TOXIC BUSINESS

HIGHLY HAZARDOUS PESTICIDES IN KENYA

September 2023

ROUTE TO FOOD

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LIST OF ABBREVIATIONS

AAK	Agrochemical Association of Kenya
EPA	Environmental Protection Agency
ETP	Environmental Toxicity Potential
EU	European Union
FAO	Food and Agriculture Organization
GAP	Good Agricultural Practices
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
GUS	Groundwater Ubiquity Score
HTP	Human Toxicity Potential
HHPs	Highly Hazardous Pesticides
KEPHIS	Kenya Plant Health Inspectorate Service
KNH	Kenyatta National Hospital
IPM	Integrated Pest Management
LMICs	Low- and middle-income countries
MRLs	Maximum Residue Levels
PAN	Pesticide Action Network
PCPB	Pest Control Products Board
RTFI	Route to Food Initiative
SAICM	Strategic Approach to International Chemicals Management
UN	United Nations
UNEP	United Nations Environment Programme
U.S.	United States
WHO	World Health Organization
WTP	Weighted Hazard Potential

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EXECUTIVE SUMMARY

The pesticide market in Kenya has experienced significant growth, leading to concerns about the harmful effects of registered pesticides on human health and the environment. Pesticide residues exceeding limits have been found in Kenyan food, particularly in tomatoes and kale. Limited progress in implementing stricter regulations and phasing out toxic pesticides has raised concerns about food safety and environmental impact.

Accurate usage data is crucial to support the phasing out of Highly Hazardous Pesticides (HHPs) in Kenya. However, official data on national pesticide use is not publicly available. To address this gap, the Route to Food Initiative (RTFI), a programme of the Heinrich Böll Foundation in Kenya, obtained a pesticide dataset from a private market research company. The analysis focuses on Highly Hazardous Pesticides (HHPs) and provides insights into the most commonly used and most toxic pesticides, as well as the crops and companies involved. This data underscores the need for immediate regulatory attention to prioritize substances that pose risks to the environment and human health.

GENERAL INFORMATION ON PESTICIDE USE

An analysis of the data revealed that during the reporting period of 2020 farmers in Kenya used a total of 310 pesticide products containing 151 active ingredients. They applied a total volume of 3,068 tonnes of pesticide products to control insects, diseases, and weeds on 26 different crops. Farmers spent all in all $72.7 million on the purchase of pesticide products, with $28.2 million on insecticides (led by chlorpyrifos, flubendiamide, and imidacloprid), $26.4 million on herbicides (led by glyphosate and paraquat), and $18.1 million on fungicides (led by mancozeb).

Out of the 310 pesticide products used, 195 products (63%) containing one or two active ingredients that are categorized as HHPs, accounting for 76% of the total volume of pesticides used. This indicates that farmers in Kenya predominantly use HHPs, despite their known detrimental effects on human health and the environment. Notably, almost half (44%) of the total volume of pesticides used in Kenya are already banned in Europe due to their unacceptable risk to human health and the environment.

PRODUCT USE

Among the top 30 pesticide products in terms of volume, the majority are highly hazardous pesticides (HHPs) as well.

The top five widely used insecticides in Kenya are Marshal (carbosulfan), Thunder (beta- cyfluthrin + imidacloprid), Belt (flubendiamide), Occasion-Star (emamectin benzoate + indoxacarb), and Dursban (chlorpyrifos). These highly hazardous insecticides cover an area of 635,350 hectares, which accounts for 21% of the total pesticide-treated area.

The most heavily applied herbicides include Kalach, Touchdown Forte, Dryweed, Roundup Turbo (containing glyphosate), Herbstar, Gramoxone (containing paraquat), Lumax (containing mesotrione), HY-2.4-D, 2.4-D-Max, and Agromine (containing 2.4 D-amine). Paraquat and 2.4 D-amine are both banned in Europe. The most widely used fungicides are Ridomil-Gold (mancozeb/-metalaxyl-M), Nordox-Super (copper-oxide), and Milthane (containing mancozeb). Insecticidal products are generally applied in lower volumes due to their higher toxicity. Among them, Dursban (containing chlorpyrifos), which is banned in Europe, has the highest volume.

BRANDOWNERS

A total of 73 different companies serve as brandowners for the products used in Kenya. Syngenta leads the pesticides market with a 20% market share, followed by Bayer AG with 15%, Corteva Agriscience™ (agriculture division of DowDuPont™) with 7.7%, FMC Corporation with 5.7%, and Adama Agricultural Solutions with 4.4%.

Syngenta, headquartered in Switzerland, sells 40 products with the highest volume of pesticides in Kenya (544 t), of which 68% are HHPs. The top three products in terms of volume contain glyphosate, paraquat (banned in Europe), metalaxyl and mancozeb (banned in the EU).

Bayer AG, a German company, sells 39 products with a total volume of 286 t, of which 84% are HHPs. Their top-selling product in terms of volume contains glyphosate, while the top- selling product in terms of value is the insecticide Thunder, containing beta-cyfluthrin and imidacloprid (both banned in the EU).

CROPS

Maize, wheat, coffee, potatoes, and tomatoes in Kenya require the largest volumes of pesticides, with a heavy reliance on Highly Hazardous Pesticides. In maize and wheat production, herbicides such as 2.4-D, S-metolachlor, glyphosate, atrazine, and paraquat are primarily used. However, the insecticide chlorpyrifos is also applied in high volumes. Coffee production uses high volumes of highly hazardous insecticides (chlorpyrifos, diazinon, omethoate, and thiophanate), fungicides (chlorothalonil), and herbicides (glyphosate, atrazine). Potatoes and tomatoes also heavily depend on HHPs, with mancozeb being a widely used fungicide. Mancozeb is banned in the EU and has been linked to cancer. Tomato production also involves the use of a variety of highly hazardous insecticides (e.g., diazinon, thiamethoxam).

BIOPESTICIDES

Out of the 310 pesticide products used, only six are biopesticides, which are primarily used for insect pest control, and one biopesticide (Trianum-P), which is used to combat fungal diseases like Fusarium. Sustainable biopesticides account for a mere 2% (47.3 t) of the total pesticide volume used in Kenya, while Highly Hazardous Pesticides (HHPs) account for 76% (2353 t). HHPs like Marshal, Thunder, and Dursban are priced lower per hectare compared to the biopesticide like Achook. Most of these biopesticide products are used on beans, a significant export crop to Europe.

ACTIVE INGREDIENTS OF CONCERN

Based on their potential human health toxicity, considering factors such as carcinogenicity, reproductive toxicity, endocrine disrupting activity, mutagenicity, and neurotoxicity, several active ingredients require urgent regulatory measures. The most toxic and most commonly used ingredients are the insecticide chlorpyrifos, the herbicides acetochlor, glyphosate, and 2.4-D, and the fungicides mancozeb and chlorothalonil. Considering their environmental toxicity and widespread usage, immediate regulatory action is required for the insecticides chlorpyrifos and imidacloprid, the fungicide mancozeb, and the herbicides glyphosate, atrazine, and 2.4-D.

Additionally, even if some insecticides have low application volumes, it is crucial to regulate and withdraw these substances due to their demonstrated high levels of human or environmental toxicity. Notably, bifenthrin, dichlorvos, diazinon, carbaryl, fipronil, thiamethoxam, and carbendazim have already been banned in Europe, highlighting the urgent need for regulatory measures. The priority list provided in the report can guide the implementation of immediate actions and phase-out strategies for these active ingredients.

RECOMMENDATIONS

To achieve sustainable agriculture and uphold the right to healthy food and a healthy environment, the following actions are crucial:

- Phase out Highly Hazardous Products: Gradually eliminate the use of products containing harmful ingredients that jeopardize human health and the environment, following the prioritized list.

- Implement Integrated Pest Management (IPM) Strategies: Prioritize the adoption of IPM strategies, especially for crops like maize, wheat, coffee, potatoes, and tomatoes. These strategies combine various pest control methods, including biological controls, crop rotation, and cultural practices, reducing reliance on synthetic pesticides.

- Promote Access to Knowledge and Information: Ensure that farmers, including women, extension officers, and Agrovet shop owners, have access to relevant information and knowledge for making informed decisions about sustainable agricultural practices, including pest and disease management.

- Invest in Research on Biopesticides and Biocontrol Methods: Support research efforts to develop and promote biopesticides and biocontrol methods as alternatives to HHPs. Emphasize the registration process for biopesticides, giving them appropriate attention compared to hazardous pesticides.

- Ensure Affordability of Biopesticides: Make biopesticides affordable for all farmers, regardless of whether they export their products to Europe or not. This will encourage the widespread adoption of sustainable pest management practices, benefiting small-scale farmers.

- Address Corporate Accountability: Governments should hold agrochemical companies accountable by regulating and monitoring their activities, promoting transparency, and encouraging responsible practices that prioritize human health, environmental protection, and sustainable agriculture.

By taking these actions, we can promote a transformation towards sustainable agriculture, embracing agroecology principles while safeguarding the right to healthy food and a healthy environment.

INTRODUCTION

Pesticides have been one of the main tools used for pest management worldwide. Today, global pesticide consumption amounts to more than 4 million tonnes per year[1] and is still on the rise. The use of pesticides, especially cases of overuse and misuse, results in significant negative impacts to health and the environment, including poisoning incidents and suicides, chronic diseases like cancers, and severe contamination of food, water and soil.

Pesticides are inherently hazardous, and among them, several Highly Hazardous Pesticides (HHPs) cause disproportionate harm to the environment and human health. According to the Food and Agriculture Organization (FAO) and the World Health Organization (WHO), HHPs are a class of pesticides acknowledged to present high levels of acute or chronic hazards to human health and the environment[2]. In addition, pesticides that appear to cause severe or irreversible harm under conditions of use in a country may be treated as highly hazardous. The WHO has assigned HHPs to Class 1b out of five categories of hazard classification (Table 1). The classification system used by the WHO is consistent with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) and applies various criteria for classification based on the toxicity of a technical compound and its formulations[3].

Table 1. WHO recommended classification of pesticides by hazard

Class		LD_{50} for the rat (mg/kg body weight) Oral	Dermal
Ia	Extremely hazardous	< 5	< 50
Ib	Highly hazardous	5-50	50-200
II	Moderately hazardous	50-2000	200-2000
III	Slightly hazardous	Over 2000	Over 2000
U	Unlikely to present acute hazard	5000 or higher	

Note: The classification is based primarily on the acute oral and dermal toxicity to the rat since these determinations are standard procedures in toxicology. LD_{50} is the amount of chemical required to provide a "lethal dose" to 50% of the test population. The smaller the LD_{50}, the more toxic the pesticide.

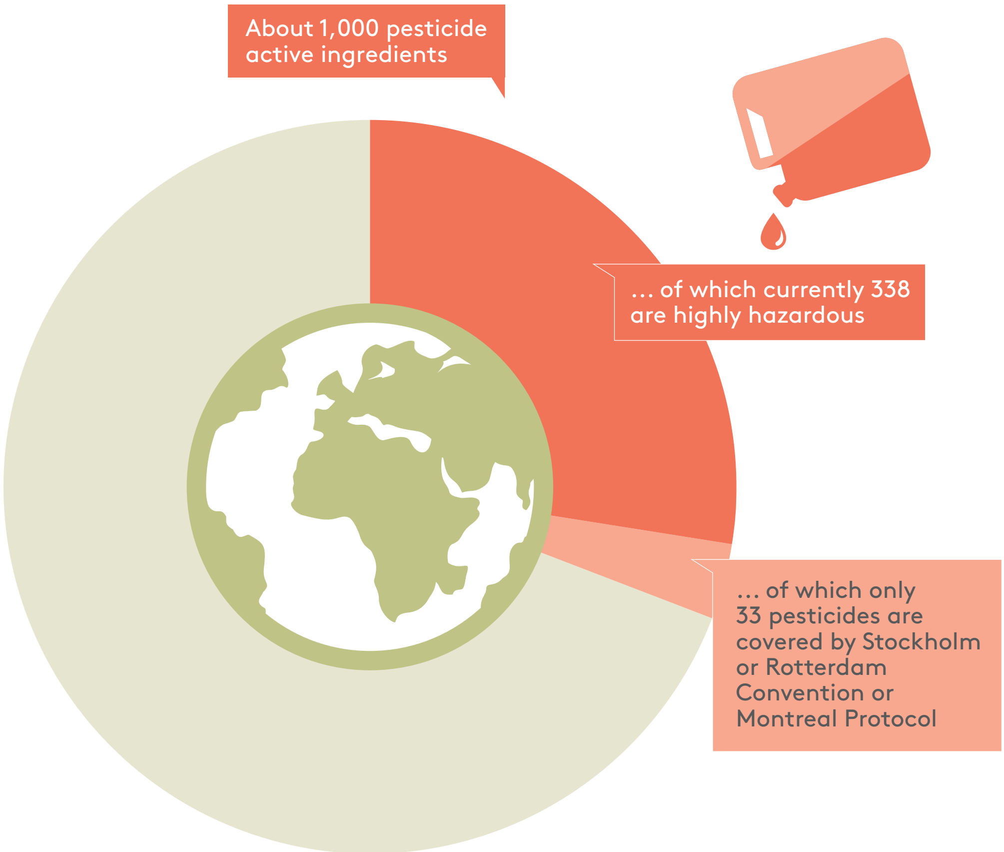
To identify Class 1b HHPs, the WHO and FAO have outlined eight criteria. Pesticides are highly hazardous if they have an acute lethal effect, cause cancer or genetic defects, impair fertility, or harm unborn children. Likewise, pesticides are classified as highly hazardous if they cause serious or irreversible damage to health or the environment under normal conditions of use or are listed in internationally binding conventions like the Stockholm Convention on Persistent Organic Pollutants, the Rotterdam Convention, or the Montreal Protocol[4].

Although the WHO and FAO have developed these criteria, they have not published an official list that includes all HHPs used worldwide. This makes it challenging for governments, agricultural extension agents, distributors, and spray service providers to identify and replace HHPs with less hazardous alternatives. The Pesticide Action Network International (PAN) has filled this gap by publishing and regularly updating a list of HHPs. The "PAN International List of HHPs" considers stricter toxicity and environmental criteria than the WHO and FAO[5].

The longstanding concerns and mounting evidence about the impacts of HHPs have motivated stakeholders to act at global, regional, and national levels. The FAO addresses HHPs as a priority in its pesticide risk reduction and integrated pest management (IPM) programmes which includes the progressive ban on HHPs[6]. Regulatory bodies in Southern and East Africa and in the Caribbean are developing regional strategies and risk reduction plans on HHPs[7].

FAILURE TO PROVIDE ASSISTANCE

Utilized Highly Hazardous Pesticides worldwide



Various countries have also started phasing out HHPs. In addition, private and public sector actors support initiatives to reduce the use of HHPs in agriculture. However, we still have a long way to go.

There is no globally binding legal framework that addresses pesticides at every stage of the life cycle – from production to use and disposal. Less than 4% of all pesticides used globally are regulated by binding international conventions[1]. HHPs are of particular concern in low- and middle-income countries (LMICs) where capacity and resources to appropriately manage exposure to highly toxic products are lacking. By contrast, many HHPs are banned in higher income countries that have robust regulatory and enforcement programmes.

Pesticides are a political priority in Kenya. In 2020, the National Committee on Health highlighted the complex problems that have emerged because of increased exposure to agrochemicals. The Committee's report in response to a public petition, was a political statement about the serious public health concerns and environmental consequences of pesticides use and misuse[8]. Kenya's Parliament called for swift action by the Ministry of Agriculture, through the Pest Control Products Board (PCPB), to review the list of pesticides allowed in the country. This review is still underway.

