Value Chain Study on African Leafy Vegetables

January 2023

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Acronyms

Acronym	Meaning
ACIAR	Australian Centre for International Agricultural Research
ADS	Anglican Development Services
AFA	Agriculture and Food Authority
AFFM	Africa Fertilizer Financing Mechanism
AGRA	Alliance for a Green Revolution in Africa
ALVs	African Leafy Vegetables
AMPATH	Academic Model Providing Access to Healthcare
BFN	Biodiversity for Food and Nutrition
CBO	Community Based Organization
CBR	Cost Benefit Ratio
CIAT	International Center for Tropical Agriculture
FAO	Food Agriculture Organization
FCI	Farm Concern International
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IPGRI	International Plant Genetic Resources Institute
IPM	Integrated Pest Management
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KALRO	Kenya Agricultural & Livestock Research Organisation
KCB	Kenya Central Bank
KCDMS	Kenya Crops and Dairy Market Systems
KEBS	Kenya Bureau of Standards
KEPHIS	Kenya Plant Health Inspectorate Service
KWFT	Kenya Women Finance Trust
MoALF	Ministry of agriculture livestock and fisheries
NARIGP	National Agricultural and Rural Inclusive Growth Project
NCPB	National Cereals and Produce Board
PELUM	Participatory Ecological Land Use Management
PROTA	Plant Resources of Tropical Africa
ROA	Rural Outreach Africa
SMEs	Small Medium Enterprises
UK	United Kingdom
UNESCO	United Nations Educational, Scientific and Cultural Organization.
US	United States
USA	United States of America
USAID	United States Agency for International Development
VC	Value chain

1. Introduction

1.1 Background and objectives of the value chain analysis

The African Leafy vegetables (ALVs) value chain analysis is a key deliverable of the Transforming Livelihoods through Climate Resilient, Low Carbon, Sustainable Agricultural Value Chains in the Lake Region Economic Bloc, Kenya (CRLCSA) Project. CRLCSA focuses on the Lake Victoria Region (LREB) for various reasons including that it exhibits moderate to high levels of vulnerability and houses a high number of people.

African Leafy Vegetables was selected due to several factors, which include economic importance, growth potential and a relatively high potential for upscaling. ALVs have moderate to high levels of vulnerability and benefits from continued levels of agricultural suitability (with adaptation measures). They carry ecological importance both nationally and regionally thus, enjoy priority focus in projects being implemented in the Lake and other regions. These factors underpin why the Government of Kenya has requested for its focus in the CRLCSA project and other projects.

CRLCSA's main objective is to implement a deep transformation of agricultural production, processing and marketing towards low-carbon, climate resilient pathways with a focus on six value chains (dairy, poultry, coffee, tea, fruit tree and indigenous vegetables) with the aim to transfer both adaptation and mitigation technology at each value chain's production, harvesting, processing, and marketing stages.

The project builds on the private sector and the strength of the cooperative movement in Kenya and creates a mechanism for North-South and South-South technology transfer, leveraging the knowledge and expertise that exists in national and international farming networks. It is against this background that a value chain analysis on African Leafy vegetables was carried out to understand the status of the value chain and identify gaps for development initiatives.

1.1.1 Global, National and County overview of the value chain

ALVs described as weeds by early scholars and researchers are indigenous vegetables of African origin[1]. In Africa, has documented 1,000 edible species of ALVs[2] while Kenya alone has more than 200 species[3]. The priority species include amaranth, African nightshade, cowpeas, spider plant, Ethiopian kales, slender leaf, jute plant, and pumpkin leaves among others. Findings indicate 80%[4] of Kenyan households grow the value chain at subsistence level in rural and urban communities in Kenya owing to their nutritive and medicinal value, agronomic advantage, and their potential to be commercialized as a source of income[5]. Their commercial potential has not been exploited.

[1] ALVs are mainly grown in African countries i.e., West Africa in Ghana, Nigeria, Benin and Senegal; in East and Central Africa it is grown in Kenya, Uganda, Cameroon, Gabon, Zambia, Tanzania & Ethiopia while in South Africa they are mainly grown in Zimbabwe and South Africa. (Oniang'o, R., Grum, M. and Obel-Lawson, E., editors. 2008).

[2] PELUM Kenya 2014; African leafy vegetable enterprise boosts livelihood of rural communities in Kenya Case Study

[3] http://www.b4fn.org/case-studies/case-studies/african-leafy-vegetables-alvs/#:~:text=More%20than%20200%20species%20of,food%20ingredients%20in%20Kenya%20alone.

[4] http://www.b4fn.org/case-studies/case-studies/african-leafy-vegetables-alvs/

[5] Mary Oyiela Abukutsa-Onyango; 2021 Production and Marketing of African Indigenous Leafy Vegetables

The introduction of exotic fruits and vegetables negatively affected their consumption and production of ALVs. However, they have recently received recognition through crop research at international, regional, and national institutions – resulting in their commercialization via formal and informal markets[6]

In the LREB the main ALV-producing counties include Busia, Kisii, Vihiga, Nyamira, Trans-Nzoia, Kakamega, Bungoma, Kakamega, Nandi, Kericho and Migori. ALVs are also produced in other counties in Kenya such as Kiambu, Nakuru, Embu and Meru. The main varieties produced and consumed include the African nightshade (*managu*[8]), leafy amaranth (*terere*), spider plant (*sagaat*), slender leaf (*mitoo*), cowpeas (*Kunde*), jute mallow (*mrenda*), pumpkin leaves (*malenge*) and African kales (*kanzira)*[9].

Table 1 Priority ALVS in Lake Victoria Region

Common Name	**% Contribution in production**
Cowpeas	30
Amaranths	21
African nightshades	12
Jute mallow	11
Spider plant	7
Slender leaf	7
African kale	7
Pumpkin leaves	5

Source: Department of Botany and Horticulture, Maseno University[7]

1.2 Key statistics on value chain performance (production, productivity, industry, and market trends

National Level Performance

Before the year 2000, ALVs were dominant in the back streets of town centers. There were still large volumes that were consumed at household level. However, owing to their nutritional value, demand has progressively increased to grocery shops, main shopping areas, supermarkets and even exportation (of dried vegetables) to Kenyans and other Africans living abroad.

The production has been commercialized following the increased marketing and consumption in the urban centers such as Nairobi. The value chain has attracted global interest with the recent recognition by UNESCO in 2022 as part of Kenyan cuisine and culture and most importantly their ability to improve nutrition and sustain smallholder farmers' livelihoods.[10]

To meet consumer demand in the urban markets, farmers, need to consider quality and fresh produce as well as value addition products. Value adding will address the challenge faced by some urban dwellers who avoid purchasing due to the long process of preparing. The women who run small grocery shops commonly known as *mama mboga* in Kenya address this challenge by adopting ways to provide *ready-to-cook-or-eat* products by washing, cutting, and boiling before selling to local consumers[11].

[6] KALRO; Climate Smart Agricultural Technologies, Innovations and Management Practices for Indigenous Vegetables Value Chain, March 2020
[7] Department of Botany and Horticulture, Maseno University (2022)
[8] https://www.agcenture.com/2020/02/06/kienyeji-vegetables-in-kenya/
[9] https://ruraloutreachafrica.org/african-leafy-vegetables-project/
[10] Eliot Gee; https://alliancebioversityciat.org/stories/traditional-vegetables-recognized-unesco-kenya
[11] Mary Oyiela Abukutsa-Onyango; 2021 Production and Marketing of African Indigenous Leafy Vegetables

According to the Horticulture Validated Report of the Agricultural Food Authority (AFA):

- In 2019 land under production of African leafy vegetables increased from 45,508 Hectares (Ha) 2018 to 54,235 Ha in 2019 a 19% increase which led to an increase in volumes and value (Volumes increased by 28% while value increased by 26%)[12]

- In 2020, the total area, volumes and value of production decreased by 45% (from 98,940 Ha in 2019 to 54,235 Ha in 2020), 19% (from Kshs 10,251,436,747 in 2019 to Kshs 944,431,110 in 2020, and 13% (from 374, 489 MT in 2019 to 303,666 MT in 2020)[13]

- The export market in 2019-2020 had increased demand by Kenyans in the diaspora particularly in United Kingdom and Germany.

Table 2 Total Production and Value of African leafy vegetables in 2019-2020 Kenya

Summary of African Leafy Vegetables by Area, Volume and Value in 2019-2020[14]						
African Leafy vegetable name	2019			2020		
	Area (Ha)	Volume (MT)	Value (KSHS)	Area (Ha)	Volume (MT)	Value (KSHS)
Cowpea	79,535	159,386	3,512,308,830	36,018	113,666	3,348,701,203
African Nightshade	6,950	69,254	2,397,810,725	5,917	58,909	1,831,009,726
Spider Plant	4,280	35,295	1,229,098,895	3,949	36,445	1,315,530,681
Leaf Amaranth	3,996	54,813	1,322,286,150	3,237	38,172	831,076,886
Grain Amaranth	453	3,020	178,728,617	511	2,459	127,453,939
Pumpkin Fruits	1,487	31,022	722,892,977	1,755	35,829	813,596,889
Slender leaf	355	7,107	350,836,860	841	5,605	260,730,596
Pumpkin Leaves	903	6,650	147,623,496	900	6,172	158,159,801
Jute Mallow	672	5,894	309,079,967	657	3,373	155,029,483
Russian Comfrey	75	644	19,460,000	163	1,354	50,321,660
Vine Spinach	193	811	33,530,230	217	1,030	29,476,001
Malabor	41	593	27,780,000	70	652	23,344,245
Total	**98,940**	**374,489**	**10,251,436,747**	**54,235**	**303,666**	**8,944,431,110**

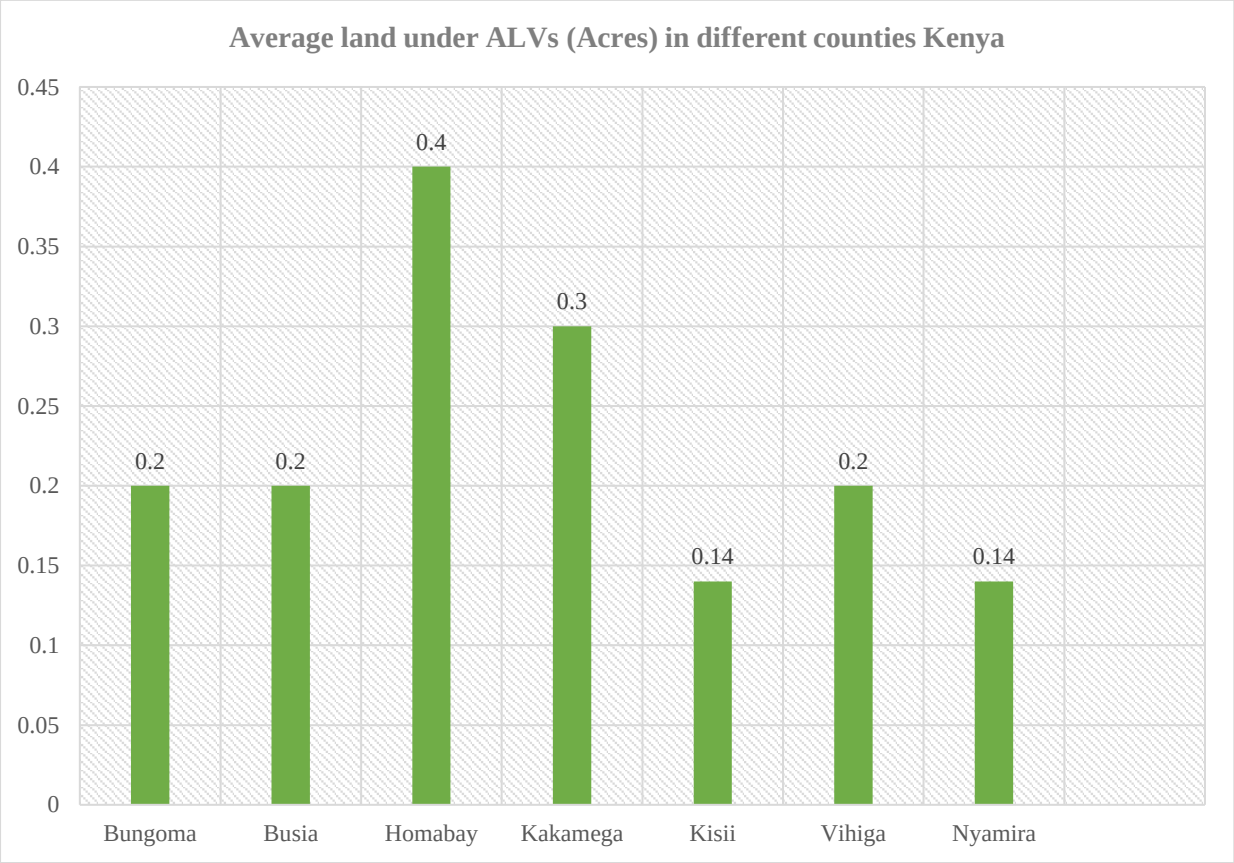
Source: AFA 2021, Horticultural statistics January-July (volumes and values)

Performance in the Lake Region Economic Bloc

Cowpeas, leaf amaranth and African Nightshade are leading in the production of ALVs in LREB. According to the USAID Kenya Crops and Dairy Market Systems Activity (KCDMS) project, ALVs are mainly produced by smallholder farmers on less than one-acre farm unit[15]. This finding is also corroborated by another study by the European Centre for Development Policy Management (ECDPM) and Agile Consulting for the AgrInvest-Food Systems project of the Food and Agriculture Organization (FAO)[16] . Figure 1 provides these statistics.

[12] AFA Horticulture Validated Report 2019-2020 & AFA Horticulture Validated Report 2018-2019
[13] AFA Horticulture Validated Report 2019-2020
[14]AFA Horticulture Validated Report 2019-2020
[15] County specific value chain analysis: production and market systems analysis for African vegetables funded by USAID via RTI in 2020.
[16] Rampa, F. and Obiero Were, T. 2021. AgrInvest-Food Systems Project – Increasing sustainable investments in the Kenyan indigenous vegetables chain. Rome. https://doi.org/10.4060/cb7413en

Figure 1 Average land size allocated to African leafy vegetables



Source: Author compilation of the Agri-Invest-Food Systems Project in 2021 and the KCDMS value chain studies in 2020)

1.3 Methodology

1.3.1 Mixed methods approach (qualitative and quantitative methods)

The study analyzed the status of the value chain in production, distribution and marketing, value addition; and identified the existing gaps and areas of intervention. Desk research was the main method used in generating data. The results of the desk research were thereafter validated and complemented through primary data collection using; Focus Group Discussions (FGD), field observations and Key Informant Interviews (KII).

