ROUTE TO FOOD

# Pesticides in Kenya:
## Why our health, environment and food security are at stake

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# Introduction

Agriculture accounts for about 24% of Kenya's GDP with an estimated 75% of the population working in the sector either directly or indirectly. As an agricultural economy and while promoting mainly conventional agriculture, Kenya's demand for pesticides is relatively high and steadily increasing (Fig. 1). In 2018 Kenya imported 17,803 tonnes valued at 128 Mill $. These pesticides are an assortment of insecticides, fungicides, herbicides, fumigants, rodenticides, growth regulators, defoliators, proteins, surfactants and wetting agents. Of the total pesticide imports, insecticides, fungicides and herbicides account for about 87% in terms of volume and 88% of the total cost of pesticide imports.

It's remarkable that the volume of imported insecticides, herbicides and fungicides has more than doubled within four years from 6,400 tonnes in 2015 to 15,600 tonnes in 2018, with a growth rate of 144% (Fig. 2).

**FIGURE 1** Monetary value of imported herbicides, insecticides and fungicides from 2015 to 2018.

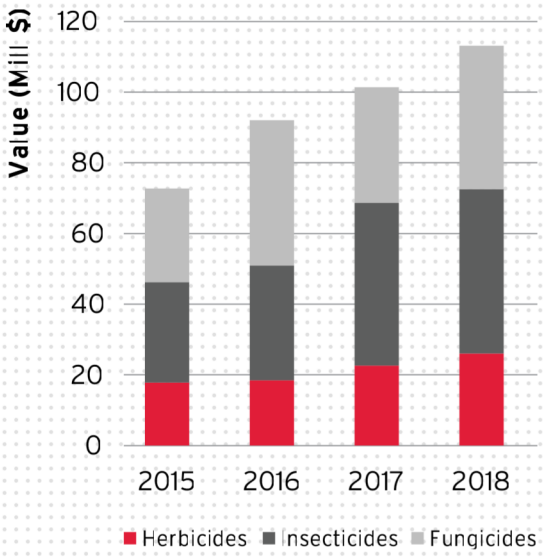
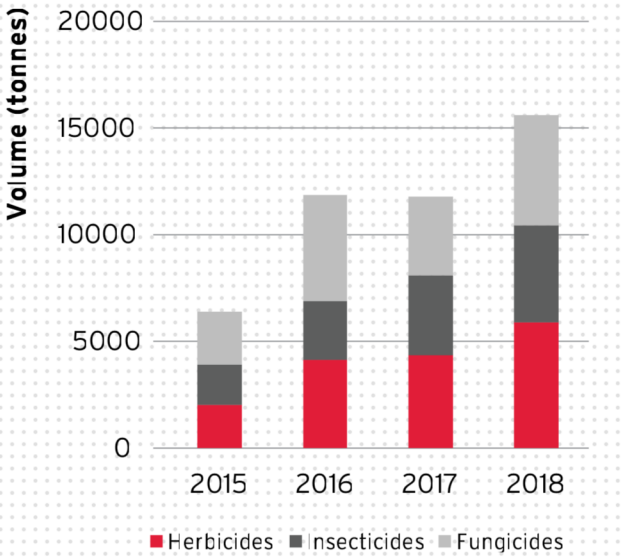



**FIGURE 2** Volume of herbicides, insecticides and fungicides imported from 2015 to 2018.




The increase in pesticide use requires necessary safe guards to control how they are applied, which will be challenging to fulfil in Kenya as is shown in this paper.

In Kenya there are no data available concerning the use of pesticides or the concentrations of pesticides in water, soil and food and the related impacts. Most of the research focuses on the persistent organic pollutants, such as DDT, lindane and endosulfan, which are rarely used anymore (Abong'o *et al.*, 2018). On an irregular basis, Kenyan Plant Health Inspectorate Service (KEPHIS) takes food samples, initiated and funded by the EU (EC, 2013), but the actual levels of pesticides are not made available to the public. Additionally, no regular monitoring system is in place. Epidemiological health studies related to pesticide exposure in Kenya, do not exist. This means it is not definitively known if we are facing an impact of pesticides on our environment and our health.

**NEED TO KNOW**

Kenyan consumers and farmers are not aware about the extent of pesticide use, their concentrations in food and environment and their possible effects on the environment and ecosystem services.