In the meantime, steps have been taken by the PCPB to update the legislation regulating pest control products in the country. The existing Pest Control Products Act was made law in 1982. The purpose of the revised proposed, "Pest Control Products Bill, 2022" is to safeguard human health and the environment from risks associated with pest control products whilst promoting IPM and Good Agricultural Practices (GAP).

The ongoing political processes in Kenya reflect worrying truths about the international manufacture and trade of pesticides, such as the double standard, as well as the realities facing farmers and consumers and the threats to national biodiversity (Fig. 1).

Less than 5% of total pesticides sales are in Africa. Agrochemical companies see the business potential of smallholder farmers.

In total, 171 companies have registered 862 products in Kenya. Most of the products originate from China (342 products), followed by Europe (253 products).

Although there are 36 different European companies, more than half of the registered products (57%) are sold by BASF, Bayer AG, and Syngenta.

34% of the pesticides registered by the PCPB in Kenya, are withdrawn from the European market or are heavily restricted due to potential chronic health effects, environmental persistence and high toxicity towards fish or bees.

In Kenya, only 1 in 6 farmers wear full protective gear when applying pesticides.

Only 15% of farmers in Kenya store pesticides in a safe place away from children.

Many studies in Kenya have shown pesticide residue levels in food that exceed allowable limits. In 2018, 1,139 samples of fresh produce intended for export and local markets, were tested by Kenya Plant Health Inspectorate Service (KEPHIS). Pesticides were detected on 46% of the samples, while 11% had residues exceeding EU maximum residue levels[11]. Kenyan scientists are calling for the withdrawal of harmful pesticides as a result.

Figure 1: Setting the scene: Existing Pesticide Issues in Kenya

The information above is based on previous studies: Pesticide Atlas 2022, Heinrich-Böll-Stiftung & others; Activity Report April to June 2022, Agrochemical Association of Kenya; Pesticides in Kenya: Why our food security is at stake 2019, Route to Food Initiative; Annual Report and Financial Statement 2018, Kenya Plant Health Inspectorate Service.

PURPOSE OF THE STUDY

Highly Hazardous Pesticides In Kenya

Official data on national pesticides use is not publicly available. In addition, monitoring and surveillance schemes by the relevant government authorities are not comprehensive and are irregularly carried out. Therefore, It is difficult to establish which pesticides are used and their toxicity profiles. For this reason, the Route to Food Initiative (RTFI), a programme of the Heinrich Böll Foundation in Kenya, purchased a pesticide dataset from a private market research company. Data was purchased for the year 2020, which is the most recent set of data available for Kenya. Data analysis focuses on HHPs and reveals which pesticides are most used, and most toxic. In addition, it was possible to assess the use of HHPs on different crops.

The purpose of the study is to provide critical evidence to legislators and the wider public about pesticides use and their potential risk in Kenya. The study provides guidance to policymakers on how to prioritize which pesticides should be withdrawn based on their use on specific crops, and toxicity to human health and the environment. A final prioritization list is presented. The information can also be used to inform the design of regular pesticide residue monitoring programmes and alternative pest control strategies.

The Kenyan government ultimately bears responsibility for maintaining the safety of its own people and national biodiversity, upon whose integrity a significant component of the economy rests. In support of State interventions, this study adds to the body of evidence collected by civil society to address the concerns surrounding highly hazardous pesticides with the aim of protecting fundamental human rights and promoting transformation of agriculture to resilient, agroecological models that enhance food sovereignty.

METHODOLOGY

General Approach

The data analysis process followed certain phases. The first phase identified all products and their active ingredients used in agricultural crop production within Kenya. Data on applied volume (L), area of land (ha) and value ($) were analyzed according to each active ingredient and product.

The brand owners[a] of products were also examined to illustrate the prominence of selected pesticide companies with respect to the sale of HHPs, which were categroized according to the list of PAN International[5]. The exact volume of applied active ingredients (illustrated in Fig. 8) was calculated based on the concentration of each active ingredient in a product. During the second phase, the pesticides underwent various scoring procedures for their potential endocrine disrupting, carcinogenic, reproductive, mutagenic, and neurotoxic effects, so that the pesticides could be ranked in terms of their relative toxicity to human health.

Additionally, they underwent scoring procedures for their potential to cause bee and fish toxicity to rank pesticides in terms of their relative toxicity to environmental health. The environmental toxicity scores for each pesticide were then multiplied by a mobility score (determined by the Groundwater Ubiquity Score) to provide an indication of the potential environmental hazard of each pesticide. Finally, the potential hazard of the chemical was expressed as a function of its total use in relation to the total use of all active ingredients applied in the country to give a weighted hazard score.

Human health effects of pesticides

ENDOCRINE DISRUPTION (affects hormone system) | CARCINOGENIC (causes cancer) | REPRODUCTIVE AND DEVELOPMENT TOXICITY (toxic to reproduction system and unborn child | MUTAGENIC (changes genetic material) | NEUROTOXIC (toxic to the nervous system)

[a] There are instances where the brand owner differs from the distributor. For this analysis, distributor information was not captured.

Additionally, they underwent scoring procedures for their potential to cause bee and fish toxicity to rank pesticides in terms of their relative toxicity to environmental health. The environmental toxicity scores for each pesticide were then multiplied by a mobility score (determined by the Groundwater Ubiquity Score) to provide an indication of the potential environmental hazard of each pesticide. Finally, the potential hazard of the chemical was expressed as a function of its total use in relation to the total use of all active ingredients applied in the country to give a weighted hazard score.

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MUTAGENIC (changes genetic material)

NEUROTOXIC (toxic to the nervous system)

Pesticide Use Data

Pesticide use data for Kenya was obtained from the Sigma™ programme, a proprietary database maintained by the market research company GfK Kynetec Ltd ("Kynetec"). The company provides quantified data on the use of agricultural active ingredients on a country-by-country and crop-by-crop basis. For example, data provided by Kynetec is used by the United States Geological Survey to estimate pesticide use in the U.S. as part of the National Water Quality Assessment Programme. For this study, data purchased from Kynetec was for the year 2020 which was the latest data available. Data is collected from agrochemical manufacturers, distributors, trade associations, importers, and farmers.

Pesticide Prioritization

The Pesticide Properties Database[12] was used to obtain information on endpoints for endocrine disruption potential, carcinogenicity, reproductive toxicity, mutagenicity, and neurotoxicity, bee toxicity and fish toxicity for each of the active ingredients.

Pesticides were then ranked or scored according to quantity of use (QI) and toxicity potential (TP). Pesticide sales data was available on a product by crop basis. Therefore, it was possible to rank product use nationally, as well as product use by on different crops.

For human health, five toxic effects were used to score each pesticide (endocrine disruption potential, carcinogenicity, mutagenicity, reproductive toxicity, and neurotoxicity) (Table 2). Each toxic effect was classified into one of four different endpoint categories, namely "Yes" (there is definitive evidence that the chemical causes the toxic effect), "Possible" (there is evidence that the chemical may possibly result in the toxic effect), "No Data" (no studies have been performed to confirm whether the pesticide does or does not cause the toxic effect) and "No" (there is definitive evidence that the chemical does not cause the toxic effect).

Data endpoints for each toxic effect were obtained from the Pesticide Properties Database. The scores for each of the different categories for each toxic effect were weighted according to classification scheme to prioritize pesticides according to their effects.

Table 2. The scoring system used to rank pesticides for five human health effects [13]

Toxic effect	Classification	Score
Endocrine disrupting activity (affects hormone system)	Yes	8
	Possible	6
	No data	3
	No	0
Carcinogenicity (causes cancer)	Yes	8
	Possible	6
	No data	3
	No	0
Mutagenicity (changes genetic material)	Yes	6
	Possible	4
	No data	2
	No	0
Reproduction (toxic to reproduction system and unborn child)	Yes	4
	Possible	2
	No data	1
	No	0
Neurotoxicity (toxic to the nervous system)	Yes	4
	Possible	2
	No data	1
	No	0

For environmental health, two toxic effects were used to score each pesticide (bee and fish toxicity). Each toxic effect was classified into one of five different endpoint categories (very toxic, toxic, moderately toxic, low toxicity and not toxic) (Table 3).

Table 3. The scoring system used to rank pesticides for two environmental health effects

Toxic effect (bee and fish toxicity)	Classification	Score
Very toxic	<0.1	4
Toxic	0.1-1.0	3
Moderately toxic	1.0-10	2
Low toxicity	10-100	1
Very low toxicity	>100	0

Pesticides are mobile in the environment. The Groundwater Ubiquity Score or GUS index[14], has been developed to provide a relative indication of the potential of a chemical to move via leaching and runoff. Runoff or leaching can occur when pesticides are carried off the application site into water.

The GUS score incorporates half-life and Koc values of the compounds and provides a measure of the mobility of a substance. Compounds with a value higher than 2.8 are classified as highly mobile and those with a value less than 1.8 are classified as non-leachers (Table 4).

Table 4. Scoring system used to rank pesticides in terms of their potential exposure risk to water resources based on their groundwater ubiquity score (GUS)

GUS	Score	GUS Score
High	>2.8	4
Medium	2.8-1.8	2
Low	<1.8	1
No data	No data	1.5

Toxicity Potential (TP) and Weighted Hazard Potential (WHP)

- The human toxicity potential (HTP) provides an indication of the chronic toxicity to human health (Table 2).

- The environmental toxicity potential (ETP) provides an indication of the potential for exposure to highly toxic pesticides and is calculated as follows:

ETP = TP x GUS Score

---TP is the toxicity potential score of the pesticide (Table 3) and GUS Score is the environmental exposure potential score of the pesticide (Table 4).

- Following this, the ETP and HTP were multiplied by the proportion of the usage of the pesticide relative to the total usage of all pesticides included in the analysis, to obtain the weighted hazard potential (WTP):

WTP = (HTP or ETP) x (Ql/Qtot)

---HTP or ETP is the hazard potential of the pesticide, Ql is the total quantity of usage (kg) of the specific pesticide nationally and Qtot is the sum of the quantity of usage (kg) of all the pesticides included in the prioritization process (1,714,072 tonnes of active ingredients).

RESULTS

General Use Of Products

An analysis of the data revealed that a total of 310 products were used by farmers containing 151 active ingredients. There are more products than active ingredients since one active ingredient can be in different formulations registered by different companies in different products.

What are active ingredients?

Active ingredients are the chemicals in a pesticide product that act to control the pests. They must be identified by name on the pesticide product's label together with its percentage by weight.

The products (310) were sold by 73 different companies. A total volume of 3,068 tonnes of pesticide products were applied to control pests, diseases, and weeds on 26 different crops (excluding flowers and ornamentals).

Types of pesticides include insecticides (designed to kill insects), herbicides (designed to kill unwanted plants, or weeds) and fungicides (designed to kill fungi such as molds, mildew and rust).

In Kenya, insecticides are applied most widely on 1.33 Mill hectares of agricultural land followed by herbicides on 0.94 Mill hectares and fungicides on 0.50 Mill hectares.

The data showed that more than half of the total volume of pesticides consisted of herbicides (52%; 1596.45 t) with 78 different products, followed by fungicides (27%; 814.8 t) with 90 different products and insecticides (21%; 656.82 t) with 142 different products. The average dose rate for insecticides is much lower than the dose rate for fungicides and herbicides (Table 5), meaning that the farmer needs to use much less insecticides per hectare than fungicides or herbicides. Therefore, the total volume of insecticides used is lower than the total volume of fungicides and herbicides.

(52%; 1596.45 t)

(27%; 814.8 t)

(21%; 656.82 t)

The total volume of pesticides used by farmers in Kenya equates to $72.7 Mill. Although more herbicides are used than insecticides, the total product value of insecticides is $28.2 Mill whereas the total product value of herbicides is $26.4 Mill. This is because insecticides are generally more expensive (average 65$/kg) than herbicides (36.82$/kg). The total product value of fungicides is $18.1 Mill with an average product price of 34.95$/kg.

Table 5. Summary of pesticide products used in Kenya in 2020, volume and costs

Pesticide Group	Sum of Area Treated (1000 ha)	Average Dose Rate (kg;l/ha)	Average Product Price (US$/kg)	Average Product Cost (US$/ha)	Sum of Volume (1000 kg;l)	Sum of Product Value (1000 US$)
Insecticide	1331.6	0.69	65.00	27.31	656.82	28150.58
Fungicide	502.8	1.71	34.95	43.94	814.80	18184.91
Herbicide	937.0	2.09	36.82	34.85	1596.45	26356.87
Sum					3068.07	72692.37

What is a Highly Hazardous Pesticide (HHP)?

HHPs have high levels of acute or chronic hazards to human health and the environment. In addition, pesticides that appear to cause severe or irreversible harm under conditions of use in a country may be treated as highly hazardous. This would apply in Kenya, for example, where only about 1 in 6 farmers wear full protection equipment because the equipment is too expensive, not available, or not appropriate to the climate[15].

Whereas only 7 products (2%) belong to biopesticides assisting in a more sustainable pest management, a total of 195 products (63%) containing one or two active ingredients that are categorized as HHPs[5]. In terms of product volume, sustainable biopesticides make up only 2% of the total pesticide volume (47.3 t), but HHPs make up 76% (2353 t). Pesticides categorized as non HHPs make up 22% (693 t) (Fig. 2). This shows that farmers in Kenya are mostly using HHPs. Almost half of the total volume of pesticides used in Kenya are already banned in Europe (Fig. 3).

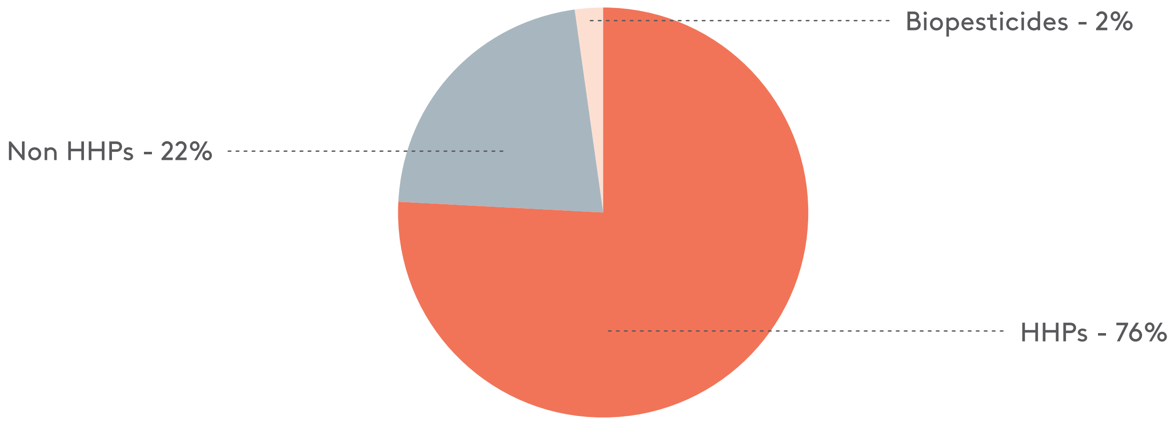


Figure 2. Share HHPs as the total volume of pesticides used in Kenya

Which pesticides are HHPs?

Although the FAO and WHO developed criteria for HHPs, they have not published an official list that includes all HHPs used worldwide yet. This makes it challenging for governments, extension officers, distributors, and spray service providers to identify and replace HHPs with less hazardous alternatives. The international Pesticide Action Network (PAN) has filled this gap and published an HHP list in 2009. The "PAN International List of HHPs" has been used for the analysis in this report[5].