1.3.2 Desk research

This involved review of available secondary data to provide preliminary information regarding the value chain in line with the study objective. A compendium of literature reviewed including previous reports done on ALVs, project documents, County Integrated Development Plans, Climate Risk Assessment Framework, national policies and strategies on sustainable food and nutrition security, Economic Survey Reports and have been referenced in footnotes sections of this report. The review identified gaps that were addressed during the primary data collection with the relevant respondent categories.

1.3.3 Key Informant Interviews

Key Informant Interviews were conducted to obtain and collect information from various chain actors. Interviews were administered face-to-face to targeted input suppliers, traders, financial service providers, business development service providers, county government officers in the departments of agriculture and trade, seed companies, research organizations and development agencies in the value chain in Kisumu and Trans Nzoia counties.

1.3.4 Focus Group Discussions

To obtain a richer and in-depth information, data was also collected through FGDs with 10-12 participants who included men, women and youth involved in producing, distribution and marketing as well as value addition of ALV. Participants in the FGDs included cooperatives members and producer groups.

1.3.5 Data processing and analyses

Quantitative data obtained from desk review was analyzed using Microsoft Excel. The analysis involved descriptive statistics with outputs presented in tables and charts. Qualitative data was analyzed using thematic and content analysis and presented in prose form. Using the analysis, a comprehensive report was written based on a set outline.

1.4 History of Value Chain

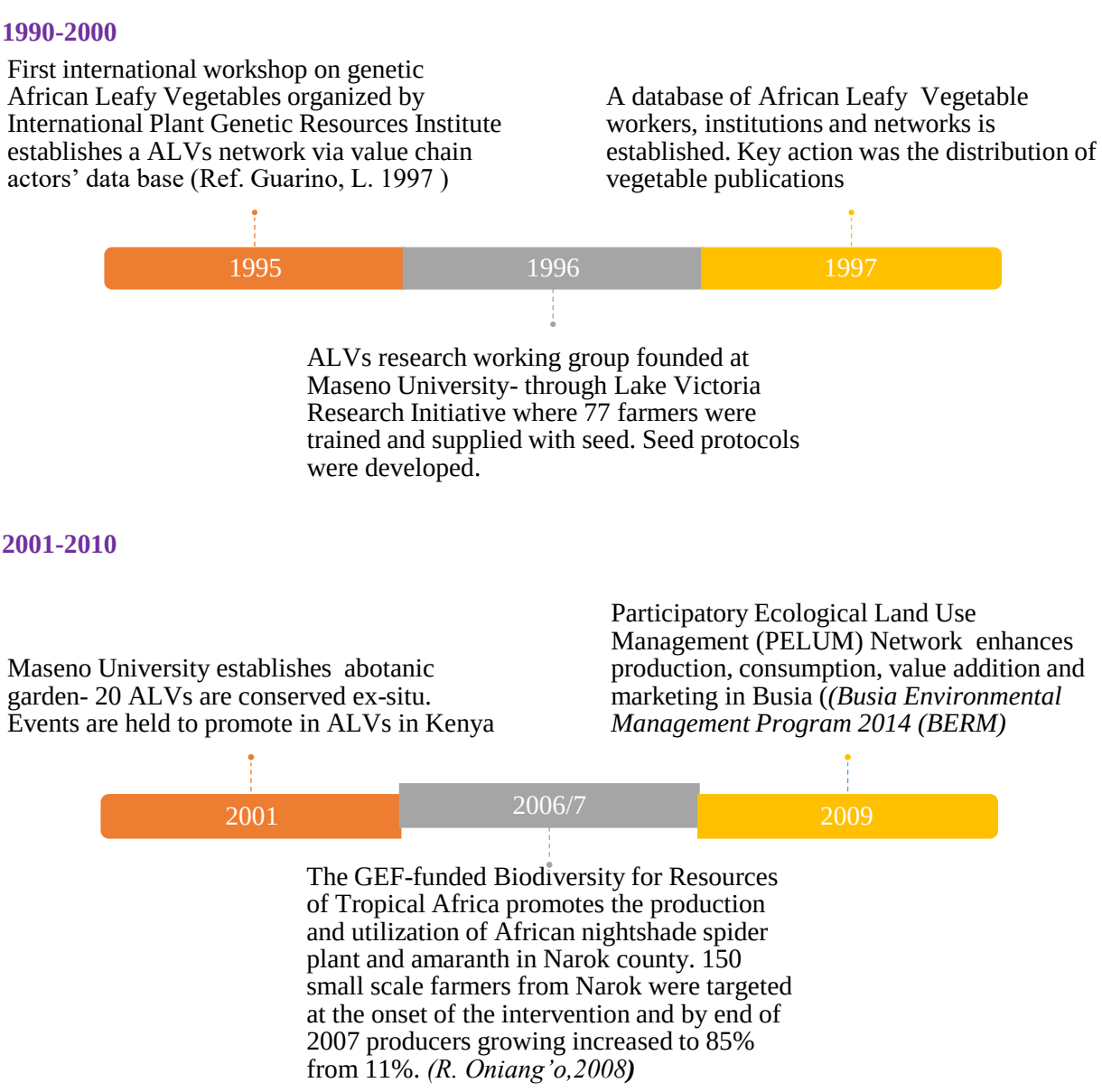
1.4.1 Brief history of the sector

As mentioned earlier, ALVs are believed to be vegetables indigenous to Africa whose leaves, shoots and flowers are consumed. They are increasingly being recognized for household food security by adding variety to cereal-based staple diets. Their commercialization provides an economic opportunity for reducing rural poverty in Kenya and many other countries in sub-Saharan Africa.

1.4.2 Previous development activities

The table below summarizes some of the development initiatives that have taken place in Kenya for ALVs

Figure 2: Past development activities



2011-2020

ALVs are officially marked with recognition by the United Nations Educational, Scientific and Cultural Organization (UNESCO) its list of 210 protected vegetables (*UNESCO(UNESCO,2013)*

The Horticulture Innovation Lab aimed at increasing production in Nandi ,Busia and Kakamega Counties develops and tests Development and testing of five new varieties of ALVs sourced from World Vegetable Center released by government of Kenya for commercial production. An initiative of KALRO, AMPATH, Rutgers University, Purdue University and the World Vegetable Center

The GEF-funded Biodiversity for Food and Nutrition (BFN) Project in Busia county is piloted in schools - 25 farmer groups trained to build capacity to sustainably produce

2022

Maseno University establishes abotanic garden- 20 ALVs are conserved ex-situ. Events are held to promote in ALVs in Kenya Awuoth Widows and Orphans CBO rolls out support widows (400) and youths (100) in Kisumu County. Partnership with KALRO to train the beneficiaries on regenerative agriculture using organic manure to boost yields. *(Evangeline Mola and Lorine Awin, 2022)*

Source: Author's Compilation

1.4.3 Current state and structure of the value chain

The industry operates under technical and policy guidance of the Ministry of Agriculture, Livestock and Fisheries (MALF). The value chains operations are regulated under the horticulture sub-sector overseen by the Horticultural Crops Directorate (HCD), which was formerly known as Horticultural Crops Development Authority (HCDA) established under the Agriculture Act, Chapter 318 of the Laws of Kenya. Kenya lacks formal structures specifically for African Leafy vegetables as it is assumed under horticulture crops.

Despite recent modest improvements in private sector seed, supply, farmer-owned and recycled seeds are the norm within informal networks and exchanges between different community seed production systems. Kenya Plant Health Inspectorate Service (KEPHIS) for the first time released pure seeds of indigenous Vegetables to the Kenyan market in 2016. The licensed vegetable seeds are African nightshade *(managu*), vine spinach *(nderma*), Jute mallow (*murenda*), and spider plant

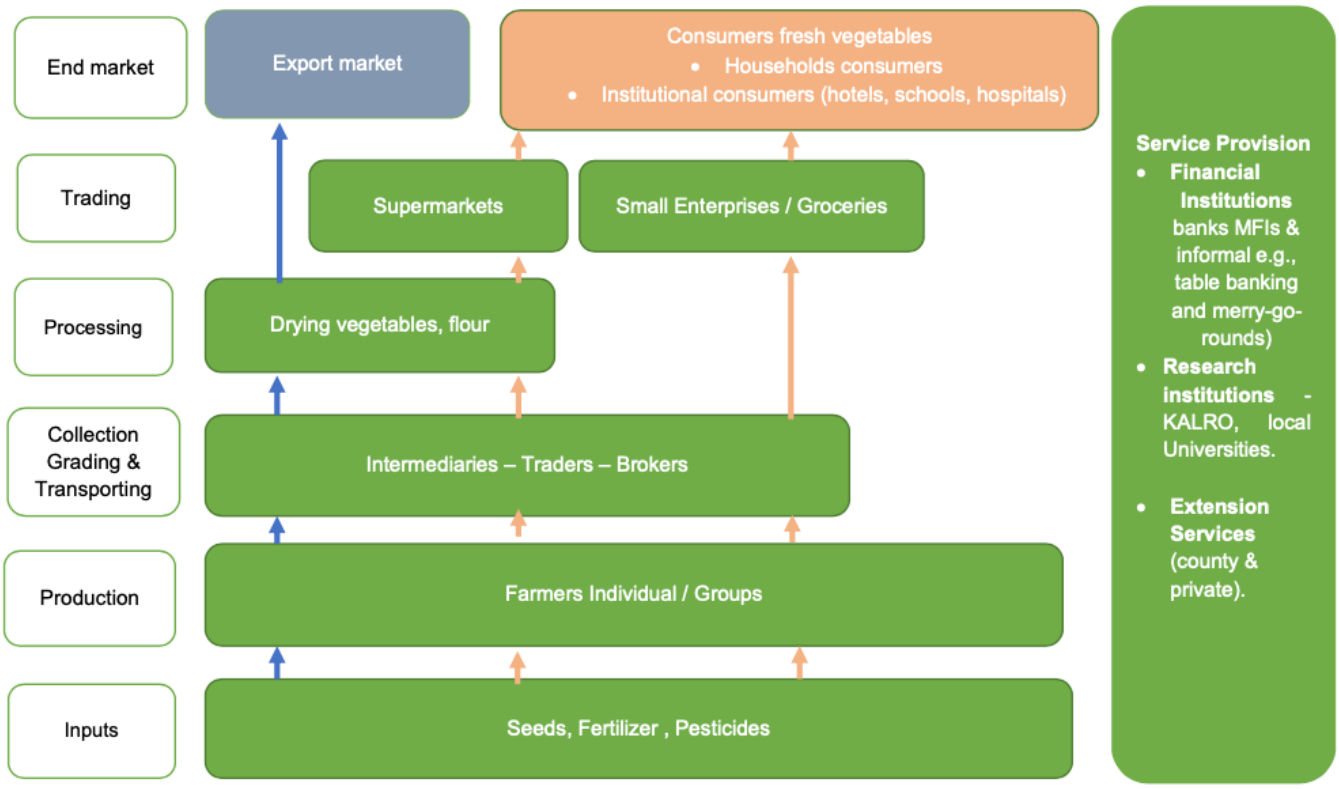
(sagaa). Not only is the availability, but also the access to quality seeds is problematic, with these licensed varieties being too expensive for most of the smallholder farmers in Kenya[17].

2. Functional Analysis

Functional analysis illustrates series of activities from initial production of African Leafy Vegetables to final consumption and the actors involved at each stage, as well as the flow of products and information along the chain are presented in the figure below.

2.1. Value Chain Map

Figure 2 ALV Value chain Map



Source: Author's Compilation, 2022

2.2. End-market Analysis

In this section, the study analyses market structure, existing and potential market demand, market actors and their roles along the value chain.

2.2.1 Demand

Local Demand

[17] Rampa, F. and Obiero Were, T. 2021. *AgrInvest-Food Systems Project – Increasing sustainable investments in the Kenyan indigenous vegetables chain*. Rome. https://doi.org/10.4060/cb7413en

- ALVs have for decades been a part of the diet for Kenyans. However, the introduction of exotic vegetables such as spinach, kales and others eclipsed their consumption largely. The average consumption of ALVs in Kenya in 2008 stood at an average of 147 kg per capita by urban consumers per year while rural consumers consume 73 kgs per year. The findings indicate that urban consumers consume more vegetables compared to rural consumers, which could be attributed to their exposure and increased knowledge on the nutritional and health benefits of the value chains as well as access to stable incomes- increasing their purchase power[18] .
- A report by Biodiversity for Food and Nutrition Project (2012) indicates that about 34% of people living in urban and peri-urban Nairobi consume ALVs.
- The current expansion in production, marketing, and consumption could be attributed to increasing consumer awareness about their health and nutritional benefits (Schippers 2000) resulting to urban, rural, and peri-urban increased demand.
- Currently, most food retail outlets sell ALV leaves, and their availability and diversity in high value retail outlets such as supermarkets have further induced their consumption in urban areas (Ngugi et al. 2007; Irungu et al. 2008). An analysis carried out by the AFA in 2017 indicates that the demand for ALVs has been on the rise due to the increased awareness on the nutrition and health benefits.

International Demand

Currently, there exists a small demand by Kenyans living abroad (e.g., the United Kingdom) for the value chain, although it has not been quantified. Data gathered by AFA 2021 (January-July period) revealed that there is potential for export for horticultural exports and specifically for vegetables amounted to 43,819.777 Tones valued at Kshs.16,797,875,128.82[19]. These findings indicate that the existing vegetable markets could be leveraged to markets ALVs.

The international demand potential could be attributed to i) rise in African immigrants to the countries such as the US, Europe and Australia demanding for dried vegetables, and ii) reduction of barriers in accessing these markets because of ongoing deals between the Kenyan government and their counterparts abroad. (Brian Moseti, 2021).

2.2.2 Market structure

The value chain lacks a well-structured market system. Producers harvest and pack the produce in sacks and place them at the roadside buying centres. The traders (vendors) who come from the urban markets buy and transport the vegetables to the market[20]. A few farmers have formal market structures where they aggregate the produce and supply to supermarkets, and to institutions such as hotels, schools, or hospitals.

