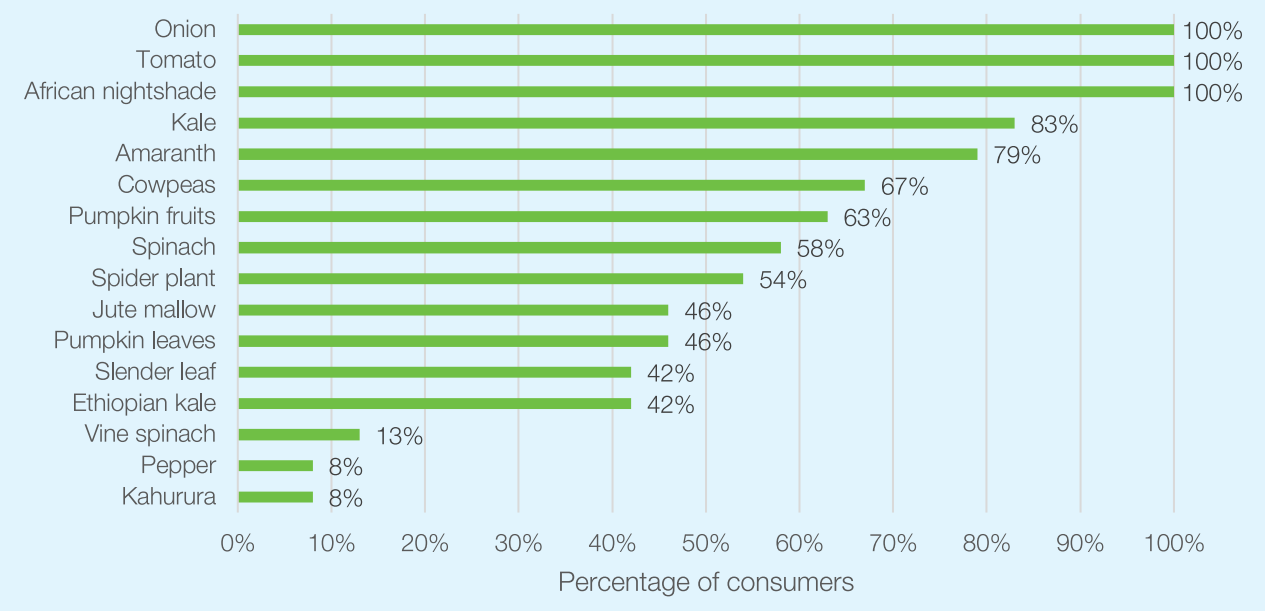


Figure 15. Vegetables consumed

Both traders and consumers in the study indicated that the most considered factor while purchasing TAVs was the freshness of the vegetables followed by availability and packaging/size of the bunch while the least factor was the price. The low consideration for the price was because it was consistent across sellers. The findings further revealed that TAVs produced using organic practices did not attract higher consumer prices. This is attributed to lack of product differentiation at the marketplace.

Both traders and consumers in the study indicated that the most considered factor while purchasing TAVs was the freshness of the vegetables followed by availability and packaging/size of the bunch while the least factor was the price.

Gross margin analysis

The gross margins were calculated per acre. Total average cost was calculated based on the average quantity of inputs used and the unit cost. The cost of inputs used included land lease (in some cases), ploughing, the cost of seeds, fertilizer, manure, irrigation, and pesticides while operational costs included labor costs in ploughing and nursery preparation, planting, irrigation, weeding, spraying, and harvesting. Table 13 and 14 below show the gross margin analysis; a case of African nightshade vis-à-vis kale, tomatoes, and onions. (*Gross margin analysis for the leading value chains in the respective counties are tabulated in annex 3*).

3.4 Vegetable Business Networks

This section of the report identifies the existing Vegetable Business Network (VBN) actors, their relationships, and entry points in the development of functional and sustainable VBNs

The survey found out that a majority of the farmers across the counties belonged to a farmer group (60 percent; n=151). Most of the groups were involved in various activities beyond vegetable production and agriculture in general. The groups were beneficial in accessing training on good agronomic practices mainly offered by NGOs and the private sector (seed companies). Other benefits mentioned were access to quality seeds, financial and credit facilities, and supporting members to address social challenges such as financial support during funerals or illness. The latter was common in western Kenya as shown in the figure below. None of the farmers interviewed indicated benefiting from marketing or market access through the groups. This is attributed to the common practice of farmers producing and selling produce individually and only coming together for training purposes. In addition, all the groups visited had a demonstration plot on one

Table 13. Gross margin analysis for African nightshade and kale value chains

		African Nightshade (Murang'a)				Kale (Kiambu)			
Item	Unit	Ave. Qty./ Season	Ave. Unit Cost (Ksh)	Total Cost/ Season	Total Cost/ Year	Ave. Qty./ Season	Ave. Unit Cost (Ksh)	Total Cost/ Season	Total Cost/ Year
Land leasing	Acre	1	5000	5000	10000	0	0	0	0
Ploughing	Acre	1	3000	3000	6000	1	3000	3000	6000
Purchase of fertilizer	kg	250	54	13500	27000	250	54	13500	27000
Purchase of pesticides	Kg/liters	1	1500	1500	3000	1.5	1500	2250	4500
Purchase of manure	Bags	10	400	4000	8000	10	400	4000	8000
Purchase of seeds	Kg	0.5	2000	1000	2000	0.5	3400	1700	3400
Land preparation labor	Man-days	4	300	1200	2400	4	300	1200	2400
Manure application labor	Man-days	1	300	300	600	1	300	300	600
Irrigation fuel/ power	Units	0	0	0	0	1	3000	3000	6000
Irrigation labor	Man-days	20	300	6000	12000	20	300	6000	12000
Planting labor	Man-days	4	300	1200	2400	4	300	1200	2400
Fertilizer application labor	Man-days	1	300	300	600	1	300	300	600
Weeding labor	Man-days	8	300	2400	4800	12	300	3600	7200
Spraying labor	Man-days	3	300	900	1800	3	300	900	1800
Harvesting labor	Man-days	16	300	4800	9600	20	300	6000	12000
Total cost of production	KES			45100	90200			46950	93900
Total output	kg			4000	8000			7000	14000
Price/kg	KES			20	20			15	15
Total income	KES			80000	160000			105000	210000
Less total cost	KES			46300	92600			46950	93900
Gross margin	KES			33700	67400			58050	116100

