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TEGEMEO INSTITUTE OF AGRICULTURAL POLICY AND DEVELOPMENT

FINAL REPORT

POTENTIAL IMPACTS OF WITHDRAWAL OF AGROCHEMICALS ON AGRICULTURAL VALUE CHAINS

Submitted to:
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Executive Summary

The agricultural sector plays a significant role in the country's economy and has enormous potential for growth and transformation. Currently, the sector directly contributes 34% of the Gross Domestic Product (GDP) and 27% indirectly through linkages to manufacturing, distribution, and services sectors. The Kenya Vision 2030 identified the agriculture sector as a critical enabler for attaining the economic growth target of 10% per annum. Furthermore, the sector plays a key role in attaining food and nutrition security as envisioned in the Constitution of Kenya (2010), in which it guarantees all citizens the right to safe and nutritious food.

In recent years, the sector has faced several challenges. Top among these include the adverse effects of climate change, weather variability, and increased pest and disease outbreaks. Building resilience against these shocks remains a strategic focus to overcome these challenges. The use of agrochemicals is one of the ways to attain resilience, especially against emerging pests and diseases. However, when misused, agrochemicals pose a threat to humans, animals, wildlife and the environment. This makes the debate on the safe use of agrochemicals a policy priority.

At the heart of this debate is a petition to the National Assembly for a ban on pesticides that adversely affect human, animal, and wildlife health and the environment. Civil society organizations initiated the petition to the health committee of the National Assembly. The petitions seek to have a local ban on pesticide products that use the active ingredients that have been banned in Europe. On the other hand, the local agrochemical industry and agricultural sector players oppose the petition and propose the safe use and disposal of pesticides to minimize adverse effects on humans, animals, wildlife, and the environment.

The use of credible data in informing this debate remains critical. First, it is crucial to highlight that evidence of the causal relationship between the use of pesticides and health outcomes for human, animal, wildlife health, and the environment in Kenya is weak. This is mainly because of low investments in research to generate such data and evidence. Although the existing studies suggest a correlation between adverse human, animal, and wildlife health outcomes and pesticide use, the causal inference has not been established. The safe use and disposal of pesticides reduces adverse effects resulting from their use. Furthermore, a blanket ban on pesticides products may not be the sole option to ensure minimal adverse effects on humans, animals, wildlife and the environment. In addition, it may be useful to evaluate the wholesome effects of different options to ensure the first-best policy option.

Therefore, this study evaluates the potential impacts of a blanket ban on pesticides as contained in the petition. The study also evaluates alternative options for attaining the objectives of the petition. The study focuses on the potential impacts on food security, food safety, livelihoods and the overall economy.

Findings

The use of agrochemicals has increased significantly in recent years as a direct response to the increased incidence of pests and diseases. However, per ha use of pesticides in Kenya remains significantly low compared to countries in Europe. In the past decade, the country has

faced increased pest and disease incidences. The major ones include the Maize Lethal Necrosis Disease (MNLD), Fall Army Worm (FAW) and *tuta absoluta* (tomato leaf miner) for tomatoes and desert locust infestation. Pest and disease control and management remain a critical production challenge for primary cash crop commodities such as coffee, horticulture, and the flower industry. Kenya mainly imports pesticide products. The volume of imports for insecticides and fungicides has fluctuated with the increasing demand for control and management of pests and diseases. For example, the import volumes for fungicide accounted for almost one-third of total import pesticide volumes between 2010 and 2013. The imported volumes then fell by a fifth and a quarter in 2014 and 2015, respectively. This coincided with the disease outbreaks for major crops such as the MNLD for maize, wheat, and rice blast, and blight for Irish potatoes. In 2017 and 2018, there was an increase in import volumes for insecticides, coinciding with the FAW infestation. In 2020, the use of insecticides was expected to be much higher due to the desert locust infestation.

Changes in pest and diseases management policy, such as banning products that contain ingredients banned in Europe, is likely to negatively impact the sector's general agricultural growth and its contribution to the economy and worsen the country's trade balance. Besides, the ban is unlikely to guarantee food safety in the country. There are no safeguards to ensure that food imported to the country will be safe. Kenya is a net importer of staple food commodities such as maize, rice, and wheat. Kenya mainly imports maize from the region, i.e., Uganda, Tanzania, Zambia, and Malawi. For wheat, the country's primary sources of wheat imports include Russia, Argentina, and Ukraine, which account for more than half of total wheat imports. The main import countries for rice are Pakistan and Thailand, which account for about 90% of total rice imports. These countries have not imposed a similar ban. The agrochemicals ingredients proposed for expulsion from the Kenya market are used extensively in Tanzania, Uganda, Pakistan, and Thailand to control pests, diseases, and weeds. Therefore, the country would be putting local farmers at a disadvantage while purchasing agricultural produce from farmers in other countries using the similar products.

Also, the country is likely to experience economic losses as a result of the ban. Currently, the horticulture industry employs about 350,000 directly and supports over six million livelihoods. The proposed ban will drastically disrupt the production of cut flowers, which will significantly increase the likelihood of job losses for millions of Kenyans. Furthermore, economic losses arising from crop losses from a potential ban is estimated to be about 4.5% of the agricultural GDP through direct production losses. The impact on the economy, thereof, will be greater, considering the multiplier effect on other sectors.

Alternative use of chemical pesticides, such as the use of biopesticides, is low. In Kenya, about 10% of farmers are reported to use biopesticides. Generally, farmers have a higher preference for chemical pesticides over bio-pesticides because of effectiveness, speed of action, the spectrum of activity, availability, and affordability.

There is justification to pursue other measures to ensure food safety other than a ban. The country's pesticide regulation is widely regarded as one of the most rigorous in the African continent and closest to global benchmarks. Exploring how to make these regulations effective is an option for ensuring the safe use and disposal of pesticides. Measures that can be pursued

include strengthening the implementation of the pesticide's regulations, which is currently weak, and building the capacity for farmers on the safe use and disposal of pesticide products. Besides the local pesticide industry players have made investments in promoting knowledge and information on safe use and disposal of pesticides, traceability systems and are actively involved in the fight against counterfeit products. In addition, there is a need to undertake sensitization to the food supply chain actors, including aggregators, traders, and consumers, on food safety. Moreover, stepping up surveillance along the food value chains to identify unsafe food and sources of contaminations remains critical. Also, the continuous investment in research to develop safer agrochemicals, resistant varieties, biological controls for pests and diseases is vital for ensuring food safety.

1. Introduction

The agricultural sector is the mainstay of Kenya's economy, currently directly contributing 34% of Gross Domestic Product (GDP), valued at KES 3,326 billion in 2019. Additionally, the sector accounts for approximately 60% of export earnings and is a source of 18% of the country's formal employment and about 60% of the informal employment (MOALF, 2015). Kenya's rural economy mainly depends on smallholder subsistence farming and livestock production, accounting for 70% of Kenyan agricultural production and 50% marketed output. The Kenya Vision 2030 envisages an annual economic growth rate of 10%, and the agricultural sector is expected to play a significant role in realizing this goal. A key challenge for agricultural production in Kenya remains low productivity. However, the stagnation and decline in productivity have mainly been attributed to low uptake of yield-enhancing inputs such as improved seeds and fertilizers, erratic and unfavourable weather conditions, suboptimal investments at farm level due to liquidity constraints, ineffective public policies, increased incidence of pest and diseases and effects of climate change and variability (Makau, et al., 2016; Makau, et al., 2018; Njagi, et al., 2017; Otsuka & Muraoka, 2017; Tjernström, et al., 2017).

The debate on the use of pesticides and agrochemicals continues to be at the forefront of public policy. There are several bodies involved in the regulation of the use of agrochemicals. The regulatory bodies include the Pest Control Products Board (PCPB), Kenya Plant Health Inspectorate Services (KEPHIS), and the National Environmental Management Agency (NEMA). The industry also has a self-regulatory mechanism under the Agrochemical Association of Kenya (AAK). Besides, the Ministry of Agriculture, Livestock, Fisheries, and Cooperatives (MoALF&C) also plays a critical role in shaping policy.

Contentious issues in the debate on pesticides touch on food safety, safe use and disposal of pesticides, and potential adverse effects on human, animal and wildlife health and the environment. Civil society organizations have petitioned for a total ban on pesticides that adversely affect human health or the environment. At the heart of this prayer are active ingredients that have been banned in Europe to be banned locally. The contrary opinion is that all pesticides contain hazardous ingredients, and their safe use and disposal can significantly minimize adverse effects on human or animal life and the environment. Data and evidence on the causal relation of effect on pesticides lack or weak in the country. If not backed up by evidence, a blanket ban of pesticides can potentially have adverse effects on agricultural production and, by extension, food security, livelihoods, and the overall economy.

Therefore, this study aims to evaluate the positive roles of pesticides use and the potential impact of removing the registered pest control products from the PCPB approved list on food security, GDP and food safety.

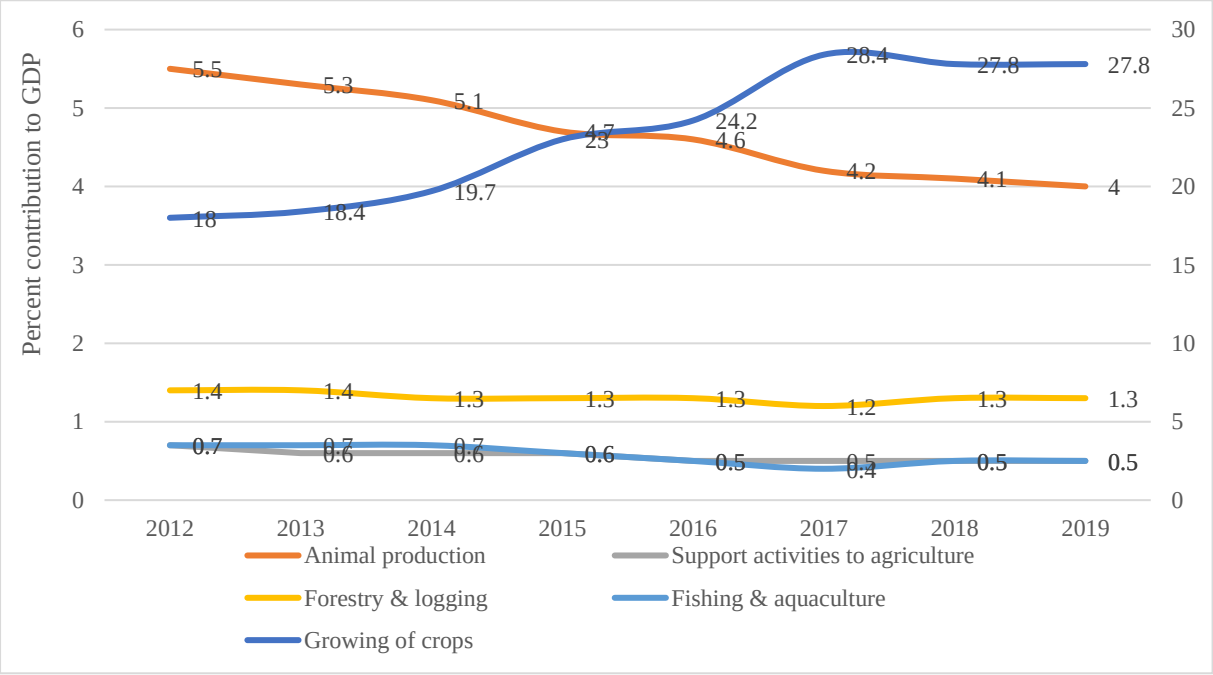
1.1 Contribution of Agriculture to Kenya's Economy

Kenya is renowned for the supply of quality agricultural produce to the global markets, with key exports including tea, coffee, and horticultural crops. The sector has grown to become

significant to the country economy as a key source of foreign exchange and contributing to households' incomes and food and nutrition security.

Figure 1 shows the trends in contribution to GDP from various subsectors. Crop production dominates the contribution to the economy. The subsector plays an essential part in maintaining the country's food security and. are a crucial anchor in terms of incomes and foreign exchange, the latter mainly from export-oriented crops such as horticulture and traditional cash crops such as tea and coffee. Between 2012 and 2019, fishing and aquaculture contributed the least to GDP in Kenya among the agricultural subsectors.

Figure 1: Contribution of Agricultural Subsectors to GDP 2012-2019

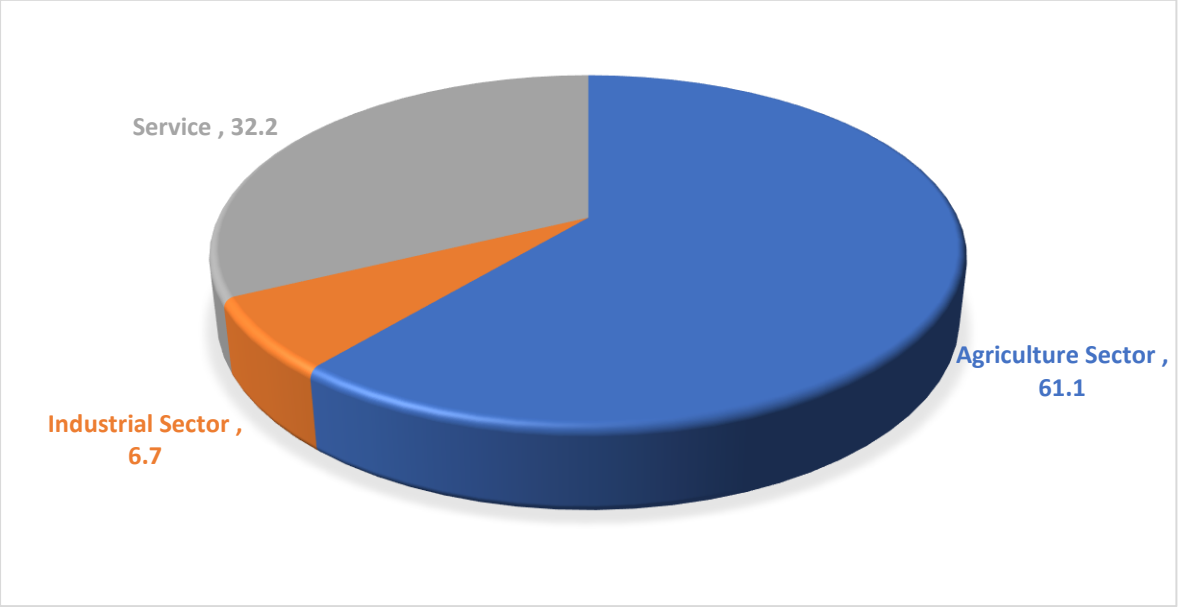


Source: Authors' elaboration using data from KNBS (2020)

The crops subsector has faced numerous challenges despite the significant contribution of crop production to Kenya's economic growth. Crop yields are hampered by more than 10,000 types of insects and 30,000 types of weeds (Dhaliwal et al., 2010). The utilization of pesticides has been favoured to protect crops from destruction from pests and diseases. Besides, there are interlinkages between the subsectors, especially between crop production, forestry and animal production. Furthermore, a large majority of primary producers practice mixed farming

The agriculture sector also plays a significant role in providing income and employment. The agriculture sector accounts for 61% of wage employment (Figure 2). As the sector expands, it is likely that the sector will lead to expanded employment creation in other sectors such as manufacturing and services. This goal can be realized if the government realizes the Agriculture Sector Transformation and Growth Strategy (ASTGS).