Market players include wholesalers, retailers, brokers, transporters, and consumers. Notably value-added products are very few and have low demand in the markets. In Kakamega County, some farmers sold collectively to Mace Foods Eldoret although the business was short lived as the buyer collected a few times and cited insufficient supply. The export market is also slim as only very small quantities are exported.

[18] Eric Obedy Gido1,2*, Oscar Ingasia Ayuya2, George Owuor2 and Wolfgang Bokelmann1; Consumption intensity of leafy African indigenous vegetables: towards enhancing nutritional security in rural and urban dwellers in Kenya

[19] AFA statistics 2021

[20] P. Nekesa and B. Meso; Traditional African vegetables in Kenya: production, marketing and utilization 1993

To increase access to the world agricultural markets, Kenya has signed multilateral and bilateral trade agreements[21] with the World Trade Organization (WTO). These include:

- **ACP-EU Trade Agreement**: Signed in 2000 between the European Community and the African, Caribbean, and Pacific states (ACP), gives Kenya a no-reciprocal market access to the European Union
- **Common Market of Eastern and Southern Africa (COMESA**): The member states agreed to form a Free Trade area, which led to reduction the imports tariffs for goods produced within its members.
- **East African Community (EAC):** The partner states (Burundi, Democratic Republic of Congo, Kenya, Rwanda, South Sudan, Tanzania, and Uganda) signed a treaty to widen and deepen economic, political, social, and cultural integration to improve the quality of life of the people of East Africa through increased competitiveness, value added production, trade, and investments.

2.2.3 Market Drivers

Drivers of the African Leafy Vegetables market include:

1. Nutritional value and consumer knowledge[22]:

- General health knowledge shared through NGOs, Ministry of Health, and media especially on recent diseases such as diabetes, blood pressure and their link to unhealthy eating has increased. Other diseases such as HIV/AIDS and the recent Covid-19 have required patients to eat healthy, including feeding on vegetables and fruits that are high in vitamins and minerals to boost immunity. This has resulted to increased demand for the specific vegetables nationally.

- Amaranth demand for example has lately grown, as it is increasingly known to offer intrinsic medicinal benefits such as it is high in protein, rich in antioxidants, calcium, and carbohydrates.
  Moreover, an expanding aged population is also supporting the market progression, as the product's medicinal properties have been demonstrated to have positive effects on relieving old age- related ailments.

- In Homabay county 80% consumers indicated they consume ALVs because of their nutritional value[23]

2. Availability

- Availability of the ALVs in rural areas such as groceries, *mama mboga* outlets as well as supermarkets in urban and peri-urban centers have led to increased demand as consumers have unlimited access.

- Beyond production, availability is dependent on infrastructure and logistics that facilitate access to the markets. Due to the highly perishability the value chain

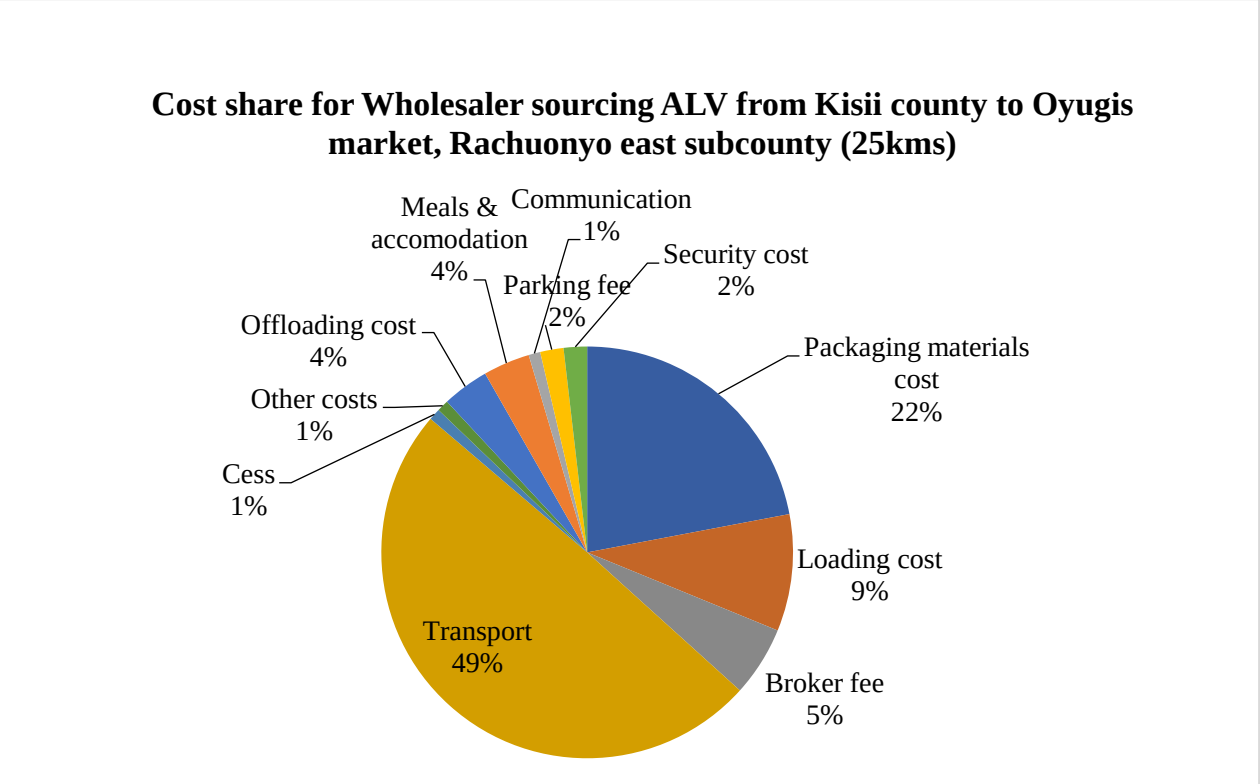
[21] https://www.wto.org/english/tratop_e/tpr_e/tp124_e.htm
[22] Charity Irungu 2007, Analysis of markets for African leafy Vegetables within Nairobi and its environs and implications for on farm conservation of biodiversity
[23] County specific value chain analysis: production and market systems analysis for African vegetables funded by USAID via RTI in 2020

necessitates specialized transportation (cold chain trucks) as well as post-harvest handling.

- Roads in the rural areas in Kenya are in poor conditions making it difficult to transport ALVs to the markets during rainy seasons – leading to delays in delivery, as well as to increased spoilage, loss of quality and increased costs which could result to low supply[24].

- According to USAID- RTI work in Kisii county transport cost and packaging cost were among the highest cost to availing ALVs to the market.[25]- *see figure below.*

Figure 4 Cost share at the market level



Source: County specific value chain analysis: production and market systems analysis for African vegetables funded by USAID via RTI in 2020

3. Cultural norms and beliefs

- In addition to knowledge on health and nutritional benefits consumer demand is influenced by cultural beliefs and norms. Vegetables production and consumption is perceived to be women's value chain. This study reveals that majority Kenyan

[24]Charity Irungu, 2007, Analysis of markets for African leafy Vegetables within Nairobi and its environs and implications for on farm conservation of biodiversity

[25] County specific value chain analysis: production and market systems analysis for African vegetables funded by USAID via RTI in 2020

communities such as in Nandi County the value chain is highly regarded as beneficial food for pregnant women. [26]

[26] Riang'a, R.M., Broerse, J. & Nangulu, A.K. Food beliefs and practices among the Kalenjin pregnant women in rural Uasin Gishu County, Kenya. J Ethnobiology Ethnomedicine 13, 29 (2017). https://doi.org/10.1186/s13002-017-0157-8

2.3. Analysis of Value Chain

2.3.1 Value Chain Nodes, Activities & Actors

1. Production

The description of the production activities begins with profiling 4 of the high producing counties in the LREB, as follows:

Kisii:

- The main ALVs producing sub-counties are Bomachoge, Borabu, Bobasi and Kitutu Chache North. Black nightshade and spider plant are the most popular ALVs grown because of their high profitability. Others are pumpkin leaves, cowpea leaves and amaranth and African spinach which are grown mainly for domestic use while the surplus is sold in the local markets.

- Production is carried out by smallholder and farmers and producer groups.

- There are about 98 community-based organizations (CBOs) in vegetable production in the county with a production capacity of 5 366 tones per year.

- The black nightshade and the spider plant are mainly produced for commercial purposes and is sold locally or in the neighboring counties of Kisumu, Homabay and Migori and to urban centres such as Nairobi, Nakuru, Eldoret and Mombasa.

Nyamira

- The main production areas are in the sub-counties of Masaba North and Manga.

- Black nightshade and spider plant are mainly grown on a commercial scale while the others are grown in smaller amounts for home consumption and the surplus is sold at the local markets.

- From 2013 to 2017, farmers' groups in the county were trained and given 210 kg of certified seeds by the County Government. This led to farmers improving their yield per unit area and subsequently increased marketed volumes resulting in more income.

Nakuru

- The major ALVs grown are black nightshade, cowpeas, amaranth, spider plant, pumpkin leaves and jute mallow.
- The nightshade and amaranth are the most produced and are widespread across all the major open markets in the county as well as in the supermarkets.

- National Agricultural Rural Inclusive Growth Project (NARIGP) and the Kenya Climate Smart Agriculture Project (KCSAP) strengthened the capacity of producer groups and umbrella cooperatives to perform the aggregation function

Vihiga

- The major producing area is the Luanda sub-county.

- The most popular ALV is cowpeas followed by slender leaf, black nightshade, and spider plant.

- The ALVs from this county are mainly sold in the local market with a few traders exporting to the main urban centers of neighboring counties i.e., Kisumu and Kakamega.

Due to social cultural factors, women dominate production, marketing, and distribution. A study conducted in 2020 for USAID-Kenya Crops and Dairy Market Systems Activity Project revealed that adult women dominated the production of ALVs in Bungoma and Homa Bay counties at 61%. Production is mainly on a subsistence level with minimal commercialization. ALVs are produced in areas around the house and are often intercropped with other crops such as maize, beans etc. - hence the below-1 acre crop cover.

ALVs mature in 3 months and are produced in 2 annual cycles i.e., during long (April-June) and short rain seasons (October- December). Farmers using irrigation can produce in up to 3 cycles in a year. Amaranth, for example has a 70–90-day maturity period. Supply is highest in the 2 months after the onset of the long rains, when tender plants are uprooted for use[27].

Farmers growing for the market use fertilizers and pesticides for those ALVs that are prone to attacks from pests such as the African Nightshade and spider plant. Production systems are constrained by the availability of high-quality seeds, and this is a key bottleneck for further investment in the value chain. Despite recent modest improvements in private sector seed supply, farmer-owned and recycled seeds are the norm within informal networks and exchanges between different community seed production systems (Pincus et al., 2019).

Several institutions are developing quality seeds. The Jomo Kenyatta University of Agriculture and Technology (JKUAT) developed and promoted 9 varieties after approval by Kenya Plant Health Inspectorate Service (KEPHIS) in 2016[28]. The seeds for the African Night shade, vine spinach, jute mallow spider plant is accessible at the Maseno Botanic Garden[29] in Kisumu County. Maseno University, Kenya Livestock Research Organization (KALRO), Biodiversity International are working closely with KEPHIS for development, testing, certification, and promotion of certified ALVs seeds. Other institutions such as Kisii University, Egerton University and Baraka Agricultural College continue to research and innovations to improve ALVs inputs.

The study reveals that availability is one problem, but also the access to quality seeds is even problematic, with the licensed varieties being too expensive for most of the smallholders.

A study carried out for Veggies 4 Planet and People (V4PandP) of Netherlands Development Organization (SNV) in 2021 revealed that; 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. In the Western region (Homabay, Migori, Kisii, Nyamira, Siaya, Busia and Kakamega) and Nyanza regions, KALRO and county governments gave free seeds to some

[27] P. Nekesa and B, Meso, 1993; Traditional African vegetables in Kenya: production, marketing and utilization
[28] https://farmbizafrica.com/high-yield/3042-jkuat-selling-nine-varieties-of-indigenous-vegetables-released-by KEPHIS
29 Mary Oyiela Abukutsa-Onyango, 2011 Researching African Indigenous Fruits and Vegetables – Why?

farmer groups while One-Acre Fund is on contractual farming agreement with farmers who purchased seeds on credit.