Table 14. Gross margin analysis for tomato and onion value chains

Item	*Tomato (Murang'a)					**Onion (Machakos)			
Item	Unit	Ave. Qty./ Season	Ave. Unit Cost (Ksh)	Total Cost/ Season	Total Cost/ Year	Ave. Qty./ Season	Ave. Unit Cost (Ksh)	Total Cost/ Season	Total Cost/ Year
Land lease	Acre	1	5000	5000	10000	0	0	0	0
Ploughing	Acre	1	3000	3000	6000	1	2800	2800	8400
Purchase of fertilizer	kg	300	60	18000	36000	50	70	3500	10500
Purchase of pesticides	Kg/liters	5	4000	20000	40000	2	1000	2000	6000
Purchase of manure	Bags	30	400	12000	24000	12	250	3000	9000
Purchase of seeds	Kg	0.025	320000	8000	16000	1	8000	8000	24000
Nursery preparation	Man-days	1	300	300	600	1	300	300	900
Land preparation labor	Man-days	8	300	2400	4800	4	300	1200	3600
Manure application labor	Man-days	3	300	900	1800	2	300	600	1800
Irrigation fuel/ power	Liters/Units	150	120	18000	36000	30	116	3480	10440
Irrigation labor	Man-days	24	300	7200	14400	16	300	4800	14400
Planting labor	Man-days	4	300	1200	2400	4	300	1200	3600
Fertilizer application labor	Man-days	2	300	600	1200	2	300	600	1800
Weeding labor	Man-days	16	300	4800	9600	8	300	2400	7200
Spraying labor	Man-days	32	300	9600	19200	2	300	600	1800
Sticking materials	Man-days	1	10000	10000	20000	6	300	1800	5400
Sticking labor	Man-days	20	300	6000	12000	-	-	-	-
Harvesting labor	Man-days	24	300	7200	14400	-	-	-	-
TOTALS	KES			134200	268400			36280	108840
Total output	kg			6000	12000			2200	6600
Price/kg	kg			25	25			40	40
Total income	KES			150000	300,000			88000	264000
Less total cost	KES			134200	268,400			36280	108840
Gross margin	KES			15800	31600			51720	155160

*-Two seasons per year **-Three seasons per year

of the member's farm where they learn and practice new farming technologies. Some of the farmer groups also engaged in other agribusinesses such as fish farming and value addition of groundnuts in Siaya and sweet potatoes and groundnuts value addition in Kakamega County.

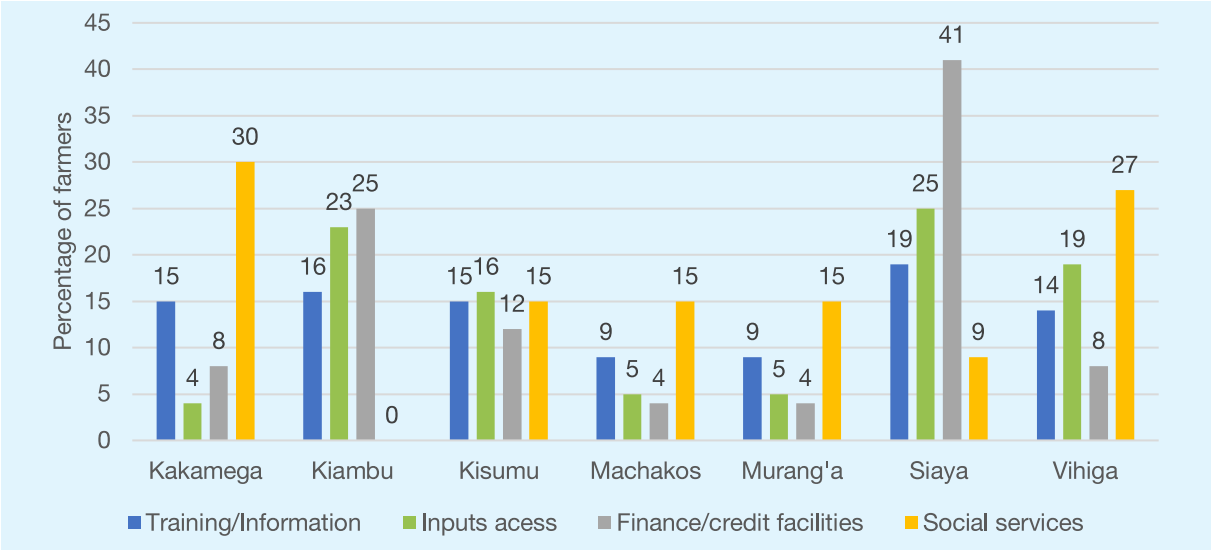


Figure 16. Services accessed through VBNs

The challenges associated with the VBNs included lack of commitment among members and leadership wrangles while the opportunities reported were increased knowledge on agronomic practices through training opportunities and farmer-to-farmer learning, collective purchase of inputs which lowers the cost of production and sharing information on market opportunities including identification and engaging potential buyers to negotiate on prices.

3.5 Regenerative Technologies

This section identifies and assesses the existing regenerative/circular technologies adopted by producers and practiced and potential ones to be promoted

3.5.1 Existing Regenerative Technologies

The study sought to find out the level of awareness on certain regenerative technologies, level of knowledge amongst farmers, and their application in vegetable production. These technologies included integrated pest management, mulching, minimum tillage, agroforestry, crop rotation, use of cover crops, soil testing, bio-slurry, bio-fertilizers, biochar, composting, vermicomposting, use of organic manure, micro-irrigation, and post-harvest handling technologies.

Level of awareness

From the total number of farmers interviewed (252), a majority were aware of most of the regenerative technologies. The technologies with the highest awareness level were; use of organic manure and crop rotation (94 percent), followed by mulching (84 percent), composting (77 percent), agroforestry (74 percent), use of cover crops (73 percent), and micro-irrigation (70 percent). Bio slurry, bio-fertilizers, vermicomposting, and biochar were less popular amongst the farmers as shown in Figure 17.

Farmers' level of knowledge

The study findings further established the level of knowledge on regenerative technologies amongst the farmers. This was analyzed using a Likert scale of 1 to 4 where 1 was just aware; 2 basic knowledge; 3 moderate knowledge and 4 very knowledgeable. The different knowledge levels were defined as; *[1] Aware*

– The farmer has only heard about the practice/technology but can't explain; *[2] Basic knowledge* – Farmer can explain the basics about the practice but is not very confident on application. Never tried it; *[3] Moderate knowledge* – Farmer can explain the basics of the technology/practice confidently and has tried it with below average results; *[4] Very knowledgeable* – Farmer can explain the practice accurately and can confidently demonstrate/explain its application and has applied it with good results.