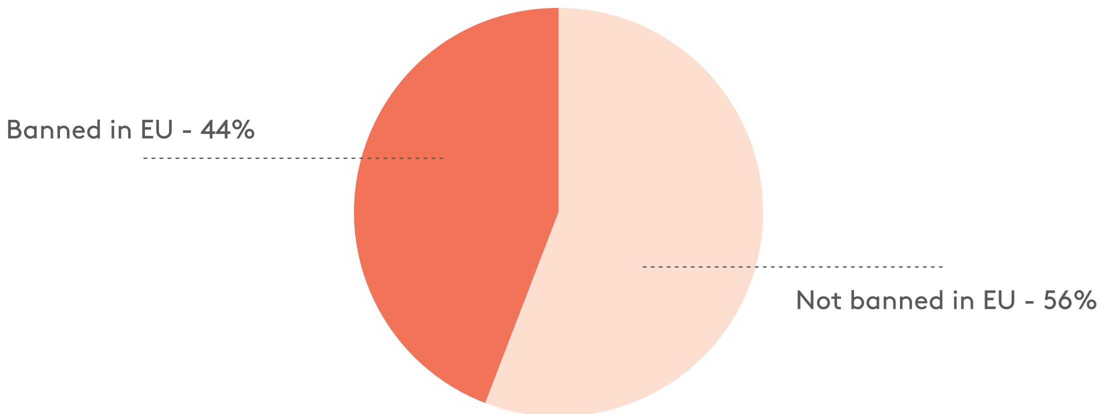


Figure 3. Share of pesticides banned in the EU as the total volume of pesticides in Kenya

Double standards

Double standards in pesticide trade refers to the situation where pesticide products or active ingredients that are not allowed for use in their country/region of origin, are exported and sold in other parts of the world. The UN Special Rapporteur on toxics and human rights has made it clear that this discriminatory practice exacerbates environmental injustice and violates international human rights and environmental standards[9].

There are positive examples of countries, like France and Switzerland that have already forbidden the export of pesticides that are banned in the European Union (EU)[10].

Use Of Specific Products

Area

The different products can be ranked according to the area of land under use (Fig. 4). The area extent of product application could be important when ranking them in terms of the environmental and human health impact on communities and bystanders. The five most widely used products are insecticides called Marshal (carbosulfan), Thunder (beta-cyfluthrin + imidacloprid), Belt (flubendiamide), Occasion-Star (emamectin benzoate + indoxacarb) and Dursban (chlorpyrifos).

An area of 635,350 ha is applied with these five insecticides products, which equals to 21% of the total area under pesticide treatment. They are all categorized as HHPs and are very toxic to human health and the environment.

The most areawide used insecticide is the product Marshal, which contains the active ingredient, carbosulfan, and is sold by FMC Corporation. Marshal is used as a seed treatment/coating mainly for maize seeds (and partly for rice and beans). The size of the treated area use is concerning. Carbosulfan is highly toxic to bees and birds, and not approved in Europe anymore.

Another toxic product, Thunder, is also used extensively. Thunder is sold by the German company, Bayer AG, and contains the acutely toxic beta-cyfluthrin (Class 1b HHP), and imidacloprid (highly toxic to bees). Thunder is used on various crops, but mostly on maize and wheat, to control sucking and chewing insect pests. Both active ingredients are not approved anymore in Europe and 21 other countries.

Know your pesticide: Imidacloprid

Imidacloprid is the most used neonicotinoid insecticides (others are thiamethoxam, thiacloprid, fipronil and acetamiprid). In Kenya, it is registered for use in 42 products. One active ingredient can be registered by different companies in different products.

Scientists in Kenya recommend the immediate withdrawal of imidacloprid because of the strong body of research that suggests it is lethal for pollinators such as bees[16]. The concerns surrounding the use of neonicotinoids in Kenya have been widely covered in local media outlets.

Dursban sold by Corteva Agriscience™ contains chlorpyrifos, which shows neuro and developmental toxicity as well as high environmental toxicity to aquatic ecosystems. Due to its high human toxicity, it is not approved in Europe and 12 other countries. This product is mostly applied on maize and coffee, to control chewing insect pests.

Action is needed

The active ingredients – carbosulfan, beta-cyfluthrin, imidacloprid and chlorpyrifos – are not approved in the EU. The registration status of imidacloprid and chlorpyrifos are currently under review by the PCPB[17]. Scientists in Kenya recommend the immediate withdrawal of all three active ingredients because of their harmful potential effects on human health and the environment[16].

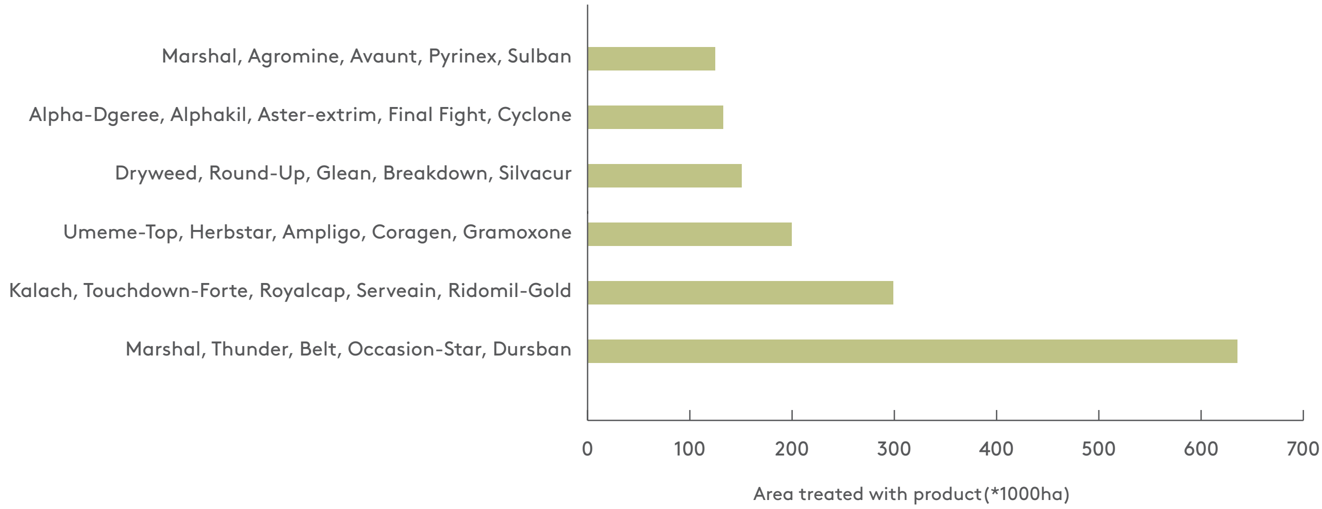


Figure 4. The top 30 products in Kenya according to areawide application

Note: Products pooled due to observe restricted data rights.

Volume

Products with the highest volume application in Kenya are mostly herbicides like Kalach, Touchdown Forte, Dryweed, Roundup Turbo (containing glyphosate), Herbstar and Gramoxone (containing paraquat), Lumax (containing mesotrione), HY-2.4-D, 2.4-D-Max and Agromine (2.4 D-amine) (Fig. 5). Paraquat and 2.4 D-amine are both banned in Europe. Kenyan scientists are calling for the immediate withdrawal of paraquat and a phased withdrawal of 2.4 D-amine whilst less toxic alternatives are developed and introduced[18].

Fungicides with the highest volume application are Ridomil-Gold (mancozeb/metalaxyl-M), Nordox-Super (copper-oxide) and Milthane (mancozeb). Therefore, mancozeb is the most used fungicide, although it is an HHP and already banned in Europe and four other countries. Insecticidal products with the highest application are Dursban (containing chlorpyrifos) and the biopesticide Achook (containing azadirachtin). The top 30 pesticide products by volume, are mostly HHPs.

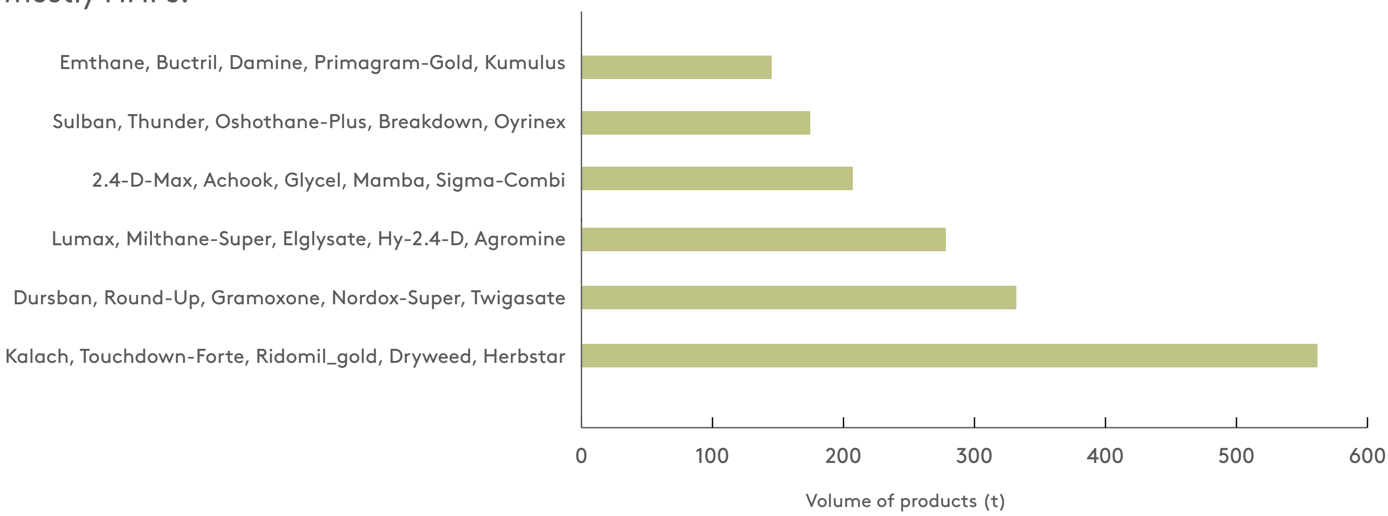


Figure 5. The top 30 products in Kenya according to volume of application

Note: Products pooled due to observe restricted data rights.

Value

Pesticide application rates

Generally, herbicides are applied with a higher application rate than fungicides and insecticides i.e., you need more herbicide than you would need insecticides or fungicides. Insecticides are more potent, so you need to apply them in lower doses, but they are mostly more expensive than herbicides or fungicides.

Figure 6 shows that products with the highest monetary value are mainly the insecticides like Belt (containing flubendiamide) and Thunder (containing a mixture of beta-cyfluthrin and imidacloprid) (sold by Bayer AG), Achook (containing - azadirachtin, sold by Organix), Benenvia (sold by FMC Corporation), Occasion Star (sold by Ningbo-Megagro), Coragen and Dursban (sold by Corteva Agriscience™).

Additionally, farmers in Kenya spend a significant amount of money on the fungicide, Ridomil-Gold (sold by Syngenta) and herbicides like Servian (sold by Syngenta), Herbstar (sold by King Chemical), Gramoxone and Touchdown Forte (sold by Syngenta).

It is striking that HHPs are the cheapest products for farmers in Kenya and that they are still available on the market despite widespread criticism (Fig. 7). Although HHPs are generally cheaper, the social and environmental costs are often unseen and much higher.

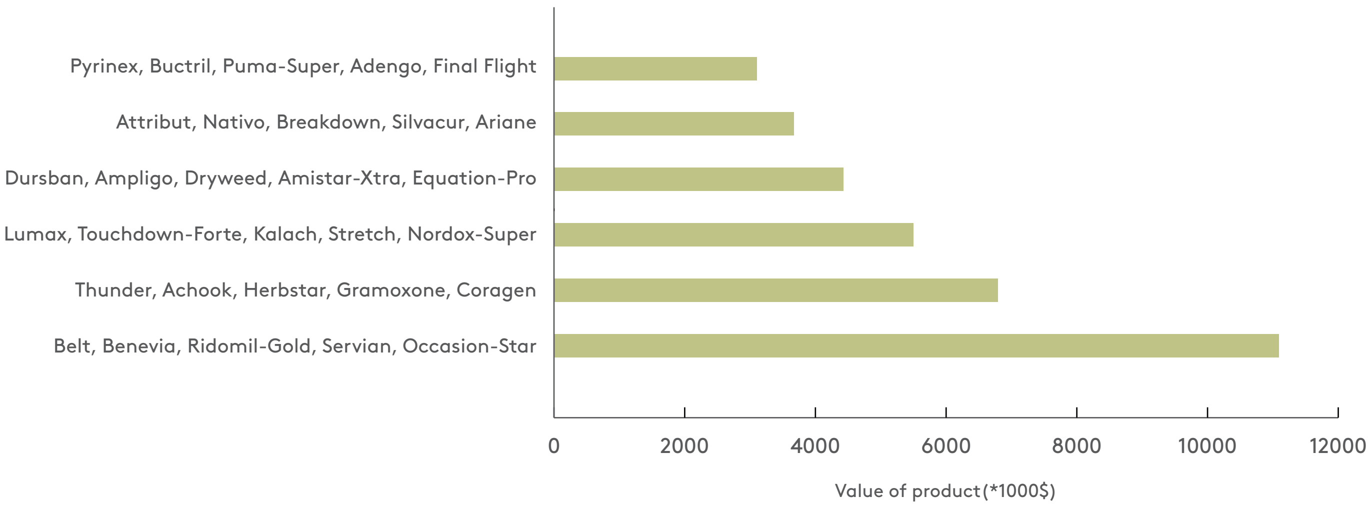


Figure 6. Top 30 products in Kenya with the highest sales value

Note: Products pooled due to observe restricted data rights.

United Nations experts have considered HHPs a global human rights concern for a long time. HHPs endanger among others the right to live in dignity, the right to bodily integrity, and the right to a healthy environment. The UN Special Rapporteur on the right to food has made it clear that the use of hazardous pesticides is a short-term solution that undermines the right to food.[19]

Toxic costing

Farmers are paying less per hectare for toxic insecticides like Marshal, Thunder and Dursban, than for the biopesticide, Achook. This is because toxic pesticides need to be applied in small concentrations only e.g., 0.05kg/ha, whereas Achook has a recommended dosage rate of 2.5kg/ha and is more expensive than other insecticides (Table 6). Highly toxic pesticides are only cheaper because the external environmental and human health costs are not included.

Among herbicides, there is also a big price difference with glyphosate being by far the cheapest. Although products like Kalach, containing glyphosate, require a much higher dosage rate than more modern herbicides e.g., Servian, farmers need to pay less to apply Kalach per hectare.

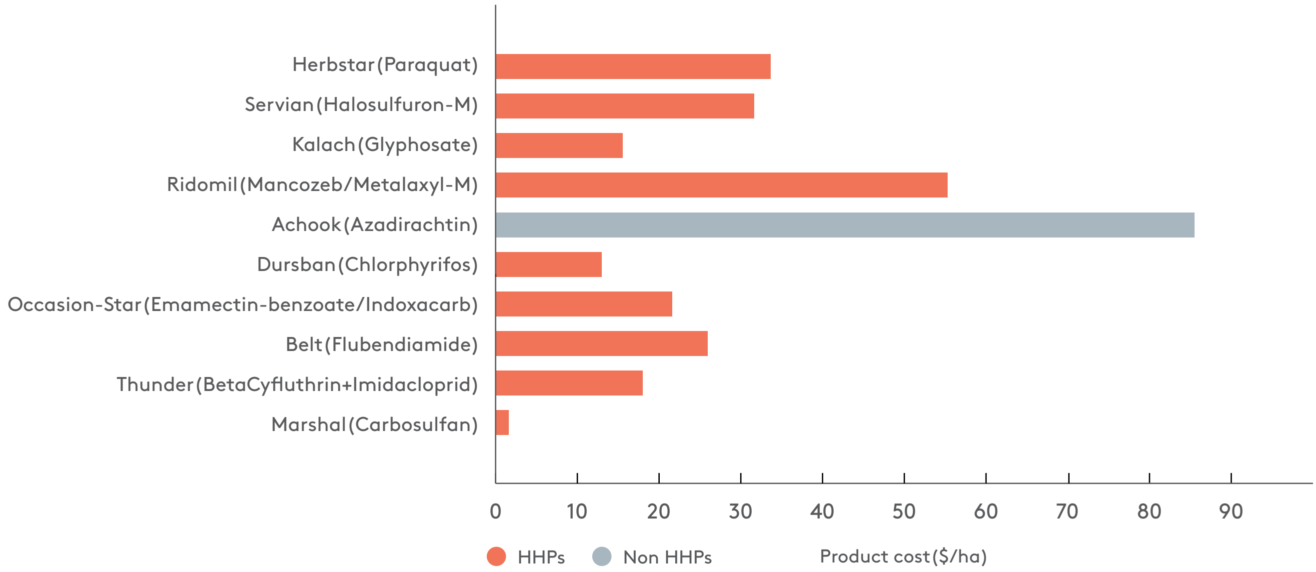


Figure 7. Selected insecticides, herbicides and their costs per hectare

Table 6. The cost of selected products per hectare based on price and the dosage rate.