With the production and commercialization gaining traction in the country, smallholder ALV's farmers have started federating into producer organizations/ cooperatives for various commercial and social capital reasons. The cooperatives are:

- Providing market linkages to farmers, cushioning farmers against brokers and advocating for better prices for farmers- The main buyers of their produce include Mace foods, East Africa grower's fresh ltd, regional markets (Uganda) and local supermarkets and hotels).
- Facilitating affordable access to inputs to farmers though bulking and negotiating inputs' (e.g., ALVs certified seeds etc.) prices.
- Acting as entry point/ development hub for extension services, business development support, agronomic and other technical support to members
- Bringing farmers together to not only benefit from shared resources (such as aggregation facilities, pooled transport arrangements, collective bargaining etc.) but also improve in their economic, social, and cultural needs.
- Providing tailored-financial services to members to purchase inputs, equipment etc. and providing a platform for members to accumulate savings

In the LREB, the study came across 9 cooperatives that are representing ALVs-only farmers (characterized in terms of membership, energy source, market outlet and access to climate information) only- see table below:

Table 3; Cooperatives focusing on ALVs as the main value chain

County	Name	Year registered	# Of members	# Of active members	Source of energy	Access to information on Climate	Main buyers of their products
Trans-Nzoia	Kwanza Horticultural and Fruits	2020	30	15	Solar	Yes	East Africa Growers Fresh Produce Limited.
	Cherangany Chera Tomato Marketing	2020	504	230	Electricity Solar	Yes	Schools, supermarkets, Local market
Siaya	Siaya County Honey Producers and Processors	2014	1124	380	Electricity Solar	No	Local market Retailers
Nyamira	Nyamira North Women Sacco	2014	1604	756	Electricity Solar	No	Mace Foods Company Ltd
Vihiga	Vihiga Local Vegetables	2019	1317	850	Electricity	Yes	Local hotels, schools and community vendors
Kisumu	Southwest Kano	2009	1000	150	Electricity Firewood Charcoal Solar LPG	Yes	Local market, customers from Uganda
Migori	Karungu Central	2022	122	122	Electricity	No	Schools in the community
	Lake Belt	2020	500	350	Electricity	Yes	Local market Schools

Other cooperatives that focus on African leafy vegetables alongside other value chains are as presented on the table below*:*

Table 4: Cooperatives focusing on ALVs along other value chains

County	Name	Year registered	# Of active members	Source of energy	Access to information on Climate	Main buyers of their products
Kisii	Bomabobo Dairy	54	30	Electricity Solar	No	Local Market
	Mamboleo Gesusu Dairy	345	190	Electricity Charcoal LPG	No	Sasini Millers
Kisumu	Seme	81	60	Electricity Charcoal Solar	Yes	Highland Creameries
	Southwest Kano Smallholders Farmers	1000	150	Electricity Firewood Charcoal Solar LPG	Yes	Local market, Kajulu Dairy, Equator Hotel
Bomet	Abosi Tophill	130	130	Electricity	Yes	Locals
Trans-Nzoia	Kwanza Horticultural and Fruits	30	15	Solar	Yes	Cherubet, Spice World, Boron Traders, local Schools
	Cherangany Chera Tomato Marketing	504	230	Electricity Solar	No	Local market Institutions such as restaurants and hotels
Kakamega	Mumunyonzo	750	600	Electricity	Yes	Schools, hospitals and Local market
Nandi	Kipnyigei Farmers	12	12	Electricity Solar	Yes	Coffee Services Management, Local market
Siaya	Siaya County Honey Producers & Processors	1124	380	Electricity Solar	Yes	Local market
	Gem Horticulture	400	200	Electricity Solar	No	Local market Retailers
Vihiga	Gambogi Equator Farmers	68	45	Electricity Solar	Yes	Schools, Supermarkets, Local market
Migori	Karungu Central	122	122	Electricity	Yes	Local market, Customers from Uganda
	Pamoja Suna East	411	310	Electricity	No	Schools
	Bukuria	800	700	Electricity	Yes	East Africa Growers Fresh Produce Limited.
Nyamira	Manga Farmers	300	270	Solar	Yes	Local market

2. Harvesting and transportation

Harvesting is done morning or evening to maintain freshness and avoid drying. The vegetables are handpicked and packaged into gunny bags then transported to the roadside for onward transportation by vendors[30]. Transportation is by local means (matatus, boda-bodas and human transport).

3. Aggregation and Trading

ALVs are mainly sold at the local markets at the county levels and the current growing urban markets such as Mombasa and Nairobi. The end markets however are majorly the urban consumers and food service joints - restaurants, hotels.

Aggregation from farmer to farmer or from the local market to other markets is carried out by traders/ marketing agents. few of these aggregators sell to supermarkets and groceries located in urban centres. ALVs are also sold directly to consumers at the local markets. Sometimes, and this mainly happens in Kisii, traders buy the crop while it is still on the farm; with the trader meeting the harvesting costs.

Once aggregated, the ALVs are sold to retailers and wholesalers. In Kisii county, the World Bank and Government of Kenya funded projects (i.e., NARIGP) and KCSAP) have strengthened the capacity of producer groups and umbrella cooperatives to perform the aggregation function. In some cases, the cooperatives were funded by these projects to construct marketing infrastructure for ALVs, complete with cold storage facilities.

4. Value addition

Value addition for vegetables is still on the low as consumers prefer fresh vegetables and have yet to embrace the culture of consuming value-added vegetables such as vegetable flour, dried vegetables etc.

Traders carry out basic value addition activities to increase value, while producers only harvest into bags for picking up by vendors. For example, traders in Migori county carry out basic value addition practices such as washing, sorting, grading, packaging, and storage (-see figure below) while only a few SMEs are involved in medium-scale commercial drying and processing of these vegetables, often for export although the demand is still low[31].

Research revealed that flour made from some of the ALVs such as Amaranth (made by Annico's Enterprise), was supplied to 52 supermarkets in Turkey before the contract was terminated due to business closure in 2017. The Economic Survey Report (2018) indicated there was an increase in exports for value added vegetables and fruits by 23.3 %.

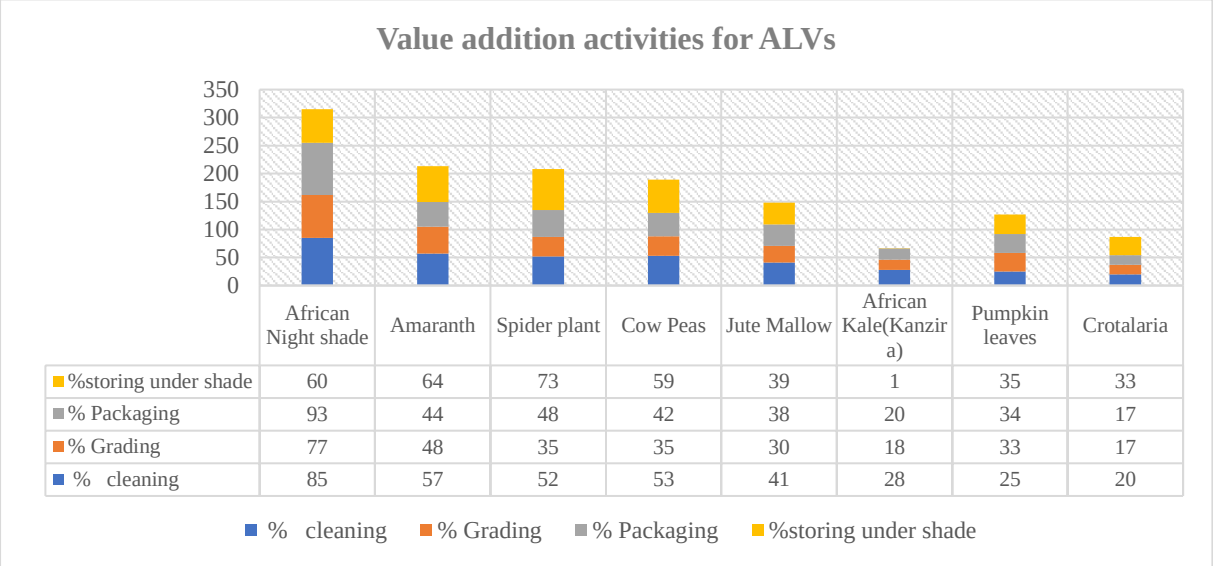
During the rainy season, there is often overproduction of ALVs causing a glut in supply and leading to high post-harvest losses, while in the dry season there is short supply. Hence the importance of introducing processing to prolong their shelf life and penetrate export markets.

[30] Field notes from Nandi

[31] National Museum of Kenya 2020; Feasibility Study on Commercial Viability of African Indigenous Vegetables in Western and Central Kenya

The figure below presents the common value addition activities for ALVs across the bloc.

Figure 5: Value addition activities for ALVs



Source (National Museum of Kenya, 2020)

More traders practice value addition on African nightshade compared to other varieties. These findings could be attributed to the fact that the variety's delicate stem and leaves deteriorates easily when picked making them less appealing to buyers and depreciating their value[32]. Other varieties such as spider plant, cowpeas and Ethiopian kale have stronger leaves, which enable them to stay fresh longer hours.

Table 5: Summary of value chain actors' roles

Value chain Node	Value chain actor involved	Role played at the level of involvement
Inputs	Input suppliers e.g., KARLO, Universities, agro dealers	Supply of inputs such as seeds fertilizer, pesticides, and herbicides
Production	Smallholder farmers	• Land preparation • Input acquisition • Planting, weeding, and spraying
	Cooperatives, producer groups/ CBOs etc.	• Land preparation • Input acquisition • Planting, weeding, and spraying • Act as hub for procurement of inputs and other services i • Act as entry point for development support
	Extension officers, NGOs, and Community based organizations	• Capacity building services to producers – on crop agronomy and agribusiness
	Financial service providers	• Agi-financing financial services- e.g., Family bank is offering loans to women producers in Kisii, Homa Bay, Migori, Kisii, Kakamega, Bungoma, Busia, among others.

[32] https://farmbizafrica.com/markets/10-smart-farms/3422-limuru-farmer-banks-in-on-kenyans-growing-managu-appetite

Collection, Aggregation, and **Transportation**	Cooperatives, producer groups/ CBOs etc.	• Aggregation and market linkages
	Transporters (traders, middlemen/ brokers etc.	• Provide transportation services e.g., *boda-boda, tuk-tuks* and tracks to the market / aggregation centers.
	Wholesalers	• Purchase produce from producers at wholesale prices • Provide market information e.g., quality requirements, pricing, and packaging information to producers
	Brokers (middlemen)	• Purchase from producers, collect and transport to the markets where they sell to the wholesalers. • Acts as a link between farmers and traders (wholesalers and retailers)
Processing	Local millers, producers	• Drying and milling of the vegetables to extend the shelf life and increase value
Market	Individuals at the local and secondary markets, institutions such as hotels, prisons, hospitals etc.	• Provision of market outlets

Source: Author's compilation, 2022

5. Consumption

Past research has established that consumption of ALVs has been on the rise both in rural and urban centers with African nightshade, spider plant, cowpeas, and amaranth gaining popularity in the urban centers[33]. Local demand has been matched by supply, mainly due to increased production by smallholder farmers in the peri-urban areas of the city, as well as an increase in supplies from distant traditional production areas in western and eastern Kenya.

The research details that consumption in Nairobi increased by over 100% in 6 years. The number of ALV traders in Nairobi markets, which are served by produce from the counties located in the Lake Region Economic Bloc, also increased (following the expanded demand) by 139% from 540 to 1,289 traders. The markets sampled in the survey included wholesale and retail destination markets Kangemi, Wangige, Gikomba, Ngong, Githurai, Ngara, Toi, City Park and Githurai in Nairobi and its suburbs.

The fact that ALVs are on sale in the major reputable supermarkets in the capital cities has particularly enhanced their rating in the eyes of the consumers. The findings revealed that the consumption of amaranth and spider plant was high compared to other varieties as seen in table below. This finding is complemented by the findings in Homabay county where consumption of African nightshade and spider plant was high compared to other varieties- (*see figure below).*

Table 6: Comparing # of ALV bunches sold in 2001 and 2006 in Nairobi markets

	Number of bunches sold per week		**% Change in 5 years**
Name of Vegetable (English)	2001	2006	Percentage
African nightshade	50,830	83,835	65%
Amaranth	41,293	51,054	24%
Spider plant	27,670	31,942	15%
Cowpeas	10,060	23,980	138%
Ethiopian kales	7,585	20,492	170%
Slender leaf	8,675	14,795	71%

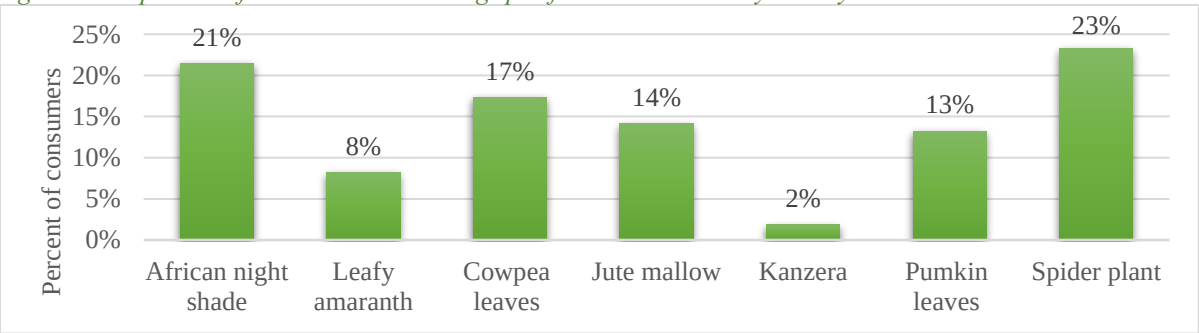
[33] Charity Irungu,2007, Analysis of markets for African leafy Vegetables within Nairobi and its environs and implications for on farm conservation of biodiversity

Pumpkin leaves	5,535	11,440	107%
Pumpkin leaves	5,535	11,440	107%
Jute plant	1,425	6,035	324%
Total Bunches	***155,074***	***245,579***	***58%***
Number of ALV traders	***540***	***1,289***	***139%***

Source: Charity Irungu, 2007

Consumption of ALVs is still higher in rural areas compared with urban areas. The rural dwellers consume ALVs four times a week on average, while urban dwellers do so twice a week (Gido, Ayuya, Owuor, and Bokelmann, 2017). This is despite ALVs finding their way into supermarkets, grocery stores, small market outlets and major restaurants and hotels in urban and peri-urban areas in Kenya[34].

Figure 6: Proportion of consumers consuming specific ALV in Homabay County[35]



Larger households are likely to purchase large quantities of vegetables, hence they would prefer retail outlets with relatively low prices to minimize their food expenditure (Gido et al., 2016). Farm-gate prices for most agricultural commodities are relatively lower than at other retail outlets and, therefore, rural households with large families prefer farm-gate outlets as opposed to greengrocers. This explains why they would avoid supermarket outlets in the peak seasons, and instead revert to purchasing from local open-air outlets.[36].

The consumption of ALVs is also driven by a socio-cultural value dimension across counties. Some varieties are considered to belong to certain ethnic groups or regions which raises demand in these regions when compared with others. This will mean that consumers in each area will purchase more than one type of ALVs and mix or blend them during cooking. Some will prefer them prepared in the traditional ways such as boiling, owing to the perception that those produced in modern ways such as frying changes the taste and erodes nutritiveness.

6. Policy and Regulatory framework

Several laws exist that guide the production and commercialization of horticultural products in the country. These (see bullets below) may largely, affect the ALVs sub-sector:

- *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

[34] (Rampa and Knaepen, 2019); Ochieng et al., 2017).
[35] County specific value chain analysis: production and market systems analysis for African vegetables funded by USAID via RTI in 2020
[36] https://www.fao.org/3/cb7413en/cb7413en.pdf

crops as export crops. For ALVs, the Act guides in the production distribution of quality and safe vegetables to ensure food and nutrition security for Kenyans.

- *Plant Protection Act 324:* This Act ensures the management of pests and diseases in crops. This should in turn reduce losses of vegetables hence increase marketable volumes of ALVs giving a rise to farmers' incomes.

- *Plant and Seed Varieties Act 326:* Productivity and quality of products depends largely on the quality of seed used for production. This Act recommends that seeds used in the production of ALVs 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 ALVs varieties are now available[37].

- *Irrigation Act:* This law 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 ALVs production if the crop is to be available all year round in sufficient quantities for the market.