Figure 2: Wage Employment by Industry and Sector, 2019



Source: Author's elaboration using data from KNBS (2020)

1.2 Methodology

This study used qualitative and quantitative data analysis to evaluate the potential effects of a potential ban on pesticide use in Kenya. Specifically, a literature review of policies and regulations was undertaken to appreciate Kenya's policy and regulatory context and landscape governing pesticide use. This was supplemented by key informant interviews with various industry players, bureaucrats, regulators, and end-users (farmers) on prevalence rates for pest and diseases, resistance, value chains, agro-ecologies, quality, and access to knowledge on the safe use and disposal of pesticides. After that, a quantitative analysis of secondary data on the potential impacts of a ban on pesticide products was carried out. The scope of the quantitative analysis covered the impact on farmers' welfare, rural economies, food and nutrition security (food safety and availability), food commodities trade, and the effects on the overall economy. Finally, we undertook a qualitative analysis of pesticide regulations and use for countries likely to gain from increased exports as a potential ban of pesticide products in Kenya.

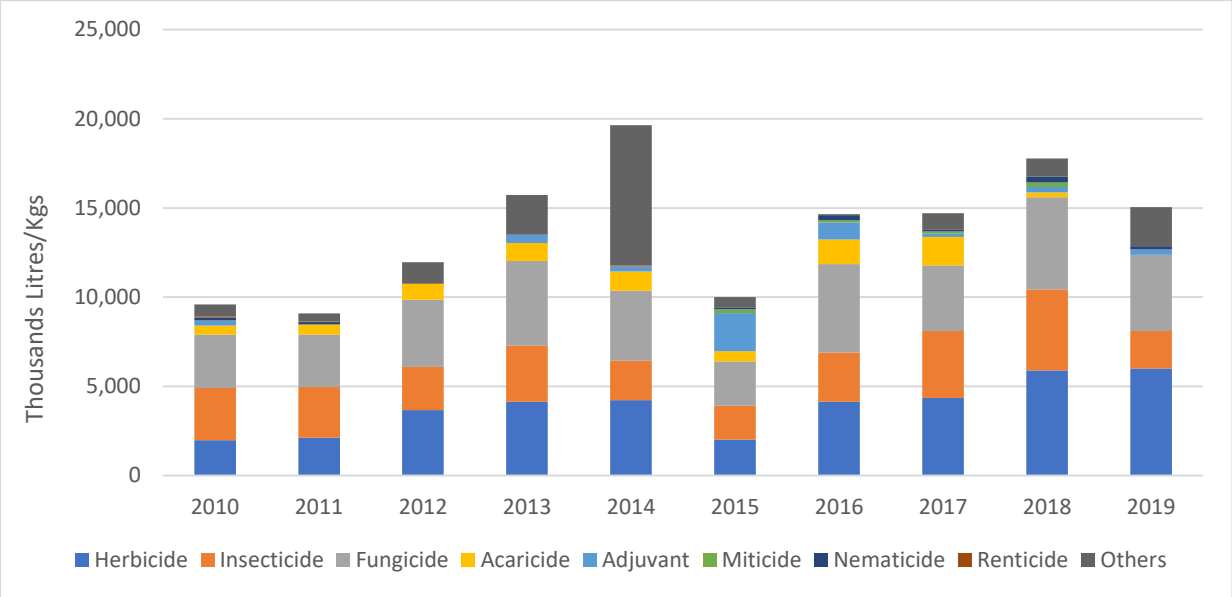
The rest of the report is organized as follows. The trends in pesticide use in Kenya are presented, followed by the policy and regulatory environment on pesticide use in Kenya. The potential effects of the ban are then discussed, first evaluating the potential impacts on food trade and food security, then the economy-wide effects. The proposals for the safe use and disposal of pesticide products are discussed in the context of global trends. The report then concludes and presents recommendations.

2. Trends in pesticide use in Kenya

The country imports chemical pesticides for domestic use. The main classes of pesticides and agrochemicals imported include; herbicides, pesticides, fungicides, acaricides, miticides, fumigants, and nematicides. Other categories include; plant growth regulators, public health insecticides, biocides, wood preservatives, and technical grade materials imported into the country. Figure 3 shows the trends in imported pesticides since 2010.

The country has faced increased pest and disease incidences in the past decade, the major ones being the MNLD, FAW, and *tuta absoluta* (tomato leaf miner) for tomatoes. For key commodities such as coffee, horticulture, and the flower industry, pest and disease management continued to be a critical production challenge, balancing safe use and disposal of pesticides and increased productivity. Figure 3 shows the trends for imports for pesticides from 2010 to 2019. Pesticide imports increased between 2010 and 2014, dipped in 2015 before rising in subsequent years.

Figure 3: Imported pesticide volumes from 2010 to 2019



Source: Author's elaboration using data from AAK, 2020

As expected, the use of agrochemicals has increased significantly in the past five years in direct response to the increased incidence of pests and diseases. In the last two years, the increased incidences of quarantine pests have begun to cause a threat to export market access.

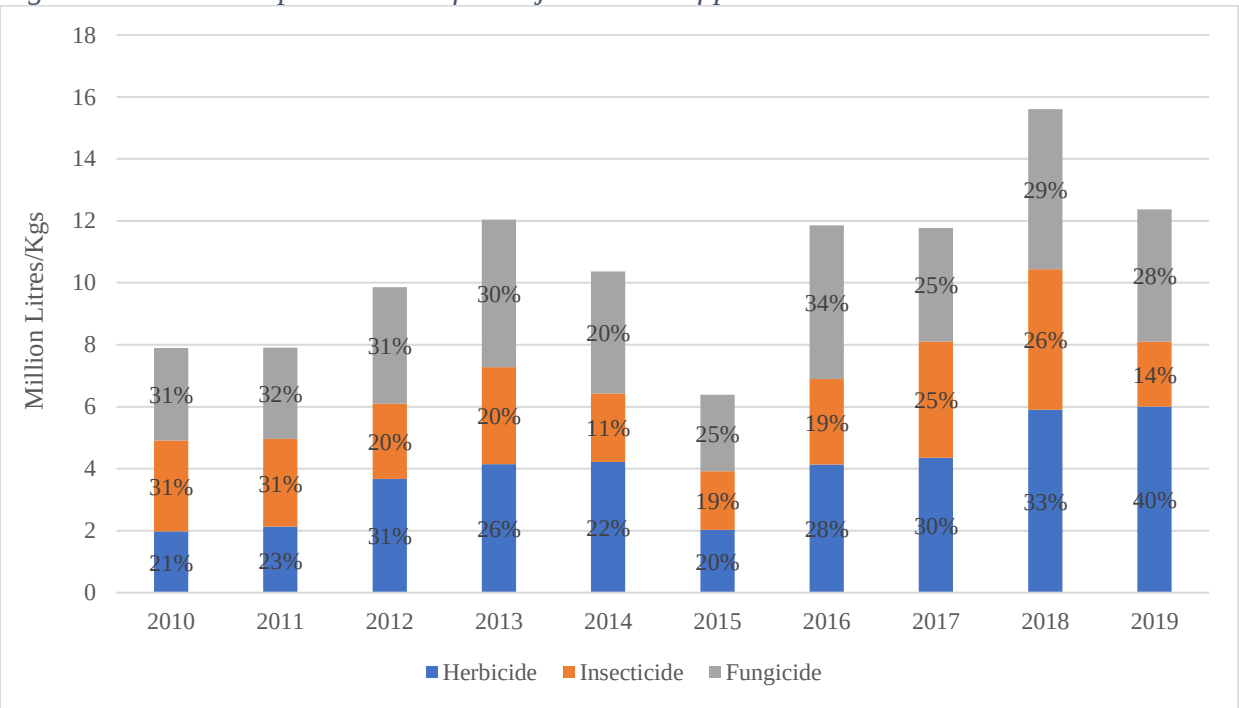
A key assumption is that all imported pesticide is used in the same year. A key gap is the per hectare pesticide use in the country. It was estimated that the per ha pesticide use in Kenya was less than 1kg/ha (FAO, 2018). This was consistent with other SSA countries have very low per hectare utilization such as Rwanda (1.47kg/ha), Sudan (0.25kg/ha), Zimbabwe (0.53kg/ha) and Malawi (0.6kg/ha) (Sharma et. al., 2019). On the other hand, pesticide utilization in Europe is significantly higher i.e., France (3.9kg/ha), Spain (3.35kg/ha), Germany (3.8kg/ha), Italy (6.45kg/ha), Portugal (6.84kg/ha), Netherlands (9.86kg/ha) and Belgium (7.73kg/ha) among top pesticide consuming countries.

2.1 Pesticide use patterns

Figure 4 shows the importation trends for the major pesticides imported, i.e., herbicides, insecticides, and fungicides. Herbicide use increased in direct response to labour shortages in rural areas where farmers now use herbicides to control weeds. The use of herbicides allows farmers to cut on costs on labour costs. Labour shortages, especially during peak periods in the production cycle, have led to increases in the wage rate. The volume of imports for insecticides and fungicides has fluctuated. The import volumes correspond to the demand for these products

in response to the shock being addressed. For example, the import volumes for fungicide accounted for almost one-third of total import pesticide volumes between 2010 and 2013. The imported volumes then fall to a fifth and a quarter in 2014 and 2015, respectively. From 2010 to 2013, major crop diseases included wheat rust, rice blast, and MNLD for cereal grains, the incidences from other crops notwithstanding. In 2017 and 2018, there was an increase in import volumes for insecticides, coinciding with the FAW infestation. In 2020, the use of insecticides was expected to be much higher due to the desert locust infestation.

Figure 4: Trend in import volumes for major classes of pesticides



Source: Author's elaboration using data from AAK, 2020

3. Pesticide Policy and regulatory framework

The Pest Control Products Board (PCPB) is the primary regulator for pesticide products in the country. The Kenya Plant Health Inspectorate Services (KEPHIS) supports the monitoring of pesticide residues in agricultural products. KEPHIS also plays a crucial role in the monitoring of threats to agricultural production from pests and diseases. The National Environmental Management Authority (NEMA) has the mandate to ensure environmental health for the various land uses. Industry players adopted a self-regulating mechanism that is overseen by the industry's leading association, the Agrochemical Association of Kenya (AAK).

Through the Ministry of Agriculture, Livestock, Fisheries, and Cooperatives (MoALF&C), the national government leads in policy development for the sector, including policies on the use and disposal of pesticide products. The Ministry of Health also plays a crucial role in food safety policies. County Governments now play a vital role in the safe use of pesticide products through the extension function.

Altogether, these institutions are expected to ensure the safe use of pesticide products from production and supply chains until it reaches consumers. This includes strict compliance with

registration requirements, utilization and disposal of products, and monitoring residues in agricultural products.

The PCPB, Pest Control Products Act Cap 346 (revised in 2012) is the overarching law governing the use of pesticide products. The regulations developed to operationlise the Act provide for the following measures (Kenya Law Reports, 2012):

a) Description of the classification of pests, pest control products and classes, kinds of pests, and pest control products;
b) Describe the application procedure for registration for pesticide products and the information to be provided;
c) Determine the fees for registration and the procedures to be followed when reviewing the registration of pest control products. This review includes refusal, suspension, or cancellation of the registration
d) Prescribe the form, composition, and all other standards relating to the safe use of pest control products, including toxic residue effects;
e) Facilitate product differentiation and branding by manufacturers
f) Develop standards for efficacy and safety of any pest control product;
g) Guide the manufacture, storage, distribution, display, and use of any pest control product;
h) Guide the packaging, labelling, and advertising of pest control products;
i) Undertake quality control and quality assurance of pesticide products;
j) Prescribe the information to be supplied for any pest control product that is to be imported into Kenya.

Key Facts

- The Kenyan pesticide regulation regime is widely seen as one of the most rigorous on the African continent and closest to global benchmarks (Talk Africa, 2019).
- In Kenya 18% of the pesticides used are considered to be counterfeit and illegally imported.
- The main significant hot spot source for counterfeit pesticides in Kenya is from neighboring Tanzania and Uganda, where counterfeit pesticide levels may be over 40%. (AgriBusiness Global, 2018, Nampeera et al., 2019)

The implementation of the regulations of pesticides in the country has faced several challenges. First, the surveillance and monitoring systems for pesticide use and disposal are weak. This stems from weak data collection systems, the lack of investment in modern laboratories to undertake pesticide toxicology testing, and weak investment in research and development to support the regulations. Second, the lack of financial resources has hampered both the staffing capacities for the regulatory bodies as well as key functions such as routine monitoring and surveillance. Third, the know-how on pesticide use and disposal among users, especially smallholders, is also constrained by a collapsed public extension systems that the majority of the farmers rely on to get knowledge and information on farming practices. Of importance is that although the country has established a standard, the Kenya Good Agricultural Practice

(Kenya GAP), its adoption remains low among farmers, and the domestic food markets do not incentivise its adoption through the pricing of products. Fourth, regional collaboration for the registration of pesticide products, information and data sharing on emerging pests and diseases within the East African Community (EAC), the Common Market for Eastern and Southern Africa (COMESA), and the greater Sub-Saharan region has not been robust. We explain below the effect of a potential ban and how that affects the existing situation.

Role of local industry in enhancing safe use and disposal of pesticides

The local industry has made significant investments to promote the safe use and disposal of pesticides. First, industry players developed a brand/mark of quality for pesticide products imported by members of the industry association. Distinguishing the quality of products through branding was a first step in providing guarantee to respective users as to the quality of products especially due to growing counterfeit products. Second, the association members invest in field days and demonstrations to teach farmers how to safely use and dispose pesticide products. Other investments by the industry include compliance with packaging and labelling requirements and investments in traceability systems especially for horticulture products.