Due to the high toxicity towards human health and the environment and due to their persistence (length of time in the environment), many of these pesticides are banned or heavily restricted in Europe. Despite European restrictions and interventions to use less hazardous products, some of the withdrawn pesticides are still in use in Kenya, and continue to threaten the environment and the health of Kenyan citizens.

**NEED TO KNOW**

This paper sheds light on the amount and type of active ingredients and related harmful products used in Kenya, as well as Europe's and other countries' contribution to the situation.

The paper discusses potential impacts on environment and human health and the shortcomings in international and national legislation, which enable the current use of restricted pesticides in Kenya. To conclude, different solutions are suggested to introduce the first steps towards a better pesticide management approach and towards a more sustainable and regenerative agriculture.

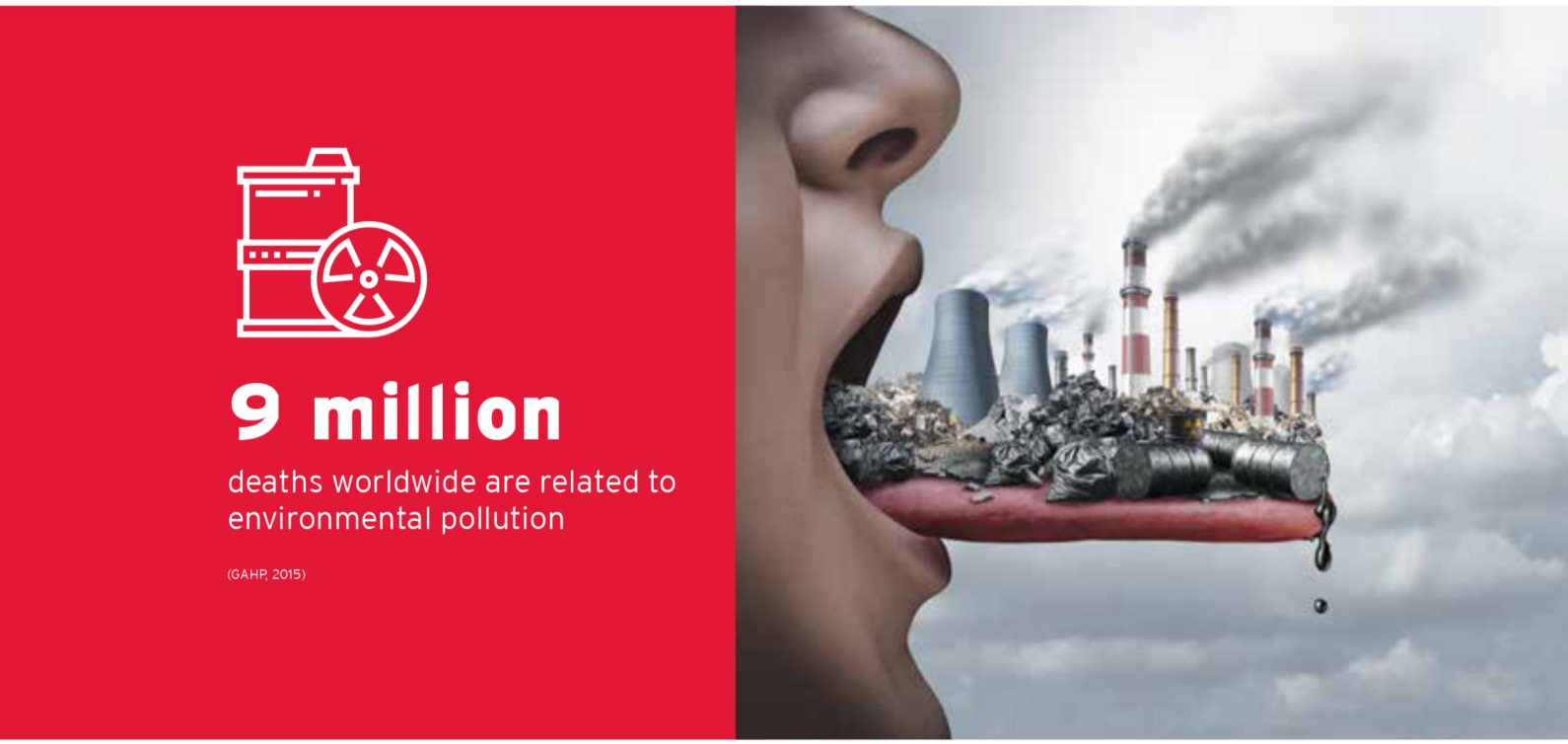
# Hazards of pesticide use

The heavy use of pesticides in industrial and domestic settings, has resulted in negative health, environmental and economic consequences worldwide (Ashburner and Friedrich, 2001). Pesticides are widely distributed in the environment (like air, soil, water and plants) and as a result, water and soil quality are decreasing and there is an increase in chronic health effects that are suggested to be related to pesticide exposure. Very often not only one pesticide is present, but mixtures of different pesticides at the same time. For example, in Swedish surface water there are 3 to 33, different pesticides in one water sample (Adielsson *et al.*, 2019). The total cumulative effect of these mixtures on biodiversity, food production and our health is still unknown.

Many pesticides are either acutely toxic, have long-term toxic effects, are endocrine disrupters (acting on the hormone system), are toxic to different wildlife species or are known to cause a high incidence of severe or irreversible adverse effects.

## Health hazard

Based on World Health Organization (WHO) data, the Global Alliance on Health and Pollution indicated in their annual report that 9 million deaths worldwide are related to environmental pollution (GAHP, 2015). WHO warned in several reports, that chronic, non-communicable diseases are a major challenge, making up 86% of the total burden of disease in the WHO European region. Non-communicable diseases include diabetes, Alzheimer's, cancer, osteoporosis, chronic lung disease, stroke, and heart disease. While WHO does not provide any figures on the respective share of pesticides to environmental pollution, experts consider them as one of the principal environmental risk factors for chronic diseases.



**9 million**

deaths worldwide are related to environmental pollution

(GAHP, 2015)