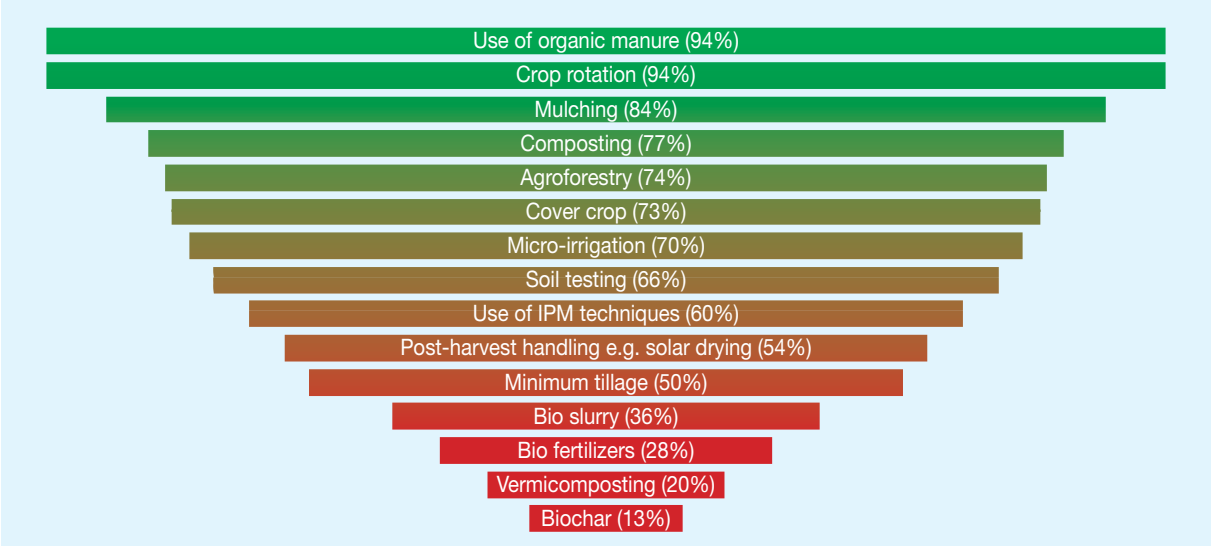


Figure 17. Level of awareness on regenerative technologies

Table 15. Service providers of the regenerative technologies

Existing regenerative technologies	Examples of providers
IPM (biological pest control practices e.g., intercrop with onions	Sustainable Organic Farming Development Initiative (SOFDI -Vihiga) Christian Impact Mission (CIM -Machakos)
Crop rotation	CIM (Machakos); ITK
Use of organic manure	CIM(Machakos); ITK
Use of bioslurry	CIM (Machakos) Practical Action (Kisumu)
Water harvesting using water pans, shallow wells	CIM (Machakos)
Composting	CIM (Machakos) Practical Action (Kisumu)
Green wall CSA technology	Youth in Agriculture CBO (Murang'a)
Sustainable land management practices and on-farm water harvesting	GIZ (Siaya)
Irrigation infrastructural support	FAO (Kiambu)
Various regenerative technologies	Bukura Training College

Out of those farmers that were aware of the technologies, a majority reported basic to moderate knowledge levels for most of the technologies as indicated in the Figure 19 below. The IPM practices reported were intercropping onions and Mexican marigold plants to control aphids. Farmers also applied indigenous knowledge such as use of ash, pepper, and tithonia leaves concoction to control pests. The practices with a high level of knowledge were the use of organic manure, crop rotation, cover crops, composting, mulching, agroforestry, and micro-irrigation.

Figure 18. Examples of regenerative technologies applied

Top-biological IPM practices for control of pests; bottom left is composting; bottom right is a sample of a biofertilizer

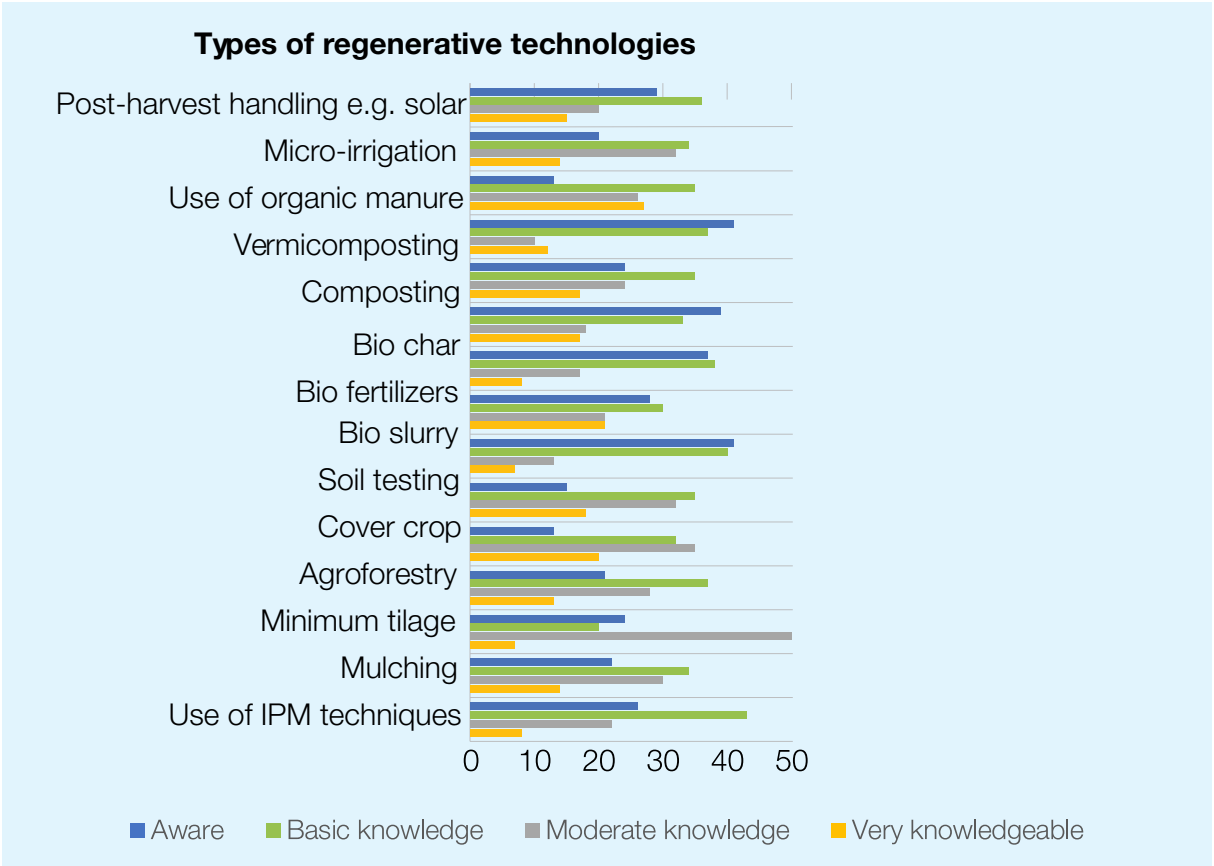


Figure 19. Farmers' level of knowledge on regenerative technologies

Farmers uptake of regenerative technologies

The study established that most of these technologies were being applied on the farms. The rate of application was related to the level of knowledge which was highest among those regenerative technologies that farmers were more knowledgeable about. The most applied technology was crop rotation and use of organic manure as reported by 96 and 93 percent respectively. The two practices had over 90 percent adoption rate across all the counties (see Table 15). The knowledge on these two technologies was sourced from training and perfected from continuous practice on their respective farms. Mulching, use of cover crops, minimum tillage, and composting were applied by over 70 percent of the farmers interviewed. The least applied technologies were vermicomposting, soil testing, and post-harvest handling with 25, 28, and 37 percent adoption rate. This is reflected by their lower levels of knowledge (figure 19). In addition to low knowledge levels, the low post-harvest handling technology uptake was also attributed to a low consumer preference for dried vegetables hence low demand.

