

STUDY

Requested by the DEVE committee



The use of pesticides in developing countries and their impact on health and the right to food



Policy Department for External Relations
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STUDY

The use of pesticides in developing countries and their impact on health and the right to food

ABSTRACT

This study provides a broad perspective on the main trends regarding the use of pesticides in developing countries and their impacts on human health and food security. Information is provided on the challenges of controlling these hazardous substances, along with the extent to which pesticides banned within the European Union (EU) are exported to third countries. The analysis assesses the factors behind the continuation of these exports, along with the rising demand for better controls. Recommendations are intended to improve the ability for all people, including future generations, to have access to healthy food in line with United Nations declarations. These recommendations include collaborating with the Rotterdam Convention to strengthen capacity building programmes and the use of the knowledge base maintained by the Convention; supporting collaboration among developing countries to strengthen pesticide risk regulation; explore options to make regulatory risk data more transparent and accessible; strengthen research and education in alternatives to pesticides; stop all exports of crop protection products banned in the EU; only allow the export of severely restricted pesticides if these are regulated accordingly and used properly in the importing country; and support the re-evaluation of pesticide registrations in developing countries to be in line with FAO/WHO Code of Conduct.

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Abbreviations

ASEAN	Association of Southeast Asian Nations
AU	African Union
BPH	Brown planthopper
DDT	Dichlorodiphenyltrichloroethane
DNA	Designated National Authority
ECHA	European Chemicals Agency
EFSA	European Food Safety Authority
EU	European Union
FAO	Food and Agriculture Organisation
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
GMO	Genetically Modified Organisms
ICM	Integrated Crop Management
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management
MRLs	Maximum Residue Limits
OECD	Organisation for Economic Co-operation and Development
PCPA	Pest Control Products Act
PCPB	Pest Control Products Board
PES	Pesticide Environmental Stewardship
PIC	Prior Informed Consent Procedure
POPs	Persistent Organic Pollutants
PPE	Personal Protective Equipment
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SAICM	Strategic Approach to International Chemicals Management
SDGs	Sustainable Development Goals
SDS	Safety Data Sheet
TRACIT	Transnational Alliance to Combat Illicit Trade
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
WHO	World Health Organization

Executive summary

The following study on the use of pesticides in developing countries and their impacts on human health and food security was produced within Framework Contract Reference EP/EXPO/FWC/2019-01/Lot3/4, Tender Procedure Reference: EP/EXPO/FWC/2019-01 between the European Parliament and OA Europe. The study is intended to provide a general understanding of pesticide use in developing countries, including the scale of the use, most notable trends, including the health impacts, and the role they play regarding food security.

Growing use of pesticides

Pesticides are widely used throughout the developing world, and pesticide demand is increasing due to the current system of crop production, which prioritises high agricultural yields. Made up of chemicals that can control pests or regulate plant growth, pesticides have provided developing countries with one way to increase those yields. Many farmers in developing countries view pesticide use as the best means to protect their crops against pests, such as desert locusts in parts of Africa this year, which are often the main threat they face. As such, pesticides can provide the only form of crop insurance available.

This is especially the case as changeable weather conditions related to global warming increase the uncertainties associated with crop yields. This year, the COVID-19 pandemic has added another factor to the situation by pushing up costs for farmers while reducing income. The pandemic has also made it harder to get farm labour and more complicated to get crops to a functioning market. The pandemic has created shortages of Personal Protective Equipment (PPE) for farm workers in the United States, according to the University of Illinois, raising the possibility that a similar dynamic is occurring in developing countries, even if the use of high-quality PPE is generally much less common in developing countries than in North America.

Against this background, this report considers the issues surrounding the export from EU Member States to developing countries of some pesticides that have been banned from use within the European Union (EU), because it has recognised the hazardous nature of those pesticides. However, it remains possible to export pesticides that are currently banned from use within the EU. Four of the top ten destinations for this category of pesticide are countries in Latin America, led by Brazil. Although less than 5 % of pesticide sales currently go to Africa, the use of pesticides is growing sharply, especially in West Africa since the arrival of a major new crop pest, the Fall armyworm, in 2016.

Health and environmental impacts

Pesticides have generally been considered to be a contributor to global food security, although the importance of that contribution, and how it is balanced against their potential to cause harm to human health and that of the broader environment, is a subject of fierce debate, often pitting companies against consumers or non-governmental organisations (NGOs). Today, there is evidence that the use of some pesticides causes long-term severe negative effects on human health and the environment.

Moreover, health concerns associated with the handling and use of pesticides are greater in developing countries because farmers often do not have adequate personal protective equipment (PPE) and are often unable to read labels that are usually the only source of safety instructions. In-person education for farmers on these topics is rarely available.

Problems related to pesticide use can extend beyond the farming area when residential areas are nearby. Pesticides pose a particular danger to children, not only through their use but through their storage within the household. Statistics show that pesticides are involved in a significant number of suicides every year.

The challenges of adopting alternatives

Driven by growing global concerns about the environment and sustainable food production, a transition away from exclusive reliance on chemical pesticides has gained critical importance. Integrated Pest Management (IPM) is advocated by the Food and Agriculture Organization of the United Nations (FAO) and the EU, meaning the use of natural predators and biopesticides in conjunction with mixed cropping and rotation where possible. Attempts to replace the use of pesticides with alternative approaches such as IPM have been tried in a number of countries, most notably Indonesia, but have required a level of government support that has been difficult to maintain due to resistance from farmers and the system's complexity.

The shift to alternatives is also complicated by shocks such as climate events and pandemics, and the challenges of the alternatives themselves. Moreover, the corporations that produce harmful pesticides may lack the short- to medium-term business incentives to make changes to their product portfolios: some products that are now known to be harmful retain significant market shares in many developing countries. Once a product has been developed and approved, there is relatively little incentive for a company to make product safety improvements beyond any need to meet new regulatory requirements.

Therefore, to encourage the shift to alternatives, enhanced regulation and enforcement in both developed and developing countries, and leadership on these issues by the EU will be critical. However, regulators in many developing countries often take years to approve new pesticides, meaning that older (and possibly more harmful) products are more likely to be available. These older pesticides have usually recouped their development cost and so can be offered by companies at a lower cost, making them more attractive in low-income countries.

Monitoring the legitimate trade in pesticides is challenging enough for developing country governments, but many also have to contend with an influx of counterfeit imports as well as local traders illegally mixing and marketing their local variants of pesticides to sell at affordable prices to small farmers.

Managing and diminishing the risks of pesticide use

The pace of the shift to alternatives over the coming years will be insufficient to eliminate the use of pesticides. For the foreseeable future, pesticides will remain widely used in developing countries. They will continue to contribute to part of the solution to providing food security.

However, in the coming years, clearer and more consequential differentiation among different types of pesticides will be needed. The use of highly hazardous pesticides (HHPs) can be phased out and less dangerous pesticides can be used in specific cases. Again, leadership by the EU in regulation and enforcement will be critical.

At present, international accords and declarations make governments responsible for ensuring access to safe food, meaning food that is safe at each stage from its initial production to its final consumption, and there are international standards that set minimum residue limits for pesticides. However, most of these recommendations are for voluntary practices and there is relatively little international coordination of restrictions on the sale of hazardous pesticides. Multilateral cooperation leading to the further standardisation of metrics and approaches will be needed to consolidate a new approach to food security.

As well as regulation, enforcement and standardisation, communication will also be key to managing and diminishing the risks of pesticides use in developing countries. Building awareness of the hazards associated with pesticides as well as of the benefits of alternatives will be an integral part of the approach that is needed. Other policy levers could also be used, encouraging private sector investors interested in sustainability, and fomenting the widespread adoption of digital technologies that enable better product tracing.

Recommendations

In summary, this report illustrates the role that pesticides play and, for the foreseeable future, are likely to continue to play in the agricultural sectors of developing countries. This high likelihood of continuing reliance on pesticides into the medium term makes it all the more urgent for concrete steps to be taken by the EU to help reduce the health and environmental impacts of pesticides used in developing countries, and to encourage a rapid shift away from HHPs as soon as possible. In parallel, EU policy can increase momentum for the shift towards alternatives to pesticide use.

The following are our specific recommendations arising from the material in this report. The EU should:

- 1: Collaborate with the Rotterdam Convention to strengthen capacity building programmes and the use of the knowledge base maintained by the Convention.
- 2: Fulfill a role in supporting collaboration among developing countries to strengthen pesticide risk regulation.
- 3: Explore the options to make regulatory risk data more transparent and publicly accessible. This could require long-term changes in the organisation and funding of the underlying risk research and the structure of intellectual property rights of risk data.
- 4: Strengthen research and extension in the fields of agroecology, organic farming and IPM, in particular supporting network initiatives on these themes among local universities and farmer associations in developing countries.
- 5: Stop all exports of crop control products banned in the EU.
- 6: Only allow the export of severely restricted pesticides if these are regulated accordingly and used properly in the importing country.
- 7: Support developing countries in establishing an efficient process of re-evaluating pesticide registrations according to contemporary good regulatory practices in line with the FAO/WHO Code of Conduct.