Key challenges facing the Implementation of Regulations	Effect of ban
Regional collaboration on registration pesticides and sharing registration procedures and data are widely reported not to be robust within the COMESA region and greater Sub-Saharan Africa countries.	✓ Banned pesticides are likely to be smuggled into the country while food below the maximum residue limits is imported. ✓ 18 % of the pesticides used in Kenya may be counterfeit (AgriBusinessGlobal, 2018, Nampeera et al., 2019) ✓ The use of illegal pesticide products and food imports.
The national and local authorities and regulatory bodies are not well funded to monitor, evaluate, and enforce regulations on safe pesticide use.	
Despite the assumptions that biopesticides may replace some of the banned chemicals no biopesticides can effectively substitute existing pesticides in fighting some pests and diseases	The development of biopesticides is still in its infancy stages and not effective in some cases. In Kenya's use of bio-pesticides is less than 2%, farmers perceived bio-pesticides as not effective (Constantine et al. 2020).
Kenya lacks an advanced pesticide laboratory and adequate pesticide toxicology analysis capacity at the local levels to provides results promptly for food imports	✓ Kenya's arbitrary banning of pesticides will negatively affect farmer's ability to manage pest and diseases, consequently high food production cost and food insecurity challenges
Despite the available regulations, Kenya agencies cannot implement and supervise the safe disposal of agricultural pesticide waste or empty containers	✓ The national government and local government lack systems to collect empty pesticide containers
Kenya has developed Kenya GAP as a national system to monitor pesticide residues in food and the environment but not widely adopted by farmers.	✓ Most counties lack regional officers to oversee the implementation of the maximum residue limit.
In Kenya, gaps are evident in sufficient extension training of farmers on pesticide use and management	✓ Majority of the farmers are not aware of the standards and the requirements need to implements nations maximum residue limits
There is low investment in research and development (R & R&D) in pesticides, especially by government agencies requiring a great deal of capital and man power investments	✓ Lack of trained storekeepers and lack of safe pesticide transport procedures, es-pecially in rural areas, still remain remain a concerned
There is weak supervision on pesticide use surveillance and monitoring systems to collect information on common conditions of use and their impact on health and the environment.	

3.1 Harmonization of policies in EAC and COMESA

Kenya is a key EAC Partner State and has been leading in harmonising regulations on inadequate and varied pesticide regulatory systems within the region. Inefficient and varied pesticide regulatory systems within the region are likely to result in environmental deterioration, reductions in agricultural productivity, and adverse impacts on the health of consumers and the surrounding community. Developing an efficient, competitive, and sustainable agricultural sector in the region requires strict standards on the use of pesticides.

Table 1: Pesticides Ingrediencies Listed for banning in Kenya and are Used in COMESA Region

Countries Pesticides ingrediencies	Uganda	Tanzania	Kenya	Ethiopia	Sudan	Egypt	Zambia	South Africa
Chlorothalonil	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clodinafop	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Oxyfluorfen	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Yes
Permethrin	No	Yes	Yes	No	No	Yes	Yes	Yes
Pymetrozine	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Carbendazim	Yes	Yes	Yes			Yes	Yes	Yes
Dichlorvos	Phasing out	Yes	Yes			No	Yes	Yes
Dimethoate /Omethoate	Yes	Yes	No	Yes		Yes	Yes	Yes
Thiacloprid	No	Yes	Yes			Yes	Yes	Yes
Deltamethrin	Yes	Yes	Yes			Yes	Yes	Yes
Abamectin	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Chlorpyrifos	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Yes
Gamma-cyhalothrin	No	Yes	Yes			Yes	Yes	Yes
Oxydemetonmethyl	No	No	Yes			No	?	Yes
2,4-D-Amine	Yes	Yes	Yes	Yes	N/A	No	Yes	Yes
1,3 Dichloropropene	No	No	Yes		N/A	No	No	Yes
Thiophanate-methyl	Yes	Yes	Yes	Yes		Yes	Yes	Yes
Bifenthrin	Yes	Yes	Yes			Yes	Yes	Yes
Carbaryl	Yes	Yes	Yes			No	Yes	Yes
Fenitrothion	Yes	Yes	Yes			Yes	Yes	Yes
Flubendiamide	Yes	Yes	Yes			Yes	Yes	Yes
Flufenoxuron	No	No	Yes			Yes	Yes	Yes
Glufosinate-ammonium	Yes	Yes	Yes			Yes	No	Yes
Imidacloprid	Yes	Yes	Yes			Yes	Yes	Yes
Mancozeb	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Yes
Tebuconazole	Yes	Yes	Yes			Yes	Yes	Yes
Malathion	Yes	Yes	Yes			Yes	Yes	Yes

Kenya is a member of COMESA, and a potential ban on pesticides will indirectly affect agricultural products from the COMESA region. Also, the potential ban will contravene the regulations of COMESA operation. Table 1 shows the potential list of pesticide ingredients recommended for banning in Kenya but are used with COMESA regions.

Kenya has been instrumental in the development and adoption of key pesticide regulations within the EAC. These regulations include:

i. Guidelines for evaluating and reporting the efficacy of pest control products for plants
ii. Guidelines for the conduct of supervised pesticide residue field trials on crops
iii. Guidelines for the Protection of Confidential Business Information Submitted for Pesticide Registration Actions in the EAC Partner States
iv. Technical Criteria for Designating Efficacy Trial Centres – East African Community (EAC)
v. EAC harmonized guidelines for the Registration of Biopesticides and Bio Control Agents for plant protection
vi. EAC Harmonized Guidelines for the Registration of Biopesticides and Biocontrol Agents for Plant Protection

Besides, Kenya has also influenced the harmonization of policies for the COMESA region. The development and adoption of regional and international standards for Sanitary and phytosanitary (SPS) measures increased access to competitive markets and enhanced intra-regional and international trade.

The proposed ban on pesticide products will likely have adversely affect the trade with the EAC and COMESA region. First, Kenya is considered the leader in the pesticide industry in the region. Its agricultural pesticide regulations inform EAC countries. However, the proposed change in policy is not shared across the EAC Partner States and COMESA member countries. Kenya imports more than 72% of consumer-oriented agricultural products, mainly from Uganda, South Africa, and Egypt. Most of the COMESA members have an underdeveloped capacity to address trade constraints related to pesticide Maximum Residue Limits (MRLs), which poses difficulties in the production of safe food for both domestic and international markets. Often, the absence of an MRL result from a lack of residue data for the particular crop/pesticide combination. Most COMESA countries cannot generate this high-quality data to establish international trade standards. A likely result is a non-tariff barrier to trade, which is likely to have adverse effects on consumers and producers alike. Consumers are likely to face higher prices due to shortages, especially for products that the country is a net importer, and producers will face constraints in access to export markets if the countries introduce retaliatory measures to restrict Kenya's access to these markets.

For key food items such as maize, where the country is a net importer, there is a significant likelihood that commodities from the neighbouring countries will still be imported through informal cross-border crossings where they will not be subjected to MRLs testing defeating the purpose of the ban.

4. Potential impacts of a ban on pesticides

4.1. Food Imports

4.1.1 Rice Imports

In Kenya, rice consumption is the fastest growing cereal in terms of growth in per capita consumption. Currently, the demand for rice in Kenya outstrips its production, with the gap filled through imports. Table 2 shows that Pakistan accounts for more than half of Kenyan rice imports (54% in 2018, rising to 63% in 2019). Thailand is the second-largest importer of rice to Kenya. China and India are other vital sources of rice imports to Kenya. In total, rice imports account for over 90% of domestic consumption, implying that local rice production accounts for less than 10% of the total demand.

Table 2:Trends for rice imports into Kenya

	(Import value in thousands USD)				
Source Country	2016	2017	2018	2019	2020
Pakistan	115,821	153,809	135,258	157,305	129,614
Tanzania	3,067	708	1,203	659	34,851
India	3,033	7,256	13,763	6,186	32,330
Thailand	16,677	65,407	76,861	65,454	28,496
Myanmar	0	329	0	1,842	9,369
China	211	27,809	18,445	3,877	5,241
Vietnam	337	859	20	279	3,453
South Korea	0	0	6,106	9,479	3,237
Others	817	2,873	920	203	130
Total	139,963	259,050	252,576	245,283	246,721

Source: TradeMap, 2021

The agrochemicals ingredients proposed ban in the Kenya market are used extensively in Pakistan, India, Thailand, and China to control rice production pests, diseases, and weeds. For instance, herbicides with pretilachlor ingredients control weeds in paddy rice fields in China and India. At the same time, fungicides control rice blast in Japan, where rice production pesticides account for 41% of total pesticides used in that country (WenJun Zhang1,2, FuBin Jiang1, JianFeng O, 2011). In the region, these pesticides that are proposed for a ban are also used in Tanzania. If the ban is successful, Kenya cannot impose restrictions on imports from these countries. First, such measures will likely be met with retaliatory measures for Kenyan exports. In the past, Pakistan has immediately retaliated against measures against their rice exports, as was the case of tariff measures.[1] Second, restraining import volumes would significantly affect food markets, creating a vibrant black market for imports imported through informal channels, e.g., Tanzania. This would be significantly advantageous to external producers while greatly disadvantaging local producers and consumers.

4.1.2 Wheat Imports

Wheat is the second most-consumed cereal in Kenya after maize. Wheat production has declined over the years due to high production costs, increase in pests and diseases. Kenya has had to rely on imports to meet domestic demand. Table 3 shows wheat imports by the source of origin.

[1] Pakistan is the largest export market for Kenyan tea

Kenya's primary wheat sources are Russia, Argentina, and Ukraine, which account for more than half of total wheat imports. Russian wheat aphid pest has dispersed globally, mainly affecting Africa, Asia, Europe, the Middle East, North America, and South America. Insecticide's ingredients are highly effective in controlling Russian wheat aphids. Countries like Australia, Canada, and the USA that export wheat to Kenya heavily use pesticides ingredients.

Table 3: Trends for wheat imports into Kenya

	(Import value in thousands USD)				
Source Country	2016	2017	2018	2019	2020
Russian Federation	76,793	126,450	174,926	147,476	145,096
Argentina	2,608	80,903	89,489	116,658	134,759
Germany	38,762	24,566	12,635	24,533	46,564
Canada	26,013	39,124	37,131	44,832	44,422
Lithuania	34,321	1,101	6,727	10,596	17,860
Latvia	17,488	11,583	6,759	29,207	17,413
Poland	26,186	29,213	5,312	16,846	15,889
Australia	61	20,247	13,865	14,038	12,422
Ukraine	20,377	42,514	54,566	50,589	7,476
United States of America	20,786	29,598	8,313	33,231	11
Czech Republic	10,036	4,792	5,051	0	7,405
Others	11,253	28	8,644	13,973	8,834
World	284,684	410,119	423,419	501,979	458,151

Source: TradeMap, 2021

Similar to rice, the primary countries for wheat imports, such as Russia and Argentina, are not imposing the ban on pesticides ingredients proposed in Kenya. Furthermore, Kenya also has a total ban on genetically modified crops, restricting further the options for identifying alternative source countries. If the ban is successful, lower yields and production are anticipated as an immediate impact, and therefore both local consumers and producers will be adversely affected.

4.1.3 Maize Imports

The country mainly imports maize from Uganda, Tanzania, Zambia and Ethiopia in normal years. This is because of the EAC and COMESA tariffs and the total import ban from GM producing countries. However, in drought and famine years, Kenya usually requests waivers to import maize outside the EAC and COMESA region, importing white maize from Mexico, and yellow maize from South Africa, USA, Canada, Mexico, Argentina, and Brazil (Table 4).

Table 4 Trends for maize imports into Kenya

	(Import value in thousands USD)				
Source Country	2016	2017	2018	2019	2020
Tanzania	10188	6,835	14,967	42,169	22,010
Mexico	4	184,797	2	1	20,385
Zambia	7,581	35,361	29,604	15,660	8,282
South Africa	1,471	74,261	1,650	2,144	7,414
Serbia	0	0	0	0	6,237

	(Import value in thousands USD)				
Source Country	2016	2017	2018	2019	2020
Ukraine	0	22,491	0	0	1,950
Uganda	15,935	37,412	70,113	0	2
Ethiopia	0	12,495	329	0	0
Others	666	15,815	1,861	717	2,534
Total	35,845	389,467	118,525	60,693	68,814

Source: TradeMap, 2021

Agrochemical ingredients are critical in maize production, and maize producers rely on pesticides to increase their production. Agrochemical ingredients recommended for the ban in Kenya are used in maize production in countries exporting maize to Kenya. Counties such as Brazil and Mexico have more than threefold the level of productivity for maize, relying on pesticides for pest control. A variant of the corn earworm (*Helicoverpa armigera*) was detected for the first time in Brazil and spread rapidly. This new pest reduced some maize yields by 50% (Jones, Parry et al., 2019). Since some maize varieties do not control corn earworms, insecticides on maize in Brazil have increased. In Mexico, the soil pest complex is a significant problem in maize production and is estimated to account for about 8% of yield declines for the affected crop. Seed treatment with insecticides is an economically feasible technological solution to problems in rainfed maize production.

4.2. Agricultural Exports

4.2.1 Horticulture Exports

Currently, the horticulture industry is the fastest growing agricultural sub-sector and is ranked second in foreign exchange earnings from exports after tourism. The horticulture industry directly provides about 350,000 employment opportunities and supports over six million livelihoods.

4.2.1.1 Cut flowers

In Kenya, 95% of flowers grown are for export to various international markets. Globally, Kenya controls 40% of cut flower export to Europe. The Netherlands and the United Kingdom is Kenya's most significant export destination for Kenya cut flowers, accounting for two-thirds of the exports (Table 5). To improve margins, Kenya has focused on enhancing flower production efficiency and diversifying to non-traditional export markets such as the Middle East, China, Japan, Australia, and New Zealand. The key to the sector's success is using the latest technology, availability of technical training, and easier access to markets. Also, to enhance the quality of Kenya's produce, the industry associations and other players have trained and supported producers and exporters on international accreditations on food safety and traceability requirements.