Table 16. Level of application of regenerative technologies across the counties

County	Kakamega	Kiambu	Kisumu	Machakos	Murang'a	Siaya	Vihiga	Overall
Technologies	Percentage of farmers							
Use of IPM	79	60	84	70	60	55	76	71
Mulching	94	65	84	78	65	80	88	80
Minimum tillage	86	58	92	81	80	44	77	76
Agroforestry	60	31	85	79	33	68	78	67
Crop rotation	97	94	97	97	93	94	97	96
Cover crop	93	48	79	86	0	77	89	77
Soil testing	29	9	46	35	17	35	22	28
Bio slurry	35	47	92	70	0	42	84	61
Bio fertilizers	50	25	57	57	0	71	33	52
Bio char	70	40	83	22	0	100	0	52
Composting	92	46	91	76	55	62	85	74
Vermicomposting	14	0	83	27	17	100	14	25
Organic manure	100	94	97	97	74	91	100	93
Micro-irrigation	50	81	44	57	100	90	36	65
Post-harvest handling	35	5	44	59	0	59	23	37

Most applied technologies

96% crop rotation

93% use of organic manure

>90% adoption rate across all the counties

70% Mulching, use of cover crops, minimum tillage, and composting

Least applied technologies

25% vermicomposting

28% soil testing

37% Post-harvest handling

The findings further established that the low uptake of some of the technologies was also attributed to the perceived higher initial cost of investment in the technology i.e micro-irrigation. Low soil fertility was reported as the major factor influencing farmers to use conventional farming systems considering that in most of the regions, the soils have been used over time hence the need to use more inputs if the farmers are to quickly improve soil fertility and enhance productivity.

Besides, the use of IPM to control pests and diseases was reported not effective for all the cases resulting in the use of pesticides. A comparison of conventional and organic farming amongst the farmers interviewed shows higher productivity and returns per acre in the former as compared to the latter (see Table 16).

Table 17. A comparison of gross margins in conventional versus the use of regenerative technologies (a case of African nightshade)

		Kakamega (Organic)				Kiambu Conventional			
Item	Unit	Average Quantity/ Season	Average Unit Cost	Total Cost/ Season	Total Cost/ Year	Average Quantity/ Season	Average Unit Cost	Total Cost/ Season	Total Cost/ Year
Land leasing	Acre	0	0	0	0	0	0	0	0
Ploughing	Acre	1	2500	2500	7500	1	2000	2000	6000
Purchase of fertilizer	Kg	0	0	0	0	50	70	3500	10500
Purchase of pesticides	Kg/liters	0	0	0	0	1	2000	2000	6000
Purchase of manure	Bags	9	100	900	2700	10	300	3000	9000
Purchase of seeds	Kg	0.5	1000	500	1500	0.5	1000	500	1500
Land preparation labor	Man-days	4	300	1200	3600	4	300	1200	3600
Manure application labor	Man-days	2	300	600	1800	2	300	600	1800
Irrigation fuel/ power	Litres/ Units	0	0	0	0	1	10000	10000	30000
Irrigation labor	Man-days	0	0	0	0	5	300	1500	4500
Planting labor	Man-days	4	300	1200	3600	4	300	1200	3600
Fertilizer application labor	Man-days	0	0	0	0	1	300	300	900
Weeding labor	Man-days	6	300	1800	5400	8	300	2400	7200
Spraying labor	Man-days	0	0	0	0	4	300	1200	3600
Harvesting labor	Man-days	10	300	3000	9000	16	300	4800	14400
TOTALS	KES			11700	35100			34200	102600
Total output	Kg			1300	3900			2500	7500
Price/kg	KES			20	20			30	30
Total income				26000	78000			75000	225000
Less total cost				11700	35100			34200	102600
Gross margin per year				14300	42900			40800	122400

3.5.2 Potential Regenerative Technologies to be Promoted

Until recently, the choice of technologies available to farmers was largely determined by the need to increase production, profits, and productivity with the main constraints being the availability of capital, knowledge of how to use the technology, and market risks. However, currently, the farmers are aware that, agriculture has to address all these diverse objectives as well as environmental sustainability aspects.

According to the survey findings, all the technologies applied increased soil fertility, promoted environmental health, food safety, and enhanced productivity. Among the technologies, farmers gave priority to be supported in the project include; micro-irrigation and IPM practices especially the use of bio-pesticides. Other technologies are composting, use of bio-fertilizers, and soil testing. The support requested is in both capacity building through training as well as infrastructural support. The selection was guided by the farmers' keen interest to promote organic vegetable production as they believed its more sustainable in the long run.

3.6 Enabling Environment in Traditional African Vegetable Value Chain

This section presents findings on the enabling environment surrounding the vegetable value chain including but not limited to extension providers, government interventions, development partners and their projects, rules and regulations and informal rules and norms

The growth of the TAVs sector in Kenya can be attributed to the efforts by research organizations such as KALRO and institutions of higher learning such as Jomo Kenyatta University of Agriculture and Technology to restore and reposition TAVs strategically for food and nutrition security. For instance, research on improved seeds and seed systems for spider plants, amaranth, and nightshade has led to the production and bulking of certified seeds by companies such as Kenya Seed.

3.6.1 Supporting Functions in Vegetable Farming

The services that farmers have access to in vegetable farming include extension and financial services. According to the findings, the majority access extension services from other farmers, lead farmers, NGOs, CBOs, and development agencies working in the regions. They reported that extension services support from the government mainly focused on selected enterprises such as dairy, coffee, and tea and staple food crops like maize. Financial services on the other hand were sourced from personal savings and loans and table banking.

3.6.2 Rules and Regulations, Informal Rules and Standards Governing Vegetable Value Chain

Current legal and policy framework

Legal framework

Several laws exist that guide the production and commercialization of vegetables in the country which impact the TAV value chain. Some of these laws include;

- *The Crops Act of 2013:* This Act is aimed at accelerating the growth and development of agriculture in general, enhance productivity and incomes of farmers and the rural population, improve the investment climate and efficiency of agribusiness and develop crops as export crops. In TAVs, the Act guides in the production distribution of quality and safe vegetables to ensure food and nutrition security for Kenyans.
- *Plant Protection Act 324:* An Act of parliament was created to ensure the management of pests and diseases in vegetables. This should in turn reduce losses of vegetables hence increase marketable volumes of TAVs giving a rise to farmers' incomes.

- *Plant and Seed Varieties Act 326:* Productivity and quality of products depend largely on the quality of seed used for production. This Act recommends seeds used in the production of TAV go through the process of certification to ensure farmers plant quality seeds all the time. This also prevents the spread of diseases and thus contributes to reduced losses. Certified seeds for some of the TAV varieties are now available[6].

- *Irrigation Act:* This is a law that provides for the development, management, and regulation of irrigation, to support sustainable food security and socio-economic development in Kenya. It applies to matters relating to the development, management, financing, and provision of support services and regulation of the entire irrigation sector. Irrigation is important for TAV production if the crop is to be available all year round in sufficient quantities.

Informal rules and norms

Farming and trading of vegetables are largely associated with women. However, due to the increasing commercialization of the sub-sector, men, and youth are gaining interest. Nonetheless, the participation of women and youth has been limited by some existing community norms and practices which according to the study findings include;

- *Access to land*: in most African societies, men are the household heads, own land, and are also the decision-makers on land use including allocation of different farm enterprises. Women and youth, therefore, have to rely on tWhe priority enterprises allocated by the men. Further, parents are still the holders of land title deeds and are not willing to grant the youth land ownership for the fear that they will sell off the land.