1 Introduction

The export of synthetic pesticides banned for use within the European Union (EU) to developing countries is increasingly questionable, especially given the growing awareness of evidence that these chemicals pose serious and long-term risks to human health and the environment. While the EU is increasingly concerned about the export of these products by firms headquartered within the bloc, the overall usage of pesticides is rising in developing countries, i.e. the World Bank categorisation of low- and middle-income countries (LMICs). The resulting impacts on human life and the planet are contrary to the United Nations' Sustainable Development Goals (SDGs) and threaten global food security. These impacts are all the more urgent to understand and consider at a time when the repercussions of climate change and the COVID-19 pandemic are constraining availability and access to food.

This report provides an overview of the scale of pesticide use across developing countries, discusses four notable trends regarding the impacts of its application, and explores the connections between pesticides and food security. It then details the scale of the problem of pesticides banned for use within the EU being exported from the bloc, and examines the attitudes of manufacturers that are engaged in this trade.

The report goes on to assess current international, national, and EU arrangements to control pesticides, including a series of recent developments in developing countries, some of which are notable in part because they show improvement in laws and because they show the impact that civil society advocacy can have in this area. The report concludes with a set of recommendations for the EU, which are intended to assist in improving the quality of life for all people across developing countries, in line with the SDGs, in addition to the health of the planet.

The report is based on a review of published academic literature and publicly available data; interviews with industry stakeholders, pesticide manufacturer representatives, researchers and academics; and written contributions from agriculture sector experts focused on Asia, the Middle East, Sub-Saharan Africa, Europe, and Latin America. In most cases, the experts contributing to this report live and work in the regions that they specialise in. The report received multiple independent critiques from experts specialising in the agriculture sector, pesticide use in developing countries, and related public and private sector policies.

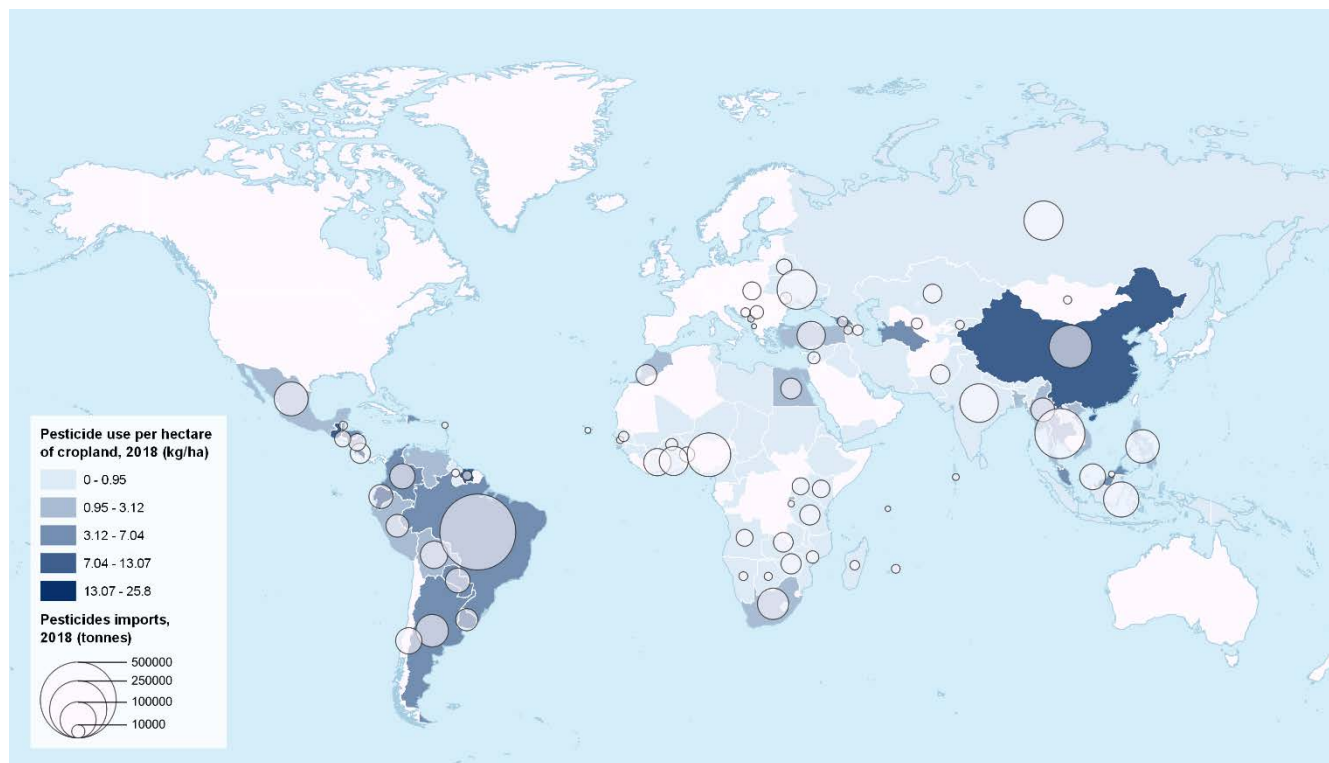
The report is intended for a non-specialist audience. Therefore, the word pesticide is used broadly to refer to all sub-categories of synthetic crop protection products. Biological pesticides are referred to separately. The term developing country is used instead of LMICs for similar reasons.

2 Pesticide use in developing countries

Composed of chemicals that can control pests and disease, pesticides are currently a widely used tool for pest and disease management across developing countries. Concomitantly, human health and environment issues related to pesticide handling are often pronounced in these countries because farmers and agricultural workers very often do not have adequate personal protective equipment and may also be unable to read labels with safety instructions. Pesticide manufacturers view their products as safe if used properly. However, product usage and handling as prescribed by the manufacturers are often not realistic in the settings in which pesticides are deployed: this a significant problem given the scale of their use by both large and small-scale farms and the pressure to produce crop yields.

2.1 Scale of use

Figure 1. Scale of pesticide use, selected developing countries



Source: FAO (2018).

The perceived role of pesticides in reducing uncertainty regarding harvests means that the scale at which pesticides are being used is expanding rapidly. Both large producers and smallholders purchase pesticide. Subsidies for pesticides have become less common in most developing countries since the 1990s, due to a combination of structural adjustment policies and emerging sustainability thinking. Currently, around two million tonnes are used per year on a global basis, most of which are herbicides (50%), followed by insecticides (30%), fungicides (18%) and other types such as rodenticides and nematicides (Sharma et al., 2019). Even as the EU sees regulatory approvals of chemical substances used in pesticides decline, demand is increasing in many developing countries, which together account for a quarter of global pesticide use (UNICEF, 2018). Industry lobby group CropLife International (hereinafter CropLife) has said that of 6,400 crop protection products sold by its members in 2015, 15% were Highly Hazardous Pesticides (HHPs), as defined by the World

Health Organization (WHO), one indicator of the extent to which dangerous pesticides still exist in great numbers¹.

Increased usage can be driven by the expansion of export markets or changing opportunity costs for labour, which makes hiring local workers more expensive. It may also be caused by disease, like the coffee leaf rust in Central America that began in the 2011-2012 harvest, which prompted the return to pesticide use for coffee farmers. Emergency situations can sometimes lead to strong increases in pesticide use. In Kazakhstan, the area treated with pesticides to control locusts quadrupled between 1998 and 2000 due to the development of a locust outbreak (Toleubayev et al. 2007). The outbreak of Black Sigatoka disease affecting the banana crop in Honduras led to a doubling of national fungicide use from 1991 to 1992 (Jansen, 2002). However, in most cases it is the general development and industrialisation of agricultural practices that explains the evolution of the pesticide market. While only 2-4% of the global usage is in Africa, demand for pesticides is expected to surge in the continent, driven, among other factors, by population growth and the expansion of local markets (Sharma et al, 2019)². Directly bordering the EU, Ukraine saw a 47% increase in pesticide use between 2015-2019, a trend that is expected to continue (Tkachenko et al., 2019).

Projections indicate that agricultural production in Brazil will continue increasing, and so will the associated demand for pesticides. Growth in 2020 relative to 2019 was estimated at 6.6% in terms of pesticide volume (975 000 tonnes); 5.8% in terms of revenue; and 8.0% in terms of application area (1.6 billion ha), of which 2.0% referred to new agricultural areas.