		Product price (US$/kg)	Product cost (US$/ha)	Product dose rate (Kg;l/ha)
Insecticides	Marshal (carbosulfan)	31.73	1.59	0.05
	Thunder (betacyfluthrin+imidacloprid)	45.29	18.00	0.4
	Belt (flubendiamide)	173.08	25.96	0.15
	Occasion Star (emamectin-benzoate/Indoxacarb)	216.35	21.63	0.1
	Dursban (chlorpyrifos)	12.98	12.98	1.0
	Achook (azadirachtin)	34.21	85.53	2.5
Fungicide	Ridomil (mancozeb/metalaxyl-M)	22.12	55.3	2.5
Herbicides	Kalach (glyphosate)	7.79	15.58	2.5
	Servian (halosulfuron-M)	632.69	31.63	0.05
	Herbstar (paraquat)	16.83	33.65	2.0

Use Of Specific Active Ingredients

Volume

Figure 8 shows the amount of pure active ingredients (contained in various products) applied on Kenyan croplands. The fungicide, mancozeb ranks highest with 273 t, followed by the herbicides, glyphosate (241 t) and 2.4 D-amine (145 t), sulphur (117 t) and the insecticide, chlorpyrifos (96 t). Apart from sulphur, they are all known for their high toxicity towards the environment and/or human health and are categorized as HHPs.

Value

Figure 9 shows which active ingredients were associated with a lucrative business in 2020. The herbicide, glyphosate was sold with the highest value in Kenya. Farmers spend a total of $4.2 Mill buying glyphosate. The insecticide, chlorpyrifos shows the second highest value. Farmers spent a total of $3.2 Mill. Paraquat, mancozeb and imidacloprid, all three banned in Europe and some other countries, are among the active ingredients with high sales value in Kenya as well.

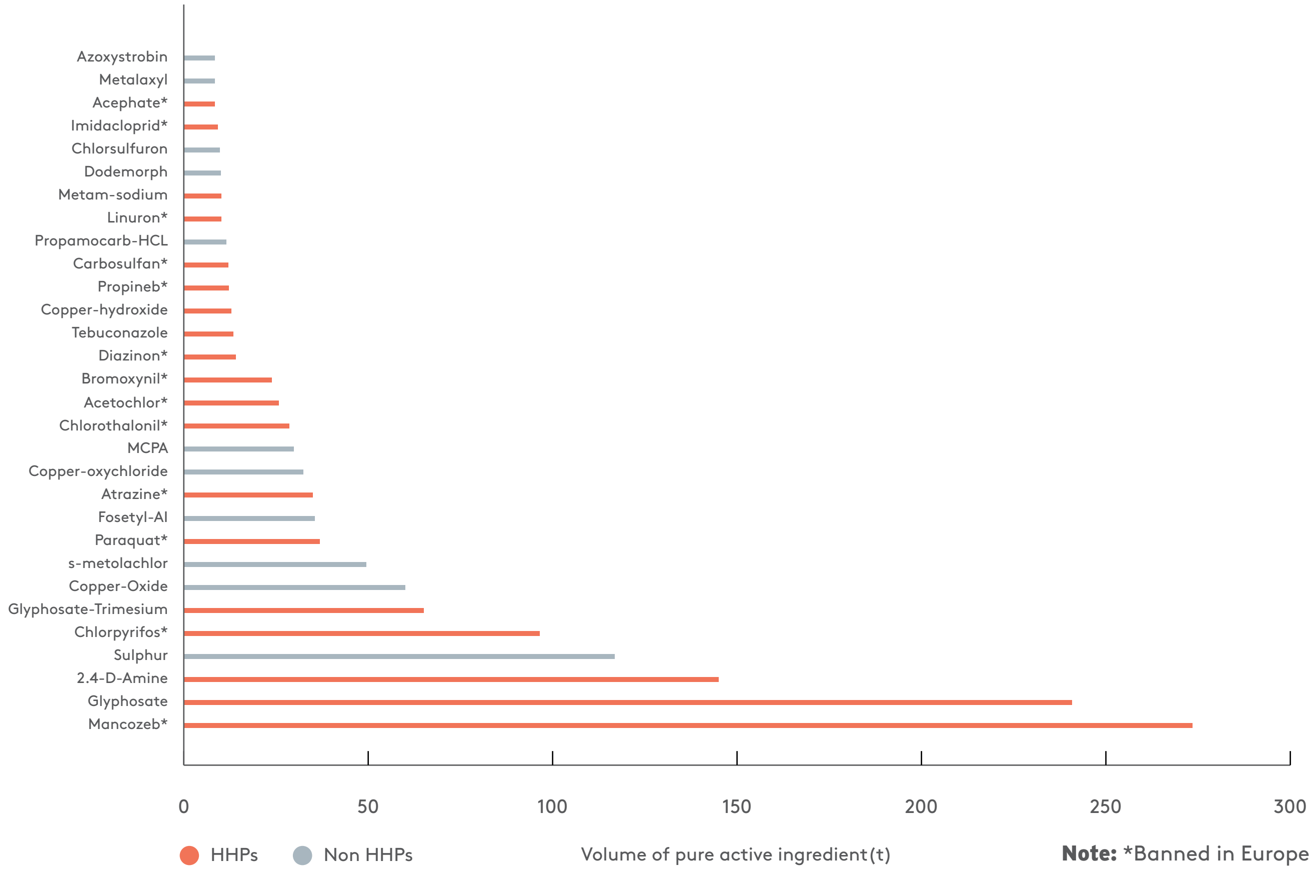


Figure 8. The top 30 active ingredients in Kenya according to volume of application

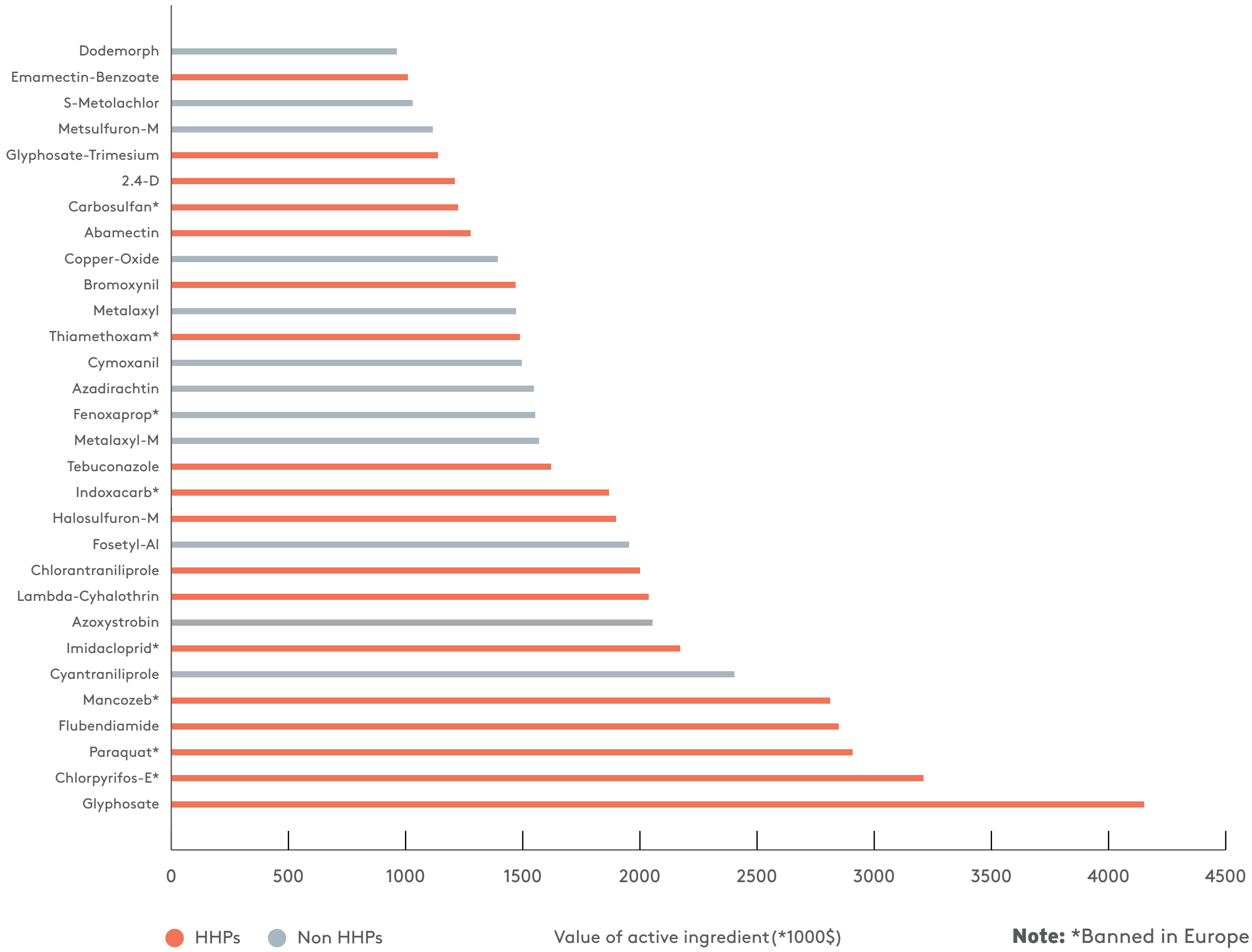


Figure 9. The top 30 active ingredients in Kenya according to their total sales value

Biopesticides

Out of 310 products there are only six biopesticides used to control insect pests and one biopesticide (Trianum-P) to control fungal diseases, such as Fusariam (Table 7). Fusarium is a group of soil-borne fungi. It is widespread and can infect a range of host crops.

Achook (containing azadirachtin from neem) is clearly dominating the biopesticide marketwith the highest area under application (16,800 ha), highest volume (42 t) and highest value ($1.44 Mill).

According to the Kynetec database, Organix is the only company that sells products containing azadirachtin, although neem is commonly available in Kenya. All other biopesticides still play a minor role in the Kenyan pest control market.

Most of the products are used on beans, which is one of the main export items to Europe. The EU sets high food safety standards and as a result, produce imported from Kenya needs to comply with set Maximum Residue Levels (MRLs) and is monitored through the European Commission's Rapid Alert System for Food and Feed.

The quality and safety standards of food available in Kenya's local market should be as important as the ones for the export market. Farmers should be encouraged to use biopesticides for the local market as well.

Table 7. Summary of bio-products used in Kenya in 2020 and their product value

	Active Ingredient	Crops	Area Treated (1000 ha)	Product Volume (1000 kg;l)	Product value (1000 US$)
Achook	Azadirachtin	Bananas, Coffee, Beans, Maize, Peas, Tea, Tomatoes, Brassicas	16.8	42.0	1436.9
Flower-DS	Pyrethrins	Beans, Peas	2.4	4.7	203.4
Halt	Bacillus-thuringiensis	Brassicas	1.6	0.8	33.2
Biocatch	Verticillium	Beans	0.2	0.8	10.2
Bio-Magic	Metarhizium-anisopliae	Beans	0.1	0.4	5.1
Trianum-P	Trichoderma	Beans	0.04	0.1	5.8
Bio-Nemation	Paecilomyces	Beans Tomatoes	0.02	0.1	1.9
Sum			21.1	48.9	1696.4

Product Use On Crops

The pest control on maize requires the highest volumes of pesticide products, followed by wheat, coffee, potatoes, and tomatoes (Fig. 10). The high volume is correlated with the large area of land that is cultivated for these crops. Maize, wheat, coffee, potatoes, tomatoes, and tea are the main crops grown in Kenya.

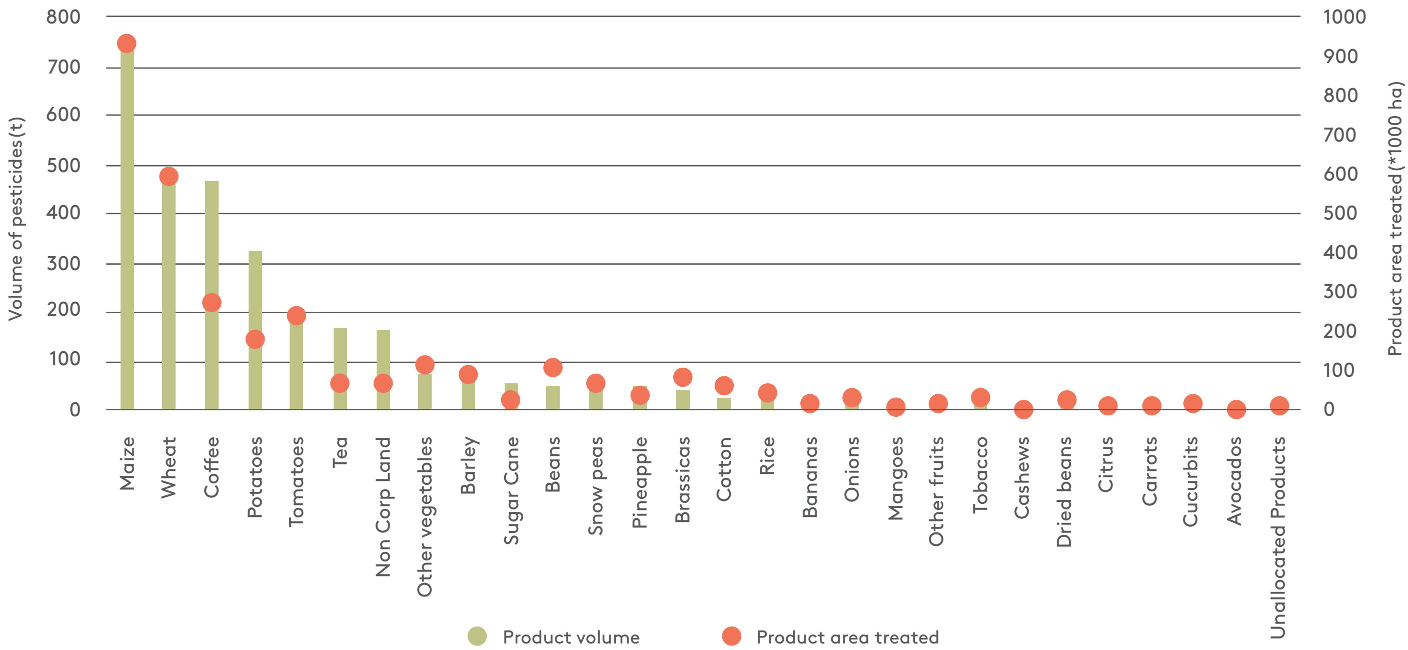


Figure 10. Volume of products used on different crops in relation to area treated per crop

Most pesticides used on different crops in Kenya are categorized as Highly Hazardous Pesticides. Pesticides categorized as non HHPs only make up 22%.