While farmers and rural residents are exposed most frequently and directly to pesticides, residues are found everywhere – in our food, our drinking water, in the rain and in the air. No one remains untouched by pesticide exposure. Long-term exposure to pesticides can also result in chronic health effects. Accurately estimating the number of such cases is even more challenging as symptoms may develop only years after exposure, diseases are often multi-causal, and people tend to be exposed to multiple harmful substances throughout their lifetime. A few studies in Kenya established a link between pesticide exposure and acute and chronic health effects (e.g. Tsimbiri *et al.*, 2015; Ohayo-Mitako *et al.*, 2000 ).

In terms of chronic health effects, pesticides can be classified as causing carcinogenicity, mutagenicity / genotoxicity, reproductive toxicity and neurotoxicity (UN, 2017). Additionally, many pesticides are classified as endocrine disrupters, meaning they interact with the hormone system, causing adverse effects such as increase or decrease in the activity of male or female hormones. This is not surprising since most pesticides are deliberately designed to act on the hormone system of plants and insects and accordingly their toxicity derives from the resulting change in hormones activities.

## Environmental hazard

While regulators are mostly concerned about health risks through pesticide residues, their effect on non-target organisms are hugely underestimated, especially in African registration procedures.

Pesticides can persist in the environment for decades and pose a global threat to the entire ecological system upon which food production depends. Excessive use and misuse of pesticides results in contamination of surrounding soil and water sources, causing loss of biodiversity, destroying beneficial insect populations that act as natural enemies of pests and reducing the nutritional value of food.

Evidence of these effects worldwide are numerous: Acute bird poisoning with carbofuran (Munir *et al.*, 2011), endocrine disrupting effects of atrazine in amphibians (Hayes *et al.*, 2010), population change of macroinvertebrates (insect larvae) in agricultural streams (Bollmohr & Schulz, 2000) and decrease in bee populations due to neonicotinoids (Dively *et al.*, 2015) are just a few examples. The impact of neonicotinoids on pollinators places special emphasis on the possible effect of pesticides on ecosystem services and in turn on sustainable food production.

Neonicotinoids, a commonly used class of systemic insecticides, cause soil degradation and water pollution and endanger vital ecosystem services such as biological pest control. Designed to damage the central nervous system of target pests, they can also cause harm to beneficial invertebrates as well as to birds, butterflies and other wildlife. For example, heavy use of these insecticides has been blamed for the 50% decline over 25 years in honeybee populations in the United States and the United Kingdom. This decline threatens the very basis of agriculture, given that wild bees and managed honeybees play the greatest role in pollinating crops. According to estimates from the Food and Agriculture Organization of the United Nations (FAO), of some 100 crop species (which provide 90% of global food), 71% are pollinated by bees. The European Union (EU), unlike the United States, restricted the use of certain neonicotinoids in 2013.