Table 1. Crops for which pesticides are purchased, selected countries

India	Brazil	Indonesia
Cotton	Soybeans	Rice
Paddy	Corn	Corn
Rice	Sugar	Fruit
Vegetables	Citrus	Vegetables

Source: Expert interviews

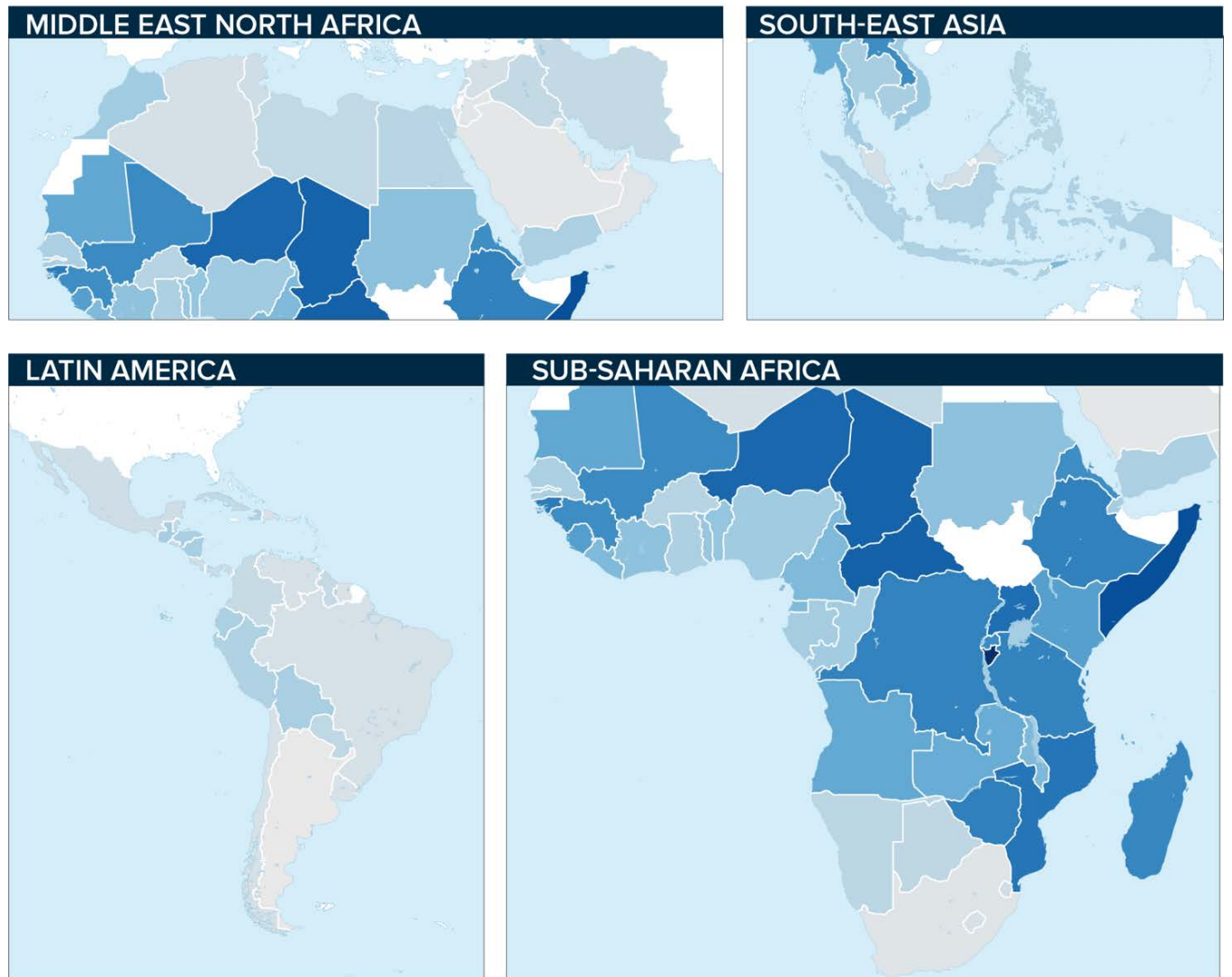
Figure 2 shows the percentage of people employed in agriculture in selected developing countries. In many of these countries, the number of people employed in the sector remains high. This makes it all the more important to consider the impacts of the rising use of pesticides, including HHPs, and concomitant difficulties in adhering to recommended usage and application protocols. There are implications for human health, the environment, and the structure of the agricultural sector in developing economies.

¹ According to the FAO and WHO HHPs can be defined as: 'pesticides that are acknowledged to present particularly high levels of acute or chronic hazards to health or environment according to internationally accepted classification systems such as WHO or GHS or their listing in relevant binding international agreements or conventions. In addition, pesticides that appear to cause severe or irreversible harm to health or the environment under conditions of use in a country may be considered to be and treated as highly hazardous.'

² The global population is expected to grow from seven billion in 2020 to more than nine billion by 2050, with more than half of that growth expected to occur in Africa (UN, 2020).

Figure 2. Share of employment in agriculture, developing countries

Employment in agriculture, 2020 0.1% 92.0%
(% of total employment, by country)



Source: World Bank.

2.2 Case study: Pesticide use and agriculture in Kenya

Kenya is a major destination for pesticides that have been banned for use within the EU. Its economy is heavily dependent on agriculture, which accounts for around 30 % of GDP, and more than 75 % of Kenya's population of 53 million people is directly or indirectly involved in agriculture either as smallholders or agricultural labourers. The country is the world's leading exporter of black tea and cut flowers, as well as a major exporter of coffee, and agriculture accounts for 60 % of Kenyan export earnings.

2.2.1 Agriculture intensification

Agriculture has intensified in Kenya, a trend linked to population growth, urbanisation and increased market integration. At the same time, pest and disease pressure on crops has also increased³.

Kenya, together with neighbouring Ethiopia and Somalia, has recently been facing a high threat of crop damage and new food security stresses due to the worst desert locust infestation in decades. The locust outbreak has had a devastating effect on livelihoods and food security across the Horn of Africa, as prevention systems have failed and an international emergency response has been slow to mobilise. The FAO has supported aerial spraying of insecticide as the most effective control measure⁴.

Since the active ingredients for pesticides are not produced on the African continent, and very few countries have any pesticide formulation capacity, Kenya is reliant on importing pesticides either from China (42 %) or from the EU (30 %)⁵. Demand for pesticides in Kenya is increasing rapidly, with imports increasing from 6 400 tonnes to 15 600 tonnes between 2015-2018, according to the Association of Agrochemicals of Kenya.

This demand helps explain why as much as 18 % of the pesticides used in Kenya may be counterfeit. Significant volumes of pesticide come into Kenya from neighbouring Tanzania and Uganda, which are hotspots of fake agrochemical production and where counterfeit pesticide levels may be over 40 % (AgriBusinessGlobal, 2018, Nampeera et al., 2019). Kenya also has a serious problem of stocks of obsolete pesticides, which are not stored safely and so could contaminate drinking water.

2.2.2 Regulatory shortfalls

Despite the many challenges described above, the Kenyan pesticide regulation regime is widely seen as one of the most rigorous on the African continent and closest to global benchmarks (TalkAfrica, 2019). The Kenyan pesticide industry is regulated by Chapter 346 of the Pest Control Products Act (PCPA) issued in 1985. Companies that wish to register their products first must go through the trial conducted by the PCPA. After successful completion of the trial, the company applies for a certificate which is valid for three years (Kenya Law Reports, 2012). Nonetheless, during the registration only the purity and efficacy of the product are tested. The PCPA does not mention the potential threats to human health, the environment, or biodiversity.

³ Studies show that for high-value horticultural crops such as mangoes, post-harvest losses can be around 50 %, and can be partly attributed to pests. The Fall armyworm has had a serious impact on maize yields in much of the country, with yields down by 70 % in some areas.

⁴ The FAO also has a history of promoting monitoring and very site specific controls before an outbreak occurs (preventive treatment), e.g. with the use of biopesticides.

⁵ According to the Kenyan Pest Control Products Board (PCPB), there are currently 247 active ingredients registered in 699 products for horticultural use, flower production and forest management. Out of these ingredients, only 150 are approved in Europe, 11 are not listed in the European Database and 78 have been banned in the European market because of their potentially hazardous nature. When it comes to products, 188 products (around 27 %) are no longer produced or consumed in the EU.

In addition, international regulations are unable to control the flow of dangerous products in Kenya, as pesticide manufacturers are still able to export goods to countries with weaker legislations from where they can find their way into Kenya (Route to Food, 2019).

Meanwhile, pressure on public sector budgets in Kenya limits the capacity of the extension system to work with farmers on training in the correct use of approved pesticides, including safe handling and dosage, use of buffer zones and the use of biopesticides or integrated pest management strategies. The government also lacks capacity to regulate the sale of illegal, unapproved, and unlabelled pesticides in rural markets and farmer-to-farmer exchanges. In addition, in Kenya most farming is done by women. Kenyan women tend to have much lower levels of education than men, and so lower levels of literacy, making it difficult for them to read labels and instruction manuals. Regulation is more effective in the large-scale commercial export sector, but 80 % of horticultural products are produced by smallholders, and half of these produce for export markets (Ridolfi et al., 2018). Working with this large and dispersed population is a challenge for government agencies.