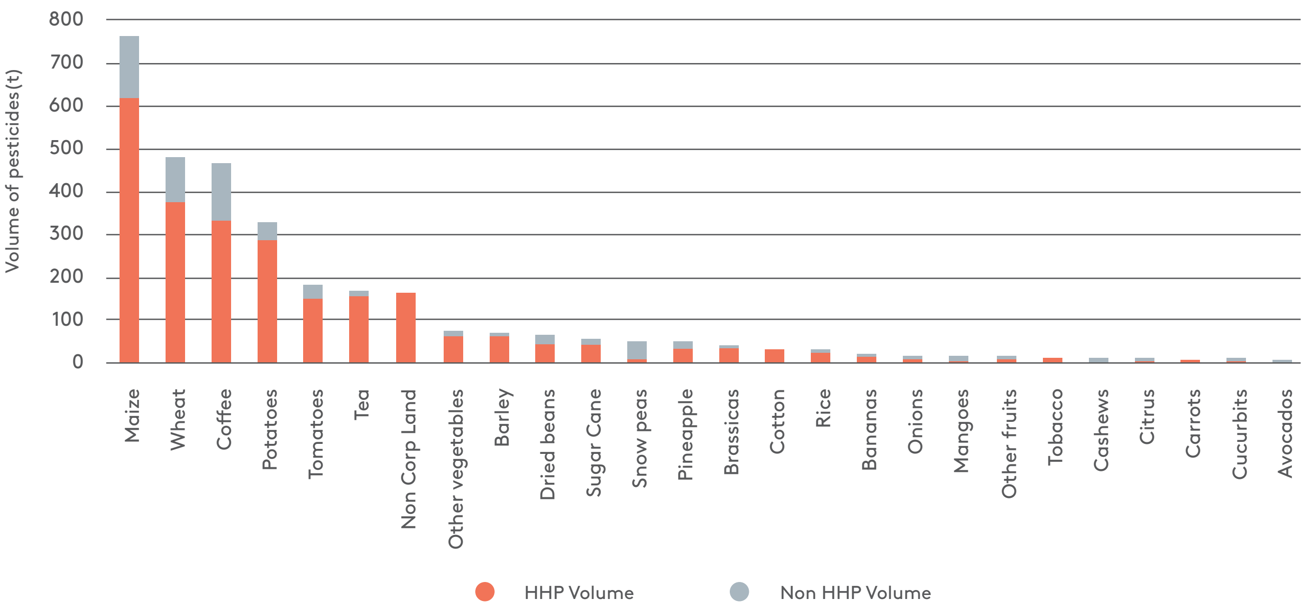
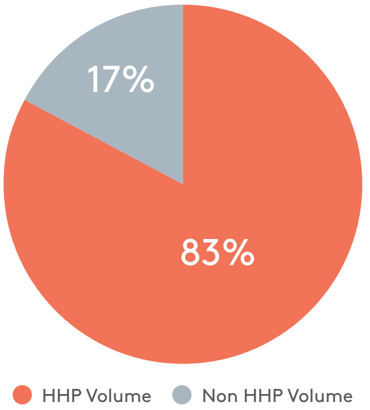


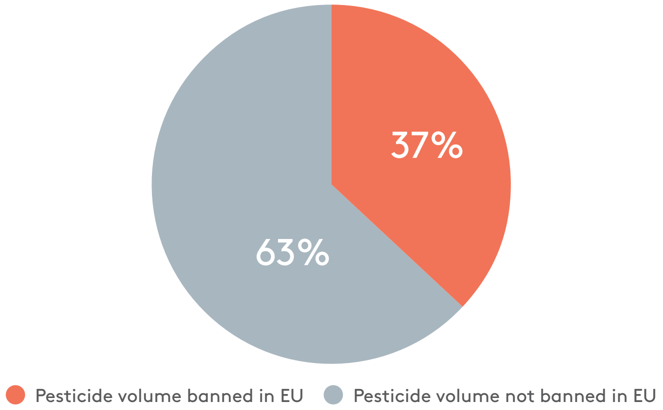
Figure 11. Share of HHPs used on different crops in Kenya

Figure 12–16 show the volume of the top 20 different active ingredients used to control insect pests, diseases and weeds in maize, wheat, coffee, potatoes and tomatoes. According to the dataset, these crops require the highest volume of pesticides and are therefore shown in detail.

Maize

Maize production in Kenya, relies on 40 different active ingredients for pest, disease and weed control, with 83% of the volume of pesticides being categorized as HHPs. Weed control is the biggest problem in maize production. Herbicides comprise 86% of the total use and include 2.4-D, S-metolachlor, glyphosate, atrazine and paraquat (Fig. 12). Insecticides, like chlorpyrifos, flubendiamide and carbosulfan, make up 13% of the total use. Carbosulfan is used as a seed treatment only. Fungicides only make up 0.5% of the total use.





Know your pesticide: Atrazine

Atrazine is a common agricultural herbicide with endocrine disrupting activity. There is evidence that it interferes with reproduction and development and may cause cancer. Although the U.S. Environmental Protection Agency (EPA) approved its continued use in October 2003, the EU decided not to re-register the active ingredient because of its leaching potential to groundwater. Atrazine is not under official review by the PCPB, despite scientists calling for urgent reconsideration of its registration status[16].

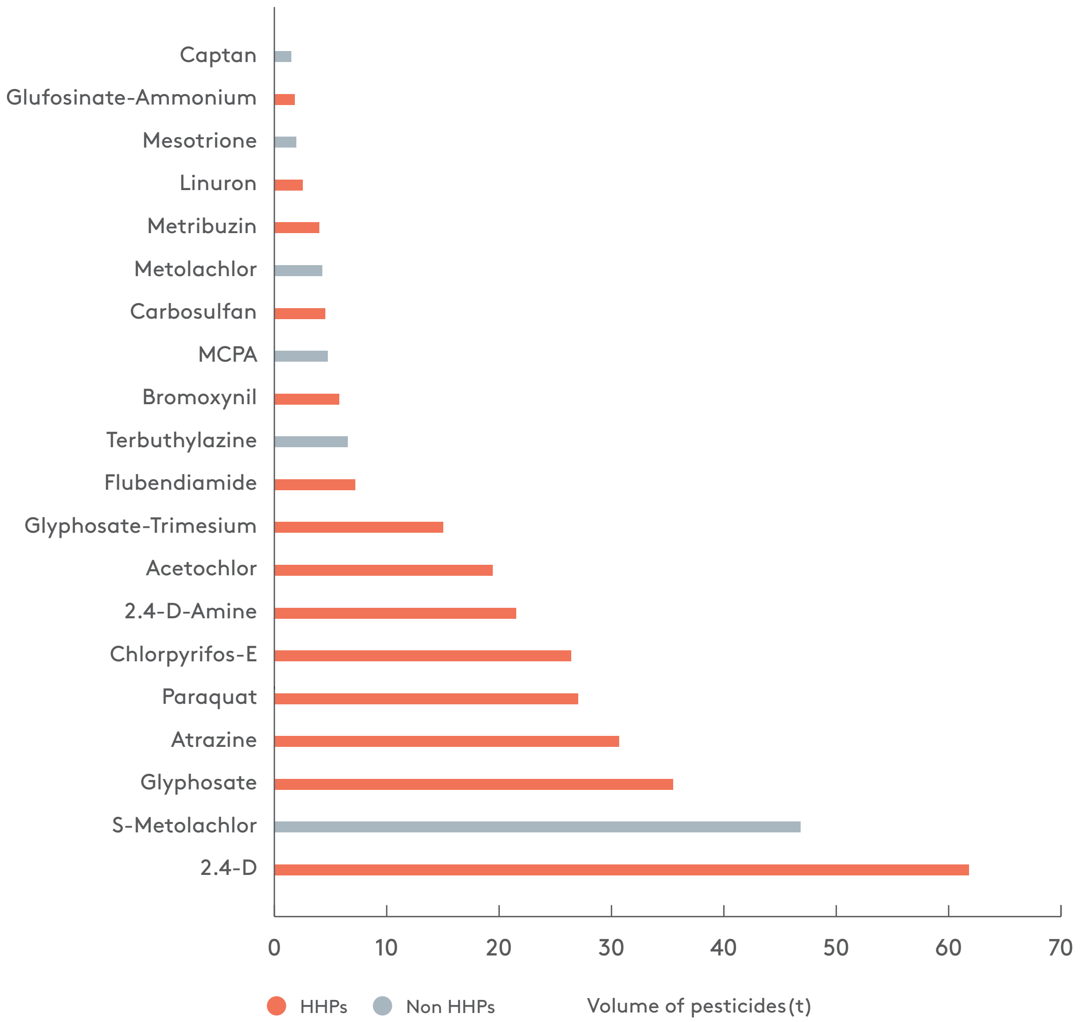
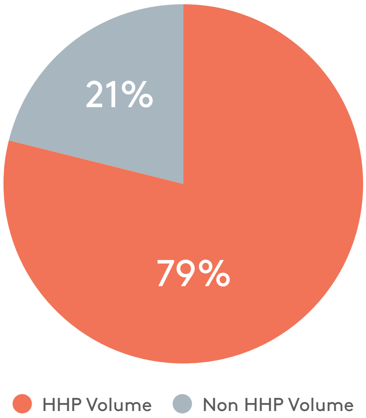
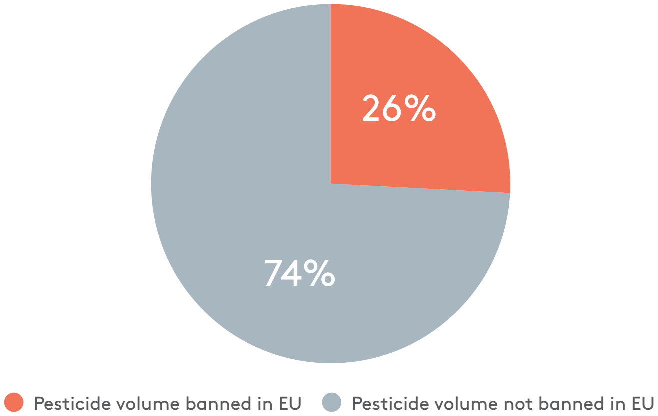


Figure 12. Volume of active ingredients used in maize production

Wheat

There are 58 different active ingredients used in wheat production, where 79% of the volume are categorized as HHPs (Fig. 13). Similarly to maize, weed control is the most important challenge in wheat production because herbicides, like 2.4-D, glyphosate, MCPA, bromoxynil, are the most used (77% of the total use). However, paraquat and atrazine are not used as heavily as in maize production. Insecticides, like chlorpyrifos, imidacloprid and acetamiprid, make up 11% of the total use. Fungicides, like tebuconazole, azoxystrobin and epoxiconazole, make up 13% of the total use. This means fungal disease control is more important than in maize production.





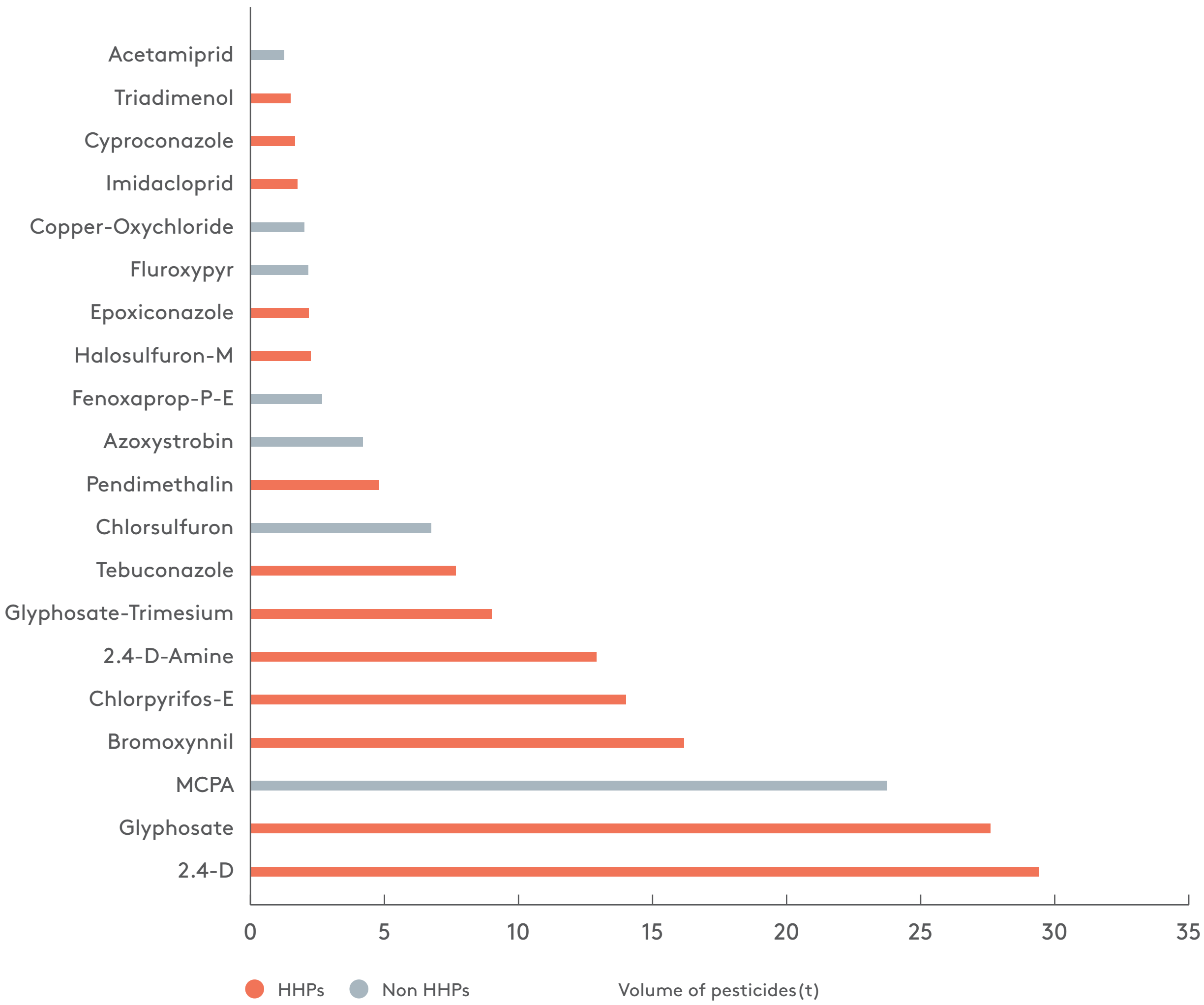


Figure 13. Volume of active ingredients used in wheat production

Coffee

Farmers in Kenya use 30 different active ingredients to grow coffee. HHPs make up 72% of the volume of pesticides used in coffee production (Fig. 14). Fungal diseases and insect pests are more important than weed control. Fungicides like copper-oxide, copper-oxychloride, chlorothalonil, sulfur, and copper-hydroxide make up 50% of the total use of pesticides.

Glyphosate and paraquat are the most used herbicides in coffee production. Herbicides make up 31% of the total use of pesticides. Many insecticides that are in use, are classified as toxic to human health, like chlorpyrifos, diazinon, omethoate, thiophanate and are therefore banned in the EU. In total, insecticides make up 19%.