## Toxicity of active ingredient vs toxicity of products

The product (e.g. Roundup) that one can buy is actually a pesticide formulation that contains a number of different materials, including active and inert ingredients, as well as possible contaminants and impurities.

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

**NEED TO KNOW**

If a new pesticide is registered in Europe, it is first the active ingredient not the product, which is tested and registered.

However, the product mostly contains the ***inert ingredient***, which often constitutes over 95% of the pesticide product. Inert ingredients are mixed into pesticides products as a carrier or sticking agent, and are often as toxic as the active ingredient and sometimes even more toxic. For example, the inert ingredient called POEA in Roundup, which is not allowed in various European countries. Pesticide manufacturers are only required to list the active ingredients in a pesticide, leaving consumers and applicators unaware of the possible toxics present in the inert ingredients of pesticide products they are using. Pesticide manufacturers argue they cannot release information on inert ingredients because they are trade secrets, and if released, their products could be duplicated.

In addition, pesticides, when subject to various environmental conditions, break down to other materials known as metabolites, which are sometimes more toxic than the parent material.

# Pesticide use in Kenya

The Pest Control Products Board (PCPB) is a statutory organization of the Government of Kenya established under the Pest Control Products Act of 1982 to regulate the importation and exportation, manufacture, distribution and use of pest control products in the country.

Through the PCPB, 247 active ingredients are registered in 699 products for horticultural use. Active ingredients registered for flower production and forest management, as well as substances used for biological control are excluded from this analysis.

There are more products than active ingredients since one active ingredient can be in different formulations registered by different companies in different products. The active ingredient glyphosate for example, is registered in 39 products by 22 companies, followed by imidacloprid being registered in 30 products registered by 13 companies.

When it comes to reducing the risks and public health problems posed by pesticides, it is important to understand that the toxicity of different substances for human beings and for the environment, vary greatly.

For each active ingredient and product registered in Kenya, we looked up the different toxicity data in the Pesticide Properties Database (PPDB) (FOOTPRINT, 2006), which provides toxicity information on all active ingredients worldwide (Table 1). The tabulation is shown in Figure 3.

**Table 1.** Categories of toxicity according to PPDB

| Wildlife toxicity (bees, fish) [↔g/L] | | Chronic human health | |
|---|---|---|---|
| Very toxic | < 0.1 | Yes | Carcinogenicity<br>Mutagenicity<br>Reproduction toxicity<br>Neurotoxicity<br>Endocrine disruption |
| Toxic | 0.1-1.0 | Possible | |
| Moderately toxic | 1.0 -10 | No | |
| Low toxic | 10-100 | No data | |
| Not toxic | >100 | | |

Thereafter, for each active ingredient registered in Kenya (database available on the PCPB website), we looked up the registration status in Europe in the EU Pesticide Database. The tabulation is shown in Table 2.

## Registered products in Kenya and human health

**NEED TO KNOW**

It is concerning that there are products on the Kenyan market, which are certainly classified as carcinogenic (24 products), mutagenic (24), endocrine disrupter (35), neurotoxic (140) and many which show clear effects on reproduction (262) (Fig. 3).

Additionally, many products show "possible" effects on carcinogenicity, mutagenicity, reproduction toxicity, neurotoxicity and endocrine disruption. Some active ingredients in products are not found in the European database, meaning that they have never been registered in Europe. However, some data on their toxicity are available in the scientific literature, for example cuprous oxide (de Oliveira-Filho *et al.*, 2004). A minority of the products show no chronic effects, especially concerning endocrine disruption and reproduction toxicity.

**FIGURE 3** Number of products showing the probability of chronic health effects according to the classification in Table 1. The data are based on the Pesticide Properties Database (FOOTPRINT, 2006).