Several independent studies have demonstrated that a significant proportion of registered ingredients are dangerous for health and the environment in Kenya, and its vegetables are on the EU quality watch list⁶. Kenya is one of 14 countries listed in the 2017 European Food Safety Agency report (published 2019) in which Maximum Residue Limits (MRLs) were exceeded in more than 10 % of samples tested. Residue levels that exceed the European MRLs were found in kale, tomatoes and water (Ngolo et al., 2019).

2.2.3 Implications for health

There is growing awareness in Kenya of the health impacts of pesticide use. The Route to Food Initiative, the Biodiversity and Biosafety Association of Kenya and the Kenya Organic Agriculture Network have pushed for a ban on 24 chemicals known to be carcinogenic and/or mutagenic.

A study sampling 800 residents in the Lake Naivasha region, the centre of large-scale horticulture in Kenya, showed evidence of respiratory, skin, bone and nervous system problems. The frequency of symptoms is higher among planters, weeders and harvesters (Tsimbiri et al., 2015).

The health impacts on children of pesticide use are closely related to child rights. Agriculture in Kenya is a major sector in which child labour is used (US Department of Labor, 2019), particularly for crops such as tea, coffee, rice, sugarcane, flowers, tobacco and cotton. Children may be more vulnerable to pesticides as their nervous systems are developing, and because they are less likely to be supplied with protective clothing or trained in appropriate use of agrochemicals.

2.2.4 Implications for the environment

Government agencies in Kenya do not conduct regular checks to assess environmental damage caused by pesticides. However, the overuse of pesticides has been the reason for declining insect populations in Kenya, as they kill insects in direct and indirect ways. In the latter case, they harm the reproductive ability of insects by increasing their susceptibility to diseases (Heinrich Böll Foundation and Earth Europe, 2020). Other environmental issues include runoff contaminating water bodies and spray drift where pesticides are not applied carefully, affecting people as well as non-target crops.

Africa is the fastest growing market for neonicotinoid pesticides (Network of African Science Academies, 2019). These pesticides have a lower human toxicity than earlier classes of pesticide, but still pose particular problems

⁶ Food from Kenya is to be analysed according to Regulation (EC) No 669/2009 24 July 2009 on import controls.

for pollinators and aquatic organisms and are partially banned in the EU. Over the longer term, neonicotinoid use could have serious implications for biodiversity and the environment.

2.2.5 Outlook

Kenya has managed the development of its agricultural sector to encourage integration with global supply chains and improve its food security, which are impressive achievements. But productivity increases have been reached by using high amounts of pesticide. Pesticide regulation and controls have not kept pace with Kenya's agricultural development successes.

Although Kenya has some of the best scientific capacity in Africa and a clear regulatory framework for this area, it still faces challenges in establishing an effective pesticide control regime that works in practice; there is mounting evidence that products have been approved that have harmful health and environmental impacts. Pressure from consumers or exporters to reduce the use of harmful agrochemicals can be expected to increase and so require the adoption of practices and products that have fewer downsides.

Kenya's new pesticide regulations and revamped institutions are an attempt to get to grips with some of the issues around lax enforcement of rules, and to establish clearer approved channels for sale. This is positive, but much still needs to be done in terms of training and education to support the correct use of approved products. Enhanced inspection of pesticide sales points and policing of illegal supply chains are also needed to curtail the supply of unapproved products, where fake or illegal products can easily cross borders from neighbouring countries. None of this will be easy with public spending under pressure as a result of the COVID-19 pandemic.

According to Kenya's 2019-2029 Agricultural Sector Transformation and Growth Strategy, the government aims to develop a prosperous, modern and sustainable farming sector that generates export revenue, supports livelihoods, and contributes to food security and poverty reduction. Crop protection is an important part of this and will require the safe use of approved pesticides applied appropriately within IPM strategies, supported by effective well-resourced implementation of regulations, and monitoring of environmental and health impacts.

Achieving this will take time but is far from impossible. If affordable alternatives to current pesticide use are available and offer clear benefits such as market access and higher prices (if commodities are certified), then small-scale farmers, who dominate production, will subscribe. The large-scale farming sector will welcome integrated solutions if they offer a cost advantage and will also want to ensure that they are on the right side of MRL requirements.

There is a role for the EU in supporting Kenya's effort to achieve these objectives as it is an important supplier of produce to the EU member states. The EU could work on developing a roadmap and action plan with key stakeholders. Along with training and incentives to supply improved and approved inputs, the promotion of more knowledge intensive approaches such as IPM and organic agriculture could also be included. Export sectors can provide leverage points for generating funds to improve local pesticide regulation.

3 Safety challenges of pesticides

As concerns about the environment and sustainable growth become more prominent in shaping public and private sector agendas, and awareness of the negative impacts of pesticide use grows, the scale of current pesticide use is increasingly viewed as untenable in the long term. Four key trends highlight the degree to which pesticides are embedded in the agriculture sector in developing countries as well as the challenges involved in shifting to healthier alternatives.

3.1 Harm to human health is underestimated

There is evidence that farmers, their families and those living adjacent to farming areas may face long-term health risks associated with the use of pesticides, although the impact of pesticide use is often undetected (Larsen et al., 2017). In developing countries, incidents involving handlers of pesticide occur more often and the health impacts may be more immediate, given a frequent lack of PPE and minimal education about the correct way to spray chemicals. About 20 % of the approximately 800 000 people who die from suicide every year do so by ingesting pesticides (WHO, 2019). The issue is particularly significant in Asia, where pesticides are often used in ‘impulsive’ suicide attempts brought on by stress (Bonvoisin et al., 2020). A ban on paraquat and two other pesticides resulted in a 21 % fall in suicide mortality in Sri Lanka between 2011 and 2015 (Knipe et al., 2017).

3.1.1 Direct and indirect exposure

The negative health effects associated with some pesticide use include respiratory, integumentary, cardiovascular, gastrointestinal, and neurological problems⁷. Between 2008 and 2014, there were more than 2 000 cases of acute pesticide poisonings in Morocco. Of those cases, 50 % of the pesticides involved were classes I (extremely or highly hazardous) and II (moderately hazardous) according to WHO classifications (WHO, 2019). Longer-term effects are harder to attribute directly to pesticide use but may include cancer. There are also health impacts from the consumption of food with residues over regulatory limits (Joko et al., 2020).

3.1.2 Impacts on adjacent residential areas

Individuals and families living in the vicinity of an area where pesticides are used are at risk. In South Africa, there have been many cases focused on the occupational health risks of pesticides for farm workers, and some in which people living adjacent to agricultural fields have reported symptoms associated with exposure to spray drift. A key factor has been the proximity of residential areas to farming areas, a situation which appears to be increasingly common and indicates a need for a clear buffer zone between farming operations and residential housing. Data from Brazil shows a similar risk to those living adjacent to areas that experience the spraying of pesticides (Bombardi, 2017).

In Costa Rica, a research programme on bystanders, in particular pregnant women and children, found that exposure to pesticides during the first half of pregnancy may be associated with respiratory outcomes in the first year of life and was associated with poorer verbal learning outcomes in children (Barraza et al., 2020; Mora et al., 2020; van Wendel de Joode et al., 2016).

⁷ The main symptoms of pesticide exposure are headaches, dizziness, excessive sweating, blurred vision, nausea, breathing difficulty and skin rashes. Pesticide impacts occur through pesticide inhalation, skin contact and lack of protective equipment.