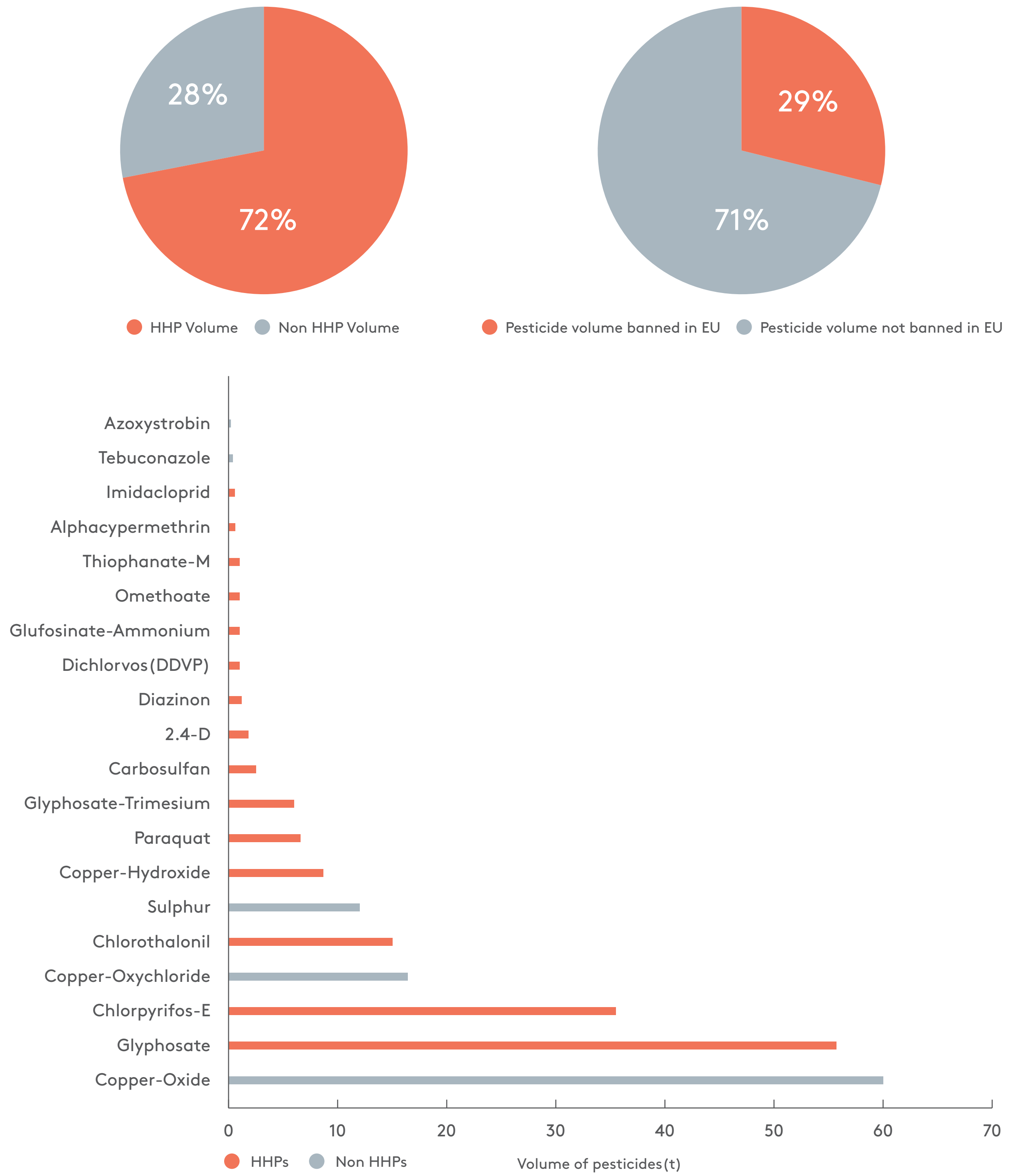


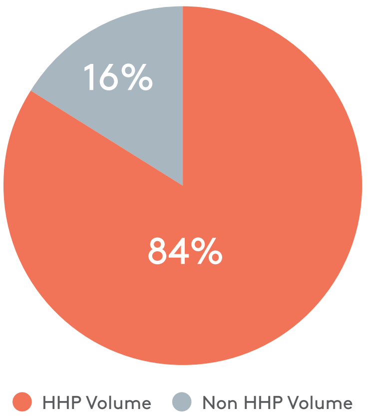
Figure 14. Volume of active ingredients used in coffee production

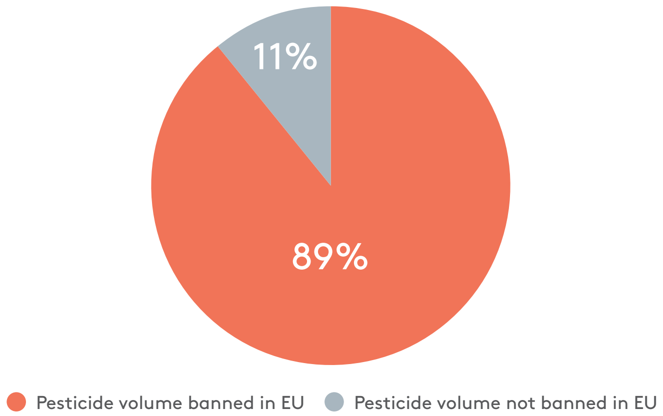
The glyphosate controversy

In 2019, the Ministry of Health in Kenya submitted an official recommendation to remove all products containing glyphosate to safeguard the public against risks, harm and exposure. The WHO has classified glyphosate as probably carcinogenic. However, Bayer AG and other companies are trying to deny there is any valid evidence that glyphosate causes cancer, but the studies they present are old and suggest the opposite[1].

Potatoes

The control of pests, fungal diseases and weeds in potato production requires 22 different active ingredients, where 84% of the volume of pesticides used are categorized as HHPs. A similar pattern is seen with pesticide use for tomatoes. Fungicides, first and foremost, mancozeb, are the most used category and comprise 97% of the total use (Fig. 15). Pest and disease control play a minor role in potato production.





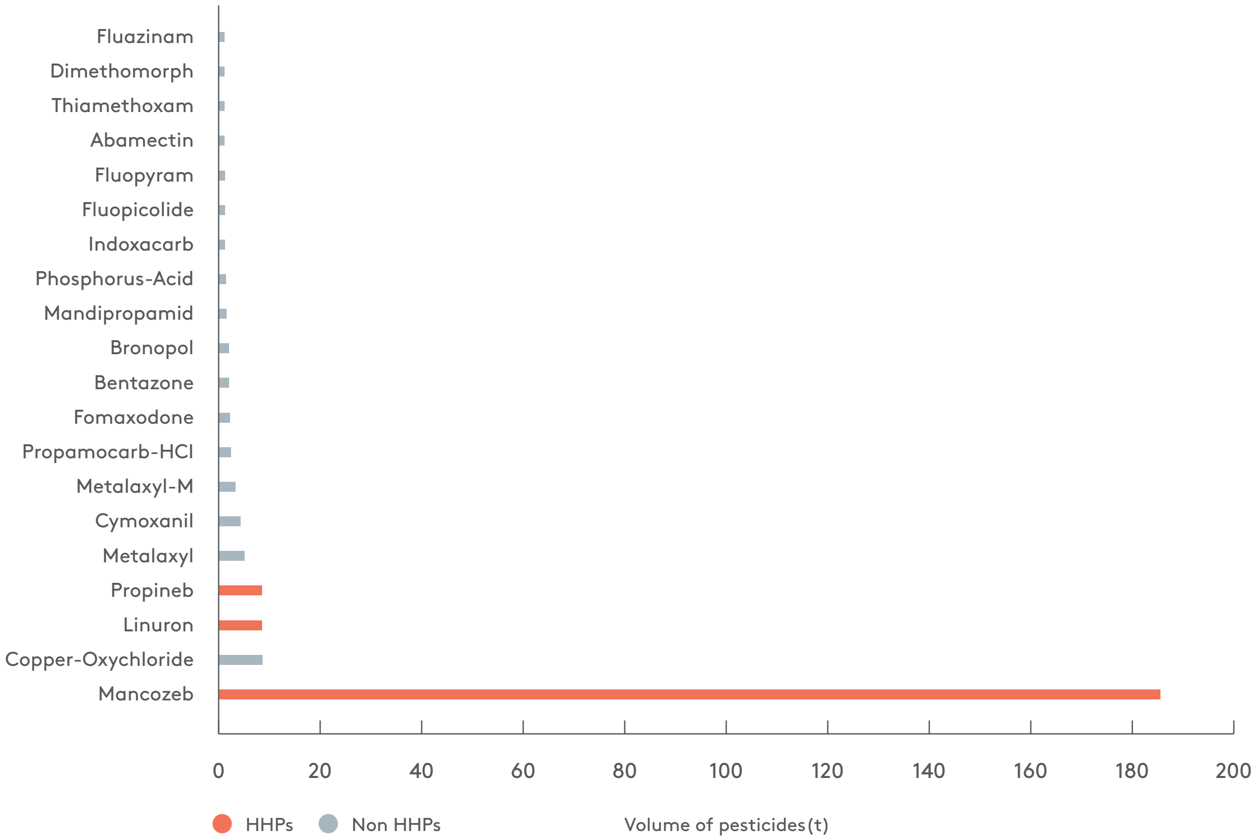


Figure 15. Volume of active ingredients used in potato production

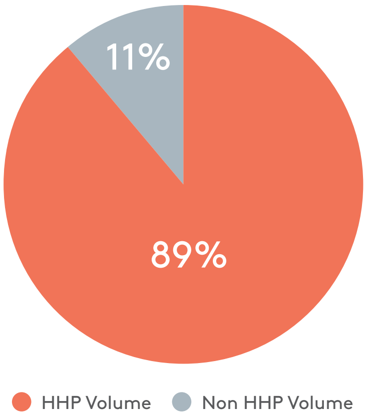
Tomatoes

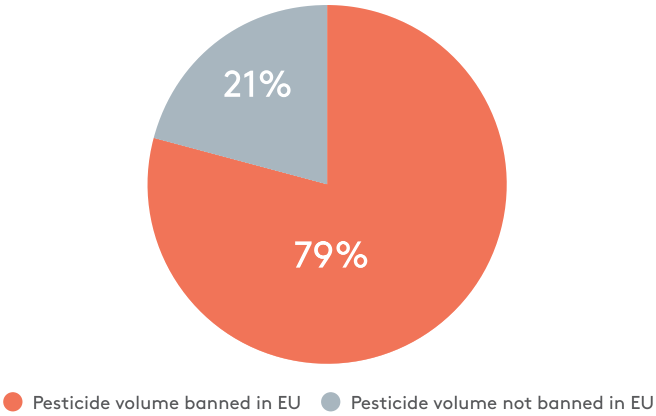
The control of pests, fungal diseases, and weeds in tomato production in Kenya requires 56 different active ingredients, where 89% of the volume of pesticides used are categorized as HHPs. Fungicides, first and foremost, mancozeb, are clearly the most used category with 90% of the total use (Fig. 16).

Know your pesticide: Mancozeb

> Scientists in Kenya have called for the immediate withdrawal of mancozeb because it is widely used by farmers in Kenya, but has been found to cause cancer and is toxic to reproductive and endocrine systems. Mancozeb is banned in the EU.

A wide variety of insecticides are applied on tomatoes. Notably, diazinon, thiamethoxam, thiocyclam, which are all banned in the EU. Insecticide use makes up 8% of the total use of pesticides. Weed control plays a minor role in tomato production and comprises 2% of the total use.





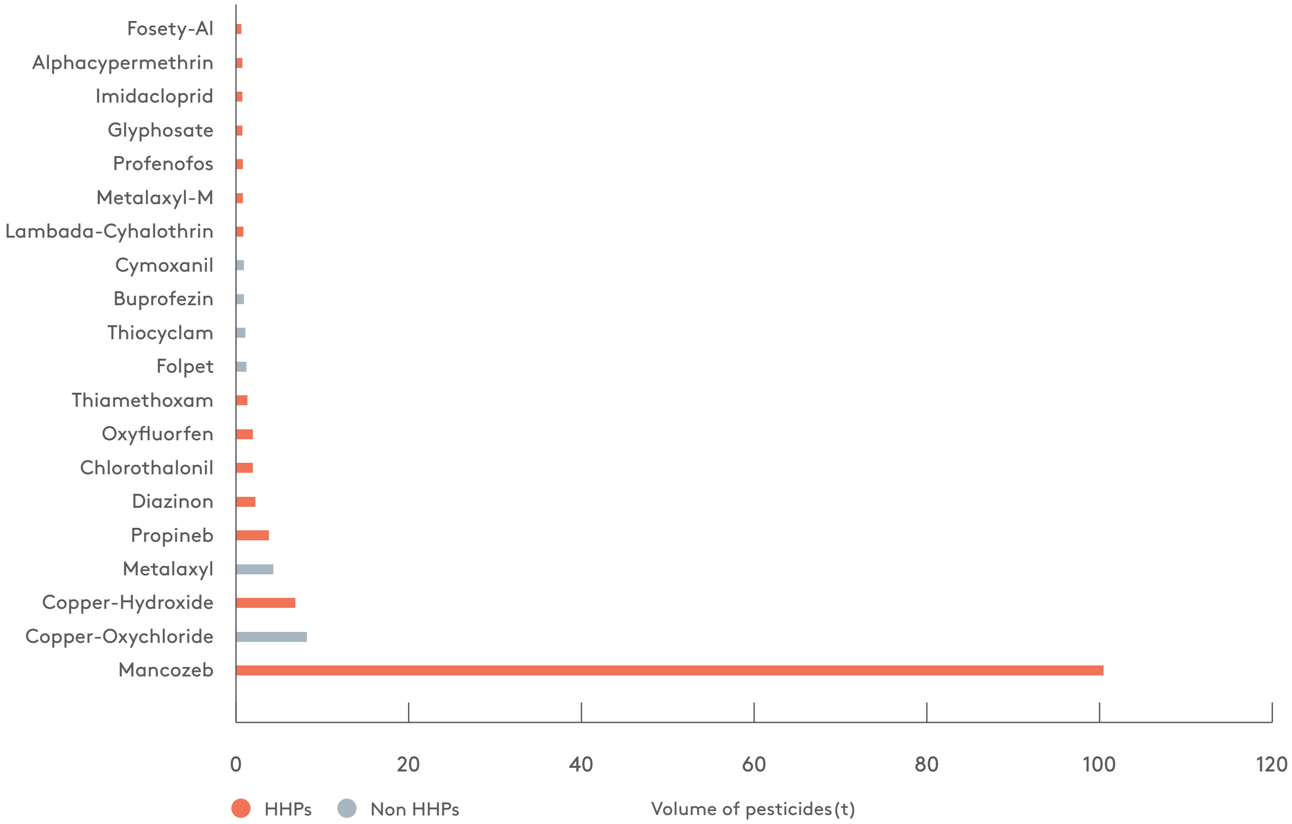


Figure 16. Volume of active ingredients used in tomato production

Residues in Kirinyaga County

A study by Kenya Organic Agriculture Network (KOAN) and EcoTrac Consulting found concerning pesticide residues in tomatoes from three markets in Kirinyaga County. The levels of acephate exceeded the allowed MRL in all the samples. Acephate is a strong endocrine disrupter, is a possible carcinogenic and neurotoxicant. The PCPB has registered acephate to control aphids, whiteflies and thrips on roses and tobacco and for the control of the Fall Armyworm on maize. The presence of acephate on tomatoes is a threat to food safety and illustrates pesticides are being misused by farmers[20] and should be adressed by government. Training and alternatives need to be provided.

As maize, wheat, coffee, potatoes and tomatoes require the highest volume of pesticides, it is not surprising that pest control costs are the highest with these crops (Fig. 17). Farmers in Kenya paid a total of $16.43 Mill to control pests in wheat production, followed by $15.95 Mill to control pests in maize production.