- *Inadequate financial access:* Youth and women lack the financial capacity required in investment especially where irrigation is required and can hardly access credit because they lack collateral.

- *Negative attitude towards agriculture by the youth*: Youth engage in activities that give them quick money such as casual labor in building and construction and motorbike/*bodaboda* transport business. They also have the perception that agriculture is a dirty venture and they prefer 'cleaner' jobs.

3.6.3 Service Providers and Partners

The support given to farmers interviewed was mainly capacity building through training on good agronomic practices (GAPs) and occasionally farm inputs. The service providers included government institutions, NGOs, and development agencies. The type of support offered and service providers / partners involved with the farmers interviewed are highlighted below;

- *Farm inputs supply*:
    - In Kisumu, the County Government provided farmers with the African nightshade seeds.
    - In Vihiga and Siaya counties, the county governments and KALRO supported farmers with the provision of seeds of African nightshade, amaranth, and spider plant.
    - Christian Impact Mission (CIM) is supporting farmers in Machakos by providing certified seeds
    - One Acre Fund provides support to farmers in the western and Nyanza regions by offering credit facilities in terms of farm inputs which farmers pay after production. Their initial focus has been on maize. Some TAVs are used for intercropping with maize.

6 https://www.kephis.org/images/pdf-files/UPDATED%202020%20August%20NATIONAL%20VARIETY%20LIST1.pdf

- *Capacity building*:
    - In Kisumu, Practical Action provided capacity in sustainable land management practices and organic farming practices
    - The International Center of Insect Physiology and Ecology (ICIPE) is partnering with farmers in building capacity in agroecology and using shade nets in pest control in Machakos.
    - In the Nyanza region, KALRO is training farmers on GAPs including land preparation, planting techniques, crop husbandry, and climate-smart agricultural practices.
    - Sustainable Organic Farming Development Initiative (SOFDI) is working with farmer groups in Vihiga and Kakamega counties by training them on organic farming practices in vegetable production to promote safe food and improve human health.
    - Christian Impact Mission (CIM) is training farmers on regenerative technologies such as water harvesting and storage using shallow wells and water pans, use of organic manure, bio-slurry, IPM, and making compost in Machakos County
    - Green Villages International is training vegetable farmers on GAPs, minimum tillage, and IPM practices in the western region (Kakamega and Vihiga counties)
    - Youth in Agriculture Development Projects CBO in Murang'a is supporting the value chain through training farmers on GAPs
- *Irrigation technology*:
    - The Food and Agriculture Organization of the United Nations (FAO) is currently engaged in the sector by supporting farmers to put up irrigation systems to increase production. This was the case reported in Kiambu where FAO funded a community water project in Githunguri and supported farmers in the installation of a drip irrigation system which was done on the group's demo plot.
    - GIZ is supporting farmer groups in Siaya County in digging water pans and acquiring water pumps for irrigation
- *Market linkages*:
    - In Kakamega, the Anglican Development Services (ADS) is supported farmers by linking them to large off-takers such as Mace Foods
    - NARIGP project in Vihiga County has supported farmers to form a producer organization that will assist in collective marketing and hence improved prices for the farmers. In addition, the project has funded the construction of a vegetable market in Cheptulu that is currently ongoing
- *Value addition:*
    - Youth in Agriculture Development Projects CBO in Murang'a is supporting food nutrition and value addition through drying of TAVs into porridge flour

3.6.4 Opportunities in Vegetable Value Chain

Given the current status of the TAV value chains, there exist opportunities along the value chain that can be exploited especially for the youth and women to increase their incomes. These include seed bulking, value addition, market research, and linkages.

Seed bulking; The high market demand for TAVs drives the demand for seeds hence seed bulking is an opportunity that can create employment for the youth. Especially if the youth and women capacity can be enhanced in production and marketing of quality declared seed.

Market research and linkage; limited access to market information remains a challenge among producers. Researching available markets as well as the market prices will not only improve income to the farmers but also offer an opportunity where the youth can take advantage of the growing information and technology to link producers to the market.

Value addition; this can be through packaging and branding as organic for export in other counties with scarcity. Besides, the women and youth can also take advantage of market diversification by venturing into niche markets such as high-end markets through appropriate packaging and branding.

4.0 CONCLUSION AND RECOMMENDATIONS

This chapter of the report presents the conclusions of the study as per the four objectives and presents proposed recommendations.

4.1 Conclusion

The TAV sub-sector in Kenya is on an upward trajectory in terms of the increase of area under TAV production and consumption trends. It has been gaining momentum from the awareness campaigns over the last decade and support through research and policy development by the government. While the supply has been increasing, a deficit is observed as a result of the high and rising demand. The potential for further growth of the sub-sector still exists. With further awareness campaigns on the nutritional values of TAVs, more demand can be created locally and even abroad, especially among the Kenyan diaspora.

There is high usage of uncertified seeds in the production of TAVs as compared to other vegetables. Farmers rely on informal sources which are either own-sourced from the previous harvest or bought from other farmers and local markets. Taste preference and high cost for the certified seeds mainly influence a majority of the farmers preferring to use uncertified seeds.

Rain-fed farming is still the most common farming system. Low adoption of irrigation (34 percent) is attributed to the perceived high cost of acquiring irrigation equipment and unreliable water sources.

Farmers grow different types of vegetables with the highest preference given to African nightshade (76 percent), kale (68 percent), cowpeas (63 percent), and amaranth (53 percent). The choice and preference for specific types are driven by consumer/market demand, potential in terms of total production, and profitability. For some of the TAVs like the slender leaf and jute mallow, cultural dietary practices influence the choice to grow them since they form part of the community diet. The two are more popular in Western and Nyanza regions as compared to Central and Eastern regions. These driving factors form the criteria for selecting the priority viable value chain in each county.

The market system for TAVs is still underdeveloped with most farmers relying on local markets. Supermarkets, online markets, and processors have not been fully exploited due to limited information and delayed payments to farmers supplying to supermarkets. Despite farmers being organized into groups, the service offered to members is limited to training opportunities on GAPs. The limited benefits could be attributed to the lack of a proper vision or foundation for group formation. Inadequate skills in group governance and dynamics and lack of business skills is also a huge challenge.

The consumer attributes for the different vegetables include quality which was defined by freshness and healthy leaves and free from insect and pests attack; price; the age of the plant (spider plant and cowpeas). Very few consumers and traders consider whether the vegetables were produced organically and the kind of environment it was grown. This is because of limited knowledge on identifying which products are organic and how to find them. Besides, there are many products labeled organic especially in supermarkets and high-end markets in major urban centers, but with no certification mark.

4.2 Recommendations

Based on the survey findings and conclusions above, the following are the study recommendations;

- *Access to quality seeds was one of the challenges in vegetable production according to study findings. Besides, there is still a high preference for the local variety for certain TAVs and this affects market demand*. It is therefore recommended that through the support of the project, farmer groups should be supported to carry out seed multiplication, certification, and bulking to ensure accessibility of quality seeds. This is an opportunity that women and youth can take advantage of to improve their incomes.