In the LREB, there are policy advances and commitments that are supporting the promotion of the value chain. These include:

- *Vihiga, Nyamira and Kisii counties:* These counties have designated ALVs as a flagship value chain in their County Integrated Development Plans (CIDP)

- *Vihiga County:* The government set aside KES 40 million to support ALVs; with the support of the NARIGP.

- *Kisii and Nyamira Counties:* Constructed ALVs aggregation centers to bulk produce from farmers directly or via village collection centers.

- *Nakuru County:* The 2017 CIDP included ALVs as priority crops and has currently launched a public procurement programme to source ALVs from producer for consumption in county schools and hospitals.

The value chain has recently witnessed the emergency of alliances among various actors towards developing intermediate seed systems. Intermediate bridge the formal and informal seed sectors. The Seed Savers Network Kenya[38], a local NGO based in Nakuru has documented and described local ALV seed varieties. Through the effort of this NGO a nascent multi-stakeholder forum has been launched to bring together all the ALV actors, build trust, coordinate action on ALV production, processing, distribution, and consumption, in the county.

However, there are several policy gaps that may hinder the optimization of the ALV value chain. These include but are not limited to:

- There is a general lack of policies targeting ALVs, though recently some of these varieties are receiving attention at the Ministry of Agriculture Livestock and Fisheries (MOALF)

[37] https://www.kephis.org/images/pdf-files/UPDATED%202020%20August%20NATIONAL%20VARIETY%20LIST1.pdf
[38] https://seedsaverskenya.org/

- There are no specific national policies supporting the processing of ALVs.

- There are no traceability measures along the value chain. This brings up the food safety question, as in some cases (especially in the per-urban areas), there have been claims that wastewater has been used to grow ALVs, owing to scarcity of irrigation water.

- Food hygiene measures are not in place, and if in place they are not standardized. ALVs are often tightly packed in gunny bags and transported in open trucks and public transport buses to distant markets, and it is not uncommon to find ALVs placed on the ground in informal markets.

- There are no standards such as certification of origin, safety, and development benefits of the ALVs or labelling schemes that could support the value chain by enhancing consumer confidence.

- The current 16% VAT on vegetable seed is a major disincentive to the growth of the sector, including the promotion of the ALVs' value chain.

- County extension officers operate on some "informal rules" that they would respond to requests for agronomic practices but would also require to be facilitated with meals and other incidentals- making the extension system quite unreliable.

2.3.2 Technologies used in each node

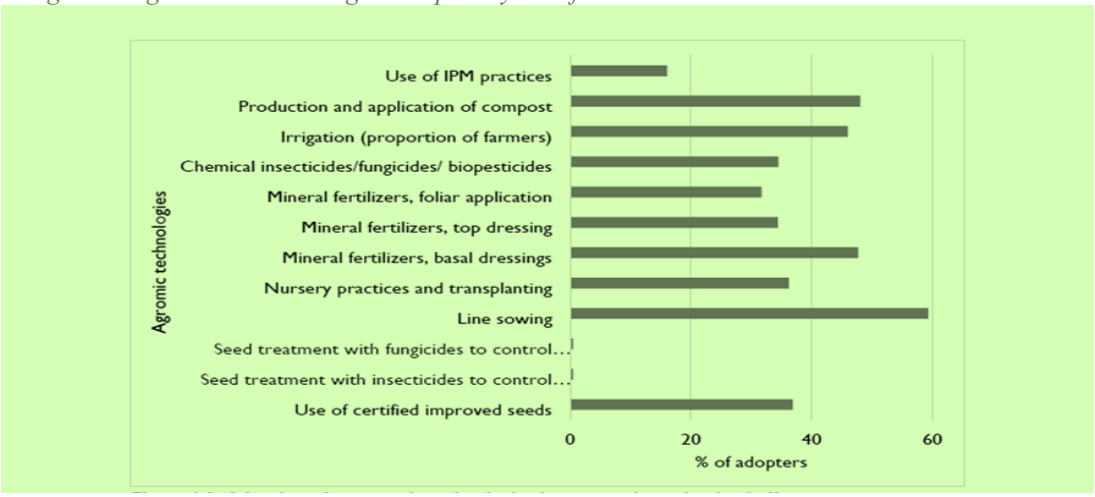
1. *Production:*
   - Agricultural technology development, testing, and adoption in the horticultural crops sector is on the rise in Kenya and it is dominated by universities, Non-Governmental Organization (NGOs), public and private institution. Production and use of certified seeds is also gaining momentum in Kenya as research institutions such as KALRO, Jomo Kenyatta University and Maseno University are developing high yielding and drought resilient seeds for vegetables.

   - Agronomic technologies mainly used in production of vegetables in central and western Kenya include line sowing, compost manure, irrigation, fertilizers, and certified seeds[39]. Drip irrigation as promoted in Trans-Nzoia county reduce water wastage and optimizes water available for production of ALVs among other vegetables.

   - Figure 7 presents a longer list of agronomic technologies adopted by ALV farmers.

[39] National Museums of Kenya, 2020; Feasibility Study on Commercial Viability of African Indigenous Vegetables (ALVs) In Western and Central Kenya

Figure 7: Agronomic technologies adopted by ALV farmers



Source: National Museums of Kenya, 2020

2. Collection, Transportation and Trading

- Technologies include the use of the digital apps for marketing, transportation technologies such as boda-bodas and trucks.

- In western Kenya, Virginia Tech's CIRED, Egerton University and the Australian start-up, -AgUnity, have adapted the AgUnity block chain-based digital platform to track ALVs from the producer to the end consumer[40].

- Marketing is also taking via digital spaces where producers, and trader's use social media accounts (such Facebooks WhatsApp, Instagram) to do transact.

3. Preservation, processing, and value addition

- Current practices to prolong shelf life include early morning and late evening harvesting. Harvesting is done early mornings and late evenings to retain the produce freshness. Traders also sprinkle water on the produce to create cool environment, which prevent withering and drying.

- Other preservation methods that have been used over time include blanching and sun drying[41], and fermentation[42]. Dried ALVs such as amaranth are ground into flour to prepare fortified soups and porridge. Companies in this space include Amaranth International Ltd, which offers both local and export market, Incas Health International Ltd, African Amarantha Ltd, Amaranth Grain ltd, Packed Amaranth flour and MAP international[43].

- To address post-harvest losses during the peak seasons, the county government of Nyamira, in collaboration with the Agricultural Sector Development Support Programme (ASDSP) and Kisii

[40]Sara Hendery, 2021; Smartphone App Tracks African Indigenous Vegetables for Improved Food Safety in Western Kenya

[41] Blanching, which is a short heat treatment aimed at inactivating enzymes in vegetables, can be done before sun-drying. Medium-scale commercial processors such as MACE Foods have used a food dryer and carry out oven drying, cooling and mixed mode solar drying.

[42] Fermentation is among the oldest preservation methods. It improves palatability, taste, aroma and texture; extends the duration of quality; increases nutritional value and improves the safety.

[43] FarmLINK, 2017

University procured and distributed 20 solar conduction dryers to dry and preserve vegetables and fruit[44].

2.4. Support services in the extended value chain

2.4.1 Suppliers of physical inputs

For smallholder farmers to increase productivity and achieve sustainable food supply, access to agricultural inputs that are of quality is essential. Smallholder farmers including those producing ALVs face challenges that include, access to quality productivity enhancing inputs such as fertilizer and certified seeds; poor infrastructure; low access to financial services as well as delays due to get to the market outlets especially for areas of production that are far flung, and not served by motorable roads.

A survey conducted in Kakamega (among other counties) revealed that producers sourced their inputs (mainly seed) from the locally accessible agro- dealers, local markets, and own saved seed from previous seasons. Research organizations such as KALRO, featured as the least popular source of seeds.

Table 7: Main Sources of agro-inputs in Kakamega

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 sourcing					
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**

Source: SNV ALV value chain study, 2021

Other inputs for production include fertilizers, pesticides and herbicides are less used by smallholder farmers because they are expensive. Achieving sustainable agricultural growth is largely dependent on access to timely and affordable fertilizers in addition to chemicals (Africa Fertilizer Financing Mechanism (AFFM)[45]. In recent times, fertilizer prices have hiked to a

[44] County Government of Nyamira, 2018
[45] Africa Development Bank, 2019; Timely access to affordable fertilizers, key to sustainable agriculture development in Africa

level that has affected both small-scale and large-scale farmers. This has been attributed to several factors such as Covid-19 pandemic and the Russia-Ukraine war.

A 90kg bag of fertilizer that is not subsidized in Kenya is trading at Kshs 6500 while the prices of the subsidized lowers to Kshs 3500 per bag. The suppliers for the fertilizers are mainly the National Cereals and Produce Board (NCPB) depots and sub-depots countrywide and agro dealers in the towns around the counties[46]. Additionally, farmers use manure sourced from their own farms and neighbors. Other inputs include equipment for land preparation which are sourced from local agro dealers.

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. KARLO is supplying seeds such as African night shade, spider plant, amaranth among others in western Kenya

2.4.2 Support services provided to actors along the value chain

Financial services

Farmers require financial services such as access to credit, loans, and financial literacy for sustainable agricultural development. ALVs farmers experience the same bottlenecks to accessing finance like farmers in other value chains. These include lengthy application processes, prohibitory high interest rates and lack of collateral.

It is estimated that about 43% of ALVs' farmers access credit, but from the informal credit and savings groups (Bayesian Consulting Group Limited, 2020), affirming the gap and opportunity to finance the value chain more formally. There are no specific loan products for SMEs involved in ALVs, i.e., traders, processors, transporters, and agro-dealers (seed suppliers)[47]. However, the
table below provides a list of some financial service providers in the counties of interest offering services to horticultural farmers.

Table 8: Financial service providers providing agri-financing services to ALV farmers

County	**ancial vice provider**	**ecific financial service provided**
Bungoma	Apollo Agriculture	Provides financial services which include ıncing, farm inputs, advice, insurance, and market access,
Homabay, Migori, Kisii, Kakamega, Bungoma and Busia among others	Family Bank	Loans and credits for small and medium enterprises in agribusiness
	Equity–Kilimo Biashara	Agribusiness loan ideal intended to finance working capital to purchase stock and/or farm inputs, such as certified seed, fertilizer and chemical applications
	Safaricom loans (M-Swari , Fuliza loans, KCB-Mpesa)	Affordable loans and credits
	Chase Bank	***Horticulture Input loans***. Tailored products offered to all players in the value chain, including: - Farmers who do commercial cultivation of flowers, vegetables, fruits, nuts, legumes, tubers, mushrooms and herbs. -Suppliers such as agro dealers, seed suppliers and suppliers of flower breeds; -Processors and packagers of vegetables, fruits, juices, nuts, legumes, tubers, mushrooms and herbs.

[46] Further Africa, 2020 Kenya announces new subsidized fertilizer prices

[47] https://www.fao.org/3/cb7413en/cb7413en.pdf

		-Traders and exporters
	Cooperative Banks	Provides loans for cereal and horticulture producers: To enable individual farmer, associations/group/co-operatives to access farm inputs and agro dealers access working capital under the Ministry of agriculture credit guarantee scheme
	Kenya Women Finance Trust - KWF	Input loans: This is a product-targeting farmer to help them acquire quality inputs for their farming activities affordably. Agro-dealer loans: This loan targets financing of agro-dealers involved in agricultural value-chains, such as agro-vets, commodity traders, etc.

Source: Author compilation

Agricultural Extension services and Training

- Agricultural extension plays a key role in disseminating knowledge and technologies as well as linking farmers with other actors in the economy.

- The information provided to farmers through agricultural extension services include new seed varieties, crop and animal husbandry, pest and disease management and innovative technology use as well as marketing information[48]

- Extension and advisory services are mainly provided by the county government, development partners and private sector players. In Bungoma, is public provision of extension services to small-scale farmers by government agents and NGOs such as SACRED Africa and One Acre Fund[49]. In the Nyanza counties, KALRO is training farmers on GAPs (including land preparation, planting techniques, crop husbandry), and climate-smart agricultural practices.

- The Sustainable Organic Farming Development Initiative (SOFDI) is working with farmer groups in Kakamega County by training them on organic farming practices in vegetable production to promote safe food and improve human health.

- In Siaya County GIZ is supporting farmer groups to excavate water pans and acquire water pumps for irrigation.

Market infrastructure, distribution, and market information

- This includes building of modern markets in the counties with proper working areas that are easy to maintain hygiene and sanitation to improve access to markets.

- In Kakamega, the Anglican Development Services (ADS) is supporting farmers by linking them to large off-takers such as Mace Foods.

2.5. Societal enabling environment

2.5.1 Institutions and Collaborators

The efficiency of ALVs value chain is largely determined by roles and functions of the institutions, which support its development. The relevant institutions are represented below in the table:

[48] Eric O. Gido, Kenneth W. Sibiko, Oscar I. Ayuya and Joseph K. Mwang; 2014, Demand for Agricultural Extension Services Among Small-Scale Maize Farmers: Micro-Level Evidence from Kenya
[49] Ibid,45

Table 9: ALVs support institutions

Institutions	Institution	Role
County Government	County governments	• Formulation of county relevant policies and development plans that enable operations along the value chain e.g., determination of levies and intercountry trade fees etc.
National Government	Ministry of Agriculture, Livestock and Fisheries (MoALF)	• Formulation of policies and regulations in agriculture that create an enables environment for agribusiness.
Government Parastatals	Kenya Agricultural and Livestock Research Organization (KALRO)	• Promotion of findings and technology in the field of agriculture. • Development, testing and promoting new varieties.
	Kenya Bureau of Standards (KEBS)	• Development and implementation of standards for seeds and processed fruits e.g. the KS 2752:2018 Kenya Standard — Processed fruits and vegetables — Code of practice, First Edition
	Kenya Plant Health and Inspection Service (KEPHIS)	• Assure the quality of agricultural inputs and produce to prevent adverse impact on the economy, the environment and human health.
Institutions of Higher learning	Jomo Kenyatta, Maseno University, Kisii University & Moi university	• Developing, testing, and promoting new varieties. • Carrying out research and providing data that is relevant in production of ALVS • Establishing Demo farms
Development Partners & NGOs	Rural Outreach Africa (ROA	• Implemented the African Leafy Project in Western Kenya
	Participatory ecological land Use Management (PELUM)	• Implementing project entitled "Scaling-Up Sustainable Agriculture and livelihood Improvement (SUSAlI). The project focused on enhancing the production, consumption, value addition and marketing of ALVs within western counties in Kenya
	Biodiversity International (African Leafy Vegetables Programme in Kenya in Kisii)	• Conservation of agricultural biodiversity by documenting identifying and genetically analyzing ALVs • Enhancing the genetic material priority ALVs, improve horticultural practices and seed systems • Introduce marketing of vegetables and dissemination of information about ALVs
	Vegetables 4 Planet Project	• Support to the development of amaranth, Ethiopian kales and cow peas in Kakamega in collaboration with World Vegetable Centre (WorldVeg), SNV, Local Government Authorities, local NGOs, business mentors MFOs, seed companies, African Seed Trade Association (AFSTA), African Breeding Vegetable Consortium (AVBC) [50].
	Rural Outreach Africa's Food Security and Nutrition Improvement Program	• Support to African Leafy Project in Butere in Kakamega county[51]
	Horticultural Innovations and Learning for Improved Nutrition and Livelihood in East Africa (HORTINLEA) in Kenya	Development of sustainable management strategies for a) root-knot nematode pests, viruses and phytoplasmas on African nightshades, b) cowpea insect pests and c) insect pests and diseases on leafy indigenous vegetables in Kenya-.[52]

Source: Author's Compilation, 2022

[50] Veggies For Planet and People Learning Event Kisumu 27-28 November 2021

[51] https://ruraloutreachafrica.org/nutrition/#:~:text=ROA's%20Food%20Security%20and%20Nutrition,rampant%2C%20especially%20among%20young%20children.