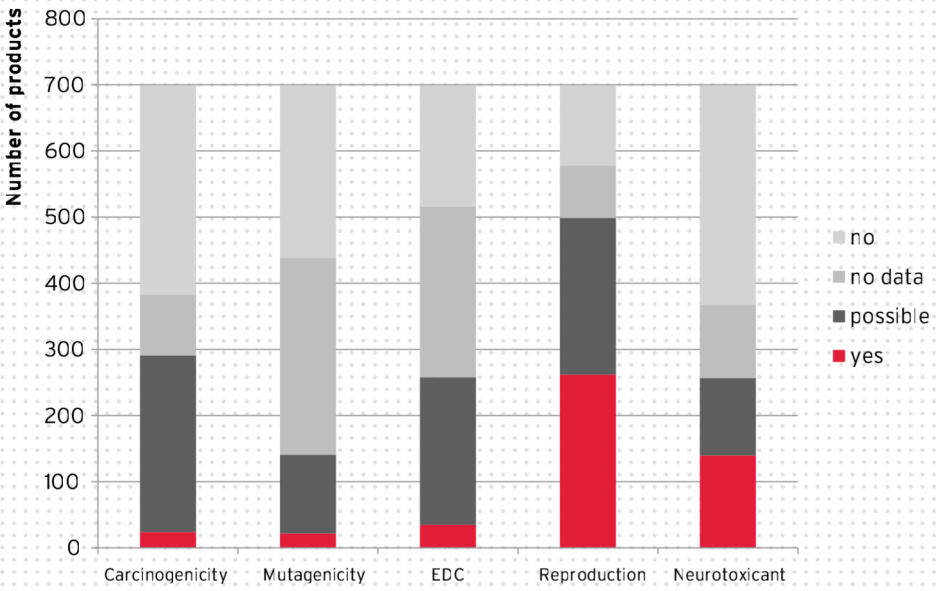



Table 2 reflects the active ingredients of products available in Kenya, which show clearly any of the five chronic health effects. Many of the active ingredients are no longer approved in Europe, for example carbendazim (marked with *) and many of them show more than one chronic effect, for example permethrin (written in bold).

**NEED TO KNOW**

Of particular concern, are the active ingredients permethrin, carbendazim and acephate which are not approved in Europe, have more than one chronic health effect and are sold in many products in Kenya.

Although abamectin and chlorpyrifos are approved for use in Europe, they are concerning as they are found in many products in Kenya, 30 and 18 products respectively, and have more than one chronic health effect. Kenya should lead on withdrawing these active ingredients from the market.

Imidacloprid (contained in 29 products) and mancozeb (contained in 44 products) show clear effects on development / reproduction toxicity and are contained in pesticide products such as Kohinor, Imidatop, for imidacloprid and Amidil, Amimax, Emthane and Victory for mancozeb.

NEED TO KNOW

The list in Table 2 can serve as a first priority list of active ingredients to be withdrawn from the market in Kenya. In absence of reliable usage data, the recommendation is based on information on pesticides that are registered.

**Table 2.** Active ingredients showing certain chronic health effects

| Carcinogenicity | Mutagenicity | Endocrine disrupter | Development/ reproduction toxicity | Neurotoxicity |
|---|---|---|---|---|
| **Chlorothalonil (11)** | 1,3-Dichloropropene*(3) | **Acephate*(6)** | **Abamectin (30)** | **Abamectin (30)** |
| **Clodinafop (3)** | **Carbendazim *(14)** | Bifenthrin (7) | **Carbendazim*(14)** | **Acephate*(6)** |
| **Fenchlorazole*(1)** | **Dichlorvos*(1)** | Carbaryl*(2) | **Carbofuran*(1)** | **Chlorpyrifos (18)** |
| **Oxyfluorfen (3)** | Thiophanate-methyl (3) | **Carbofuran*(1)** | Chlorothalonil (11) | **Dichlorvos*(1)** |
| **Permethrin*(5)** | **Trichlorfon*(1)** | **Deltamethrin (7)** | **Chlorpyrifos (18)** | **Deltamethrin (7)** |
| **Pymetrozine*(1)** | | Fenitrothion*(2) | Dimethoate*(12) | **Gamma-cyhalothrin (1)** |
| | | Flubendiamide (1) | **Gamma-cyhalotrin (1)** | **Glufosinate-ammonium*(1)** |
| | | Flufenoxuron*(2) | Glufosinate-ammonium*(1) | **Omethoate*(1)** |
| | | **Omethoate*(1)** | Imidacloprid*(29) | **Oxydemethon-methyl*(2)** |
| | | **Permethrin*(5)** | Mancozeb (44) | Malathion (9) |
| | | **Thiacloprid (1)** | **Oxydemeton-methyl*(2)** | **Permethrin*(5)** |
| | | | **Permethrin*(5)** | Tebuconazole (15) |
| | | | **Thiacloprid (1)** | **Thiacloprid (1)** |
| | | | **2,4 D-Amine (13)** | **Trichlorfon*(1)** |
| | | | +27 other active ingredients | **2,4-D-Amine** |
| | | | | + 18 other active ingredients |
| **Sum of active ingredients** | | | | |
| **6** | **5** | **11** | **42** | **32** |