3.1.3 Poor monitoring

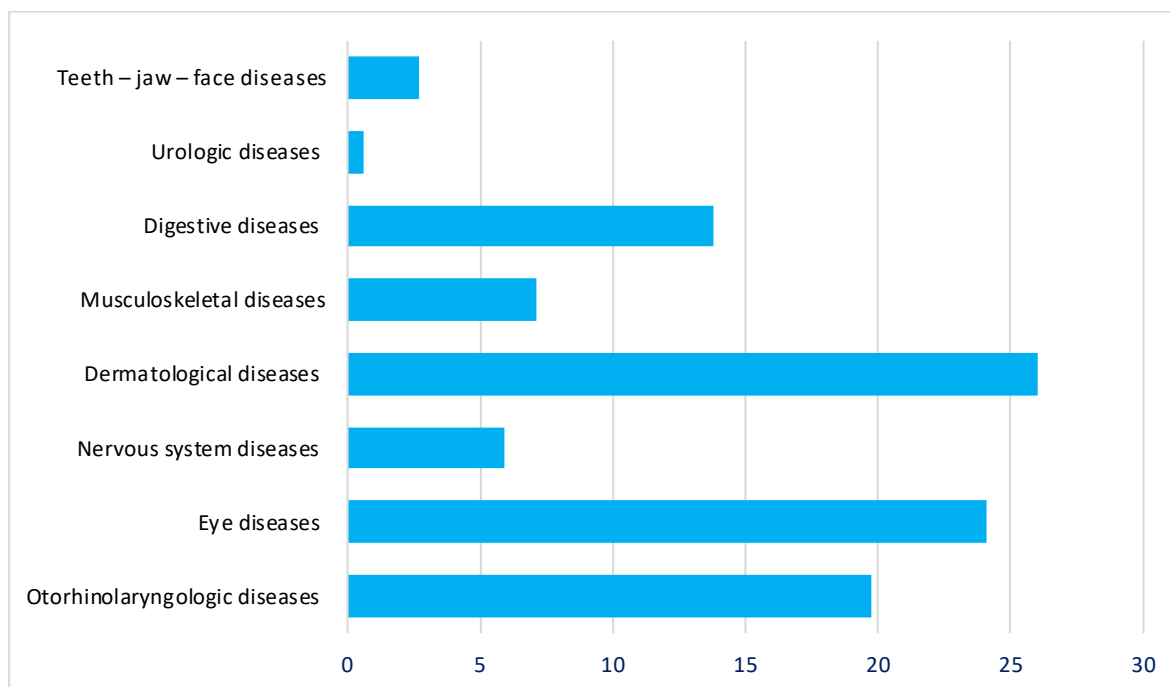
Understanding the full extent of pesticide harm to human health has been hampered by a lack of consistent monitoring and rigorous testing. However, in West Africa, episodic studies by local scholars, students, donor projects and public health agencies allow three cautious generalisations. First, dichlorodiphenyltrichloroethane (DDT, a type of pesticide) residues from spraying programmes can linger for decades in the food chain, with milk, meat, fish and even human breast milk affected. Second, many horticultural farmers apply unnecessarily potent insecticide formulations intended for cotton production. The high strengths involved pose unnecessary health risks to farmers and consumers. Finally, fungicides and insecticides applied to improve seed storage have resulted in food poisoning when hungry family members have consumed stored grains.

3.1.4 Child exposure

The effects of pesticides on children are difficult to overstate. A 'significant relationship' was found between pesticide exposure during pregnancy and low birth weight, according to a 2018 study carried out in Brebes, Indonesia. The findings are indicative of the risks faced by agriculture workers and their children who are not properly protected from pesticides. The risk of stunting was more than three times higher for children exposed to a high level of pesticides compared to children that were not (Widyawati et al., 2020). The WHO has also noted the potential connections between children's exposure to pesticides and conditions such as congenital heart disease and leukaemia. Pesticides stored inside homes are also common causes of childhood poisoning (WHO, 2017). In Costa Rica, maternal exposure to crops that were sprayed with fungicides were associated with adverse and gender-specific effects on infant neurodevelopment (Mora et al., 2018).

A recent study focusing on the health effects of pesticide use in Tu Ky district, Hai Duong province, Vietnam found that local farmers' awareness of the appropriate use of pesticides is minimal. Tu Ky district specialises in rice and vegetable production; therefore, agriculture represents the primary source of income for most of its population. Three hundred households in three different communities were interviewed, showing that a relatively high (12.48%) percentage of farmers use pesticides that are labelled as toxic, while the number of farmers who are aware of the list of banned pesticides is insignificant. Farmers lack knowledge of the proper methods of pesticide utilisation and disposal. Although the majority of the farmers use primary forms of protection equipment (masks, hats), the use of gloves, glasses, boots and raincoats is limited. After spraying, more than 93% of the farmers wash the used pesticide bottles in nearby canals, while more than 6% do not wash the bottles at all. The lack of awareness of proper pesticide use proved to be the key reason behind the common diseases of the farmers in the Tu Ky district. (Huyen et al., 2020).

Figure 3. Common diseases of farmers in Tu Ky district, Hai Duong province, Vietnam



Source: Vu Ngoc Huyen et al., 2020.

3.2 Safety guidelines are misunderstood

Many pesticide manufacturers do not provide understandable instructions to end users. Local salespersons and dealers who are relied upon for instructions often provide misleading or erroneous information. At the same time, family income from farming has declined over the years. Therefore, farmers are under pressure to protect their crops from pests and produce enough income to at least break even, with physical safety often a distant concern. With insurance against crop failure absent or prohibitively expensive, the application of pesticides is often the only type of insurance available. This is a dangerous combination that creates a situation where the 'real world' use of pesticides does not meet the intended applications of manufacturers.

3.2.1 Limited access to information

A lack of labelling in local languages and high levels of illiteracy among farm workers mean critical safety information is often not communicated to the individuals that actually handle pesticides. The Globally Harmonized System of Classification and Labelling of Chemicals (GHS) is the accepted international standard for pesticides labelling. However, only 55 % of countries have reported to the UN that their regulations for the labelling of agriculture pesticides are in line with GHS. Countries in the Americas are least compliant with the GHS (30 %), followed by the Western Pacific (40 %), African (56 %), Eastern Mediterranean (56 %), South-East Asia (75 %), and Europe (86 %) (WHO and FAO, 2018)⁸.

⁸ A particularly problematic area is the need to make clear the difference between the concentration of a pesticide water tank mixture and the dosage rate of the pesticide that needs to be applied per surface area or crop area. Erroneous calculations may result in overdosing or under-dosing of pesticides when applied. The former may result in human and environmental contamination while the latter may create the circumstances for pest or disease resistance development.

3.2.2 Homemade preparations

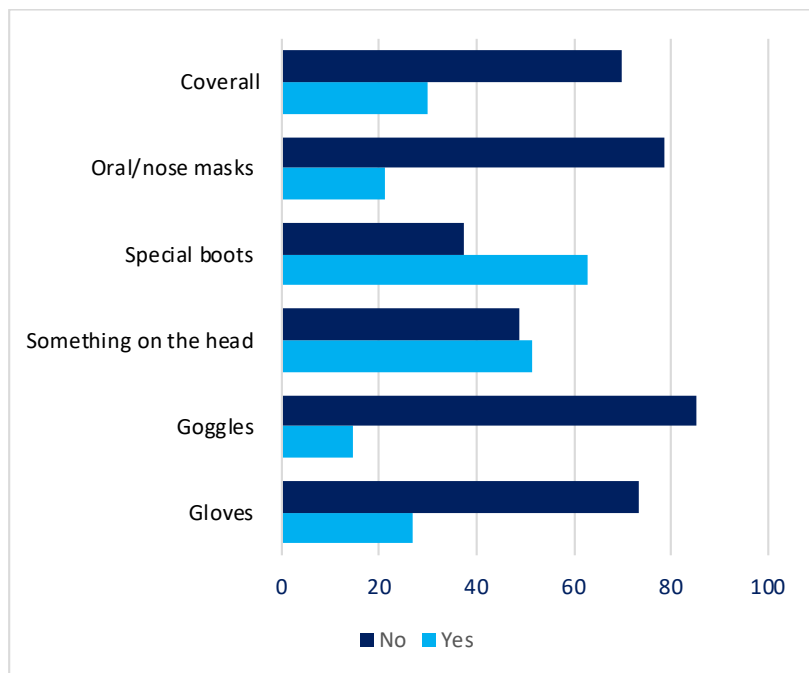
While the inability to understand labels is likely to cause farmers to use manufactured pesticides incorrectly, farmers in many countries prepare, or mix, their own tailor-made pesticide formulations to reduce costs. In many cases, local salespersons are not trained, certified, or controlled, and may also prepare their own formulations for retail sale. In Ghana, there are examples of traders mixing paraquat with glyphosate in order to combine a quick effect from the former with the more durable long-term weed-killing effects of the latter. The strategy impresses farmers and motivates return business.

3.2.3 Personal protective equipment

Across the developing world, the use of PPE is highly problematic. In large farm operations, labour rights are more closely monitored and employees tend to use PPE. Research suggests that farmers who had a higher income used significantly higher pesticide safety practices (Moradhaseli et al., 2017, Khan, 2009). They also have greater access to information that explains the need for PPE and how best to use it (Sapbamrer et al., 2020). However, some workers on large farms may still find it uncomfortable and therefore do not wear PPE, and the employer does not necessarily take responsibility to ensure that workers use it. On smaller operations, farmers more often do not follow manufacturers' safety recommendations for handling and applying pesticides and cannot afford or do not use adequate protective clothes or equipment. They might refuse the use of PPE due to cultural reasons, because they find it uncomfortable or because they lack the means to thoroughly wash it for reuse. On both large and small farms, workers that do not want to use PPE may be powerless to insist that employers provide it⁹. In addition, a recent study concludes that the actual effectiveness of PPE in working conditions may be over-estimated (Garrigou et al., 2020). Hence, pesticide risk management should go beyond simply advising the use of PPE.