[52] http://research.ku.ac.ke/en/latest-news/119-latest-research-news/328-kenyatta-university-researchers-partner-to-improve-the-african-indigenous-vegetables-ALV-value-chain

2.5.2 Infrastructure

Infrastructure such as communication networks and roads are a key enabling factor in production, access to timely agro-inputs, transportation of the produce and access to new markets. ALVs are highly perishable, and they require that transportation, preservation, and distribution time is made as minimum as possible.

Some of the new roads in the counties that enable this include:

- Kisumu Northern Bypass
- Mogonga-Kenyenya-Riokindo-Magenche-Mariba-Nyagancha-Ebegere-Daraja road connecting Kisii Nyanza and Nyamira counties
- Ahero-Kisii-Isebania road which connects feeder roads to the main road
- Kisumu-Kakamega-Kitale Road Upgrade-connects Kisii, Kakamega, Kitale and Webuye and passes through markets in Uganda and South Sudan
- The county governments have also been upgrading the traditional markets at the urban centers and among them is the.
    - Construction of a modern market at Migori town
    - Construction of *mama mboga* sheds at Koloni market and Corner Shiundu (Central Namwela) in Bungoma
    - Construction of 3 fresh produce markets in Trans-Nzoia
    - Construction of a modern vegetable market in Kisii

2.5.3 Natural environment

ALVs are grown mainly on sandy to loamy soils. Waterlogged soils cause root rot hence and are not suitable. ALVs require temperatures between 15 and 30 °C although this may differ with the varieties, however, they will require water two or three times a week, depending on the temperature and rainfall.

Heat stress and drought will cause plants to develop quicker through different stages. Effectively the plant jumps to developing flowers, and thus seed quickly skipping past growing, affecting productivity levels. If day temperatures are extremely high, watering is required daily[53]. The value chains adaptability: plasticity and resilience to stresses provides farmers with the needed coping strategies to confront climate change[54].

ALVs make a great contribution to environmental sustainability, including climate resilience, in various ways. They are well adapted to harsh climatic conditions and disease infestation and are easier to grow in comparison to their exotic counterparts. They produce seed under tropical conditions, whereas exotic species often fail to do so. They have a short growth period, with most of them being ready for harvesting within 3-4 weeks[55]. ALVs occupy a small space and are intercropped with other crops[56].

As ALVs are able to withstand and tolerate many stresses such as pests and droughts, erratic rainfall and other unpredictable weather; they can be used a coping mechanism to climatic

[53] https://www.proagrimedia.com/crops/vegetable-production-part-17-turning-a-new-leaf-with-african-leafy-vegetables/#:~:text=The%20vegetables%20grow%20well%20in,as%20this%20can%20cause%20rootrot.

[54] Capuno, O.B., Gonzaga, Z.C., Dimabuyu, H.B. and Rom, J.C. (2015). Indigenous vegetables for coping with climate change and food security. Acta Hortic. 1102, 171-178

[55] Mary Oyiela Abukutsa-Onyango 2011, Researching African Indigenous Fruits and Vegetables

[56] Gilbert Muhanji1*, Ralph L. Roothaert1, Chris Webo1 and Mwangi Stanley2; African indigenous vegetable enterprises and market access for small-scale farmers in East Africa

shocks. Their production maintains crop diversity at the level of both individual farms and the food system overall, reducing the individual farmer's and the aggregate risks of crop failure due to climate change, climatic events or the incidence of pests and diseases.

At the small-scale production, ALVs' suitability for intercropping and nitrogen fixation (including staple crops such as maize, beans and other root crops), is environmentally beneficial as it improves soil organic matter.

3. Sustainability Assessment

3.1 Economic Analysis

Currently the ALVs value chains in Kenya are relatively sustainable from an economic point of view, as they support the creation of jobs and generation of incomes for a certain share of the population over time in several counties as the demand is clearly rising for these vegetables. In comparison with conventional horticulture for local markets (common cabbage, kale and especially Sukuma wiki), ALVS tend to be more profitable as they attract higher farm-gate prices and have lower costs due to less chemical input (both fertilizers and pesticides) requirement[57].

3.1.1 Profitability

The major cost drivers in production of ALVs include costs associated with labor supply such as (land acquisition, land preparation, planting weeding and harvesting). Therefore, to maximize net income, there is need to adopt labor and energy saving technologies, particularly on land preparation, planting, and weeding activities by adopting labor saving and affordable technologies. Notably, profits realized may differ from variety to variety, volumes produced, area of consideration and farm gate prices. A gross margin analysis conducted by National Museum of Kenya in 2020 indicated spider plant has the highest gross margins of 90,430 followed by amaranth with Kshs 68,637 per acre [58] Crotalaria was reported to have the lowest Gross margin of 2,800 Kshs per acre.

Table 10: Gross margin analysis per Acre of different ALVs

ALV Type	Total Production Costs Kshs per acre	Total Revenue Per acre	Gross margin /Kshs Acre
African Nightshade	87,505	138,277	50,772
Amaranth	66,441	135,078	68,637
Spider plant	27,127	117,557	90,430
Cowpeas	177,089	191,101	14,012
Jute mallow	53,914	117,553	63,639
Crotalaria	37,650	40,450	2,800

Source: National Museum of Kenya, 2020[59]

Additionally, farmers in contractual farming realized better profits because of access to affordable inputs, better markets with better prices and better margins[60] .The Cost benefit Ratio (CBR) results indicate that, the contracted seed growers would get an approximate of $7.92 for each dollar invested in the production of African nightshade; $6.27 for each $1 invested in producing spider plant; and $5.33 for each dollar invested in amaranth production. The CBR findings for non-contracted farmers was however below one for the amaranths and nightshade which implies that non-contracted farmers are incurring losses. Implicitly, such findings provide an implication that investing in the production of ALVs seeds is worthwhile when it is done with contracted farmers.

[57] Ibid,36

[58] Rampa, F. and Obiero Were, T. 2021. AgrInvest-Food Systems Project – Increasing sustainable investments in the Kenyan indigenous vegetables chain. Rome. https://doi.org/10.4060/cb7413en

[59] National Museums of Kenya, 2020; Feasibility Study on Commercial Viability of African Indigenous Vegetables (ALVs) In Western and Central Kenya

[60] Mvungi, Henry; Alaik Laizer; Philipo J. Lukumay; Justus Ochieng; Godfrey Ngoteya; Fekadu Dinssa; James E. Simon; Ramu Govindasamy; Christine Ndinya; and Martin Odendo. 2020. "Profitability Analysis of Traditional African Vegetable Seeds Production in Kenya." Journal of Medicinally Active Plants 9, (4):281-288

Figure 8: Cost in ALV seed production

Costs incurred in TAV seeds production (in US$)	Traditional African vegetables produced					
	Amaranth		African nightshade		Spider plant	
	Contracted	Non-contracted	Contracted	Non-contracted	Contracted	Non-contracted
Seeds	9	30	10	33	14	67
Manure	34	30	7	68	2	37
Fertilizer	124	4	115	37	122	74
Pesticides	32	3	37	17	19	20
Irrigation	0	21	2	22	2	7
Hired labour**	152	79	150	143	90	237
Machine hiring	12	5	14	4	17	3
Other input	57	0	25	8	21	0
Average cost (US$/ha)	420	172	361	331	288	445
Revenue (US$/ha)	2,242	157	2,860	211	1,805	1,171
Yields (Kg/ha)	429	39.57	507	54	371	169
Average. Price/Kg	5.23	3.97	5.64	3.89	4.88	6.93
Gross Margin= TR-TVC	1,822.09	(15.30)	2,498.85	(119.84)	1,517.28	725.36
Gross Margin Ratio	0.81	-0.51	0.88	-0.61	0.85	0.32
Cost-Benefit Ratio	5.33	0.91	7.92	0.64	6.27	2.63

Note[1]: **Other inputs include inputs such as herbicides, packages and storage chemicals. Exchange rate used 1US$=101 Ksh (Ksh=Kenyan Shillings)

Source: Mvungi et al, 2020[61]

Traders' gross margin analysis also revealed a positive gross margin with daily turnover ranging between 300,000 -1,000,000 in Migori. Traders realized higher margins per kg in Spider plant, Jute mallow and African night shade of Kshs. 23, Kshs.22 and Kshs.20 respectively per every kg of the vegetable sold. - *See table below*

Table 11: Trader Gross Margin per kg of different ALVs

ALV Type	Purchase price Kshs/kg	Selling price Kshs/ kg	Total Cost of doing business/ kg	Gross Margin Kshs/ Kg
African Night shade	34	64	10	20
Amaranth	26	51	7	18
Spider plant	39	72	10	23
Jute mallow	42	74	10	22
Crotalaria	25	48	6	17

Source: National Museum, 2020[62]

[61] Mvungi, Henry; Alaik Laizer; Philipo J. Lukumay; Justus Ochieng; Godfrey Ngoteya; Fekadu Dinssa; James E. Simon; Ramu Govindasamy; Christine Ndinya; and Martin Odendo. 2020. "Profitability Analysis of Traditional African Vegetable Seeds Production in Kenya." Journal of Medicinally Active Plants 9, (4):281-288

[62] National Museums of Kenya, 2020; Feasibility Study on Commercial Viability of African Indigenous Vegetables (ALVs) In Western and Central Kenya

3.1.2 Employment

Employment opportunities:
African leafy vegetables value chain has employment opportunities for women as traders and producers as well as youth as distributors and traders. This was confirmed by a research study conducted in Kakamega which revealed that majority (65%) of the producers were women although they belonged to male-headed households[63]. In Bungoma analysis for Chwele and Naiti markets revealed more than 80 percent of traders were women (81.5%) and men traders (18.5%)[64]. The increased demand for ALVs, and other vegetables, therefore, provides an opportunity for poverty alleviation through job creations, with positive income effects (Poverty and Health Integrated Solutions).

In Kakamega women and youth dominate the production and distribution nodes of the value chain by 70% and 12%, respectively[65]. Direct youth employment along the value chain includes their engagement in labor provision in land preparation, planting, weeding, pest, and disease control and harvesting among others while future projection shows more than 90% of the youth would continue engaging in vegetable production which will be a source of employment for them[66]. The youth are engaged in other livelihood activities due to the higher and quick returns, interests, academic qualifications, and job satisfaction obtained. Indeed, the value chain is a potential source of employment for more than 50% youths in Kakamega[67].

Youth engagement in vegetable farming is however limited, by factors such as negative perception towards farming, insufficient financial resources, and inadequate support from extension services, and inadequate land for farming, and inaccessibility to farming knowledge, inadequate support from the parents and siblings and little time available for farming.

Remunerative:
Production of ALVs is remunerative through labor provision at the farms (weeding, land preparation, planting and harvesting) as well as from sale. Farm workers providing manual labor are paid an average daily wage rate of 200-500 per day depending on the nature of the farm activity. This rate falls under the regulations outlines in The Regulation of Wages (Agricultural Industry) (Amendment) Order, 2017[68]. More than 40% of smallholder women farmers in Lugari, Kakamega County indicated, they earned up to more than 9,000 Kshs in a season while another 42% indicated they earn 5000-9000 Kshs per season[69].

Conditions of work
Despite that harvesting of ALVs done during early mornings and late evenings to maintain freshness of the produce producers and traders, operate within normal working hours. Farm

[63] Annah Indeche 1*, Albert Obeng Mensah 2, Festus Annor-Frempong; women indigenous vegetable farmers in Kakamega County
[64] County specific value chain analysis: production and market systems analysis for African vegetables funded by USAID via RTI in 2020.
[65] https://ruraloutreachafrica.org/african-leafy-vegetables-project/
[66] Edwin Anakadi Buytiya,2017); Youth Participation in Vegetable Production Towards Improvement of Livelihoods in Kakamega Town, Kenya

[68] Minimum Wages Order Kenya 2017
[69] Donna Omulo, 2016; Value Addition of Traditional Vegetables: An Impact Assessment on Women Farmers in Lugari, Kenya

workers observe normal safety procedures when handling farm tools and chemicals to ensure minimal accidents.

Force and Child labor
There were no documented cases of forced labor along the value chain. Children engagement was minimal and almost invisible as they provide labor as "helpers" in their parent's farms during their holidays and after school hours.

3.1.3 Value Added

The Kenya ALV industry value is estimated to be at Kshs 8.01 billion (USD 80 Million)[70] with cowpeas contributing 38.97%, African nightshade and spider plant contributing 23.75% and 12.41 % respectively. Despite this remarkable value, only basic value addition activities are largely undertaken in the sector. This is understandably so because Kenyans prefer fresh vegetables and are yet to embrace the culture of consuming dried vegetables. However:

- Only a few SMEs are involved in medium-scale commercial drying and processing of these vegetables, often with export as the main target market. Other small and medium enterprises (SMEs) are involved in processing amaranth flour from the seed. The flour is exported and used locally as an ingredient in several foods such as nutritious soup and porridge. For example, INCAS located in Athi river which is processing amaranth.