**Note:** Highlighted in bold are the active ingredients showing more than one chronic effect, *not approved in Europe, (number) number of products containing the active ingredient.

Within the National Pesticide Residue Monitoring Programme (NPRMP) undertaken by KEPHIS, 1139 food samples were taken (KEPHIS, 2018; EC 2013). Out of the 1139 samples collected from the field under the NPRMP, 530 (46.53%) had pesticide detections, while 123 (10.80%) had exceedances of set EU maximum residue levels (MRLs). The most detected active ingredients were carbendazim, azoxystrobin, cypermethrin, chlorpyrifos, profenofos, difenoconazole, imidacloprid, tebuconazole and deltamethrin with 81, 80, 63, 50, 37, 35, 33, 31 and 30 detections respectively. Many of these pesticides show at least one of the chronic effects.

With respect to the samples collected, kales, peas and capsicum had the most pesticide residue detections at 94.40%, 75.84% and 59.18%. This means that operators and farmers as well as consumers, are directly exposed to the highly toxic pesticides.

## Registered products in Kenya and environmental health

According to the classification shown in Table 1, almost half (49%) of the products registered in Kenya are toxic or very toxic to fish (toxicity values <1), which might lead to a major threat to fish species, when pesticides enter the river and other water bodies via runoff or spray-drift. Depending on their persistence, they may have a short or long term effect on fish populations.

Thirty-one per cent of all registered products are toxic or very toxic to bees (toxicity values <1), which threatens the survival of bee populations and other pollinators and negatively effects food security as our food and seed production rely on pollination. Additionally, farmers are not aware of the toxicity to bees of many of the products they use and are not aware of the precautions to be taken. For example, not to spray in the morning when pollinators are out and foraging (van der Valk *et al.*, 2014).

**NEED TO KNOW**

Only limited data are available on the status of Kenyan pollinator populations and their importance for food production.

Examples of products that are very toxic to bees and fish are Aster Extrim (cypermethrin +acetamiprid), Lambdex (lambda cyhalothrin), Avirmec (abamectin) and Pryinex (chlorpyrifos).

**31%**
of all registered products are toxic or very toxic to bees

## Pesticide use restricted in Europe

Figure 4 illustrates that of the 247 active ingredients registered in Kenya, 150 are approved in Europe, 11 are not listed in the European database and 78 have been withdrawn from the European market or are heavily restricted in their use due to potential chronic health effects, environmental persistence, high toxicity towards fish or bees or due to the fact that there is insufficient data to prove no harm towards environment or human health ***(the "Precautionary Principle").***