- *The market system for TAVs is underdeveloped with most farmers relying only on local markets.* There is a need to provide market linkages through the establishment of partnerships/contracts with key off-takers e.g. Mace Foods, Twiga Foods, among others. Farmers should also embrace collective marketing to ensure an adequate and steady supply

- *The study found out that most of the groups formed were inactive and only came together if there were donor-funded projects or training opportunities*. The study, recommends that for sustainability and development of the VBNs and to be able to use the groups as avenues to develop the value chain, they should be trained on group dynamics, business skills, and leadership and governance besides GAPs.

- *The survey established that there were several regenerative technologies that farmers were aware of and some were applied on their farms. The level of knowledge on the technologies greatly influenced the uptake. The choice of which technology to apply was largely influenced by the level of knowledge, land size, cost, and whether the technology led to increased production. Some of the ones given priority were IPM, bio-pesticides and bio-fertilizers, soil testing, and the making of compost.* There is therefore the need to offer training on the different technologies and their application in vegetable production and most importantly, involve the farmer groups in selecting which technologies to be given priority in each county.

- *From the findings, preference for organic products was not an attribute considered by buyers when purchasing the TAVs. A majority of consumers lack knowledge of their existence and where to buy them. Producers too require more inputs yet there is currently no premium price attached to the organic products.* Therefore, the study recommends the need for awareness campaigns on organic products by consumers including training on standards and certifications in the industry.

- *The study established that the barriers to women and youth engagement in the vegetable value chains were partially influenced by access to land and finance.* It is therefore recommended that they could take advantage of other opportunities along the vegetable value chain such as seed trading, fresh vegetable trading, and value addition opportunities

REFERENCES

Abel, B.O., Gor, C.O., Okuro, S.O., Omanga, P.O. & Bokelmann, B (2019). ALVs Value Chain Governance in Kenya. *Studies in Agricultural Economics 121 (2019) 41-52*

Abukutsa, M. O. (2010). *African indigenous vegetables in Kenya: strategic repositioning in the horticultural sector.* Nairobi, Kenya.

AFA. (2017). *Horticulture Validated Report 2016-2017.* Nairobi: KNBS.

AFA. (2019). *Horticulture Validated Report 2018-2019.* Nairobi: KNBS.

AFMA. (2018). *Market Research On Purchasing Patterns of Traditional African Vegetables in Low-Income Areas in Nairobi County.*

Bayesian Consulting Group Limited. (2020). *Feasibility Study on Commercial Viability of African Indigenous Vegetables in Western and Central Kenya.* National Museums of Kenya.

Chelang'a, P. K., Obare, G. A., and Kimenju, S. C. (2013). Analysis of urban consumers' willingness to pay a premium for African Leafy Vegetables (TAVSs) in Kenya: a case of Eldoret Town. *Food Security*, 591–595.

Gido, E. O., Ayuy, O., and Bokelmann, W. (2016). Consumer's choice of retail outlets for African indigenous vegetables: Empirical evidence among rural and urban households in Kenya. *Cogent Food and Agriculture*, 1-15.

Gogo, E. O., Ulrichs, C., Huyskens-Keil, S., and Opiyo, A. (2016). Postharvest treatments of African leafy vegetables for food security in Kenya: a review. 32-40.

Hagelberg, E., Wikström, U., Joona, J. and Mattila, T. (2020). Regenerative Agriculture: A new direction of food production

Jalang'o, D. A., Kosura, W.-O., and Otieno, D. J. (2016). Factors influencing smallholder farmers' participation in domestic high-value markets for African Indigenous Vegetables in rural Kenya. *5th International Conference of the African Association of Agricultural Economists.* Addis Ababa.

Jansen van Rensburg, W. S. (2007). Water (Special Ed.). *SA 33* (3) http://www.wrc.org.za

Kebede S.W and Bokelmann W. (2017). ALVs and their Production Practices: Evidence from the HORTINLEA Survey in Kenya. *Agrotechnology 6: 170. DOI: 10.4172/2168-9881.1000170*

Maseko, I., Mabhaudhi, T., Tesfay, S., Araya, H. T., Fezzehazion, M. & Du Plooy, C. P (2018). African Leafy Vegetables: A Review of Status, Production, and Utilization in South Africa. *Sustainability 10*(16) 1-16. doi:10.3390/su10010016

Mwaura, S., Muluvi, A., and Mathenge, M. (2013). African Leafy Vegetables and Household Wellbeing in Kenya: A Disaggregation by Gender. *Invited paper presented at the 4th International Conference of the African Association*.

Rampa, F., and Dekeyser, K. (2020). *AgrInvest-Food Systems Project: Political Economy Analysis of the Kenyan Food Systems.* Rome: FAO.

Shiundu, K. M., and Oniang'o, R. K. (2016). Marketing African Leafy Vegetables: Challenges and Opportunities in the Kenyan Context. *African Journal of Food, Agriculture, Nutrition and Development*.

Singh, S., Chand, S., and Singh, D. (2012,2013). Indigenous vegetables for food and nutritional security in Andaman and Nicobar Islands, India. *International Journal of Food Science and Technology*, 503-512.

Wasike, V., Manjella, A., Wasilwa, L. & Hunter, D. (2018). Linking Farmers, ALVs, and Schools to Improve Diets and Nutrition in Busia County, Kenya. *Third International Conference; Agriculture and Food in an Urbanizing Society, 17-21 September 2018*

LIST OF ANNEXES

Annex 1: List of Key Informants

County	Organization	Name
Murang'a	Youth in Agricultural Research and Development Project (YARD) CBO	Loise Gatimu – Field and Community Mobilizer
	Farm Forestry- Small Holders Producers Association of Kenya – FF- SPAK (NGO)	Edwin Kamau – Program Co-ordinator
	County Government of Murang'a Extension officer	Kamau Kimani
Machakos	Christian Impact Mission (CIM)	Titus Masika-Director
	ICIPE	Isaac Mbeche-Technology transfer officer
Vihiga	Sustainable Organic Farming Development Initiative (SOFDI)	Isaac-Field officer
Kakamega	Green Villages International NGO	Executive Director
Nairobi	KEPHIS	Onesmus Kyalo
Nairobi	KALRO-Thika	Dr. Faith Nguthi