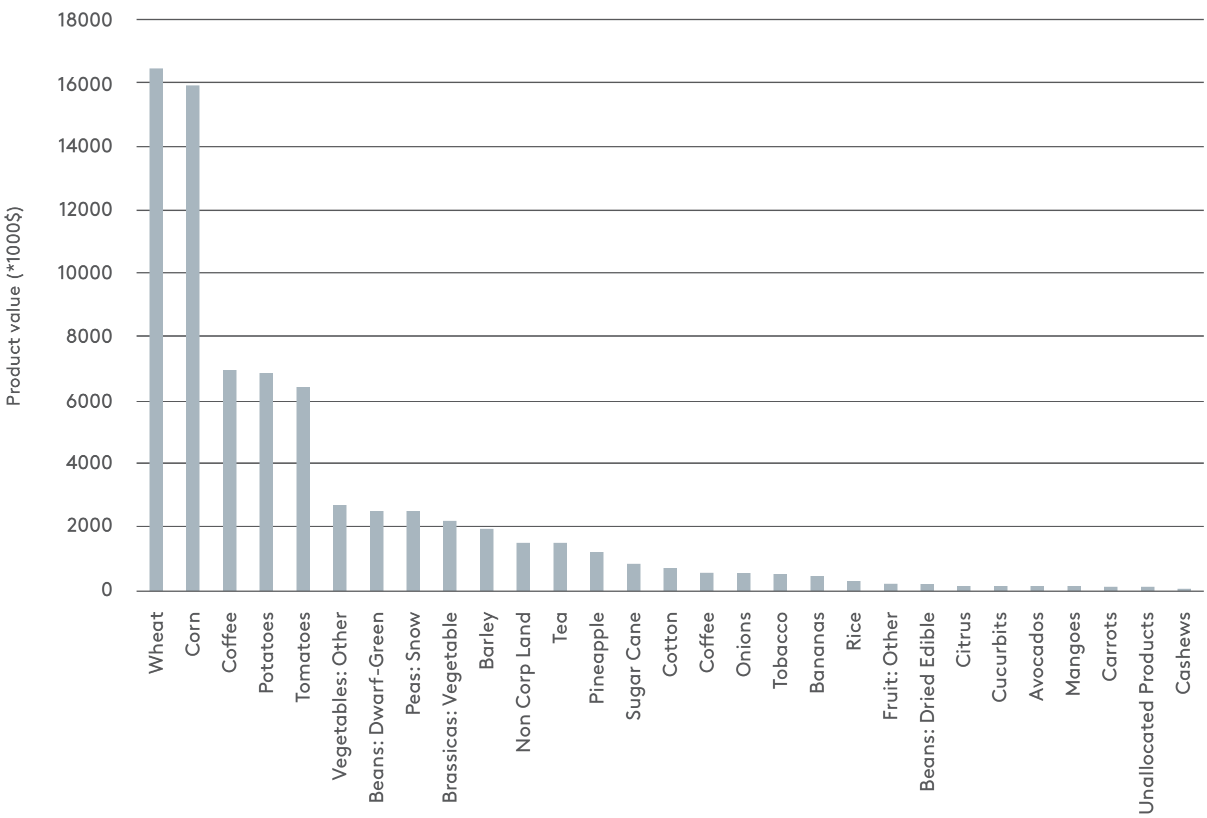


Figure 17. Value of pesticides that are used to control pests, fungal diseases and weeds

Pesticide Companies

In Africa, fewer pesticides (less than 5% of global sales) are used than in other regions of the world. However, with 33 million smallholder farmers, the African market for chemical crop protection is profitable for Western companies and projected to witness high annual growth rates. Major players in the Africa crop protection market are Adama Agricultural Solutions, Bayer AG, Sumitomo Chemicals, Syngenta and UPL Limited.

In Kenya, Syngenta leads the pesticides market with 20% market share, followed by Bayer AG with 15%, Corteva Agriscience™ (agriculture division of DowDuPont™) with 7.7%, FMC Corporation with 5.7% and Adama Agricultural Solutions with 4.4% (Fig. 18). In 2017, the Chinese state-owned enterprise ChemChina took over the Swiss agricultural group Syngenta. In 2020, Syngenta Group was formed from the Israeli pesticide company, Adama (4.4% market share in Kenya), and Chinese company Sinochem (0.24% market share in Kenya). The Syngenta Group has a total market share of 24.5% and clearly dominates the Kenyan pesticide market.

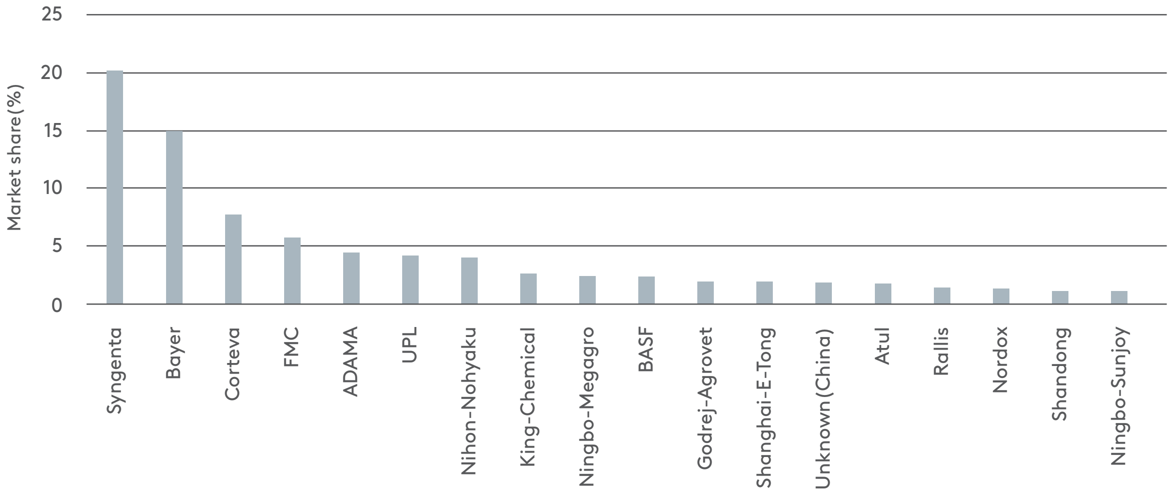


Figure 18. Market share of the top 20 pesticide companies in Kenya

Syngenta (headquartered in Switzerland)
sells 40 products with the highest volume of pesticides in Kenya 544 t of which 68% are HHPs. The top three products are the herbicides, Touchdown-Forte containing glyphosate and Gramoxone containing paraquat (banned in the EU), as well as the fungicide, Ridomil, containing a mixture of mancozeb (banned in the EU) and metalaxyl.

Bayer AG (German company)
sells 39 products with a total volume of 286 t of which 84% are HHPs. Their top selling product in terms of volume is the herbicide, Roundup Turbo containing glyphosate, but the top selling product in terms of value is the insecticide, Thunder, containing beta-cyfluthrin and imidacloprid (both banned in EU).

Corteva Agriscience™ (American company)
sells 13 products with a total volume of 173 t of which 94% are HHPs. The best-selling product in terms of volume is the insecticide, Dursban, containing chlorpyrifos (banned in EU and the U.S.) followed by the herbicide, Mamba, containing glyphosate.

Adama Agricultural Solutions (Chinese company)
sells 20 products with a total volume of 138 t of which 94% are HHPs. Adama's best-selling products are the insecticides, Pyrinex, containing chlorpyrifos and Diazol, containing diazinon as well as the herbicide, Linagan, containing linuron. All three active ingredients are banned in the EU.

UPL Limited (Indian company)
sells 12 products with a total volume of 291 t of which 95% are HHPs. Their top selling product is the herbicide, Kalach, containing glyphosate, followed by the fungicidal products Agrithane (mancozeb) and Mancolax (mancozeb/metalaxyl).

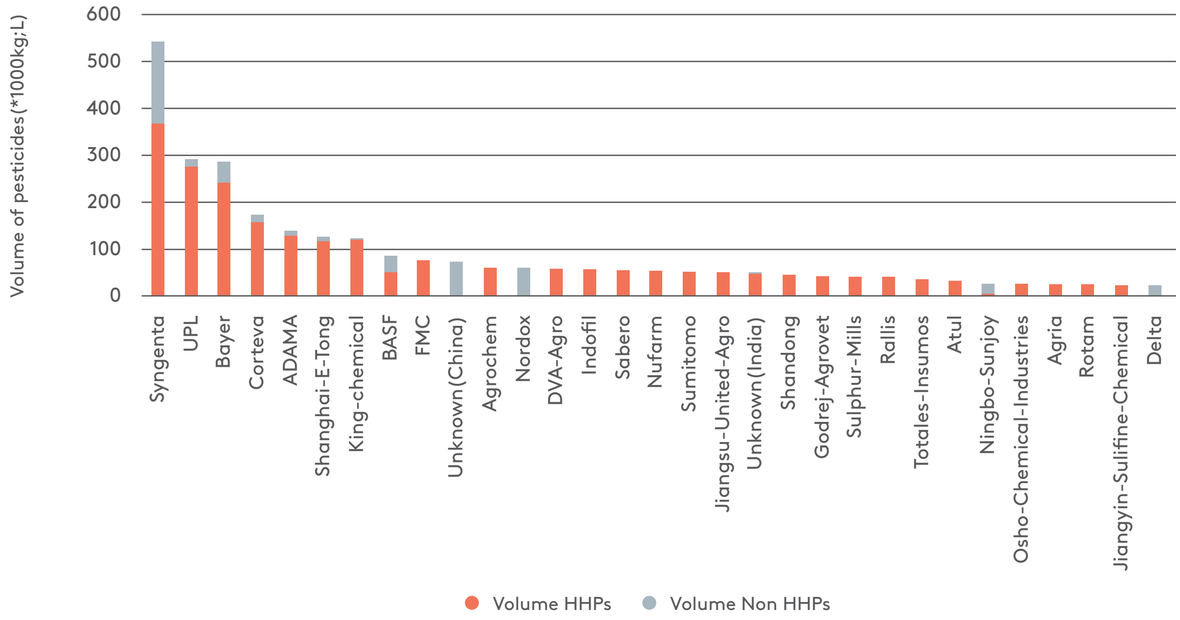


Figure 19. Share of Highly Hazardous Pesticides for the top selling pesticide companies

Prioritizing Active Ingredients To Phase Out

Human Health Toxicity

People can be unintentionally exposed to pesticides in various situations: on the field, in the forest, through food or drinking water. The clinical diagnosis of pesticide poisoning is made when typical symptoms develop after exposure. Some health effects may occur right away, while other symptoms may occur several hours after exposure. Short-term adverse health effects are called acute effects, and symptoms like stinging eyes or rashes, headaches, nausea, vomiting or diarrhea.

Poisonings in Kenya

A retrospective study of poisoned patients admitted at Kenyatta National Hospital between January 2002 and June 2003 shows that the most common type of poisoning was by pesticides (43%) followed by household agents (24%) and prescription drugs (14%). Organophosphates and rodenticides were the two most common pesticides accounting for 57.4% and 31% of poisoning, respectively. The major organophosphate encountered was diazinon[21]. Globally 385 million people suffer from unintended pesticide poisoning each year; 95% live in the Global South[22].

KNH is a national referral hospital and patients are admitted from all parts of Kenya. The results of the study are expected to mirror the situation in the rest of the country. However, Kenya does not have a good network of poison control centres and therefore the exact number of acute poisonings each year is unreported. Many pesticides are in use that have chronic effects on reproduction, are endocrine disruptors or are carcinogenic. Chronic ailments arising from pesticides exposure over the long-term are not monitored.

The higher the volume of pesticides, the greater the risk. Put differently, as the quantity of pesticides used increases, so does the probability of a negative effect on biodiversity in soil, air, and water and on human health through inhaling, digesting or accumulating substances in the body through the food chain. As we have seen earlier in this report, precaution around volume of pesticide use is specifically required with toxic herbicides like e.g. glpyhosate and fungicides like e.g. mancozeb.

However, pesticides with low use but very high toxicity, which is characteristic of insecticides, need to be cautiously considered. Many pesticides act in small amounts and can have, even when their use is not widespread, detrimental effects locally. Thus it is important to consider the volume of pesticide applied as well as its toxicity. The chance of acute, severe consequences are heightened when mitigation measures, such as protection equipment or buffer zones, cannot be implemented.

Mitigating risks

Due to the small size of most farms in Kenya, it is not possible to implement mitigation measures like buffer zones between homes, schools, clinics and treated fields. Farms are often situated along hillslopes and close to water ways and therefore prone to the risk of soil runoff containing pesticides. In many countries certain pesticides are only permitted when buffer zones are observed.

Additional factors affecting the proper use of pesticides include limited user knowledge about pests and pest management options, users not being able to read or understand labels; incomplete labels (e.g., information for bee protection is missing) or labels not available in local languages and the high cost of following label instructions like buying personal protection and application equipment. Financial stressors put pressure on farmers to sell produce, therefore pre-harvest intervals are not always observed.

Table 8 shows the top 40 pesticides (out of 151) in terms of human health toxicity. Pesticides are prioritized according to their toxicity only and according to toxicity combined with usage. The most toxic pesticides to human health (top ten) with a Human Toxicity Potential of 24 are bifenthrin, followed by dichlorvos (HTP = 23) and carbendazim, diazinon and malathion (all HTP = 22). All of these are categorized as HHPs and all (apart from malathion) are banned in Europe.

Immediate attention should be taken to reduce and ban the use of these active ingredients to avoid chronic health effects of farmers, bystanders, surrounding communities and consumers. In addition, the pesticides carbaryl, chlorothalonil, fipronil, iprodione, mancozeb, thiacloprid and thiram deserve cautious attention as they still show a high toxicity score of 20.

If one takes the usage into account, the list of problematic pesticides is different. Due to the high usage, mancozeb, clearly shows the highest score, followed by 2.4-D, glyphosate and chlorpyrifos. The use of these pesticides needs to be urgently reduced and alternatives need to be found.

Table 8. Ranking of pesticides in terms of the Human Health Toxicity Potential (HTP) and Weighted Toxicity Potential (WTP)

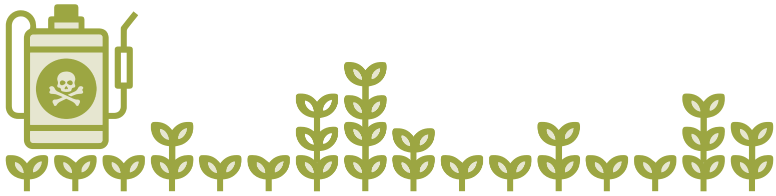
	Toxicity Potential (HTP)			Toxicity Potential x Usage (WTP)	
Rank	**Active Ingredient**	**HTP***	**Rank**	**Active Ingredient**	**WTP**
1	Bifenthrin	24	1	Mancozeb	3.74
2	Dichlorvos (DDVP)	23	2	2.4-D	1.20
3	Carbendazim	22	3	Glyphosate acid (Isopropylamine salt)	0.94
4	Diazinon	22	4	Chlorpyrifos	0.89
5	Malathion	22	5	2,4 D-Amine	0.55
6	Carbaryl	20	6	S-Metalochlor	0.49
7	Chlorothalonil	20	7	Glyphosate-trimesium	0.47
8	Fipronil	20	8	Bromoxynil	0.42
9	Iprodione	20	9	Acetochlor	0.27

	Toxicity Potential (HTP)			Toxicity Potential x Usage (WTP)	
Rank	Active Ingredient	HTP*	Rank	Active Ingredient	WTP
10	Mancozeb	20	10	Chlorothalonil	0.27
11	Thiacloprid	20	11	Copper oxychloride	0.26
12	Thiram	20	12	MCPA	0.25
13	Acephate	19	13	Diazinon	0.21
14	Acetochlor	18	14	Atrazine	0.20
15	Bromoxynil	18	15	Tebuconazole	0.19
16	Linuron	18	16	Sulphur	0.14
17	Alpha-cypermethrin	17	17	Propineb	0.12
18	S-Metalochlor	17	18	Linuron	0.11
19	Spirodiclofen	17	19	Chlorsulfuron	0.10
20	Thiophanate-Methyl	17	20	Pendimethalin	0.09
21	Triadimefon	17	21	Paraquat dichloride	0.09
22	Triadimenol	17	22	Acephate	0.08
23	2.4-D	16	23	Imidacloprid	0.07
24	2.4 D-Amine	16	24	Terbuthylazine	0.05
25	Cypermethrin	16	25	Carbendazim	0.05
26	Cyproconazole	16	26	Azoxystrobin	0.05
27	Epoxiconazole	16	27	Flubendiamide	0.04
28	Fluazinam	16	28	Epoxiconazole	0.04
29	Omethoate	16	29	Carbosulfan	0.04
30	Oxyfluorfen	16	30	Alpha-cypermethrin	0.04
31	Pendimethalin	16	31	Oxyfluorfen	0.04
32	Propiconazole	15	32	Fenoxaprop-P-ethyl	0.04
33	Pymetrozine	15	33	Copper Oxide	0.04
34	Tebuconazole	15	34	Metolachlor	0.03
35	Beta-Cyfluthrin	14	35	Cyproconazole	0.03
36	Chlorpyrifos	14	36	Fosetyl aluminium	0.03
37	Deltamenthrin	14	37	Cymoxanil	0.03
38	Esfenvalerate	14	38	Glufosinate - Ammonium	0.03
39	Indoxacarb	14	39	Triadimenol	0.03
40	Metolachlor	14	40	Metribuzin	0.03

Note: *Highest possible HTP = 26

Environmental Toxicity

Table 9 shows the ranking of the top 40 (out of 151) pesticides in terms of environmental toxicity. Again, pesticides are prioritized according to their toxicity only and according to toxicity combined with usage.