**Precautionary Principle**

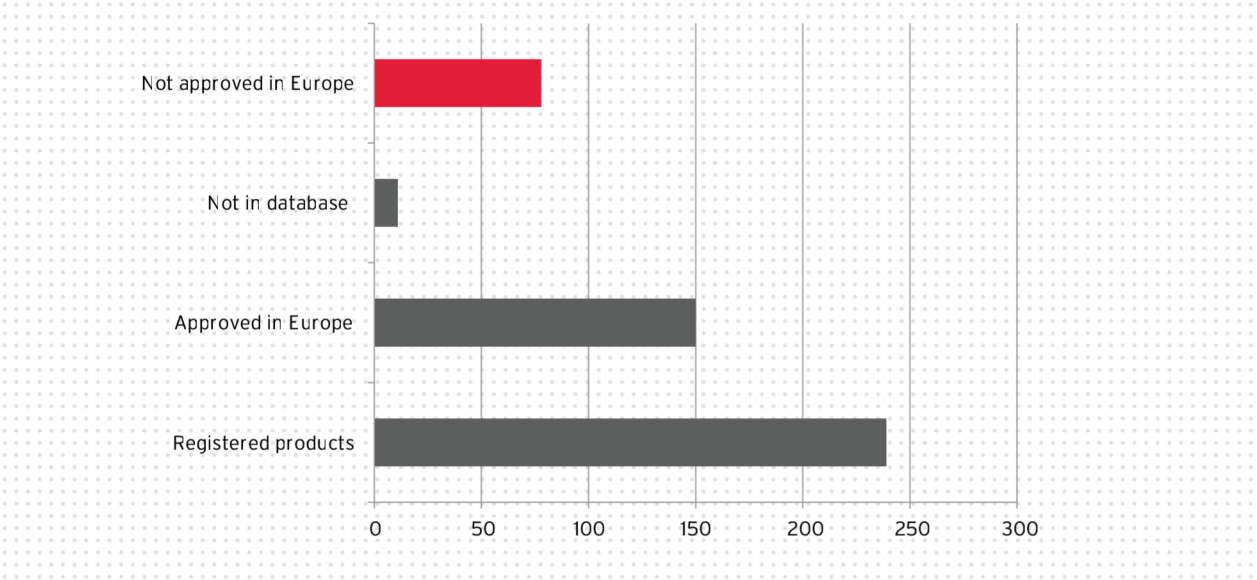
When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.

**NEED TO KNOW**

At least 32% of the active ingredients in the Kenyan market pose a serious potential impact on human and environmental health and are withdrawn from the European market.

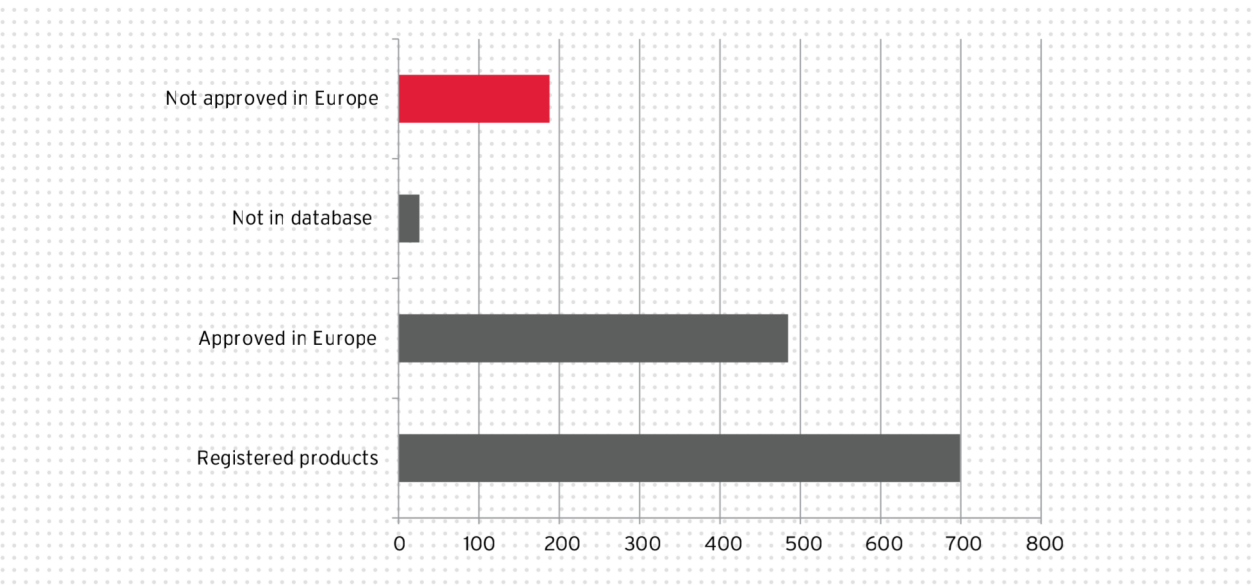
This percentage could increase, keeping in mind that not all approved active ingredients in Europe are harmless to the environment and human health. As shown in Table 2, many active ingredients influence either one or two of the chronic human health conditions or are very toxic to bees and fish, but are still approved in Europe (e.g. abamectin, chlorothalonil, mancozeb and thiacloprid).