- There exist an unexploited urban, national, regional, and international markets, which would require value addition practices such as flour milling, drying, and preserving vegetables for a longer shelf life [71].Additionally, locally the government policy requires maize flour fortification which is currently creating demand for ALVs such as Amaranth to provide nutritional elements to fight malnutrition[72]

3.1.4 National Competitiveness

National competitiveness of the value chain ranges from maturity, ready niche market nutritional advantages among others[73]:

1) Shorter maturity period compared to other exotic vegetables: Compared to other exotic vegetables such as cabbage produced in Kenya ALVs have a shorter maturity period of 2-3 weeks while cabbages take up to 3 months depending on the variety

2) Ready Market demand: Due to increased consumer health and nutritional awareness, demand for African leafy vegetables in Kenya has increased with supermarkets, groceries, and *mama mboga* outlets increasing their stock and varieties of ALVs.

3) Wide choice of variety: In Kenya, over 200 species of ALVs have been documented. The common varieties include amaranth, spider plant, African nightshade, cowpeas, Jute mallow etc. Hence Kenyans in different communities have a wide variety to choose for production and consumption

[70] Agriculture and Food Authority, 2017 validated report 2016-2017
[71] Omula, 2016; value addition of traditional vegetables: an impact assessment on women farmers in Lugari, Kenya
[72] Government of Kenya 2020: Food fortification in Kenya Policy brief
[73] Author compilation based on findings

4) Management practices are traditional. Most vegetable production is rain-fed. In the dry season, people adopt risk-avoidance strategies to meet vegetable needs. This includes production along riverbanks and supplementary watering. Management practices are traditional. Seeds are broadcast, no precise spacing being applied. Weeding is done alongside the main crop. As for soil fertility improvement, most farms visited had vegetable plots in areas with high nutrient concentrations, such as kitchen waste dumping sites, former cattle sheds, and demolished mud huts.

3.1.5 International competitiveness

In as much as the value chain is grown in different African countries, some countries are advantaged more than others placing the value chain at a competitive edge. A case in South Africa and Kenya reveals international competitive elements of the value chain include.

1. Number of species documented: Kenya has documented over 200 species while in South Africa has documented 100 species. This puts Kenyan consumers and producers at an advantage to choose from different varieties for production and consumption.

2. Niche Market. While South Africa's market niche is for dried products with vending mainly taking place at the streets and rare stocking at the supermarkets and up-market groceries, Kenya's niche is the household consumption, urban and peri-urban dwellers who mainly demand for fresh produce. Unlike South Africa, in Kenya there is stocking at the groceries and supermarkets like Carrefour, Naivash, Quickmart that are selling to direct consumers at the farm gate as well as producing for subsistence purposes[74].

3. ALVs for malnutrition. ALVs consumption has been incorporated in some feeding programs in schools such as St Mary's School, Mundika in Busia County. South Africa has adopted the same approach as a solution to address malnutrition issues in the country.

3.1.6 Value for end-consumers

ALVs are an important source of nutrients, which improve human health and reduce malnutrition cases at the county, national, internationally, and globally. In as much as this is the case consumption of adequate amounts is as critical. Apart from an important contribution to micronutrient malnutrition, consumption of ALVs could also contribute to the prevention of both non-communicable and diseases, such as certain types of cancer and HIV, because of their cell protective effects that arise from their relatively high antioxidants contents (WRC, 2012). Hence, households need to be encouraged to consume a variety of the ALVs and a balanced diet to enjoy the benefits. Detailed benefits per vegetable type are summarized in the table below:

Table 12: Nutritional value per vegetable type

Vegetable	Consumption value	Preparation
Amaranth	○ Rich in essential micronutrients like carotene, iron, phosphorus, magnesium, and calcium as well as vitamins A, B, C and E.	○ Cooked, boiled or raw.

[74] I. Maseko, B. Ncube, T. Mabhaudhi, S. Tesfay, V.G.P. Chimonyo, H.T. Araya, M. Fessehazion, C.P. Du Plooy, Nutritional quality of selected African leafy vegetables cultivated under varying water regimes and different harvests, South African Journal of Botany,

	○ Packed with antioxidants, which protect the body against free radicals, which are responsible for chronic diseases such as cancer.	
African Night Shade	○ Rich in iron, beta-carotene, protein, fiber, folic acid, magnesium, vitamin B, C. ○ Vitamin reduces risk of prostate cancer, prevents scurvy, and improves body absorption of iron.	○ Cooked or boiled
Pumpkin Leaves	○ Has high quantities of potassium, calcium, folic acid, iron, vitamin E, vitamin B6, vitamin C, magnesium, phosphorus, riboflavin, and manganese	○ Should be cooked ○ or served as salad
Cow peas	○ Source of proteins, vitamins such as beta carotene, vitamin c, riboflavin, minerals like calcium	○ Cooked or boiled
Spider plant	○ Source of calcium, phosphorus, iron, vitamins A and C and proteins, carbohydrates	○ Cooked or boiled

Source: World Health Organization

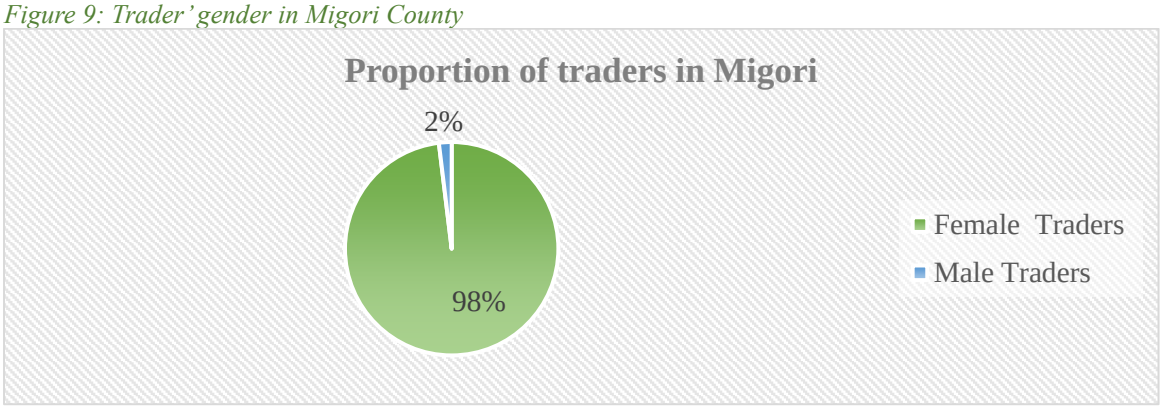
3.2 Social Analysis

3.2.1 Inclusiveness and Gender Equality

Agriculture sector is the largest contributor to Kenya's Gross Domestic Product contributing 33% directly and 27% indirectly through linkages with other sectors. More than 40% of the population depend on the sector for employment and livelihood (FAO, 2022). This therefore calls for inclusive approaches that ensure involvement of youth, women and men and other vulnerable groups for sustainable development.

Due to patriarchal set ups, high poverty levels, unemployment, illiteracy and gender discrimination, women and youth farmers in the rural areas in Kenya remain vulnerable to limited land access and control, low quality inputs and poor market linkages and non-participation on major decisions making on use of land, production and income use. In Migori county majority ALVs-producing, households are male headed yet the producers are their counterpart's women. Equally, majority of traders in Migori county are women (98%) hence the need to consider gender dimensions at every node of the value chain[75]. The Figure below bears these statistics.

Figure 9: Trader' gender in Migori County



Source: National Museum of Kenya, 2020

[75] National Museums of Kenya, 2020; Feasibility Study on Commercial Viability of African Indigenous Vegetables (ALVs) In Western and Central Kenya

A study carried out in Kakamega County to establish the competency of women farmers in ALVs revealed that with women having less access to most of the productive resources due to affordability an accessibility, for ALVs, it was the opposite, as they are not highly esteemed by men due to traditional and cultural beliefs which label it as a "woman's crop" hence allowing women more room to make decisions on production , distribution , consumption and income use form the sale.

Data obtained from the Horticultural Innovation and Learning for Improved Nutrition and Livelihood in East Africa (HORTINLEA) project, revealed that women are responsible for production and selling (73% & 83%) of ALVs in 2/3 of the households in Kenya. Men are mainly involved in decision making on income made from the sale of the ALVs and production of other crops (cash crops)[76].

3.2.2 Food and nutrition security

ALVs increasingly been a major source of healthy diets and the prevention of micronutrient deficiencies and diet-related non-communicable diseases since they contain protein, fiber, minerals, and vitamins[77].

ALVs could highly contribute to food security, to earn valuable foreign exchange by exporting, provide opportunities for import substitution, and generally benefit many people. This is so because of the recent increase in consumption among Kenyan women and men and provided a viable way of alleviating food insecurity in the country (Elisha, et al, 2016) which has led to opening of so many *mama mboga*, small and medium enterprises at the urban and peri-urban centers.

3.2.3 Social and cultural capital

While women smallholder farmers majorly do production of ALVs, they tend to operate in groups (such as cooperatives, producer organizations etc.) to enable them access-training, markets, inputs, and social support. In Lugari Kakamega County, some women are using their groups to access the Lugari Grain Amaranth mill. These groups were formed to meet the factories demand of 200 kgs per week (Donna Omulo, 2012). Other benefits accruing from social capital include social support in case of death, weddings or any other social events, investment and savings, access to affordable training, and access to affordable inputs.

3.3 Environmental Analysis

3.3.1 Climate change

Climate experienced in the Lake Region Economic Bloc counties is generally mild with temperatures between 19 and 25 degrees Celsius throughout the year. Rainfall is characterized by two seasons in a year (March-June for long rains and September-November for short rains) the rainfall

Extremes in temperature both during the day and at night & erratic rainfall patterns experienced in most counties

[76] Luzia.D etal, 2021; Gender Dynamics and Food Security in the Kenyan African Indigenous Vegetables Supply chain

[77] https://www.acts-net.org/research/projects/hortinlea

average is 700 mm - 2000 mm annually[78]. ALVs in this region experience erratic rains, prolonged droughts, increased temperatures resulting to productivity (53%), crop failure (28%), increased food insecurity (24%) [79].

In Kakamega County, farmers revealed that temperatures experienced during the day and night have been extreme[80] in the last 20 years, that rainfall patterns now become more unpredictable. Impacts of climate change ALVs production and distribution observed in Kakamega, Nyamira, Kisii, Migori include[81]

a) Droughts /Unreliable rainfall

- Counties' dry spells affect seed germination, and seed sown during dry spells is vulnerable to attack by soil pests- leading to low plant population and diminish expected production volumes.
- Dry spells affect soil fertility because inadequate moisture impedes decomposition and the integration of manure and fertilizers, reducing the nutrients available for the plants.
- Land preparation is however easy in dry spells and suppresses pests' infestation.
- Reduced post-harvest losses in the dry spell, as there is ease in transportation, reducing spoilage, and facilitate value addition by enabling easy solar drying.
- Nevertheless, extreme temperatures coupled with poor handling result in conditions that favor increased rates of spoilage and rotting, leading to low volumes of African leafy vegetables. Analysis of historical temperature trends in the county over 25 years (1981 to 2005) shows that both first and second season mean temperatures have increased by approximately 0.4 and 0.3°C respectively in Trans Nzoia county.These increases in temperature have resulted in a moderate increase in heat stress days [82].
- Increased crop wilting and drying

b) Extreme rainfall

- During planting stage extreme rainfalls complicate the preparation of land for planting, bring about the leaching of nutrients, and increases incidences of soil disease-causing microorganisms; also cause deficient germination due to poor water infiltration, waterlogging, and the washing away of ALVs seeds.
- Mudslides and soil erosion in the lowlands experience flooding risk that renders planting and germination difficult due to waterlogging.
- Increased cost of production due to heightened pesticide usage and increased labor requirements for planting and weeding

[78] MOA, The Lake Region Economic Blueprint A better life; https://cog.go.ke/phocadownload/reports/Lake_Basin_web.pdf

[79] Collins M. Musafiri, Milka Kiboi, Joseph Macharia, Onesmus K. Ng'etich, David K. Kosgei, Betty Mulianga, Michael Okoti, Felix K. Ngetich, Smallholders' adaptation to climate change in Western Kenya: Considering socioeconomic, institutional and biophysical determinants, Environmental Challenges determinants

[80] Winifred Chepkoech, Nancy W. Mungai, Silke Stöber, Hillary K. Bett and Hermann Lotze-Campen; Farmers' perspectives, Impact of climate change on African indigenous vegetable production in Kenya

[81] Kenya County Climate Risk Profile: Kisii County; [81] Kenya County Climate Risk Profile: Nyamira County; [81] Kenya County Climate Risk Profile: Kakamega County; [81] Kenya County Climate Risk Profile: Migori County

[82] Kenya County Climate Risk Profile: Trans Nzoia County

- During postharvest handling, sorting and preparing vegetables becomes costlier and more time-consuming, and high rates of spoilage and wastage result in low volumes.
- Impassable roads delay deliveries to market outlets and lead to increased transportation costs that shrink profit margins.
- Increased outbreaks of diseases such as blight and black rot, and higher demand for pesticides.
- High rainfall causes increased weeds

3.3.2 Water footprint

ALVs rely on adequate amounts of water to ensure maximum biomass and high-quality produce. The amount of water required for full production of ALVs vary with species e.g. 340 mm for pumpkin and cowpeas,368 mm for Jew's mallow, 381 mm for African nightshade and 463 mm for spider plant[83].Therefore, water use and management is critical in production of ALVs to ensure sufficiency. Smallholder farmers have adopted various techniques in water saving in the counties of study[84];

- Water harvesting from roof tops
- Drip irrigation
- Intercropping which would reduce water usage
- Reuse of kitchen water on the small vegetable gardens
- Minimum tillage,
- Communal water points such as boreholes, springs, and wells where usage is managed

3.3.3 Biodiversity and ecosystems

More than 200 species of ALVs have been recorded as food ingredients in Kenya alone. The study found of the species several are grown in the LREB counties depending on their adaptability to the environment in the regions due to their ability to grow rapidly on the onset of rains and thrive ion dry spell.