Annex 2: Gross margin analyses

A. TAVs in Kakamega, Kiambu and Kisumu

		KAKAMEGA				KIAMBU				KISUMU			
ITEM	**UNIT**	**AVERAGE QUANTITY/ SEASON**	**AVERAGE UNIT COST**	**TOTAL COST/ SEASON**	**TOTAL COST/ YEAR**	**AVERAGE QUANTITY/ SEASON**	**AVERAGE UNIT COST**	**TOTAL COST/ SEASON**	**TOTAL COST/ YEAR**	**AVERAGE QUANTITY/ SEASON**	**AVERAGE UNIT COST**	**TOTAL COST/ SEASON**	**TOTAL COST/ YEAR**
Land leasing	Acre	0	0	0	0	0	0	0	0	0	0	0	0
Ploughing	Acre	1	2500	2500	7500	1	2000	2000	6000	1	3000	3000	9000
Purchase of fertilizer	Kg	0	0	0	0	50	70	3500	10500	0	0	0	0
Purchase of pesticides	Kg/liters	0	0	0	0	1	2000	2000	6000	0	0	0	0
Purchase of manure	Bags	9	100	900	2700	10	300	3000	9000	10	200	2000	6000
Purchase of seeds	Kg	0.5	1000	500	1500	0.5	1000	500	1500	0.5	1500	750	2250
Land preparation labor	Man-days	4	300	1200	3600	4	300	1200	3600	4	300	1200	3600
Manure application labor	Man-days	2	300	600	1800	2	300	600	1800	2	300	600	1800
Irrigation fuel/power	Litres/Units	0	0	0	0	1	10000	10000	30000	0	0	0	0
Irrigation labor	Man-days	0	0	0	0	5	300	1500	4500	0	0	0	0
Planting labor	Man-days	4	300	1200	3600	4	300	1200	3600	4	300	1200	3600
Fertilizer application labor	Man-days	0	0	0	0	1	300	300	900	0	0	0	0
Weeding labor	Man-days	6	300	1800	5400	8	300	2400	7200	6	300	1800	5400
Spraying labor	Man-days	0	0	0	0	4	300	1200	3600	0	0	0	0
Harvesting labor	Man-days	10	300	3000	9000	16	300	4800	14400	16	300	4800	14400
TOTALS	**KKES**			**11700**	**35100**			**34200**	**102600**			**15200**	**46050**
Total output	Kg			1300	3900			2500	7500			1000	3000
Price/kg	KES			20	20			30	30			30	30
Total income	**KES**			**26000**	**78000**			**75000**	**225000**			**30000**	**90000**
Less total cost	KES			11700	35100			34200	102600			15200	46050
Gross margin	**KES**			**14300**	**42900**			**40800**	**122400**			**14800**	**43950**

B. TAVs in Machakos, Muranga and Siaya

		Machakos				Murang'a				Siaya			
Item	Unit	Ave. Qty/ Season	Ave. Unit Cost	Total Cost /Season	Total Cost/ Year	Ave.qty/ Season	Ave.unit Cost	Total Cost/ Season	Total Cost/ Year	Ave.qty/ Season	Ave.unit Cost	Total Cost/ Season	Total Cost/ Year
Land leasing	Acre	0	0	0	0	1	5000	5000	10000	0	0	0	0
Ploughing	Acre	1	2800	2800	8400	1	3000	3000	6000	1	3000	3000	6000
Purchase of fertilizer	Kg	0	0	0	0	250	54	13500	27000	25	60	1500	3000
Purchase of pesticides	Kg/liters	0	0	0	0	1	1500	1500	3000	0.5	1000	500	1000
Purchase of manure	Bags	12	250	3000	9000	10	400	4000	8000	10	100	1000	2000
Purchase of seeds	Kg	0.5	1800	900	2700	0.5	2000	1000	2000	0.5	1000	500	1000
Land preparation labor	Man-days	4	300	1200	3600	4	300	1200	2400	4	300	1200	2400
Manure application labor	Man-days	2	300	600	1800	1	300	300	600	2	300	600	1200
Irrigation fuel/power	Litres/ Units	15	116	1740	5220	0	0	0	0	0	0	0	0
Irrigation labor	Man-days	16	300	4800	14400	20	300	6000	12000	8	300	2400	4800
Planting labor	Man-days	4	300	1200	3600	4	300	1200	2400	4	300	1200	2400
Fertilizer application labor	Man-days	0	0	0	0	1	300	300	600	1	300	300	600
Weeding labor	Man-days	4	300	1200	3600	8	300	2400	4800	4	300	1200	2400
Spraying labor	Man-days	0	0	0	0	3	300	900	1800	4	300	1200	2400
Harvesting labor	Man-days	16	300	4800	14400	16	300	4800	9600	8	300	2400	4800
TOTALS	KES			22240	66720			45100	90200			17000	34000
Total output	Kg			1000	3000			4000	8000			800	1600
Price/kg	KES			25	25			20	20			25	25
Total income	KES			25000	75000			80000	160000			20000	40000
Less total cost	KES			22240	66720			46300	92600			17000	34000
Gross margin	KES			2760	8280			53700	107400			3000	6000

C. TAVs in Vihiga

Item	Unit	Ave. Qty /Season	Ave. Unit Cost	Total Cost/ Season	Total Cost/ Year
Land leasing	Acre	0	0	0	0
Ploughing	Acre	1	3000	3000	6000
Purchase of fertilizer	Kg	0	0	0	0
Purchase of pesticides	Kg/liters	0	0	0	0
Purchase of manure	Bags	10	100	1000	2000
Purchase of seeds	Kg	0.5	1200	600	1200
Land preparation labor	Man-days	4	300	1200	2400
Manure application labor	Man-days	2	300	600	1200
Irrigation fuel/power	Litres/Units	0	0	0	0
Irrigation labor	Man-days	0	0	0	0
Planting labor	Man-days	4	300	1200	2400
Fertilizer application labor	Man-days	0	0	0	0
Weeding labor	Man-days	0	0	0	0
Spraying labor	Man-days	0	0	0	0
Harvesting labor	Man-days	10	300	3000	6000
TOTALS	KES			10600	21200
Total output	Kg			700	1400
Price/kg	KES			25	25
Total income	KES			17500	35000
Less total cost	KES			10600	21200
Gross margin	KES			6900	13800

D. KALES AND SPINACH

		KAKAMEGA				KIAMBU				KISUMU			
Item	Unit	Ave. Quantity/ Season	Average Unit Cost (Ksh)	Total Cost/ Season	Total Cost/ Year	Ave. Quantity/ Season	Ave. Unit Cost (Ksh)	Total Cost/ Season	Total Cost/ Year	Ave. Quty/ Season	Ave.Unit Cost (Ksh)	Total Cost/ Season	Total Cost/ Year
Land leasing	Acre	0	0	0	0	0	0	0	0	0	0	0	0
Ploughing	Acre	1	2500	2500	5000	1	2000	2000	6000	1	3000	3000	6000
Purchase of fertilizer	kg	100	60	6000	12000	250	54	13500	40500	25	80	2000	4000
Purchase of pesticides	Kg/liters	1	2000	2000	4000	1.5	2000	3000	9000	1	2250	2250	4500
Purchase of manure	Bags	10	100	1000	2000	10	300	3000	9000	10	200	2000	4000
Purchase of seeds	Kg	0.5	1000	500	1000	0.5	3000	1500	4500	0.5	2000	1000	2000
Nursery preparation	Man-days	1	300	300	600	1	300	300	900	1	300	300	600
Land preparation labor	Man-days	4	300	1200	2400	4	300	1200	3600	4	300	1200	2400
Manure application labor	Man-days	2	300	600	1200	2	300	600	1800	2	300	600	1200
Irrigation fuel/power	Litres/Units	0	0	0	0	1	10000	10000	30000	0	0	0	0
Irrigation labor	Man-days	0	0	0	0	10	300	3000	9000	0	0	0	0
Planting labor	Man-days	4	300	1200	2400	4	300	1200	3600	4	300	1200	2400
Fertilizer application labor	Man-days	2	300	600	1200	2	300	600	1800	2	300	600	1200
Weeding labor	Man-days	4	300	1200	2400	4	300	1200	3600	4	300	1200	2400
Spraying labor	Man-days	4	300	1200	2400	4	300	1200	3600	4	300	1200	2400
Harvesting labor	Man-days	10	300	3000	6000	20	300	6000	18000	12	300	3600	7200
TOTALS	KES			21300	42600			48300	144900			20150	40300
Total output	Kg			2000	4000			5000	15000			1500	3000
Price/kg	KES			15	15			15	15			15	15
Total income	KES			30000	60000			75000	225000			22500	45000
Less total cost	KES			21300	42600			48300	144900			20150	40300
Gross margin	KES			8700	17400			26700	80100			2350	4700