⁹ The appropriate protective clothing should be used as a last line of defence against the dangers posed by hazardous pesticides, with users being fully aware that PPE reduces exposure but does not fully prevent it, even when the correct PPE is used. In this context, PPE includes but is not limited to: gloves, boots, aprons, coveralls, respirators, headgears, eye, ear, nose and mouth protection (FAO, 2020). The label of a pesticide product is the primary means of communicating information to the pesticide user about the need for PPE. PPE resistance to water and chemicals varies significantly across types and purpose of the equipment (PES, 2020). The reusable types of PPE are not only more expensive initially but are associated with the extra cost of cleaning, maintenance and storage, and all PPE needs proper disposal at the end of its lifecycle.

Figure 4. Use of protective measures during pesticides application in Ghana (%)



Source: Miyittah et al. 2020.

3.3 Rising counterfeit pesticides pose a risk

Use of illegal pesticides is a serious problem around the world and especially in developing countries (UN, 2020). The Transnational Alliance to Combat Illicit Trade in agrichemicals and pesticides (TRACIT), a body whose members include pesticide manufacturers, defines illegal pesticides as obsolete and unauthorised pesticides; pesticides without appropriate regulations, tests or licenses; counterfeit and fake products; and mis-labelled or re-labelled products, and refilled pesticide containers (TRACIT, 2019). The use of these types of pesticides makes enforcement of regulations more difficult, while also increasing the danger to human health and the environment. In some cases, a pesticide banned for agricultural use may be on the official market for another reason, further complicating the ability of authorities to control use. DDT, for example, is used for vector control to combat malaria.

3.3.1 Farmers on the frontline

The illegal pesticide trade has the highest impact on farmers; illegal products are often easier to access than legal products and farmers in a difficult economic situation are more likely to choose those products in order to protect their yields (UN, 2020). The labelling of illegal and counterfeit pesticides is likely to be inadequate or misleading regarding their safe use (OECD, 2020)¹⁰.

Pesticide container disposal

Inappropriate pesticide container disposal is a growing problem because of frequent pressures to re-use plastic containers. The inability to safely dispose of pesticides leads to stockpiles that pose dangers. It is the least regulated aspect of the pesticide lifecycle, and not usually part of stewardship programmes. Additionally, community-level waste management programmes rarely address this problem.

In Central America, it is the main topic of public-private stewardship programmes. Concentration on this area has been criticised for deflecting attention from the more fundamental problems with some pesticides.

3.3.2 A major criminal enterprise

According to the European Crop Protection Agency (ECPA), the trade in counterfeit pesticides has grown into a major profitable criminal enterprise. A global operation called Silver Axe seized 1 346 tonnes of illicit pesticides, worth up to EUR 94 million, during just the first four months of 2020 (Europol, 2020). However, producing a reliable estimate of the potential scale of illicit pesticides is challenging as there are discrepancies in documentation, reporting and data collection between countries. In addition, illicit pesticides are usually sold in more remote areas in which local governments lack facilities to monitor and test for fake pesticides.

3.4 Lagging regulation gives way to profits over safety

Rising pesticide demand in developing countries has generated intense competition among manufacturers. Such competition has mixed impacts on the export of safer pesticides. In many industries, a competitive market encourages innovation and helps to control prices, but existing criteria for the development of new pest control products may not sufficiently stress human health concerns or consider long-term environmental impacts. Once a product has been developed and approved, market share can become highly concentrated and there is relatively little incentive from regulators or the market to make environmental or health related product improvements beyond any need to meet regulatory requirements.

¹⁰ In 2017, 50 people died and 800 were hospitalised in India as a result of the use of unauthorised pesticides (UN, 2020). The division of power between the central state and local governments in India makes regulation a challenge. While the central government controls the licensing process and reserves the right to ban a pesticide indefinitely, the federal states can ban a pesticide for a period of only two to three months although they can recommend that the central government should ban a particular pesticide. This is a long process, which gives time for the pesticide companies to change the name of their pesticide or make a slight modification in the composition. The number of inspectors required to properly monitor the manufacturing and sale of illegal or illicit pesticide is insufficient, while companies are well-entrenched and enjoy political patronage to shield them from any punitive actions. Many of these illegal pesticides are produced by local companies, which target neighbourhood farmers and so avoid detection by the regulatory bodies.

3.4.1 Impact of generics

The environmental toxicity of glyphosate is associated with the type of agricultural system it promotes, as mono-cropping and aerial spraying can have significant long-term environmental implications.

Product consistency can be helpful to farmers and agriculture workers, especially given the expansive market of generic pesticides available. From the perspective of pesticide users, growth in the availability of generic pesticides has both advantages and risks. On the surface, the lower prices of pesticides might be seen as positive for users. However, the availability of cheap products makes the introduction of more expensive, but sometimes safer products less attractive to

companies with a large research and development (R&D) focus, and therefore less likely¹¹. Paraquat is an example of a pesticide that gained a huge market share, leaving little incentive to invest in the development of less toxic alternatives. Another example is glyphosate, which was exclusively produced by Monsanto as RoundUp. Paraquat is banned for use within the EU, while glyphosate can be used until 2022. Once the patents on these products expired, several companies started producing generic alternatives, which lowered prices but led to almost no improvement in terms of lower toxicity. At most, manufacturers would increase additives or present a new mixture to differentiate their products, while retaining similar active ingredients. This is in part the result of the significant market power of the large generics producers and illustrative of how an entrenched system propped up by inexpensive pesticides will remain pervasive without more stringent action from stakeholders (European Commission, 2020).

3.4.2 Enhancing regulation

Self-regulation by industry has had little impact on reducing the sale of harmful products. Pesticide manufacturers are primarily focused on profits and can sometimes twist public and environmental health arguments for competitive reasons rather than a general concern for human and environmental health (Jansen, 2017). They can and are willing to act as partners to achieve greater levels of safety but cannot be expected to do so on their own. Organic farming shows alternative options but has had a much lesser impact on the global growth of pesticide use than regulations by government. Regulatory requirements have yet been the only successful pathway to reducing harmful pesticides. Based on interviews with export crop producers in Central America, regulations of the EU and other importing countries are the main yardstick for deciding which pesticides to use in their crop protection programmes. This has certainly eliminated harmful pesticides from spraying programmes and intensified the search for alternatives. Without this type of standard setting by the EU and others, pest control would still be based on highly hazardous pesticides such as DDT, Methyl-parathion, and Dibromochloropropane (DBCP)¹².

¹¹ Research-based companies often make this claim while they themselves keep in their portfolio older products with expired patents that were registered in the past when less strict regulatory requirements were in place.

¹² Despite the benefits of regulation and standard setting, pesticide manufacturers may consider the costs of the regulatory process so high that they effectively prohibit the development of very targeted crop protection products that are less hazardous to human health and the environment. R&D costs are also a barrier cited by pesticide manufacturers to developing products that control specific pests for low value crops, fostering the search for broad spectrum products.

4 The role of pesticides in achieving food security

4.1 A fraught relationship

4.1.1 Persistent demand during 'normal' times

Farming is a highly uncertain practice with long periods between planting and harvesting. During normal times, i.e. those devoid of high-impact climatic incidents, pandemics, and supply chain disruptions, farmers still constantly need to manage pests and disease, on both smallholder and mass production farms. Pesticides have an established track record of short-term success within the current market system, which demands high yields and low farm gate prices. Combined with the disappearance of traditional labour-sharing systems and increased options for off-farm employment, this increases the attractiveness of substituting local manual labour with pesticides. Moreover, after decades of use of pesticides, natural predators to pests have in many cases been killed off and soils have been deeply damaged, further entrenching the use of pesticides and increasing the challenge of adopting alternative techniques. The prevalence of monocropping as a preferred method for maximising profits means that pests and disease evolve faster than the crops, developing resistance that farmers seek to combat with additional pesticides. The associated expansion of agricultural land into forested areas and the reduction of fallow land reduces those buffer areas for natural enemies to pests to live.

4.1.2 Rising food insecurity

Beyond the above factors, food security is becoming more fraught in many developing countries, encouraging the continuation of established practices that reduce the uncertainty involved in obtaining yields. In April 2020, the UN World Food Programme (WFP) warned that the number of people suffering 'acute food insecurity' could more than double this year to 265 million, up from 130 million as of 2019, due to the global COVID-19 pandemic and responses to it. This category refers to people struggling to meet basic nutritional needs due to a short-term crisis. The rise is expected to be a product of complex factors, including the collapse in economic activity disproportionately affecting those dependent on daily wages, remittances, aid and tourism. The 2019 figure was itself at a four-year high.

The UN warning presages a decline in several global food security trends. Since 2015, the number of people classified as 'hungry' has been on an upward trend and is set to rise further: the figure rose to 821 million in 2018, from 811 million in 2017, and a low of 785 million in 2015. Secondly, the disproportionate impact of the pandemic on the economic and social security of women worldwide will also further undercut their food security. Thirdly, nutritional poverty, which afflicts 26% of the global population or about 2 billion people, will also intensify with the expected decline in foreign aid and as realignment of hunger and nutrition policies in aid and agrarian supply chains takes a back seat.