Table 5: Trends in exports for cut flower by destination

	(Export value in thousands USD)				
Destination Country	2016	2017	2018	2019	2020
Netherlands	270,972	281,295	289,676	286,099	262,051
United Kingdom	84,892	85,144	95,450	103,351	118,054

	(Export value in thousands USD)				
Destination Country	2016	2017	2018	2019	2020
Germany	19,314	19,871	23,968	27,668	29,735
Norway	18,225	20,175	20,384	20,057	24,491
Russian Federation	14,651	20,729	22,243	19,871	21,928
Saudi Arabia	13,997	14,814	16,383	20,301	20,111
United Arab Emirates	13,389	14,884	19,004	20,199	18,028
Australia	12,688	13,503	14,767	13,773	11,006
Switzerland	6,868	6,503	7,374	7,687	9,080
France	6,182	6,427	7,391	7,390	6,742
Japan	7,080	7,534	7,777	6,871	5,484
Sweden	5,997	6,274	6,430	5,719	5,413
Italy	3,494	3,944	5,478	5,230	4,147
Oman	1,930	2,225	2,214	2,689	3,681
South Africa	1,931	2,314	3,164	3,678	2,677
Kuwait	1,139	1,159	1,358	1,607	2,582
Others	26,882	34,042	31,915	32,008	26,880
Total	509,634	540,831	574,977	584,199	572,093

Source: TradeMap, 2021

The proposed ban will drastically disrupt the production of cut flowers as pesticides are a significant input in their production. Reduction in production will increase the likelihood of job losses for millions of Kenyans employed in the industry while reducing significantly foreign exchange garnered by the industry. Within the East Africa region, Kenya's main competitors in cut flower production are Tanzania and Ethiopia. Therefore, the proposed ban on ingredients will reduce Kenya's competitiveness while Tanzania and Ethiopia benefit, especially if the share in the EU market declines as expected.

4.2.1.2 Tropical fruits and vegetables

The primary fruits and vegetables grown for exports include avocado, mango, passion fruit, pineapple, banana, pawpaw, and watermelon. Vegetables include French beans, chillies, snow peas, sugar snaps, runner beans, baby corn, garden peas, Asian vegetables (e.g. *Okra, Dudhi, Valore, Turia*), herbs, and spice. Kenya faces stiff competition in the fruits export markets from Colombia, Ecuador, Ethiopia, Spain, Morocco, Israel, Egypt, India, and China. Table 6 shows that fruits exports have grown over tha past five years following growth of export markets in the EU.

Table 6: Trends in exports for tropical by destination

	(Export value in thousands USD)				
Destination Country	**2016**	**2017**	**2018**	**2019**	**2020**
Netherlands	21,420	21,654	51,096	33,084	35,088
United States of America	35,519	49,576	53,603	47,448	30,727
United Arab Emirates	28,972	28,342	28,492	29,330	26,836
France	11,573	17,341	14,806	14,404	18,451
Spain	1,555	3,051	11,153	11,298	16,063
United Kingdom	13,080	9,682	9,553	10,800	14,552
Germany	4,358	6,579	13,472	9,220	14,393

	(Export value in thousands USD)				
Destination Country	**2016**	**2017**	**2018**	**2019**	**2020**
Saudi Arabia	9,996	10,947	11,579	14,317	14,022
Russian Federation	2,420	5,020	9,063	5,521	7,711
Turkey	94	364	1,180	2,701	3,474
Viet Nam	521	2,043	2,283	864	3,270
Uganda	509	928	1,639	857	3,148
Oman	218	955	2,726	3,062	2,939
Qatar	827	1,322	1,992	1,965	2,578
Egypt	1,258	1,257	1,838	2,042	2,530
Japan	3,189	3,764	3,015	5,018	1,977
Singapore	527	965	1,415	1,238	1,942
Kuwait	189	311	386	708	1,768
Others	13,568	16,679	13,227	10,551	14,822
Total	149,792	180,779	232,517	204,428	216,294

Source: TradeMap, 2021

Table 7 shows the trends in exports for vegetables bt destination. The United Kingdom remains Kenya's largest export market destination for vegetables. Overall, production shocks have continued affect export volumes and value. The shocks include weather shocks and pest and diseases outbreaks.

Table 7: Trends in exports for vegetables by destination

	(Export value in thousands USD)				
Destination Country	**2016**	**2017**	**2018**	**2019**	**2020**
United Kingdom	108,007	93,066	113,964	119,257	128,721
Netherlands	29,745	30,506	37,570	33,608	30,688
Uganda	34,54	9,514	4,374	6,522	26,189
France	15,839	20,701	225,99	22,845	21,733
India	55,048	2,541	14,594	1,561	16,438
United Arab Emirates	13,192	6,398	10,364	6,517	16,391
South Sudan	3,733	1,926	2,599	2,465	14,678
Pakistan	7,358	14,242	10,159	2,306	11,501
Belgium	4,826	4,156	4,214	5,310	4,665
Germany	3,337	3,919	3,106	3,214	2,609
Somalia	3,693	3,979	8,903	4,431	2,461
Qatar	341	375	1,042	781	2,030
Norway	1,283	1,554	1,791	1,526	1,789
Ireland	745	1,011	387	1,025	1,666
South Africa	1,641	623	1,262	2,123	1,654
Hong Kong, China	1,208	1,261	1,392	1,798	1,559
Switzerland	1,682	1,608	1,678	1,869	1,088
Others	9,670	11,775	10,089	7,489	9,526
Total	264,804	209,156	250,085	224,647	295,384

Source: TradeMap, 2021

Pests (arthropods, pathogens, and weeds) cause about 30% fruits yield loss in Kenya's farm and market levels. The losses are both the quantity and the quality of the products at various pre-harvest and post-harvest stages. At the national level, export interceptions due to quarantine pests continue to hinder the exploitation of the international market. Pests and diseases, particularly in passion fruit (i.e., increased incidences and intensity of fusarium wilt, dieback, and woodiness virus diseases), continue to be challenging. In most cases, producers have to spray their crops with caution on the risk of exceeding maximum residue levels that result in interceptions at the borders of the importing countries. The fruit fly (*Bactocera invadens*) in the mango and avocado is a quarantine pest detected by many importing countries, consequently limiting Kenya's exports. Therefore, the proposed ban on agrochemicals will affect the producer's ability to manage pests at the production and post-harvest levels.

4.2.2 Coffee Exports

Coffee remains an important agricultural export commodity to the Kenyan economy. Despite the performance of the commodity declining over the last two decades, the sector employs about 250,000 people directly. Kenya's primary export markets for coffee include the United States of America, Germany, Belgium and Sweden.

Table 8: Trends in exports for coffee by destination

	(Export value in thousands USD)				
Destination Country	**2016**	**2017**	**2018**	**2019**	**2020**
United States of America	34,606	54,137	39,961	30,687	45,588
Germany	37,173	37,523	36,141	30,965	34,936
Belgium	15,451	23,058	22,768	38,058	29,138
South Korea	11,889	16,557	24,296	18,397	18,157
Sweden	21,829	18,640	18,937	11,269	13,084
Switzerland	17,221	11,016	11,378	3,724	9,029
Norway	4,150	7,443	7,446	9,231	8,471
Australia	6,044	5,500	10,869	7,196	7,874
Finland	11,068	6,372	6,027	5,300	6,001
Japan	4,394	4,044	5,947	5,264	5,842
Denmark	1,368	2,380	2,940	4,087	5,620
United Kingdom	7,003	7,760	7,311	6,405	5,138
Canada	5,929	4,324	5,154	4,185	3,293
Romania	1,848	2,089	3,441	3,286	2,894
Netherlands	7,371	5,028	5,232	2,307	2,751
Spain	2,902	4,010	3,526	3,432	2,178
Taipei, Chinese	1,287	1,593	2,191	1,401	1,971
China	747	806	609	1,173	1,829
Ireland	173	518	289	800	1,363
New Zealand	1,180	1,321	1,310	1,097	1,266
Italy	1,683	847	1,197	9,76	1,213
Others	17,161	14,714	14,788	15,653	8,174
Total	212,476	229,678	231,756	204,889	215,808

Source: TradeMap, 2021

Over 95% of Kenyan coffee is of Arabica type (*Coffea arabica*). Most Arabica coffee cultivars are of excellent cup quality but are more susceptible to significant coffee pests and diseases. The management of various coffee diseases & pests has also become difficult and expensive. In nominal terms, most farmers incurred costs in disease control that took up 30% of the market prices. However, pesticides with Chlorpyrifos ingredients control *antestia* bugs and pests such as coffee cherry borer and coffee leaf miner.

4.3 Food Security Status

Kenya has had rather mixed results in increasing agricultural productivity and attaining food security status. In Kenya, poverty and food insecurity, undernutrition, and income inequality remain high. Approximately 1.3 people in Kenya face acute food shortages, according to the Kenya Food Security Steering Group's 2019 (FEWS NET, WFP Kenya, 2020). A decline from the estimated 2.6 million people in need of assistance in late 2019.

Food security across marginal agricultural areas improved with the prolonged rain harvest in 2020. The Ministry of Agriculture data estimates that national maize production was likely 10-15% above the five-year average. Maize production across most marginal agricultural areas was 16-31% above-average but was average in Lamu, and 16-50% below average in Makueni, Embu (Mbeere), and Tharaka Nithi. In Kilifi and Nyeri, maize production was 77% and 69% above the five-year average, respectively (FEWS NET, 2020). However, some households in Tana River, Baringo, County, and Mandera County are still food insecure.

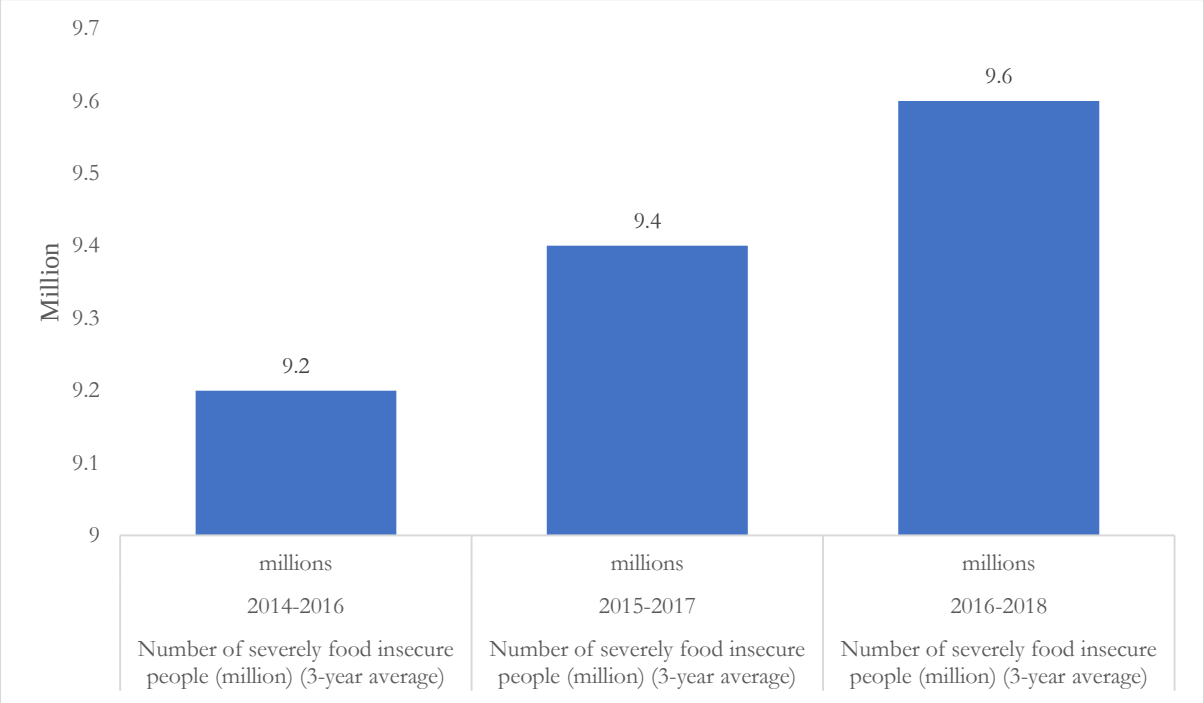
In 2020 an urban food security assessment conducted in Nairobi, Mombasa, and Kisumu's informal settlements found that households in informal settlements are likely facing food shortage crisis outcomes. The worst-affected households likely face moderate food consumption gaps due to a lack of income and increasing the necessity to engage in negative coping (FEWS NET, 2020).

The increased frequency of extreme droughts and floods and outbreaks of pests and diseases In Kenya can lead to severe food insecurity. In 2020, the pastoral northwestern areas of Turkana, Marsabit, Isiolo, Garissa, and Samburu counties are affected by desert locust swarms. The locust swamps invaded and destroyed approximately 760,000 hectares of crop and forage land (FEWS NET, 2020). The locust invention significantly affects poor household's food security outcomes (FEWS NET, 2020). However, farmers and government agencies using pesticides with Chlorpyrifos ingredients will effectively control the desert locust.

The increase in pests and diseases has necessitated the use of pesticides. A typical example was from 2016 when the Fall Army Worm caused a devastating effect on the maize farms. In 2017, FAW was reported in 43 counties and caused a 20% maize yield loss of 1.05 million bags with a value of KSh. 3.15 billion (MoA, 2017). In 2018, the loss was reduced to 5% after the systemic intervention by the government using pesticides for FAW (MoA, 2018). In most counties affected by the FAW, the application of pesticides on maize has traditionally not been expected, particularly among subsistence farmers. However, the infestation necessitated insecticide spraying. Therefore, the prohibition of pesticides will significantly affect the country's food security status.

Figure 5 shows Kenya's food security status in the period 2014 and 2018. Over this period, the number of people facing severe food insecurity increased from 9.2 million 9.6 million. Invasive species such as Aphids, Whiteflies, Caterpillars, Armyworms, Desert locusts, Stalk borer, among other pests, pose a great threat to Kenya's food security. At the same time, the proposed ban on agrochemical ingredients would seemingly affect food production, and therefore food security.

Figure 5: Food Security Status in Kenya



Source: FAO STAT 2020

4.3.1 Kenya Policy Towards Food Security under Big four Agender

The Government in the Third Medium-Term Plan (MTP III) placed the "Big Four" agenda to guide development from 2018 to 2022. The target of the program is to enhance smallholder productivity under the food security and nutrition pillar. Also, the project will include establishing 1,000 agribusiness enterprises using a performance-based incentive model along the value chain. Table 9 summarizes the key priority policy areas in driving the transformation in Agriculture.