ALVs survive harsh conditions, which has led farmers to cultivate for household and commercial purpose. Species of the value chain vary in shape, size, colour, taste, and nutritional value[85]. LREB counties have a variety of agro-ecological zones suitable for production of the diverse species of ALVs. The diversity of ALVs species is as bullet below:

- Kisii: Spider plant, African nightshade, pumpkin, cowpeas, and vine spinach. *African nightshade and spider plant grown by over 80% of the households*[86]

- Kakamega: Jute mallow, African nightshade, spider plant and cow peas.

[83] A Oelofse[1] and W van Averbeke[2] 2012; Nutritional value and water use of African Leafy Vegetables for improved livelihoods
[84] County Integrated Development Plans for specific counties
[85] Climate Risk Profile; Kericho County
[86] Climate Risk profile; Kisii County

- Migori: Amaranth, African nightshade, spider plant, cowpeas, jute mallow and slender leaves. *Jute mallow and slender leaf mainly grown for subsistence by 21-40% of the households* [87]

- Vihiga: African nightshade, amaranthcow pea, Ethiopian mustard, jute mallow, pumpkin leaves, and spider plant[88]

- Kisumu: Cowpea varieties, which include, *M66, and KVU 27-1 mainly produced by over 65% of the households in the county*[89]

- Kericho: African nightshade and spider plant *are produced in about 61-80% of the households*[90].

3.3.4 Toxicity/ pollution

ALVs provide an opportunity to realise the climate-smart agricultural (CSA) development pathway. They are more adaptable to local climate variability, productive under low input systems and more popular among the growing number of urban dwellers in Kenya when compared to exotic vegetables[91]. However, there is little data on Green House Gases emissions and carbon footprints (CF) in ALVs smallholder production systems[92]

3.3.5 Food loss and waste

Due to its high perishability nature, ALVs are harvested and sold within two days. Hence no recorded losses at the farmer's level. Traders lose from spoilage while on display for sale due to wilting (transpiration) and spillage. Amaranth for example indicate 5.5% loss (3.2 bunches out of 75.2 bunches)[93]. The loss indicates a reduction in availability of the value chain by more than 5% at the consumer end hence the need for promotion preservation technologies such as sun drying, and use of modest evaporative coolers used in Busia and Trans Nzoia counties [94]

[87] Climate Risk Profile; Migori County
[88] Climate Risk profile; Vihiga County
[89] Climate Risk Profile; Kisumu County
[90] Climate risk profile Kericho County
91 Barnabas Kurgat1, Silke Stober 2, Susanne Neubert2, Hillary Kiplangat Bett3, Winifred Chepkoech1, Hermann Lotze-Campen4; Potential of African Indigenous Vegetables to Contribute to Climate-Smart Food Systems

[93] Cecilia M. onyango[1,] Jasper K. Imungi [2] Post harvesting handling and characteristics of fresh-cut traditional vegetables in Niarobi –Kenya,2007
[94] Ayua Emmanuel Owino, post-harvest handling and value addition of african indigenous vegetables in western Kenya

3.3.6 Climate hazards, impacts, and climate resilient practices

This study summarizes the environmental chapter by illustrating the climate hazards, impacts, and climate resilient practices that are being implemented/ or have a potential of being implemented through the project.

Table 13: Climate hazards, impacts, and climate resilient practices

VALUE CHAIN STEP	CLIMATE HAZARD	CLIMATE IMPACTS	IMPLEMENTED PRACTICES	ADAPTATION RECOMMENDATIONS
	Heavy rainfall and hailstorms	Leaching of nutrients and washing away of seeds and topsoil; seed rotting and destruction; mudslides; proliferation of microorganisms bringing soil diseases; delays in land preparation; additional costs of inputs	Construction of small-scale dams and barriers for soil and water conservation; agroforestry practices; manure application; mulching; shades to protect seeds from hail	Integrated soil and water management and conservation practices; climate risk crop insurance; shade nets and greenhouse production
Input supply	**Droughts / reduced moisture**	Wilting and death of seedlings. Reduced availability of seeds and dry manure	Provision of seeds by government and research institutions	Introduction of drought, pest tolerant varieties; agroforestry practices
	Change in seasons (onset and length)	Damage to seedlings and wilting	Increased mulching and irrigation, rainwater harvesting; delayed application of seeds and manure	Promotion of early maturing varieties; local seed production and increased manure and seed commercialization, storage, and processing.
Production	**Droughts / reduced moisture**	Reduced seedling germination success rates; formation of soil pans and reduced tillage capacity; increased water and labor requirements; increased incidence of pests and diseases (aphids, termites)	Early land preparation; use of minimum tillage practices; small-scale irrigation; use of leaves as mulch; greenhouse production.	Use of mechanical tilling equipment and small-scale, drip irrigation systems; investing in water harvesting and canals; capacity building on manure management and use. Greenhouse production; integrated water management practices (ZAI pit systems, water dams, irrigation)
	Change in seasons (onset and length)	Poor seedling germination success rates; soil moisture stress; difficulties in planning farm operations according to changing weather conditions	Delays in land preparation; manual mulching and irrigation with buckets; compost production using leaves; use of extension advice on planting dates	Develop water harvesting and drip irrigation systems; capacity-building on integrated pest and disease management; improve access to agro-meteorological information and advisories for vegetable production planning and practices
	Heavy rainfall and Hailstorms	Delays in land preparation and planting; nutrient leaching, water logging, less time-efficient labour; direct damage to vegetables	Improved soil conservation measures and land preparation and planting before onset of rains.	Optimize early timing for planting, use of drainage systems; agroforestry practices and greenhouses to protect vegetables from hail
Harvesting, storage, and processing	**Droughts / reduced moisture**	Reduced quantity and quality of harvested vegetables due to withering; reduced shelf life; reduced biomass for processing practices; rapid spoilage during transportation	Reduced quantity of harvested and sold products at the farm gate according to selling capacities. Optimize harvesting timing (e.g., early morning or late evening). Improve product handling (e.g.,	Organize cooperatives for vegetables to coordinate on storage and transportation facilities; training for capacity building on value addition activities; use early warning systems to reduce harvest losses; training on solar drying, use of insulated containers and cold chain practices (e.g., refrigeration within vans and packaging)

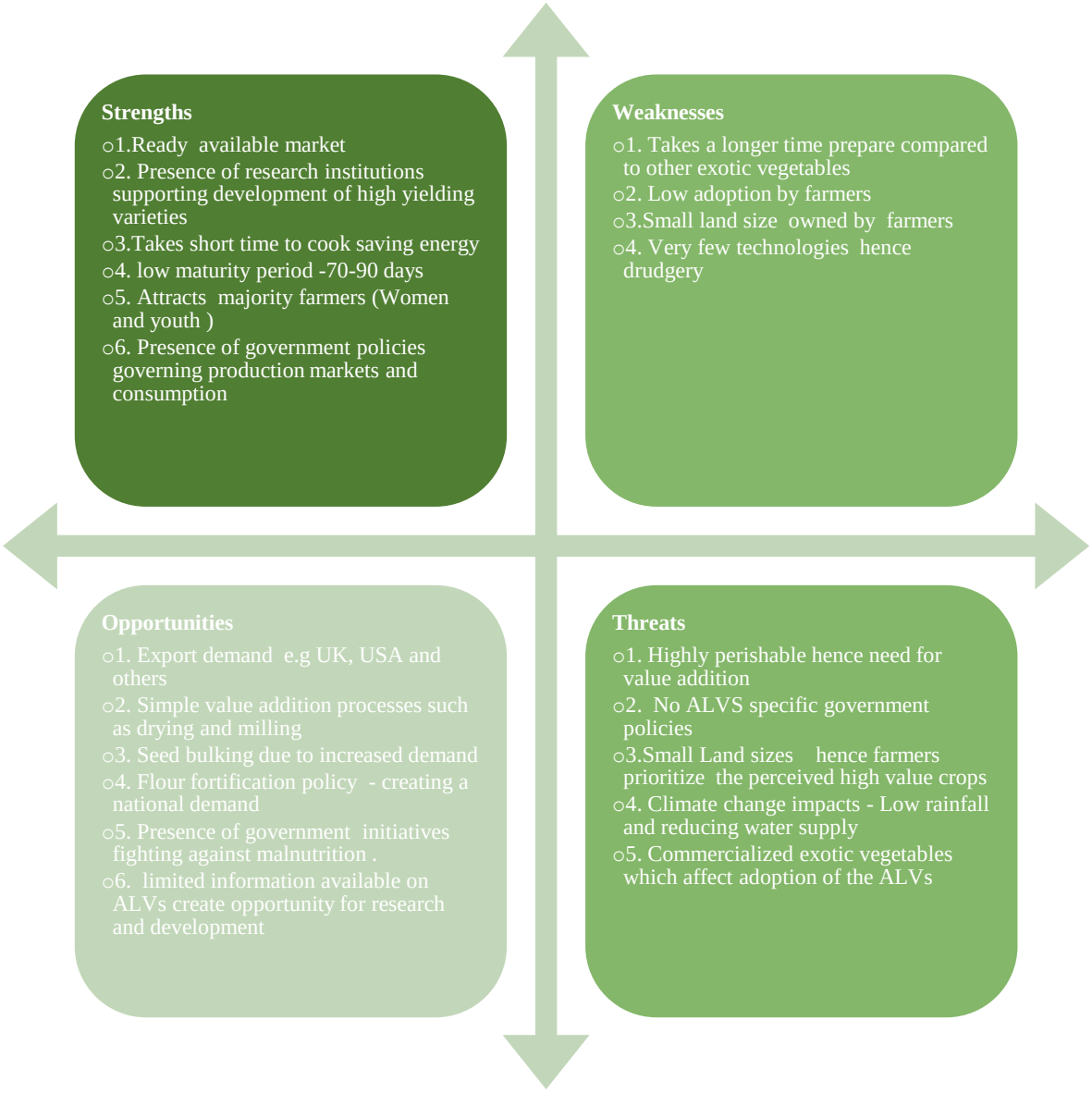
			wrapping in banana leaves, use of water sprinkles)	
	Change in seasons (onset and length)	Reduced food quality; higher storage and transportation costs; delays between harvest and aggregation-storage	Use of extension advice on harvest timing; increased home-consumption	Training on vegetable storage strategies and timing, and value addition activities
	Heavy rainfall and hailstorms	Delays in harvesting, increased risk of contamination, rotting, and spoilage.	Optimize harvesting timing and store vegetables in raised shelves to prevent wetting; use of waterproof packaging, indoor solar drying techniques	Store vegetables in climate-proofed, dry facilities; solar drying, optimize timing of transport
Markets	**Droughts / reduced moisture**	Reduced food available at markets and increased prices for consumers	Increase linkages between farmers and markets through middlemen; increase local, farm gate sales to reduce food spoilage before the sale; increased home consumption	Improve access to roads; establishment of contract marketing
	Change in seasons (onset and length)	Irregular quantity and quality of food supply to markets compared to market demand; reduced prices, value-addition and market opportunities	Increase farm gate sales; increase linkages between farmers and markets through middlemen	Capacity-building initiatives for cooperatives to support farmers with exploring different vegetable marketing opportunities; Contract farming and marketing of vegetables; increase communication of climate- and market-based information for farmers to optimize selling practices and profits
	Heavy rainfall and hailstorms	Difficulties in accessing roads and storage facilities, increased food spoilages.	Set lower prices at markets, use of mobile technology for climate and market information	Combine climate- and market information and research through most suitable communication tools to optimize vegetables marketing as well as connection between value chain actors through e-marketing

Source; MoALF, 2017

3.4 SWOT Analysis

For the success of the efforts towards upgrading the value chain towards increased production, consumption and improved food and nutrition security, the value chain actors engaged in the value chain operation ought to be aware of the strengths to build on, weaknesses, to shore up, opportunities to capitalize on and threats to recognize and mitigate along the value chain.

Figure 3 African Leafy Vegetables SWOT Analysis



3. Recommendations

Great attributes of the ALVs' value include its ability provide opportunities to healthier and more diversified diets, youth and women's empowerment, agro-biodiversity protection, better income opportunities for smallholder farmers, production diversification and climate resilience; building upon increasing national demand and the high potential for processing and synergies with other value chains, as well as increasing traction and multi-stakeholder initiatives, while targeting relatively short value chains for fresh and nutritious products that are currently neglected by policies, research and partnerships, and yet are particularly relevant considering the current pandemic.

In line with the CRLCSA project, aim will transfer both adaptation and mitigation technologies along the ALV value chain, the study recommends the following considerations for value chain upgrading:

1. *Deploy soil and water conservation interventions/ technologies:* Interventions in soil and water management improve crop health and quality, minimize water, and soil loss. Key interventions to promote, particularly for smallholder farmers include, conservation farming techniques, such as cover crops and mulching, shade nets and green house production; and increasing organic matter through use of compost and green manures.

2. *Strengthen long-term resilience for smallholder farmers:*
    a. The key to resilience for smallholder farmers is to reduce vulnerabilities associated with climate change and market shocks. Investments in water harvesting and cost-effective irrigation projects, capacity on integrated pest and disease management, improved access to agro-weather information and advisories for vegetable production planning and practices will cushion farmers against unpredictable rainfall patterns and droughts that lead to crop failure.

    b. Innovative insurance schemes will underwrite the risks associated with crop failure. At the same time, diversification of smallholder farmer household economies, by introducing African Leafy Vegetables alongside other food crops will strengthen the long-term resilience of the household economy and food security.

3. *Federate smallholder farmers into cooperatives:* Encourage smallholder farmers to form/ join cooperatives. Cooperative societies have been useful in aggregating members' input requirements, pooled/ central purchasing to create economies of scale and save costs to individual members. Secondly, cooperatives can also be used as avenues to source inputs, and explore different market opportunities such as contract farming, and coordinate climate-proof storage and transportation facilities for members. Further the cooperative set up could be strengthened to build the capacity of members to invest in low carbon and climate change resilient production, train farmer-based climate-smart lead farmers and be repository for climate-related technology, management, and innovations.

4. *Develop high yielding and promote use of certified seeds for increased production:* Since smallholder farmers tend to use recycled seeds, the project should facilitate

availing certified seeds and encourage their adoption by setting demo farms and learning visits with ALV farmers.

5. *Adopt energy options that reduce emissions and operating costs:* Uptake of cleaner energy can result in low carbon and reduced climate change and vulnerability. For example, Cooperatives should adopt use of solar energy in addition to promoting of solar drying machines; as well as other climate-proofed technologies such as cold chains, timed transport logistics etc.