UN Sustainable Development Goal (SDG) 2 calls for ending hunger and ensuring access to 'safe, nutritious and sufficient food all year round' by 2030, as well as eradicating 'all forms of malnutrition'. The FAO reports, however, that hunger has risen in many regions worldwide since 2015, the most pronounced increases occurring in sub-Saharan Africa and the Middle East: in sub-Saharan Africa, nearly 23.0% of the population is still classed as hungry (up 2 percentage points from 2015). In the Middle East, 12.4% of the population is hungry as a result of conflict (up from a low of 8.6% in 2010). Moreover, progress is not happening at a sufficient pace to meet broader global nutrition targets, such as reducing the proportion of infants with low birthweight, infant stunting and food wastage.

Furthermore, the eradication of worldwide extreme poverty has slowed, according to the United Nations. This is especially true in rural areas where small, subsistence farms are common (UN, 2019). These farmers are the least able to cope with pests and disease, which can appear suddenly and affect both primary production of food and its availability over time. (Savary et al., 2017). Such smallholder farmers are among the most difficult to reach in terms of providing training on the safe use of pesticides, as well as alternative methods of crop protection. In terms of behaviour change, in many cases they are also likely to be the most difficult to convince regarding the long-term advantages of alternative methods, especially given the widespread availability of inexpensive pesticides.

4.1.3 Disagreement over outcomes

Against this background, pesticide manufacturers argue that their products are needed to ensure food security and feed the planet's growing population because pesticides play a vital role in boosting nutrition and household income, factors that can be considered elements of food security.

However, the relationship between pesticides and nutrition, or between pesticides and household income is not clear cut. Nutrition problems are mostly found among resource-poor households that have insufficient land or other livelihoods to make a proper living. When they still have access to land for producing their own food for consumption, they very often do not use pesticides or use very low amounts. When used, such pesticides can prevent crop losses and therefore guarantee better availability of food. However, many case-based studies have shown that agro-ecological approaches (which tend to reduce or ban pesticide use) make smallholder farming systems more resilient and diverse, improving the nutrition of these households and improving the stability of household income through less spending on pesticides (Cacho et al., 2018). A 2017 report from the UN Special Rapporteur on the right to food recommended that worldwide pesticide use should be reduced, and highly hazardous pesticides phased out. Additionally, the report recommended that states prioritise non-chemical alternatives, only allowing 'chemicals to be registered where need can be demonstrated'.

However, there are also cases in which an impoverished farmer will use herbicide (a type of pesticide) in their own field to spend fewer days on weeding. The days gained are then used to work for a wage elsewhere. In such a case, herbicide use may lead to a higher income when the costs of spraying are lower than the income gained from wage work. For poor people in cities, pesticide use may increase production and reduce food prices, which may increase the food intake of this group. However, food, especially vegetables, may be more contaminated with pesticide residues when grown under intensive cultivation systems.

Commercial farming faces a different set of challenges. Though profit margins in many cases would allow for alternative methods to be considered, market forces, along with a lack of incentivisation and regulation, are the main drivers of the continued use of pesticides by large-scale farmers. Should a small percentage of commercial farmers make the shift to alternative methods and others continue with pesticides, it is likely that the latter group will emerge as the economic winners because the market will perceive them as best suited to provide a reliable supply of food, and so leading to a broader shift back to pesticides.

The ability of pesticides to reduce post-harvest losses is often disputed. Post-harvest losses are estimated at 14% globally and can reach 50% in some developing countries. Yet, the highest crop losses are seen in regions with fast-growing populations and where food security is already an issue, compounded by the frequent re-emergence of pests and disease. In contrast, crop losses are lower in areas with large production and surpluses (Savary et al., 2019). This is suggestive of the stabilising role pesticides can play regarding yields.

4.2 The multiple threats of volatility

The perceived importance of pesticides during 'normal' times is enhanced during situations that create risks for food security. The use of biological pesticides tends to be secondary during emergencies as they are deemed less powerful, as in the case of locusts which they do kill, but less rapidly than synthetic pesticides (FAO, 2020). At least 13 pesticides used against the Fall armyworm are classified as HHPs (Jepson et al., 2020).

4.2.1 Pest infection

The emergence of a pest or disease outbreak constitutes perhaps the most significant threat to farmers across the world, yet it is widely seen as one of the most controllable threats. Pests present a serious risk to agriculture, with global annual crop production losses falling in the range of 20 % to 40 %, according to the FAO. Without protection provided by pesticides, these losses could reach 80 % (Savary et al., 2019). Pesticides are particularly needed in cases of mono-cropping, which is a cornerstone of industrial agriculture, because the practice wears down the soil and the surrounding environment.

4.2.2 Unpredictable weather patterns

A key threat to food security comes from climate change and related extreme weather events (IPCC, 2019). Food production will come under further pressure as droughts and storms become more frequent and affect all four dimensions of food security; access, availability, stability and utilisation (Mbow et al., 2019). Unstable and unpredictable weather also has a direct effect on the spread of pests and diseases. Changing rainfall patterns have accelerated pest mutation, leading to the development of resistance to existing pesticides. Rising temperatures at higher altitudes have also increased the incidence of the coffee berry borer and coffee leaf rust in regions of Central America that had previously only seen damage from them in the lower regions, and has led to an increase in pesticide application.

India is an example of a weather-dependent food production region that may struggle because of extreme weather events, as almost 60 % of its agriculture is monsoon-dependent (Kumar, 2019). Food insecurity will increase in Africa, as climate change causes droughts and leads to lower crop yields (Anyu et al., 2012). Rain-fed production is a major source of income for small-scale farmers in Africa, leaving them particularly vulnerable to weather-related disruption (FAO, 2019).

Changing weather has also instigated the long-distance migration of foreign pests, such as the locust outbreak in the Horn of Africa earlier this year, which has had a devastating impact on food availability across the region. It is doubtful whether existing pesticides will be able to tackle the new and mutated pests (Deutsch et al., 2018).

4.2.3 Supply and demand shocks

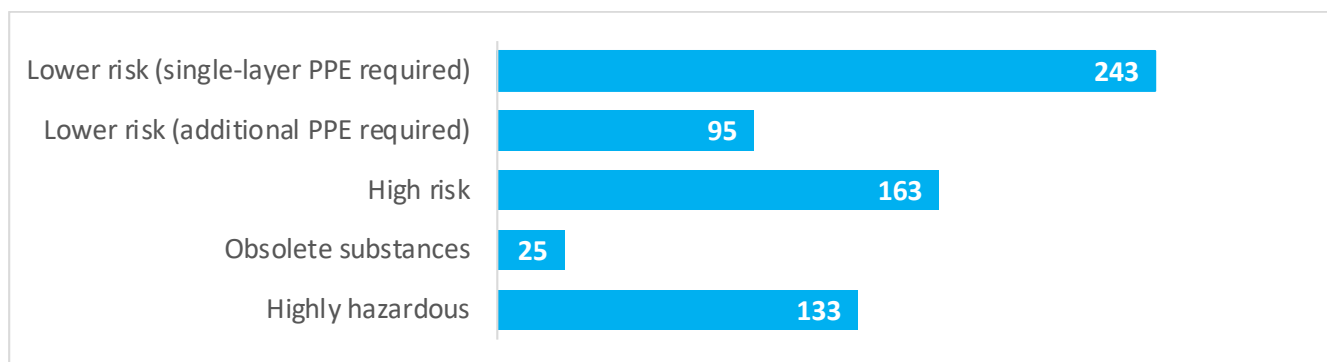
Along with the health impact, the economic impact the COVID-19 pandemic has exacerbated uncertainty among people whose livelihoods depend on farming. Government responses to the pandemic, including decisions to restrict movement, have had implications for farm labour supply. Indonesia, Cambodia and Vietnam have all faced labour issues, resulting in problems for agricultural production and thus the availability for food. The same is true for vegetable producers in Kenya's Central Rift Valley, where the farming is labour intensive but farmers have not been able to call upon large numbers of labourers from Ethiopia. COVID-19-related restrictions have also limited the ability of food to reach markets where it can be sold, which has led to some food wastage (Brescia, 2020), while fewer traders are buying produce due to travel bans, social distancing rules and concerns about coronavirus infection. This, together with reduced demand from urban markets, means prices of certain products have fallen as supply exceeds demand. In Ethiopia, for example, prices for cabbage and onions fell by 60 % and 40 % following the onset of the pandemic (Glenn et al., 2020).

The consequences of problems related to food access include a potential fall back into poverty and longer-term effects on nutrition, particularly among children. In Latin America and the Caribbean, school closures as part of lockdowns have had a major impact on food availability as more than 10 million children rely on school-provided nutrition programmes (Altieri et al., 2020). Meanwhile, pre-existing threats and challenges remain during the pandemic.