Table 9: Kenya's Agriculture Sector Transformation and Growth Strategy under Big Four

Focus area	Detailed initiatives	2017/18 baseline	2022 target
Increased small-scale farmer, pastoralist and fisherfolk	Increase incomes for 3.3 million Kenyan farming households	Ksh 465/day	Ksh 625/day
Increase agricultural output and value add	Expand agricultural Gross Domestic Product (GDP)	Ksh 2.9 trillion	Ksh 3.9 trillion

Focus area	Detailed initiatives	2017/18 baseline	2022 target
	Grow contribution of agro-processing to GDP	Ksh 130 billion	Ksh 261 billion
Increase household food resilience	Reduce the number of food-insecure Kenyans in the ASALs	2.7 million persons	
	Reduce the cost of food and improving nutrition	Restructure governance and operations of the Strategic Food Reserve	

Source: Government of Kenya (2018)

The Big Four Agenda aims to increase agricultural output, add value to products, and expand agricultural GDP by 3.9 trillion Ksh by 2022. However, one of Kenya's challenges in attaining the objective is the increasing and changing nature of invasive species in the farms. In Kenya, pests and diseases cause about 25-35% agricultural produce losses. Considering the role of pesticides in the food production system, the proposed ban on agrochemical ingredients will likely hinder the government in attaining the outlined targets, such as

i) Expand agricultural Gross Domestic Product by Ksh 3.9 trillion in 2022
ii) Increasing household food resilience
iii) Reduce the cost of food and improving nutrition.

4.3.2 Post-harvest losses

In Kenya, post-harvest losses and wastage are likely to aggravate the food security status of the country. Most of the damage happens for grain stored in large quantities at the household level i.e. between 100 and 500 kgs. For the smaller quantities, i.e. less than 50 kgs, the losses are at about 70% (KIPRA, 2020). At the same time, rodents account for about 70% of the loss for grains (Table 10). However, the availability of agrochemicals enables farmers to control weevils, reducing the losses and earning returns from farming. Also, insecticides/fumigants would allow farmers to control rodents in raw grain, processed, and packaged foodstuffs. Therefore, the potential ban on agrochemical ingredients will negatively impact farmers' incomes and, to a greater extent, threaten the food security status of Kenya.

Table 10: Food losses during storage at the household level (%) by county

	Weevils				**Rodents**		
Country	**<50kg**	**50-<100kg**	**100-<500kg**	**<500kg**	**<50Kg**	**50<100kg**	**100<500kg**
Kitui	13	11	8		1		6
Kisumu	27	4	1		24		
Siaya	9	4	1		15		
Migori	3	1	3		2		
Meru	1	4	11		_		
Kwale	5	13	8		13		
Makueni	2	2	5		_		
Kiambu		-	22	57	1	_	_

	Weevils				Rodents		
Country	**<50kg**	**50-<100kg**	**100-<500kg**	**<500kg**	**<50Kg**	**50<100kg**	**100<500kg**
Uasin Gishu	2	15	13		3	27	43
Kericho	1	4	5				
Tharaka Nithi	3	2	2				
Tana River	1	2	2				
Kilifi	1	3			2	25	
Trans Nzoia	-	-					8
Baringo	1	2	2		3	6	
Nakuru	1	-			_	14	
Kajiado	1	3			1		
Kakamega	1	3			5		13
Total	74	73	82		70	72	70

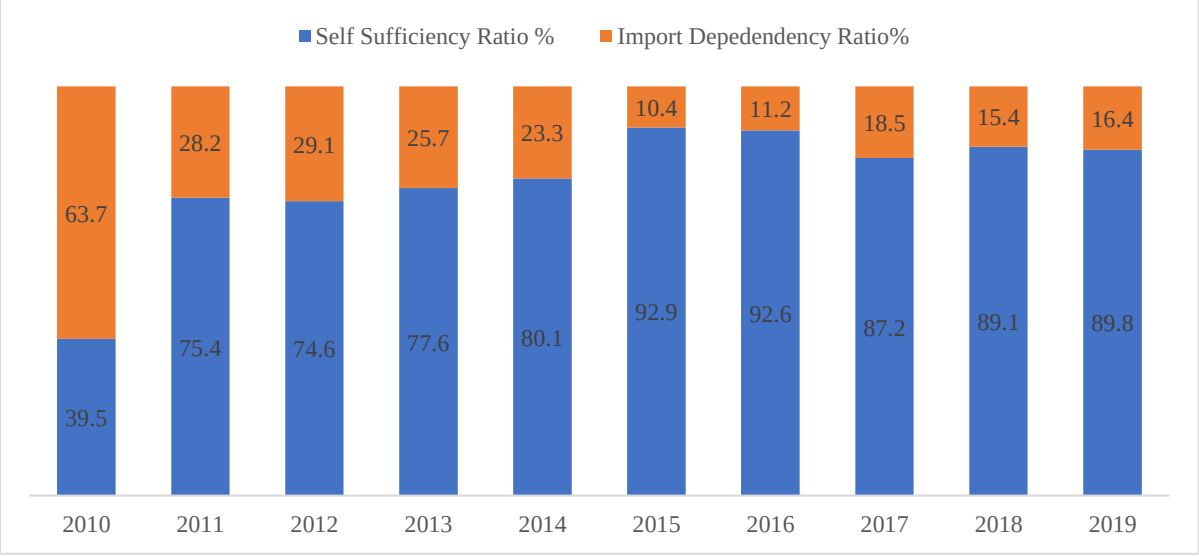
Data Source: KNBS (2016), KIHBS 2015/16

4.3.3 Food Balance and Consumption Patterns

The section presents information on food status in Kenya. Specifically, the data illustrates the extent to which a country is dependent on food imports over its domestic supply. The food Self-Sufficiency Ratio (SSR) measures how a country can rely on locally produced food. While the Food Import Dependency Ratio (IDR) shows the extent to which a country is dependent on food imports over its domestic supply. The data illustrate the potential impact of the ban on pesticide products on food IDR and SSR.

Generally, the data shows that from the year 2014 to 2019, Kenya's self-sufficient ratio was above 80% (Figure 6). The year 2015 recorded the highest self-sufficient ratio (93%), and 2010 was the lowest 40%. Despite the increase in the self-sufficient ratio, the national food poverty headcount rate of 32% and food and nutrition security remains challenging. To increase in the self-sufficient ratio, Kenya will need to sufficiently the outbreak of pests and disease. Consequently, the proposed ban on agrochemical ingredients will slow the country's goal of being food self-sufficient

Figure 6:Trends in Self-Sufficiency Ratio and Import Dependency Ratio, 2007-2019



Source: Authors' elaboration using data from KNBS (2020)

Table 11 shows the drivers of the Import Dependency Ratio (IDR) in Kenya. In 2014, maize and products recorded an IDR of 13% and increased to 13% in 2015. In 2016, the IDR for maize decreased by 62% to stand at 5%, mainly because of improved production in 2015. However, in 2017, maize and products recorded the highest IDR of 33% (KNBS, 2019).

During the year 2017, there was massive importation of maize meant to cushion consumers from maize shortage occasioned by drought. Dependency on imported potatoes, identified as a food security crop, was minimal since the IDR was either less than one or zero. In 2014 and 2016, the country did not depend on imports for potatoes and products. Considering the awareness of Kenya's food status, a potential ban of pesticides would increase Kenya's import decency ratio mainly because of the losses in production.

Table 11: Selected crops contributing to Import Dependency Ratio in Kenya (% contribution)

	2014	2015	2016	2017	2018
Wheat	85	86	87.2	92.8	86.8
Maize	12.5	12.9	4.9	33.4	13.6
Rice (Milled Equivalent)	83.4	85.8	88.9	92.6	98.3
Potatoes	0	0.3	0	0.3	0.1
Beans	0.1	0.1	0.1	0.1	3.1
Tomatoes	0.5	0.4	0.5	7.3	2.3
Onions	0	0	0	0	37.4

Source: Authors' elaboration using data from KNBS (2020)

Trade data presented in Table 10 shows that between 2015 and 2019, Kenya's production of the main food crop was not sufficient, thus relied on imports. Specifically, the data shows between the years 2015 and 2019, the lowest maize production (3.2 million tons) was experienced in 2017, while at the same time, Kenya experienced the highest maize import of 1.4 million tons. The low production was mainly attributed to diseases and weather. In Kenya, Stemborers and Striga weed account for maize losses in the eastern and southern Africa region of 15-40% and 20-100%, respectively. When they occur together, farmers can lose their entire crop (Ong'amo, Le Rü, Dupas, 2006). Also, maize lethal necrosis and armyworms are other major pests and diseases. To counter stalk borer, maize lethal, armyworm farmers use an insecticide ingredient. Also, farmers use herbicides ingredients to control Striga weed. Therefore, a potential ban on listed ingredients used in managing pests, diseases, and weeds in maize production would increase the prevalence of maize diseases and threaten the country's productivity and food security status in the long run.

Between 2015 and 2019, Kenya imported an average of 1.7 million tons of wheat and produced average of 266 tons. On average, diseases and pests are likely to destroy 20% or more of potential wheat harvest in the field or in storage. The major diseases caused by obligate pathogens of wheat are stem rust (*Puccinia graminis f.sp. tritici*) and leaf rust (*Puccinia recondita f.sp. tritici*). To control stem rust farmers, use fungicide ingredients to control for leaf rust. Considering that Kenya imports have a huge deficit in wheat production, a potential ban on agrochemicals used to control weeds, pests and diseases will drastically reduce farmer's competitiveness in wheat production. Also, Kenya's wheat imports will likely increase.

Tomatoes are an essential vegetable cash crop for the local market and are grown all year round in various parts of Kenya. The crop plays a critical role in income generation and employment for both rural and urban populations. Tomatoes production in 2019 was 541 thousans tons,

down from 494 thousand tons in 2015. Between 2017 and 2019, Kenya has experienced a surge of imported tomatoes. Despite the numerous commercial benefits of tomatoes farming, the crop is under immense threat from pests and disease, mainly early and late blight (*Alternaria solani & Phytophthora infestans*), *Fusarium wilt*, Nematode complex, and the *Tuta absoluta* (tomato leafminer). In Kenya, farmers have reported yield losses related to pests and diseases of up to 80-100 % per growing season. Farmers use registered fungicide ingredients and insecticides to control these diseases and pests. The proposed ban on agrochemicals will reduce Kenya's potential to produce tomatoes for the population and negatively impact the incomes and livelihoods of farmers. Prohibition of pesticide uses in tomato production is likely to have numerous effects on the value chain. The significant outcomes include a reduction in the local production, increase in imports. Kenyan farmers are likely to lose a competitive edge to farmers in exporting countries such as Tanzania using pesticides.

Rice is the most important cereal crop in Kenya, coming third after maize and wheat. Rice forms a very important diet for the majority of households in Kenya. The demand for rice in Kenya has dramatically increased over the last few years, while production has remained low. Specifically, Kenya produced an average of 114,000 MT of rice between 2015 and 2019. The country experienced the lowest production 81,000 MT in 2017. The main pests & diseases that affect rice include African armyworm, African gall midge, bacterial leaf blight, blast, brown leaf spot, case worm, damping-off diseases, flea beetles, hispid beetles. In addition to rice root-knot nematode, rice sucking bugs, rice whorl maggots and leaf miners, rice yellow mottle virus, spotted stemborer, stalk-eyed shoot flies, storage pests, termites, white tip nematode. In Kenya, rice blast is known to cause approximately 60% -100% yield losses (Kihoro etal 2013). Farmer's inability to use the agrochemicals in controlling the pest, weeds and diseases will significantly affect national rice production. Presently Kenya has a rice production deficit of more than 702 000 MT that is imported. The proposed ban will provide market opportunities for major rice export countries such as Pakistan, Thailand, and India that use agrichemicals that are likely to be outlawed in Kenya.

Potato is a major food staple in Kenya, and the crop contributes to more than 50% of the food and income sources for households in the highlands of Kenya (Okello, Ochieng, & Shulte-Geldermann, 2020). Kenya mainly relies on local production for potatoes. The average five-year Irish potato production was 1.7 million tons, with 2019 recorded the highest production of 2 million tons. However, potato production in Kenya has over the years been constrained by seed-borne diseases, with bacteria wilt being the most devastating and difficult to manage. Presently, there is no single remedy for the disease. Also, aphids, potato tuber, and cyst nematodes attack the crop. The proposed ban on ingredients will significantly affect the potato production that is under attack from bacteria wilt.

The domestic demand for bulb onion outstrips the local supply, resulting in India, Egypt, and Tanzania. Production between 2015 and 2019 averaged 56,000 tons, while in 2018, Kenya imported the highest amount (21,000 tons) of onion. The potential for increasing productivity and attaining self-sufficient levels depends on expanding the area under irrigable agriculture and adopting appropriate pre and post-harvest handling practices to reduce post-harvest losses. However, diseases and pests remain one of the major hindrances in realizing the full potential for the production of onions production. The main pests attacking onion include pink rot, purple blotch, and downey mildew. Also, thrips, mites, cutworms, and aphids cause poor yields in onions. Prohibition in the use of agrochemicals will significantly affect the onion production

sector in Kenya. Also, a potential ban on pesticides used in onion production would affect farmers' incomes and increase imports from countries using pesticides. Also, the possible importation of onions increases the probability of consumers using onions that do not meet the MRL requirement. Presently Kenya lacks regional officers and a monitoring system to oversee proper adherence to MRL standards within the borders.

Table 12: Food production of the main food crop (000s, MT)

		Wheat	Maize	Rice	Potatoes	Pulses	Tomatoes	Onions	Vegetables
2015	Prod.	239	3,824	116	1,960	1,028	494	67	1,856
	Imports	1,430	489	702	5	9	2	0	4
	Exports	6	15	1	2	5	0	0	40
2016	Prod.	222	3,406	102	1,300	991	324	67	1,245
	Imports	1,370	164	803	1	10	1	0	4
	Exports	21	15	1	3	14	0	0	40
2017	Prod.	165	3,186	81	1,500	1,110	284	67	1,204
	Imports	1,861	1,385	991	4	5	22	0	7
	Exports	20	18	2	17	2	0	0	44
2018	Prod.	337	4,014	110	1,898	1,181	595	35	1,962
	Imports	1,841	564	975	2	55	14	21	6
	Exports	6	8	7	2	19	0	0	72
2019	Prod.	366	3,897	161	2,000	1,150	541	43	2,202
	Imports	2,022	258	986	0	49	17	1	5
	Exports	9	4	1	2	17	4	0	108

Source: Authors' elaboration using data from KNBS (2020)

4.4 Economy-wide potential impacts

The alarming increase in the number of outbreaks of transboundary pests and diseases in crops and animals threatened the food security status of Kenya. The pests and diseases risk escalating food security status and may have broad economic, social, and environmental impacts. In part, climate change is also responsible for the upsurge in transboundary plant pests and diseases. It is modifying the dynamics of pest populations, such as locusts, and creating new ecological niches for the emergence or re-emergence and spread of pests and diseases (FAO, 2017). In Kenya, invasive pests species have become a challenge to large and small scale farmers because of the accelerating rate of trade and transport.