The most toxic pesticide to the environment is chlorpyrifos with an etp of 32, followed by imidacloprid (etp = 20), flubendiamide, fluopicolide, fluopyram and thiamethoxam (all etp = 16). As chlorpyrifos is used heavily by farmers in Kenya mainly on coffee, wheat and pineapple, this insecticide is also clearly ranked as number one. If one takes the usage into account, chlorpyrifos with a WTP of 2.04 is followed by mancozeb (WTP = 0.75) and glyphosate (WTP 0.71).

Table 9. Ranking of pesticides in terms of the Environmental Toxicity Potential (ETP) and Weighted Toxicity Potential (WTP)

	Environmental Toxicity Potential (ETP)			Environmental Toxicity Potential x Usage (WTP)	
Rank	**Active Ingredient**	**ETP***	**Rank**	**Active Ingredient**	**WTP**
1	Chlorpyrifos	32	1	Chlorpyrifos	2.04
2	Imidacloprid	20	2	Mancozeb	0.75
3	Flubendiamide	16	3	Glyphosate acid (Isopropylamine salt)	0.71
4	Fluopicolide	16	4	Atrazine	0.24
5	Fluopyram	16	5	Copper Oxide	0.21
6	Thiamethoxam	16	6	2.4-D	0.15
7	Fipronil	14	7	Sulphur	0.14
8	Abamectin	12	8	MCPA	0.12
9	Atrazine	12	9	Imidacloprid	0.11
10	Fosthiazate	12	10	Tebuconazole	0.10
11	Furilazole	12	11	Propineb	0.07
12	Methoxyfenozide	12	12	Flubendiamide	0.07
13	Carbaryl	10	13	2,4 D-Amine	0.07
14	Alpha-cypermethrin	8	14	Chlorothalonil	0.07
15	Beta-Cyfluthrin	8	15	Copper oxychloride	0.07
16	Bifenthrin	8	16	Acetochlor	0.06
17	Carbendazim	8	17	S-Metalochlor	0.06
18	Chlorantraniliprole	8	18	Diazinon	0.05
19	Clopyralid	8	19	Carbosulfan	0.06
20	Cyantraniliprole	8	20	Copper Hydroxide	0.05

	Environmental Toxicity Potential (ETP)			Environmental Toxicity Potential x Usage (WTP)	
Rank	Active Ingredient	ETP*	Rank	Active Ingredient	WTP
21	Cypermethrin	8	21	Paraquat dichloride	0.04
22	Cyproconazole	8	22	Azoxystrobin	0.04
23	Deltamenthrin	8	23	Metalaxly	0.03
24	Esfenvalerate	8	24	Thiamethoxam	0.03
25	Fluoxastrobin	8	25	Terbuthylazine	0.03
26	Fluxapyroxad	8	26	Linuron	0.02
27	Lambda-cyhalothrin	8	27	Bromoxynil	0.02
28	Profenofos	8	28	Pendimethalin	0.02
29	Propineb	8	29	Lambda-cyhalothrin	0.02
30	Pyrethrin	8	30	Carbendazim	0.02
31	Tebuconazole	8	31	Alpha-cypermethrin	0.02
32	Topramezone	8	32	Metalaxyl-M	0.02
33	Clofentezine	7.5	33	Cyproconazole	0.02
34	Carbosulfan	7	34	Epoxiconazole	0.02
35	Indoxacarb	7	35	Chlorsulfuron	0.01
36	Malathion	7	36	Fenoxaprop-P-ethyl	0.01
37	Azadirachtin	6	37	Thiocyclam hydrogen oxalate	0.01
38	Azoxystrobin	6	38	Halosulfuron-methyl	0.01
39	Cloquinotecet Mexyl	6	39	Chlorantraniliprole	0.01
40	Copper	6	40	Metolachlor	0.01

Note: *Highest possible HTP = 64

CHALLENGES IN PESTICIDE REGULATIONS

According to the Agrochemical Association of Kenya (AAK), pesticides usage in Kenya is increasing rapidly. The imported pesticide chemicals had increased from 6,400 tonnes to 15,600 tonnes between 2015-2018[23]. This trend mirrors the global situation where the pesticide market has doubled in the last 20 years. In Kenya, there are 247 active ingredients registered in 699 products for horticultural use. The increase in pesticide use and the sheer number of different active ingredients, presents a challenge for authorities to determine which pesticides should be withdrawn and replaced with alternative pest control solutions.

There have been various developments in Kenya that suggest which active ingredients should, or are, being prioritized. These include official letters and evidence submitted to the Ministry of Agriculture by civil society organizations concerning chlorpyrifos in the context of the desert locust invasion; as well as Pesticides Petition No. 70 of 2019[24], which was informed by a White Paper published by the Route to Food Initiative. In 2020, the PCPB issued circulars documenting concerns about diuron[25] and chlorothalonil specifically[26]. More recently, the PCPB published a shortlist of 30 active ingredients requesting technical information from the public[17].

Prioritizing pesticides to withdraw

Data analysis conducted for the purpose of this report adds to the weight of evidence through scientific assessment, of which pesticides to withdraw. Table 10 combines human health and environmental health toxicity and takes the usage into account. This list could be seen as a final prioritization list indicating the most toxic and most used pesticides in Kenya. Government should take immediate action to reduce their use, to make alternatives available and to spread knowledge to the farmers.

The fungicide, mancozeb, shows the highest risk towards human and environmental health. It is used on potatoes and tomatoes mainly to control fungal diseases like alternaria, phytophtora, botrytis, colletotrichum and septoria.

Chlorpyrifos is the most problematic insecticide, and is used mainly on coffee, wheat and pineapple to control chewing and biting insect pests. Chlorpyrifos is followed by the herbicide, glyphosate,that is applied on a variety of crops but mainly in wheat, tea, and maize production to control weeds.

Table 10 shows that most of the prioritized toxic active ingredients are applied to maize, wheat, coffee, tomatoes, and potatoes. There is an urgent need to develop sustainable pest control measures and holistic farming techniques to reduce the use of these pesticides.

Table 10. Final list of priority pesticides ranked by the combined Weighted Hazard Potential for Health + Environment of the top 40 active ingredients and percentage active ingredient applied to specific crop

Active Ingredient	WHP Total	Maize	Wheat	Coffee	Tomatoes	Potatoes	Tea	Grass land	Barley	Sugar Cane	Beans	Rice	Pineapple
Mancozeb*	4.49				31	58			0.5		0.4		
Chlorpyrifos*	2.94	28	15	37					0.5				13
Glyphosate	1.65	15	11	23			22	22	3	3			
2.4-D	1.35	62	30	2						4		2	
2,4 D-Amine	0.61	47	28					6				19	
S-Metalochlor	0.55	95								5			
Glyphosate-trimesium	0.47	23	14	9			25	8	8	8			
Atrazine*	0.45	88						9		4			
Bromoxynil*	0.44	24	68						8				
MCPA	0.37	19	75						5				
Chlorothalonil*	0.34		1	68	10						4	4	
Acetochlor*	0.33	74						21		5			
Copper oxychloride	0.33		8	53	17	18					2		
Sulphur	0.29			26							4		
Tebuconazole	0.29	3	53	3	1				23		2	2	39
Diazinon*	0.26		3	8	14						5		
Copper Oxide	0.25			100									
Propineb*	0.19				25	48							
Imidacloprid*	0.19	22	21	8	10				3		14		
Linuron*	0.13	25				74					1		
Paraquat*	0.13	72		19						3			
Flubendiamide	0.12	94			4								
Pendimethalin	0.11		95										

Active Ingredient	WHP Total	Maize	Wheat	Coffee	Tomatoes	Potatoes	Tea	Grass land	Barley	Sugar Cane	Beans	Rice	Pineapple
Chlorsulfuron*	0.11		69						31				
Carbosulfan*	0.09	36		24							11	13	
Acephate*	0.09										7		
Azoxystrobin	0.08	6	55	4					4		15		
Terbuthylazine	0.08	88											
Copper Hydroxide	0.07			52	43						3		
Carbendazim*	0.07		20									50	
Epoxiconazole*	0.06	4	90						6				
Alpha-cypermethrin*	0.05	5	2	17	17	1					7		
Cyproconazole*	0.05		84						16				
Fenoxaprop-P-Ethyl*	0.05		94						6				
Metolachlor*	0.04	100											
Oxyfluorfen	0.04				50								
Fosetyl Aluminium	0.04				5						1		60
Cymoxanil	0.04				11	69					2		
Metribuzin	0.03	87								11			
Triadimenol*	0.03		71						29				

Note: *Banned in Europe.

CONCLUSION

In conclusion, the analysis of pesticide use in Kenya highlights significant reliance on highly hazardous pesticides (HHPs) despite their known detrimental effects on human health and the environment. Out of the 310 pesticide products used, 63% are categorized as HHPs, constituting 76% of the total pesticide volume. Notably, 44% of the total pesticide volume consists of substances already banned in Europe due to their unacceptable risks. The top five widely used insecticides in Kenya are HHPs, and the majority of heavily applied herbicides and fungicides also fall into this category. Syngenta and Bayer AG dominate the market, both selling a substantial proportion of HHPs. Maize, wheat, coffee, potatoes, and tomatoes are the crops with the highest pesticide usage, predominantly relying on HHPs. Biopesticides account for a minimal share of the pesticide volume, and several active ingredients raise concerns about human health and environmental toxicity, warranting urgent regulatory actions and phase-out strategies.

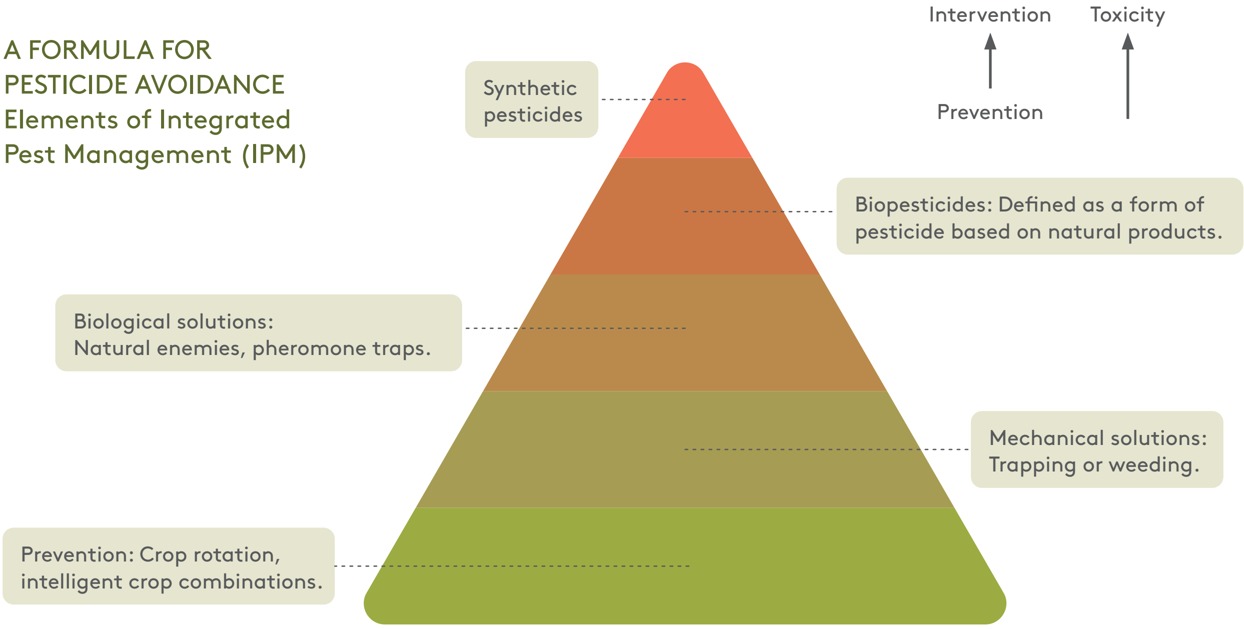
RECOMMENDATIONS

To achieve sustainable agriculture and uphold the right to healthy food and a healthy environment, the following actions are crucial:

1. **Phase out Highly Hazardous Products:** Gradually eliminate the use of products containing harmful ingredients that jeopardize human health and the environment, following the prioritized list.

2. **Implement Integrated Pest Management (IPM) Strategies:** Prioritize the adoption of IPM strategies, especially for crops like maize, wheat, coffee, potatoes, and tomatoes. These strategies combine various pest control methods, including biological controls, crop rotation, and cultural practices, reducing reliance on synthetic pesticides. However, biopesticides should only be considered as a last resort if prevention measures are not working. Priority should be given to agroecological farming strategies, focusing on a healthy, diverse ecosystem.

A FORMULA FOR PESTICIDE AVOIDANCE
Elements of Integrated Pest Management (IPM)



3. **Promote Access to Knowledge and Information:** Ensure that farmers, including women, extension officers, and Agrovet shop owners, have access to relevant information and knowledge for making informed decisions about sustainable agricultural practices, including pest and disease management.

4. **Invest in Research on Biopesticides and Biocontrol Methods:** Support research efforts to develop and promote biopesticides and biocontrol methods as alternatives to highly toxic pesticides. Emphasize the registration process for biopesticides, giving them appropriate attention compared to hazardous pesticides.

5. **Ensure Affordability of Biopesticides:** Make biopesticides affordable for all farmers, regardless of whether they export their products to Europe or not. This will encourage the widespread adoption of sustainable pest management practices, benefiting small-scale farmers.

6. **Address Corporate Accountability:** Governments should hold agrochemical companies accountable by regulating and monitoring their activities, promoting transparency, and encouraging responsible practices that prioritize human health, environmental protection,and sustainable agriculture.

By taking these actions, we can foster a transformation towards sustainable agriculture, embracing agroecology principles while safeguarding the right to healthy food and a healthy environment.

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A copy of this report is available on the Route to Food Initiative & the Heinrich Böll Foundation website and can be ordered by emailing info@routetofood.org / ke-info@ke.boell.org www.routetofood.org

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