**FIGURE 4** Active ingredients registered in Kenya and not approved in Europe.



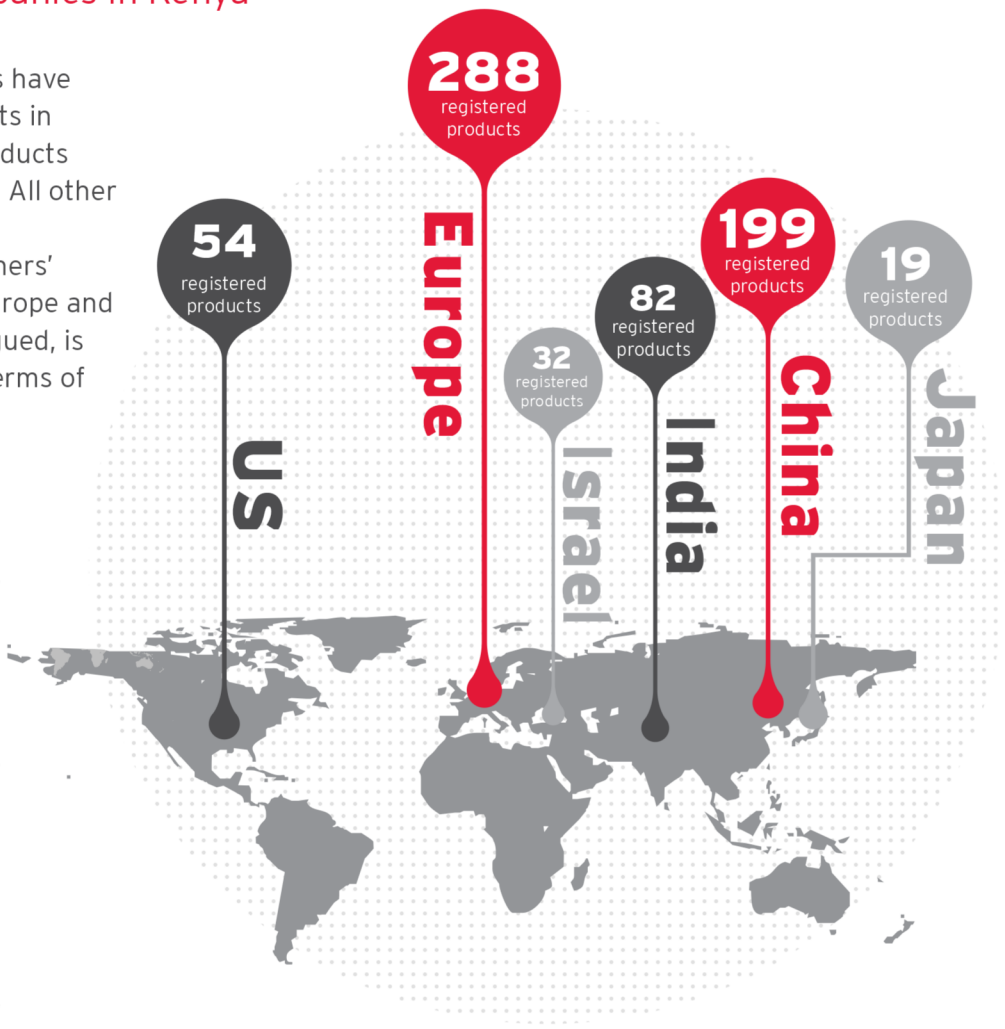

The situation looks similar if one looks at the registered products. There are 188 products (27%) out of 699 registered products that contain active ingredients, which are withdrawn from the European market (Fig. 5). Restricted active ingredients contained in most of the products are for example, imidacloprid (in 29 products), carbendazim (in 14 products), dimethoate (in 12 products), fenoxaprop-P-ethyl (in 11 products) and thiamethoxam (in 8 products).

**FIGURE 5** Products registered in Kenya and not approved in Europe.




## Registering companies in Kenya

In total, 155 companies have registered 699 products in Kenya. Most of the products originate from Europe. All other regions/countries are summarised under 'others' (Fig. 6). This means Europe and not China, as often argued, is the market leader in terms of pesticide sale.




Although there are 36 different European companies, almost half of the products (48%) are registered by BASF, BAYER AG and Syngenta.

Amongst the 47 Chinese companies, the companies Jiangsu Baoling Chemical, Ningbo Sunjoy Agroscience, Shandong Cynda Chemical and Zhejiang Bosst CropScience, registered 42% of the 199 products.