In Kenya, pesticides are essential to local farmers to control increasing and new invasive plant, pests, and diseases. However, crop damage caused by insects, pests, diseases creates a more significant economic loss to farmers. Using data and findings from Pratt, Constantine, and Murphy (2017) study, the section will illustrate the economic impact of invasive alien species in Kenya. The estimated economic impact analysis is from published data on the yield losses caused by the five types of invasive alien species that include:

i. *Chilo partellus*, spotted stem borer
ii. Maize Lethal Necrosis Disease (MLND)
iii. *Parthenium* hysterophorus, parthenium
iv. *Liriomyza* spp., L. trifolii, L. huidobrensis and L. sativae, Liriomyza leaf miners
v. *Tuta absoluta*, South American tomato leaf miner

4.4.1 Current average annual economic losses to smallholder agricultural production from individual IAS (Kenya)

Table 13 shows the estimated economic losses farmers are likely to experience from Invasive Alien Species (IAS). Maize farmers are estimated to have losses amounting up to 51 million US dollars from spotted stem root borer, 144.6 million US dollars from Maize Lethal Necrosis Disease (MLND) and 7.7 million US dollars from Parthenium. The leaf-mining flies are estimated to cause bean and pea losses amounting to 64.5 million US dollars. Tomato farmers are likely to have losses ranging from 45.9 million US dollars to 52.4 million US dollars when infested by *tuta absoluta*.

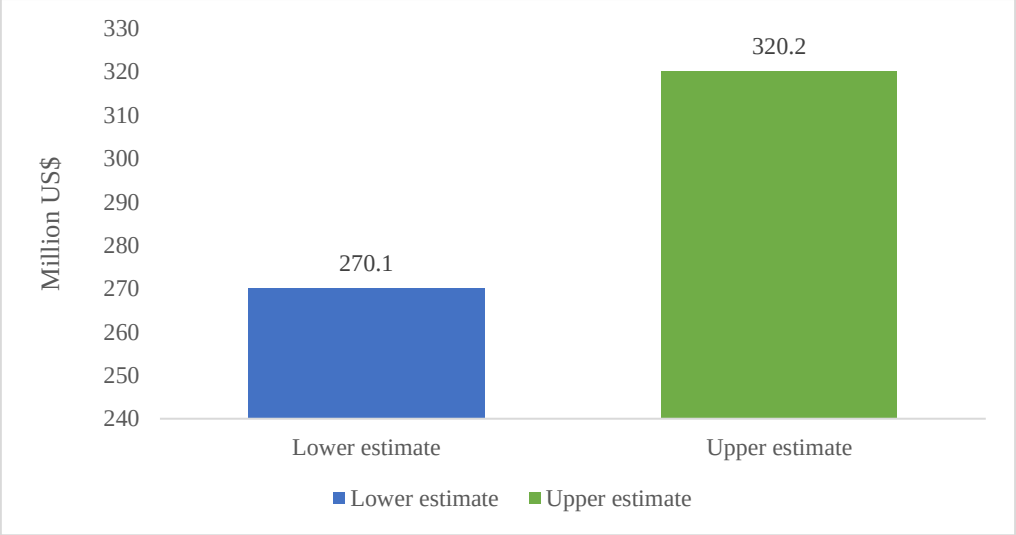
Table 13:Average annual economic losses to smallholder agricultural production from IAS

	Crop affected	Lower estimate	Upper estimate
Chilo partellus, spotted stem root borer	Maize	42.8 million US$	51 million US$
Maize Lethal Necrosis Disease (MLND)	Maize	123.6 million US$	144.6 million US$
Parthenium hysterophorus, Parthenium	Maize	3.8 million US$	7.7 million US$
Liriomyz aspp., leaf-mining flies	Bean and pea (dry/green)	54 million US$	64.5 million US$
Tutabsoluta, tomato leaf-miner	Tomato	45.9 million US$	52.4 million US$

Source: Authors' elaboration using data from Pratt, Constantine, & Murphy, (2017)

Figure 7 shows total annual economic losses to smallholder production from five major IAS in Kenya. Farmers are not able to use pesticide ingredients leading to potential losses of about 270 million US dollars from the major IAS. While on the higher level, Kenya farmers are likely to have losses amounting to 302.2 million US$.

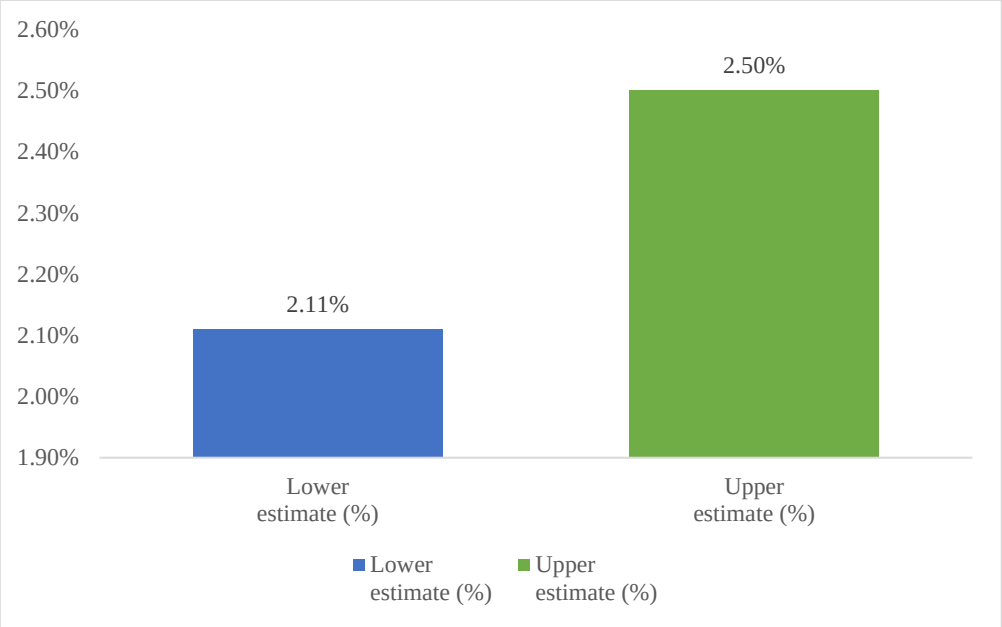
Figure 7:Estimated total annual economic losses to smallholder production from five major IAS (million US$)



Source: Authors' elaboration using data Pratt, Constantine, & Murphy, (2017)

Figure 8 shows the estimated proportion of agricultural GDP Kenya would lose to five major IAS. The data reveal that 2.1% of Kenya's GDP would be lost to IAS from the lower estimate, while on the higher estimate, 2.5% of the GDP would be lost. The analysis implies the proposed ban on pesticide ingredients that mitigate the effects of IAS would result in the significant reduction of Kenya's GDP.

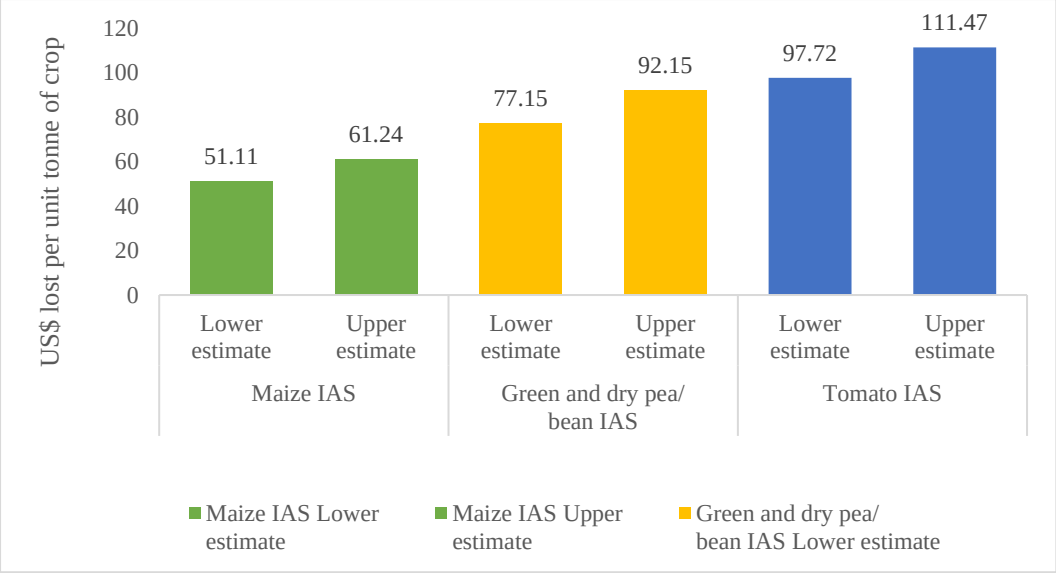
Figure 8: Estimated proportion of agricultural GDP lost to five major IAS



Source: Authors' elaboration using data Pratt, Constantine, & Murphy, (2017)

Figure 9 shows the average annual losses (US$) per unit tonne on gross production of mixed maize crops from IAS. The information presented shows that infestation of IAS on maize would lead to losses ranging from 51.11 to 61.42 (US$) per unit. The beans (dry/ green) invasion by IAS would lead to losses amounting to 77.15 (US$) per unit on the lower estimate and 92.72 (US$) per unit on the higher estimate. The invasion of IAS on tomatoes would impact lead to losses of between 97.72 (US$) and 111.47 (US$) per unit. The proposed banning of pesticide ingredients would significantly affect Kenya's production of key crops.

Figure 9: Average annual losses (US$) per tonne for selected crops.



Source: Authors' elaboration using data Pratt, Constantine, & Murphy, (2017)

Table 14 shows the predicted annual economic losses under the continued range expansion of five IAS in Kenya within 5–10 years. Considering that maize is Kenya's staple food, the data shows that within the timeline of 5 -10 years, Kenya maize farmers are likely to have losses ranging from 34.4 million US dollars and 40.6 million US dollars mainly caused by a spotted stem borer. At the same time, MNLD would lead to the estimated loss of between 140.7 million US dollars and 160.8 million US dollars The leaf-mining flies are likely to lead to beans losses amounting to 61.5 million US dollars and 71.7 million US dollars. Within 5 to 10 years, farmers engaged in tomatoes farming are estimated to have losses of between 59.8million US dollars to 66.5million US dollars from the infestation of *Tuta absoluta*.

Table 14: annual economic losses under the continued range expansion of five IAS in Kenya

	Crop affected	Lower estimate	Upper estimate
Chilo partellus, spotted stem borer	Maize	34.4 million US$	40.6million US$
Maize Lethal Necrosis Disease (MLND)	Maize	140.7million US$	160.8million US$
Parthenium hysterophorus, Parthenium	Maize	19.1million US$	28.7million US$
Liriomyza spp., leaf-mining flies	Bean and pea (dry/ green)	61.5million US$	71.7million US$
Tuta absoluta, tomato leafminer	Tomato	59.8million US$	66.5million US$

Source: Authors' elaboration using data Pratt, Constantine, & Murphy, (2017)

Table 15: Compilation of the impact of pest and disease invasion on the yields of selected crops

Crop	Pest/Disease	% yield losses if not controlled	Ingredients used to control for pests and are recommended for banning
Tomatoes	Tuta absoluta	100%	Imidacloprid, Novaluron,
	African bollworm	70%	Indoxacarb
Potatoes			
	bacterial wilt (BW)	50%	Metalaxyl, Copper Oxychloride
	Late blight (Phytophthora infestans)	60%-100%	Metalaxyl-M and Mancozeb
Maize			
	Fall Army Worm	20%	Acephate
	Stemborers: African maize stalkborer (Busseola fusca)	10-70%	Deltamethrin
	Stemborers: Spotted stemborer (Chilo partellus)	10-70%	Deltamethrin
	Maize streak virus	33 - 55%	Imidacloprid
	Striga weed	20-100%	Imazapyr
	Termites (Microtermes spp., Macrotermes spp., Allodontermes spp., and Odontotermes spp)	25%	Imidacloprid
	Grey leaf spot (Cercospora zeae-maydis	30- 50%	Trifloxystrobin and Tebuconazole
	maize lethal necrosis	50% -90%	Clothianidin
Coffee			
	Coffee berry borer (Hypothenemus hampei)	50 - 100%	Cypermethrin, Chlorpyrifos
	The coffee berry disease (Colletotrichum kahawae)	80%	Difenoconazole, propiconazole
Onion			
	Thrips tabaci Lindeman	60%	Profenofos, Cypermethrin
Rice			
	Rice blast	60% -100%	Thiophanate-methyl
	Rice Yellow Mottle Virus (RYMV) (Sobemovirus)	92%	Trifloxystrobin and Tebuconazole
Wheat			
	Russian wheat aphid (Diuraphis noxia)	25 to 90%	Acetamiprid and Cypermethrin
	Yellow rust (Puccinia striiformis)	30-50%	Azoxystrobin and Cyproconazole

5. Proposals for safe pesticide use

5.1. Policy and regulatory proposals

One of the problems that could be facing pest management strategies in Kenya seems to lie in the weak policy, institutional and legal linkages among the key players include;

Challenges	Possible effects of the policy
Pesticide and contaminant regulations in food vary from continent-to-continent and from country to country, even when those countries form part of a bigger trade block	The recommended pesticide ingredients ban would face technical implementation challenges including; i) Kenya lacks the influence, technical expertise, and appropriate technology to regulate and test for pesticides and contaminants in food outside its jurisdiction. ii) Pesticides ingredients not allowed in Kenya are listed and widely used in major countries (Tanzania, Uganda, Pakistan, South Africa) that export food to Kenya. iii) Kenya's ability to tackle the phenomenon of transboundary plant pests and diseases will be weakened. iv) Without pesticides ingredients, food production in Kenya would drop, and food prices would soar. With lower production and higher prices, farmers would be less competitive in global markets for major export commodities v) Kenya will not be able to prevent or reduce agricultural losses to pests. The use of pesticides has seen improved yields. It thus ensures reliable supplies of agricultural produce at affordable prices to consumers. It improves the quality of the product in terms of cosmetic appeal, which is also important to the buyer. vi) The reduction of pesticide ingrediency use will increase production costs to farmers. Studies have shown that growers of organic vegetables spend significantly more on hand weeding than growers who use herbicides. This explains why organic food is more expensive than conventionally grown food. vii) With pesticide ingrediencies, farmers produce more crops per unit area with less tillage, thus reducing deforestation, conserving natural resources, and curbing soil erosion. Pesticides are also critical for the control of invasive species and noxious weed viii) Crop protection products have helped farmers in Kenya grow two or three crops a year, so much that these some regions in Kenya have the potential to become 'breadbaskets' for the rest of the country. The food surplus benefit people in counties with shorter growing seasons.
Many developing countries exporting food commodities e.g. rice, maize, tomatoes, and Kenya, lack the technical expertise and appropriate technology to regulate and test pesticides and contaminants in food.	
Transboundary plant pests and diseases such as locusts, fruit flies, armyworms are becoming common because of climate change and the increase in global trade. Transboundary plant pests and diseases are major threats to the agricultural-pastoral resources and livelihoods communities	
The majority of farmers in Kenya are categorized as smallholder farmers and therefore grow more food on the same land with the help of pesticides.	