E. KALES AND SPINACH

		Murang'a				Siaya				Vihiga			
Item	Unit	Average Quantity/ Season	Ave. Unit Cost (Ksh)	Total Cost/ Season	Total Cost/ Year	Ave. Qty/ Season	Ave. Unit Cost (Ksh)	Total Cost/ Season	Total Cost/ Year	Aver. Qty/ Season	Aver. Unit Cost (Ksh)	Total Cost/ Season	Total Cost/ Year
Land leasing	Acre	0	0	0	0	0	0	0	0	0	0	0	0
Ploughing	Acre	1	3000	3000	6000	1	3000	3000	6000	1	3000	3000	6000
Purchase of fertilizer	kg	250	54	13500	27000	50	60	3000	6000	50	60	3000	6000
Purchase of pesticides	Kg/liters	1.5	1500	2250	4500	1	2000	2000	4000	1	1800	1800	3600
Purchase of manure	Bags	10	400	4000	8000	10	100	1000	2000	10	100	1000	2000
Purchase of seeds	Kg	0.5	3400	1700	3400	1	2800	2800	5600	1	2500	2500	5000
Nursery preparation	Man-days	1	300	300	600	1	300	300	600	1	300	300	600
Land preparation labor	Man-days	4	300	1200	2400	4	300	1200	2400	4	300	1200	2400
Manure application labor	Man-days	1	300	300	600	2	300	600	1200	2	300	600	1200
Irrigation fuel/power	Litres/Units	0	0	0	0	0	0	0	0	0	0	0	0
Irrigation labor	Man-days	20	300	6000	12000	10	300	3000	6000	0	0	0	0
Planting labor	Man-days	4	300	1200	2400	4	300	1200	2400	4	300	1200	2400
Fertilizer application labor	Man-days	2	300	600	1200	2	300	600	1200	2	300	600	1200
Weeding labor	Man-days	12	300	3600	7200	6	300	1800	3600	6	300	1800	3600
Spraying labor	Man-days	3	300	900	1800	4	300	1200	2400	4	300	1200	2400
Harvesting labor	Man-days	20	300	6000	12000	12	300	3600	7200	8	300	2400	4800
TOTALS	KES			44550	89100			25300	50600			20600	41200
Total output	Kg			3500	7000			2500	5000			1500	3000
Price/kg	KES			20	20			15	15			15	15
Total income	KES			70000	140000			37500	75000			22500	45000
Less total cost	KES			44550	89100			25300	50600			20600	41200
Gross margin	KES			25450	50900			12200	24400			1900	3800

F. TOMATO

		Kisumu				Murang'a			
Item	**Unit**	**Average Quantity/ Season**	**Average Unit Cost**	**Total Cost/ Season**	**Total Cost/ Year**	**Average Quantity /Season**	**Average Unit Cost**	**Total Cost/ Season**	**Total Cost/ Year**
Land lease	Acre	0	0	0	0	1	5000	5000	10000
Ploughing	Acre	1	3000	3000	6000	1	3000	3000	6000
Purchase of fertilizer	Kg	200	80	16000	32000	300	60	18000	36000
Purchase of pesticides	Kg/liters	2	2400	4800	9600	5	4000	20000	40000
Purchase of manure	Bags	10	200	2000	4000	30	400	12000	24000
Purchase of seeds	Kg	0.025	20000	500	1000	0.025	320000	8000	16000
Nursery preparation	Man-days	1	300	300	600	1	300	300	600
Land preparation labor	Man-days	4	300	1200	2400	8	300	2400	4800
Manure application labor	Man-days	2	300	600	1200	3	300	900	1800
Irrigation fuel/power	Litres/Units	60	120	7200	14400	150	120	18000	36000
Irrigation labor	Man-days	24	300	7200	14400	24	300	7200	14400
Planting labor	Man-days	4	300	1200	2400	4	300	1200	2400
Fertilizer application labor	Man-days	2	300	600	1200	2	300	600	1200
Weeding labor	Man-days	16	300	4800	9600	16	300	4800	9600
Spraying labor	Man-days	16	300	4800	9600	32	300	9600	19200
Sticking materials	numbers	1	12000	12000	24000	1	10000	10000	20000
Sticking labor	Man-days	15	300	4500	9000	20	300	6000	12000
Harvesting labor	Man-days	20	300	6000	12000	24	300	7200	14400
TOTALS				**76700**	**153400**			**134200**	**268400**
Total output	Kg			1500	3000			6000	12000
Price/kg	KES			70	70			25	25
Total income				**105000**	**210000**			**150000**	**300,000**
Less total cost				76700	153400			134200	268,400
Gross margin per year				**28300**	**56600**			**15800**	**31,600**

G. ONIONS

		Machakos			
Item	Acre	Average Quantity/ Season	Average Unit Cost	Total Cost/ Season	Total Cost/ Year
Land lease	Acre	0	0	0	0
Ploughing	Kg	1	2800	2800	8400
Purchase of fertilizer	Kg/liters	50	70	3500	10500
Purchase of pesticides	Bags	2	1000	2000	6000
Purchase of manure	Kg	12	250	3000	9000
Purchase of seeds	Man-days	1	8000	8000	24000
Nursery preparation	Man-days	1	300	300	900
Land preparation labor	Man-days	4	300	1200	3600
Manure application labor	Man-days	2	300	600	1800
Irrigation fuel/power	Man-days	30	116	3480	10440
Irrigation labor	Man-days	16	300	4800	14400
Planting labor	Man-days	4	300	1200	3600
Fertilizer application labor	Man-days	2	300	600	1800
Weeding labor	Man-days	8	300	2400	7200
Spraying labor	Man-days	2	300	600	1800
Harvesting labor	KES	6	300	1800	5400
TOTALS	Kg			36280	108840
Total output	KES			2200	6600
Price/kg	KES			40	40
Total income	KES			88000	264000
Less total cost	KES			36280	108840
Gross margin per year				51720	155160

SNV IMPACT THAT MATTERS

Veggies 4 Planet & People

SNV KENYA
Ngong Lane, off Ngong Road
P.O. Box 30776-00100
Nairobi, Kenya

In partnership with

WorldVeg

With the support of

IKEA Foundation