5.2. Alternative products and mechanisms for pest and disease control

Biopesticides

a. Biopesticides are safe crop protection products based on micro-organisms, plant extracts, and other natural compounds and have a range of attractive properties for integrated pest management (IPM).

Facts on Status of Bio Pesticides in Kenya

a) Only 10% of farmers in areas of the Central, Eastern and Rift Valley Provinces use biopesticides.
b) Farmers who did not use bio pesticides presumed them as being ineffective or slow to act, as well as not readily available or too expensive.
c) The farmers reported using chemical pesticides to manage various crop pests – with significantly more men than women using them.

Source: Constantine et al. 2020

b. The majority of the farmers mainly rely on advice from agricultural extension agents or agro vets on pesticides. However, more extensive funded programs on disseminating information should be put in place to tackle the increasing issues of farmers' ignorance on poor handling of pesticides and pesticide wastes. Farmers in rural regions have low compliance levels to waste disposal, handling of pesticide use emergencies, product selection, transportation, and storage requirements.
c. Agricultural extension information should target rural and low-level educated farmers to reduce spraying neonicotinoid on crops pollinated by bees in the early evening when bees are in their hives. Also, coordination strategies warning beekeepers of spray events so that they may protect/relocate hives should be recommended. In comparison, the use of neonicotinoid should be discouraged when the crops are flowering. All of the seed treatment pesticides, including the neonicotinoids, are safer in the environment when covered by soil. Therefore, farmers need proper planting techniques, training, and monitoring strategies.
d. The Horticultural Crops Directorate (HCD), with support from USAID Kenya Agricultural Value Chain Enterprises (KAVES) program, established the National horticulture traceability system. The system's objective was to help farmers in Kenya know utilization relating to how best to handle fresh produce in Kenya. The HTS has been fitted with a module that enables the horticultural crops directorate (HCD) to monitor and regulate the supply chain players (farmers, consolidators, markets etc.). A lot of investment will be required to extend the programs and popularize National Horticulture Traceability System to more farmers in Kenya. Currently, the program is not known by the majority of smallholder farmers in Kenya.

6. Petition put against EUs Pesticides Regulations in the WTO

6.1 Details on Petition Led by India'

Petition Raised by	In October 2010, India challenged three EU's notifications on the adoption of Maximum Residue Limits (MRLs) for certain pesticides.
Supported by	Argentina; Brazil; Pakistan; Thailand
Keys issues raised and timelines 2010 to 2020	Summary of Issues raised •India was concerned that the MRLs for a number of chemicals were set at the "limit of detection" (LOD). This was the residue limit that could be detected using analytical methods/testing procedures available in Europe. •The petition argued that different climatic conditions require different use of pesticides in agricultural production. •No scientific evidence had been provided to justify the setting of the MRL at the LOD, especially for imported products. •For some substances, the MRLs in EU cereals was much higher than the approved level of the same substance in rice. •The setting of MRLs at the LOD had impacted India's exports of agricultural products to the European Union, and India requested the European Union to provide the validated testing methods it used to arrive at the LOD as well as the scientific basis and risk assessment for the MRLs •India raised the issue that no member should set MRLs without scientific justification, as doing so violated the SPS Agreement •India requested the European Union to provide scientific justification for fixing any MRLs at the Level of Determination (LoD) for pesticides such as Carbendazim • In October 2013, India raised concern over EU MRLs of pesticides claiming that the EU MRLs for imported foods and agricultural products did not follow international standards and had no scientific basis and were in contravention of the SPS Agreement. •India requested that the European Union provide scientific justification for its MRLs and adjust those not scientifically justified levels. India also requested an update concerning tricyclazole. •Argentina shared India's concerns and highlighted the work undertaken by Codex on pesticides. There was a need to base new MRLs on Codex standards. •The establishment of MRLs of pesticides without a scientific basis was in contradiction to the SPS Agreement and has become an unnecessary restriction on trade, damaging agricultural exporting countries
Current status to the issues raised	Not solved

Source:World Trade Organization (2021)

6.2 Details on Petition Led by the United States of America

Petition Raised	Argentina, Dominican Republic; Ecuador; Guatemala; India; Panama; Paraguay; United States of America
Supported by	Australia; Benin; Brazil; Burkina Faso; Brundi;Canada; Central African Republic; Chile; Colombia; Costa Rica; Egypt; El Salvador; The Gambia; Ghana; Guinea; Honduras; Indonesia; Jamaica; Kenya; Korea, Republic of; Madagascar; Malaysia; Mexico; New Zealand; Nigeria; Pakistan; Peru; Philippines; Senegal; Sierra Leone; South Africa; Chinese Taipei; Thailand; Togo; Uruguay; Viet Nam; Zambia
Timeline 2015-2020	**Summary of Key issues Raised** • Banning chemicals and pesticides solely based on endocrine-disrupting properties might incentivize the use of more dangerous products. They mainly do not present endocrine-disrupting properties adopt an approach that fully considered the vital role of pesticide chemicals in food safety and security. • The United States questioned the scientific evidence underlying the options and the consideration of any hazard-based "cut off" option instead of risk from actual exposure • The European Union to share information on the methodology used in developing EU member States' impact assessments. The United States requested that the European Union recognize risk-based endocrine programmes designed by other countries • Actions should be taken on a case-by-case basis and based on solid scientific evidence after appropriate risk assessment. • Special attention should be given to minimizing adverse impacts on international trade, especially on trade in agricultural products and minimizing socioeconomic losses in commodity-producing countries, particularly developing countries. • "Hazard-based cut-off criteria" approach of the regulation would disrupt international trade without providing a meaningful benefit to public health. Further this approach would not include a risk assessment and has left open the scope for the interpretation of "negligible risk" and other terms, which would result in a lack of clarity in its implementation. • Kenya referred to its tropical location and the consequences of removing currently used chemicals on food security for an ever-increasing population. While acknowledging that the European Union had been providing updates, Kenya asked that the length of the process required to authorize new molecules to be considered, among other issues. • There was still a lack of conclusive scientific evidence to restrict the use of chemicals that disrupt the endocrine system and expressed concern about how the European Union would move forward with its regulations on endocrine disruptors. • Lack of clarity around the process of requesting import tolerances and the cost for developing countries to provide the data required for import tolerance requests. • Guatemala expressed the concern that the EU measure was hazard-based as opposed to risk-based. According to its commitments under the SPS Agreement, Guatemala invited the European Union to adopt a risk assessment approach to determine and regulate endocrine disruptors, applying criteria supported by adequate scientific data. • Panama recalled that this concern had been on the agenda for more than two years. The measures could carry serious consequences, especially for the farmers, the most vulnerable populations in developing countries. Panama invited the European Union to provide conclusive risk analyses and not to take hazard-based decisions. • Paraguay reiterated its concern that the EU measure could affect a high volume of its exports, with the economic implications for a developing country. • Panama requested that the European Union adopt levels of protection that did not restrict trade more than necessary, adopt the Codex standards, and, where this was

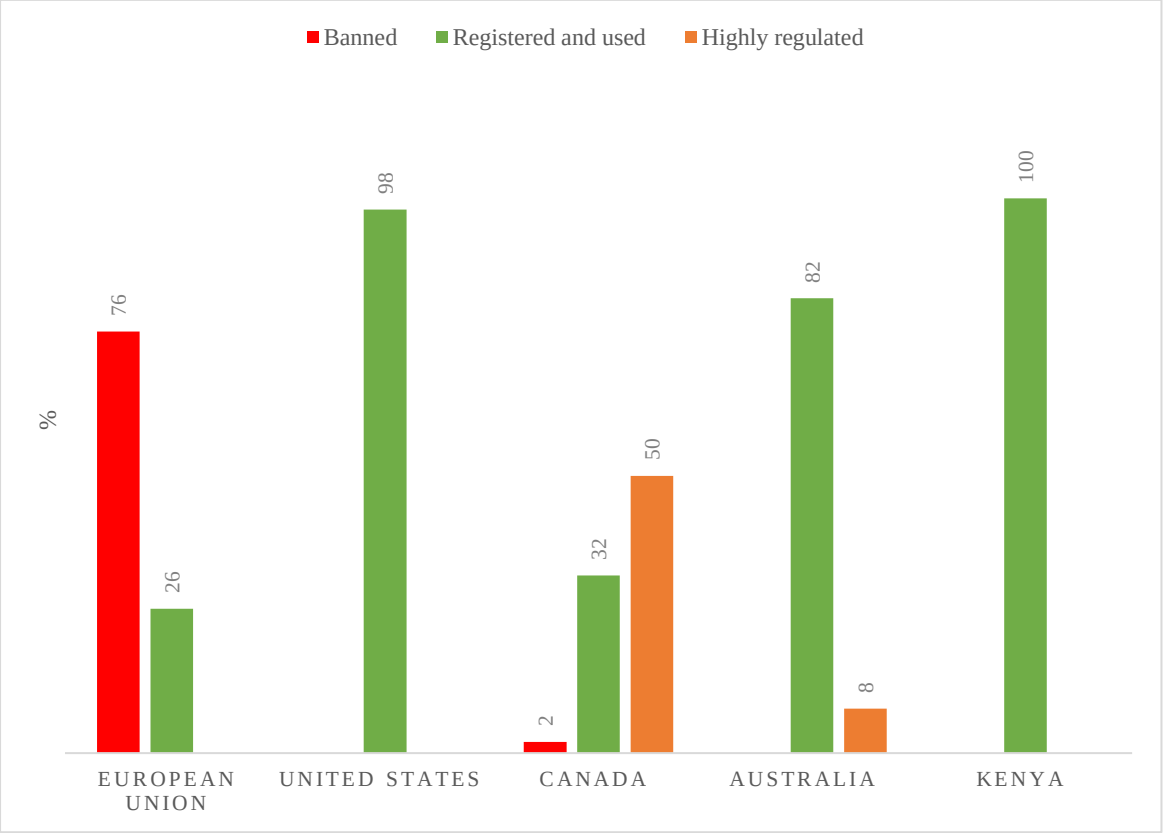
	not possible, provide conclusive scientific evidence and ensure tolerance to importations. • Ecuador reiterated its concern and requested that the European Union base its measures on the SPS Agreement without disguised restrictions on trade. • Ecuador considered that the classification criteria for endocrine disruptors could be a good starting point to characterize the toxicity of a chemical substance, especially for pesticides, but it was important to consider in vivo, in vitro, and in silico trials. • Ecuador noted that these criteria would also need to consider scientific evidence based on animal testing and epidemiological analyses of exposed populations to avoid assuming the existence of adverse effects. • The EU Regulation did not consider the definition of MRLs to ensure minimum risk under specific exposure conditions and whereby appropriate levels of protection were established. Ecuador highlighted the importance of using the three pillars of risk analysis - namely risk assessment, management, and communication -for decision-making. • Finally, Ecuador invited the European Union to revise its criteria using the risk analysis principle and develop a methodological tool to determine the actual adverse effects on human health based on real scenarios. • Brazil reiterated its concern and mentioned that an analysis carried out in a precautionary manner could result in the identification of active endocrine compounds not relevant to health • The European Union has therefore been unable to demonstrate a level of objective risk. The petitioners were particularly concerned about the measures introduced and their impact on trade and exports. • They urged the European Union to reduce the adverse effects on international trade, taking Members' concerns and comments into consideration to avoid imposing unnecessarily trade-restrictive measures.

Source: World Trade Organization (2021)

6.3 Used in the USA, Australia, Canada and Banned in the EU

Figure 10 presents a comparative analysis of pesticide ingredients listed in Kenya and the United States, Canada, Australia, and the European Union. The analysis sampled the list of active ingredients recommended for be withdrawn from the Kenya market. From the sampled pesticides, we noted that 76 % of the pesticides banned in the European Union were registered for use in the United States (98%), and Australia 82 %. Only 26 percent of ingredients registered in the European Union were reported in Kenya. In Canada, 50% of the pesticides were registered but used very strictly based on state laws.

Figure 10: Comparison of Pesticides between Countries



Source: Data compiled from PCPB, EPA, APVMA, PAN Europe, PMRA, 2021

Table 16: Agricultural pesticides ingredients used in the USA and banned in the EU,

	EU	USA	Canada	Australia	Kenya
Chlorothalonil *(20)					
Clodinafop (3)					
Fenchlorazole*(1)					
Oxyfluorfen (10)					
Permethrin					
Pymetrozine*(2)					
1,3-DichloroUSRopene*(3)					
Carbendazim *(17)					
Dichlorvos*(1)					
Thiophanate-methyl (7)					
Trichlorfon*(1)					
Acephate*(8)					
Bifenthrin (10)					
Carbaryl*(2)					
Carbofuran*(1)					
Deltamethrin (13)					
Fenitrothion*(3)					
Flubendiamide (2)					
Flufenoxuron*(1					
Omethoate*(1)					
Permethrin*(6)					
ThiacloUSRid (1)					
Abamectin (40)					
Carbendazim*(17)					
Carbofuran*(1)					
Chlorothalonil* (20)					
Chlorpyrifos (24)					
Gamma-cyhalotrin (1)					
Glufosinate-ammonium*(1)					
ImidacloUSRid*(42)					
Mancozeb (78)					
Oxydemeton-methyl*(2)					
Permethrin*(6)					
Tebuconazole (29)					
ThiacloUSRid (1)					
2,4 D-Amine (13)					
Abamectin (40)					
Acephate*(8)					
Chlorpyrifos (24)					
Dichlorvos*(1)					

Gamma					
cyhalothrin (1)					
Glufosinate					
ammonium*(1)					
Oxydemethonmethyl*(2)					
Malathion (17)					
Permethrin*(6)					
ThiacloUSRid (1)					
Trichlorfon*(1)					
2,4-D-Amine (13)					

Data compiled from PCPB, EPA, APVMA, PAN Europe, PMRA, 2021

Key Guide

Banned	
Registered	
Highly regulated based on regions	
Not found in the data base	
(number) number of products containing the active ingredient	

7.0 Case Study Interviews

7.1 Farmers Interviews

Interviews were carried out to establish farmer's association's views on agrochemicals use in farming. The majority of the farmer's representatives acknowledged that pests and disease invasion had been major factors contributing to low farm productivity in Kenya.

a) Farmer's associations we interviewed noted that herbicides played an essential role in controlling weeds in the production of crops such as maize and wheat. Also, the associations pointed out that manual weeding is no longer sustainable because of high labor costs. However, the farmers association heads recommended more farmer's training on judicious use of herbicides to control weeds to increase productivity. Studies recommend using post-emergence herbicides to kill weeds before land preparation and planting (Sivamurugan et al. 2017). Previous studies focus on the efficacy of post-emergence herbicides report suggest that the use of herbicides would likely increase gross margins of maize by roughly a third. In Germany, a study assessing glyphosate's economic impact on weed management reports ban would result in losses of up to € 10/ha (Böcker, Britz , & Finger, 2018).

b) The majority of the farmers association representatives acknowledged that more resources should focus on creating awareness of pesticides' safe use than banning pesticides. Specifically, farmers who deal with maize production noted that stemborers are major pests that affect production in Kenya and neighboring countries. While stem stemborers can be managed biologically, culturally, and host plant resistance options De Groote, Overholt et al, (2011), Chemical control methods seem to be the most effective and recommended by national agricultural extension agencies. The use of insecticide is mainly recommended because of the effectiveness and ease of application by smallholder farmers.

c) In the study interviews, farmer's representatives reported that Kenya is presently infested with transboundary plant pests such as desert locusts, armyworms, and fruit flies that pose a more significant threat to agricultural and pastoral resources livelihoods. Also, crop diseases, mainly rust diseases in wheat, coffee, and soybean, wilt diseases in bananas, and viral cassava diseases, affect productivity. The only best strategy available to tackle the diseases and the pest has been conventional pesticides since the biological methods are not effective. According to FAO (2017) globally, the impacts of transboundary plant pests and diseases on crop production would be estimated to be between 20 to 40 percent of production. While in terms of economic value, plant diseases cost the global economy nearly US$220 billion per annum and invasive insects around US$70 billion (Bradshaw *et al*., 2016).

d) From the interviews, farmers' representatives acknowledged that there are outright social and economic benefits of using pesticides. The most direct benefit farmers gained was the reduction in production inputs such as labour and fuel and the protection of commodity yield and quality. Prior studies estimate that global losses from pests for eight crops in some regions showed that pest-induced losses were more than 50% of attainable crop output (FAO, 2017). Insects destroyed 15% of crops, disease pathogens, weeds 13% each, and post-harvest pest infestations another 10%. This implies that

without pesticides, food production would drop, and food prices would soar. With lower production and higher prices, farmers would be less competitive in global markets for major commodities (Paini, Sheppard et al 2016).

e) Farmers representatives in the horticultural sector noted that in the sector required a specialized extension approach due to its dynamism and industry needs. As a result of inadequate extension services, smallholder farmers producing for the local market lack the requisite knowledge and skills to use pesticides effectively. There is inadequate extension personnel to reach all industry stakeholders and exacerbated by scattered producers who are not organized into associations to enhance pesticide use training. The lack of harmonized operational programmes by all extension providers has led to poor service delivery and non-standardization of extension messages affecting the safe use of pesticides.
f) Farmers noted that pesticides had increased crop protection levels; therefore, some farmers would grow crops two or three crops a year. This has enabled countries to become 'breadbaskets' for the rest of the country. After the crop harvest, farmers were subject to attack by pests, bugs, molds, and rodents can harm precious grains. But pesticides are presently used to prolong the viable life of the produce, prevent huge post-harvest losses from pests and diseases, and protect the grain, so it is safe to eat.
g) Farmers reported that banning pesticides would affect food production, and food prices would soar. With lower production and higher prices, Kenyan farmers would be less competitive in global markets for major commodities. The use of pesticides cautions farmers against agricultural losses to pests. The use of pesticides improves yields and thus ensures reliable supplies of agricultural produce at affordable prices to consumers and improves the quality of the product in terms of cosmetic appeal, which is also essential to the buyer.

7.2 Current Status of labelling and Pesticide packaging

The interview with key informants to provide information on Kenya's current status on the use of pesticides provided the following highlights.

a) All the farmers' representatives agreed that pesticide has increasingly become common among farmers who grow crops for commercial purposes, either targeting export or local markets. Specifically, the respondents noted that most Kenya farmers most often use the same pesticides for similar problems across various crops. The overriding factor is the pest or disease at hand. Farmers tend to have regional preferences in pesticide brands used; this is mainly attributed to previous experience, product sales support, cost, and reliable supply, among other issues.
b) All the respondents reported that pesticides from the manufacturers are available in various quantities in Kenya. This strategy mainly targets small-scale farmers of packaging pesticides in small plastic or paper packs weighing between 100gms/mls and1kg/ltr depending on the dosage rates.
c) Small quantities packaging is preferred by small-scale farmers who own small size of land. Also, farmers are most likely to afford the smaller pack in comparison to the bulkier packaging. The small-sized packaged pesticide is easy to access at the local agro

vets for direct use on their farms, most probably when the farmer purchases other items from a shopping center.

7.3 Personal protective Equipmentmen (PPE) and Application Equipment

a) The respondents agreed that in Kenya, the availability PPEs and spray equipment/machinery has become available over the last 10 years. The availability is widespread in urban towns agro vets shops with a high level of agricultural activity.
b) Items such as overalls, gumboots, gloves, and basic respirators are found in supermarkets as well. At the same time, spray application equipment is available largely depending on the type of equipment. Knapsack (15 to 20 litter capacity) and handheld (5 to 10 litter capacity) sprayers are readily available.
c) Personal protective Equipmentmen (PPE) are not strongly promoted in public forums; therefore, some farmers search for PPE.
d) Most small-scale farmers usually do their own spray applications but increasingly, farmers are using contracted spray operators for a group of farmers in cooperative societies. The strategy is a better method as the farmers can share resources while minimizing personal risk.

7.4 Used pesticide containers disposal

a) Generally, most of the respondents noted that farmers are likely to be aware that pesticides are dangerous but have little knowledge about different pesticides' different toxicity levels. Most of the small-scale farmers use small quantities of pesticides and are likely to overlook the impact of poor pesticide waste disposal practices on the environment.
b) The most common pesticide wastes include used pesticide containers/packages, reinstate from used containers and measuring cylinders, washings of application equipment, accidental spills, worn out PPE, and spray application equipment.

7.5 Pesticide Knowledge and Awareness

a) From the interviews, we found that smallholders widely use chemical pesticides in Kenya despite the awareness of the risks to human health and the environment. This was an observation also shared by Kate, Constantine, Monica et al. (2020).
b) In Kenya, farmers have a higher preference for chemical pesticides over bio-pesticides because of effectiveness, speed of action, the spectrum of activity, availability, and affordability.
c) Small-scale farmers have significant awareness of pesticides' usefulness in Kenya. Commercial farmers growing for both local and export are aware of the associated risks, safety requirements, and application-related issues. However, subsistence growing farmers had low awareness of pesticides usefulness, associated risks, safety requirements, and application-related issues among farmers growing crops for subsistence.
d) The majority of the farmers mainly relied on advice from agricultural extension agents or agro vets on pesticides. Simultaneously, they are increasing cross-cutting issues of farmer's ignorance on poor handling of pesticides and pesticide wastes.

e) Most of Kenya's farmers have low compliance levels to waste disposal, handling pesticide use emergencies, product selection, transportation, and storage requirements.
f) Pesticides have been considered threats to bees; mainly, honeybees contribute significantly to the pollination of many crops, thus playing a key role in agricultural productivity. Farmers are advised to reduce spraying neonicotinoids on crops pollinated by bees in the early evening when bees are in their hives (MoALF&C, 2018).
g) Also, coordination strategies warning beekeepers of spray events to protect/relocate hives is recommended. The use of neonicotinoids is discouraged when the crops are flowering. All of the seed treatment pesticides, including the neonicotinoids, are safer in the environment when covered by soil. Therefore, farmers need proper planting techniques, training, and monitoring strategies.

7.6 Traceability systems in Kenya

There are three traceability Systems that are found to be commercially available in Kenya. This includes ePROD, farm force, and the National Horticulture Traceability System. From the interviews, the following observations were made;

a) The traceability systems worked best for large-scale farmers and farmer groups. Farms that used the traceability system in the value chain aimed to improve efficiency and operations and offer safer and higher-quality products for the export market.
b) Presently, the traceability systems in Kenya has not been tested sufficiently and have not been fully implemented in most of the commodity value chains supplying the domestic market. The traceability systems are well implemented in the export. The main challenge is the high cost of acquisition, and implementation is extremely challenging and unrewarding for smallholder farmers with no knowledge of the supply chain.
c) Compliance with food quality and safety issues plays an essential role in Kenya's export market. Specifically, Kenya's horticultural exports have been affected mainly because of noncompliance with phytosanitary standards. Thus, a traceability system would improve compliance.
d) Traceability systems are currently being implemented in the Kenyan horticulture sector, even though most of the smallholder producers do not realize that they exist or even understand the importance of traceability implementation.
e) In Kenya, implementing traceability is mainly attributed to good organization and funding personnel training and farmers' awareness of food safety management.
f) Farmers in Kenya cannot effectively use traceability systems such as proper documentation (record keeping), compliance strategies to quality management standards. Therefore, farmers need capacity building on food quality & safety, traceability management, and proper monitoring.

8. Conclusion and Recommendation

There are no standards for food sold in the domestic market, unlike exported commodities subjected to standards such as GLOBAL GAP and KENYA GAP. The domestic food supply is mainly informal and unregulated. This is a key weakness that can lead to harmful food being sold locally. Anecdotal evidence shows that rejected export food commodities are diverted to the local markets. In addition, the country's capacity to test for food safety for imported food commodities is weak. The regional food markets within the East African Community (EAC) are largely informal, making it difficult to monitor food coming into the country.

The development of biopesticides is still in its infancy stages despite the assumptions that biopesticides may replace some of the banned chemicals no biopesticides can effectively substitute existing pesticides in fighting some pests and diseases. Therefore, Kenya's arbitrary banning of pesticides will negatively affect farmer's ability to manage will pests and diseases, consequently high food production costs and food insecurity challenges

Following the devolution of functions, the extension system collapsed. This cut off the critical pathway to provide farmers with skill and knowledge on pesticide use and disposal. At present, individual companies and AAK provide training and extension services through field days and exhibitions.

The lack of a monitoring system for humans, wildlife, and the environment is a key gap for regulation. The lack of investment in research affects monitoring and constrains the discovery or development of alternative means for pest and disease control, such as biopesticides. There exists low funding with regards to extension agencies that should provide proper pesticide knowledge to farmers. The government agencies are likely to be competent, unbiased people.

Kenya government agencies responsible for protecting human health and promoting a non-toxic environment should endeavor to develop homegrown sound scientific criteria when deciding the regulatory decisions on the pesticides to be used in the country. The evaluation process will focus on the impact of pesticides on the food security status of Kenya, the health and environmental risks.

There is a need for intensive farmers to identify illicit counterfeit pesticides and develop a working monitoring system to control illicit counterfeit pesticides in the market. This will limit the elimination of non-target species' effects altogether. To protect biodiversity, mitigation measures might include training farmers and imposing certain pesticides or prescribing use only at a specific time.

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Annexes: GDP Estimation

The data in Table A1 below shows the most common pest and disease frequently attack crops in Kenya. Also, the table's data shows the average losses expected from the selected crop when agrochemicals are not used to control for pests and disease.

Table A1: Looses to pest and diseases from selected crops

Crop	Type of Pest/Disease	Percentage average yield losses when pesticides are not controlled
Tomatoes		85%
	Tuta absoluta	
	African bollworm	
Potatoes		65%
	bacterial wilt (BW)	
	late blight (Phytophthora infestans)	
Maize		43.2%
	Corn earworm (Helicoverpa armigera)	
	Fall Army Worm	
	Stemborers: African maize stalkborer (Busseola fusca)	
	Stemborers: Spotted stemborer (Chilo partellus)	
	Maize streak virus	
	Striga weed	
	Termites (Microtermes spp., Macrotermes spp., Allodontermes spp., and Odontotermes spp)	
	Grey leaf spot (Cercospora zeae-maydis	
	Maize lethal necrosis	
Coffee		75%
	Coffee berry borer (Hypothenemus hampei)	
	The coffee berry disease (Colletotrichum kahawae)	
Onion		60%
	Thrips tabaci Lindeman	
Rice		86%
	Rice blast	49%
	Rice Yellow Mottle Virus (RYMV) (Sobemovirus)	
Wheat		
	Russian wheat aphid (Diuraphis noxia)	
	yellow rust (Puccinia striiformis)	
Cut roses		45%
	Armored scale insect	
	Thrips	
	Black spot	
	Crown gall	

Using data in Table A1 on average yield losses when pesticides are not controlled, we estimate the expected losses of selected crops using 2018 data from Kenya National Bureau of Statistics

Economic survey 2020. The data presented in Table A2 indicate that in a scenario where Kenyan farmers cannot access relevant pesticides, they are likely to have significant losses. Specifically, maize which is Kenya's staple food, is expected to lose 1.7 miollion tons. At the same time, wheat production is expected to losses of thousand tons. Cut roses, a significant export product in Kenya, are expected to lose up to 72 thousand tons.

Table A2: Losses from the selected crop

	Losses if no pest was used controlled (1000s MT)
Wheat	163.445
Maize	1,734.048
Tomatoes	505.75
Potatoes	1233.7
Onion	21
Coffee	31.5
Rice	94.6
Cut roses	72.943

Source: Authors' elaboration using data from Kenya Kenya National Bureau of Statistics 2020

Using 2018 data from marketed agricultural production at current prices, we estimate earnings from the selected crops. The data presented to estimate the potential loss of agricultural GDP when pests and diseases are not controlled. Kenya is likely to lose 4% of GDP, when pests and diseases are not controlled in maize production. Flower export is one of the sectors considered as Kenya foreign exchange-earners; however, when pests and diseases are not owned, 4.5% of Kenya's agricultural GDP will be impacted.

Table A3: Actual Loss of Gross Domestic Product by Selected Crop

	Loss million US$	Estimated loss of GDP to Agriculture Contribution (%)
Wheat	3.512	0.4
Maize	355.5	4.049
Potatoes	105.36	1.2
Coffee	526.8	6
Cut roses	395.1	4.5
Total	1386.27	16.149

Source: Authors' elaboration using data from Kenya National Bureau of Statistics 2020