4.3 Outlook for pesticides and food security

Pesticide use and food security are likely to remain connected until a broader market realignment reduces the demand for high yields, and production is re-orientated towards local markets. It will be difficult to make agricultural production shift to alternative methods via market mechanisms when the market preference is for food prices to stay low. Pesticides will not be phased out, but there is great potential for more selective and targeted use of pesticides that are considered less hazardous. A study classified a total of 659 pesticides based on their risk to human health and the environment. Intended to advance the transition to alternatives, the study sought to produce a guide to improve the understanding and categorisations of different types of pesticides. The results are illustrative of the potential for more selective and safer use of pesticides, though regulations and attitudes of manufacturers still need to catch up.

Figure 5. Analysis of 659 pesticides by risk to human health and the environment



Source: Jepson et al., 2020.

4.3.1 Phasing out hazardous pesticides

Should a reduction in pesticide use eventually begin on a large-scale, major producers will be better placed due to their profit margins, established supply chain partnerships, and access to training networks. The results of this transition will not see a complete phasing out of all pesticides, which vary in terms of their level of hazardousness, but would encourage their targeted use in specific circumstances that take into account the ecological, management, and landscape context in which they will be deployed. The ability of pesticides, including ones that are not highly hazardous, to increase the likelihood of a successful harvest is particularly relevant in developing countries which are often the most vulnerable to sudden shocks.

4.3.2 Case Study: Coordinated preventive responses to East Africa’s desert locust plague

The worst desert locust infestation in decades currently threatens crops across several East African countries. Prevention systems have failed and an international emergency response has been slow to mobilise. Without serious efforts to strengthen preventive management systems, similar crises may recur as climate change heightens the risk of new infestations.

Desert locusts are a species of grasshopper that are capable of changing behaviour depending on concentration. When few in number they move little but as their numbers multiply they transform into large

mobile swarms that consume all the vegetation they can find. Their numbers grow when good rains bring green vegetation and moist soil for breeding. Good rains combined with an absence of natural predators can see desert locusts multiply by a factor of more than 20 in one generation. As insect density increases, swarms start to migrate to find new places to feed.

Control responses revolve around pesticide-based strategies, but these are most effective as part of a preventive strategy. The principle of prevention is simple: find the locusts when they start to form into small groups and kill them before swarming becomes unmanageable. Locusts move and reproduce fast, making a quick, precise, and internationally coordinated reaction crucial. However, preventive management can eventually become so successful that countries can lose sight of its importance. The last desert locust plague was in 2003-05 and started in West Africa. The FAO initially called for USD 9 million to contain the situation but funding was slow to materialise and management of the crisis ultimately cost over USD 400 million, while crop damage was estimated at some USD 2.5 billion.

The current plague originated in the 'Empty Quarter' of the Arabian Peninsula in 2019. Good climatic conditions and lack of early control allowed locust populations to multiply and expand, cycling through around eight generations of multiplications with successive good rains in different parts of the Arabian Peninsula and the Horn of Africa. The civil war in Yemen impeded the monitoring of locust build up and early intervention, showing the connection between conflict in fragile states and subsequent environmental impacts: in this case, locust plagues and the ensuing heavy pesticides use. As the swarms multiplied, they also spread to Iran, Pakistan and India. The control responses in these countries were efficient, but in conflict-affected countries or those where plagues had not been seen for a long time, such as Ethiopia or Djibouti, preventive management was minimal.

The swarms then spread to the countries of East Africa in numbers that require huge amounts of pesticides in response. Rebuilding the necessary capacities in the affected countries will take time because they have not experienced locusts on this scale for half a century. Plant-protection specialists will be required, with training on the technical specificities of deploying ultra-low volume sprayers, barrier treatments and biological pesticides.

If these control measures are ineffective then current levels could double. North Africa, despite having strong capacities to deploy aerial treatments, could not kill all the swarms that arrived from the Sahel in the winter of 2003-04. This led to further multiplication and, when the swarms returned to the Sahel in the summer of 2004, the impact was catastrophic and cost 40 times more to control than the initial appeal for funds.

4.3.3 Case Study: Combatting the Fall armyworm

Fall armyworm (FAW), a major insect pest with origins in the Americas, first appeared in Africa in early 2016. In just two years, it had spread to nearly all sub-Saharan African (SSA) countries. Highly resistant to traditional methods of pest control and capable of feeding on almost all major SSA crop species, FAW's impact since its arrival has been dramatic. FAW moths are capable of flying up to 100 kilometres in a single night, while female moths can lay up to 1 000 eggs in their lifetime. Current estimates suggest that more than 20 million tonnes of maize, the main crop targeted by FAW, will be lost each year at a cost exceeding of USD 5 billion dollars.

Genetic analyses suggest that the FAW probably arrived in SSA via West Africa, in food imported from the Caribbean or Florida. Among the African countries affected is South Africa, the world's tenth-largest maize producer, responsible for 43 % of the 30 million tonnes of maize produced in SSA each year. Additional FAW outbreaks have also taken place in several conflict zones, including South Sudan and Somalia, where food

security conditions are already fragile. In Nigeria alone, 3.8 million tonnes of maize is believed to be at risk, potentially costing an estimated USD 1.3 billion.

In the Americas, control of the pest has traditionally been attempted via a combination of genetically modified (GM) maize and chemical pesticides. However, FAW has become resistant to many of these chemicals and resistance to GM maize is an increasing concern. Since it arrived in Africa, many millions of litres of chemical pesticides have been sprayed in an effort to control FAW. Some are classified as HHPs, posing a significant threat to human health and biodiversity. The UN FAO and the WHO have engaged with countries in an effort to discourage the use of HHPs, phasing them out in favour of safer alternatives.

Chemical control of FAW has had only mixed success, with some pesticides (such as Lambda cyhalothrin) being considered more effective than others (such as Cypermethrin), possibly due to evolved resistance in the Americas. Alternative control methods – including biological pesticides – are likely to see increased uptake, as countries relax the strict and expensive registration requirements to fast-track biopesticides. South Africa's Department of Agriculture Forestry and Fisheries (DAFF) responded to FAW's arrival by granting emergency registrations to 24 types of pesticides and helping small-scale farmers to procure them in order to minimise crop damage. Switching to other crops is sometimes considered another option in such situations. However, the market for the other crops must be carefully considered. A sudden increase in production of a crop could result in a fall in prices.¹³

4.4 The possibilities of Integrated Pest Management

Alternatives to pesticides offer great opportunity, but are fraught with challenges that are mainly related to their implementation. Approaches which 'build on agronomic, mechanical, physical, and biological principles that resort to selective pesticide use when addressing situations that cannot be successfully managed with other tools' are captured under the umbrella of Integrated Pest Management (IPM) strategies (Barzman et al, 2015). The EU is actively promoting the use of the eight principles of IPM laid out in its sustainable pesticide use directive (*Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009*) and has further strengthened its commitment to the promotion of IPM in the 'From Farm to Fork Plan'.

The principles of IPM include:

- 1) prevention;
- 2) monitoring;
- 3) decision-making based on thresholds;
- 4) the use of non-chemical pest control measures;
- 5) the selection of the most specific pesticides (if pesticides are needed);
- 6) the use of the lowest necessary dosages of pesticides (if pesticides are needed);
- 7) the use of anti-resistance strategies; and
- 8) the evaluation of the measures' success.

¹³ Such a scenario has been seen in Central America where the onset of coffee leaf rust caused a shift from coffee to avocados. The decision was based on the then current prices and demand for avocados. However, the subsequent overproduction resulted in a fall in prices.

For successful implementation, these principles must be adjusted to local characteristics, crops, and circumstances and preventive measures must play a key role (Barzman et al., 2015). The use of IPM strategies has advantages, such as reducing adverse environmental and health effects and long-term positive effects on yields, e.g., through increased bio-control and soil fertility. These positive effects will grow in importance under climate change (Lefebvre et al., 2015). Nonetheless, multiple obstacles remain to successful IPM strategies. One is the high level of knowledge needed: many IPM techniques require collective efforts, involving, for example, all farmers in a village or region, with support from the local administration or multilateral agencies. Successful cases of IPM have dealt mostly with high-value crops (either market value or in a few cases with national food security value, such as rice in Indonesia) that are threatened by secondary pests (pests that have become a problem due to pesticide use). IPM implementation is more challenging for crops that are relatively unimportant for the wider economy and suffer from primary pests and disease, and these are precisely the crops that are grown by many smallholders and which contribute to local food security. Furthermore, IPM programmes, which offer local politicians little visibility, require anticipatory and preventive measures that are not always a priority for governments facing more acute crises.

Although IPM has been the subject of much discussion in academia and the FAO, data on its effectiveness remains fairly limited and specific approaches in each area has meant IPM strategies in one place cannot be easily replicated elsewhere as techniques such as breeding natural enemies may have to be adapted to local conditions. In contrast, the same pesticides are used globally, although local application conditions differ, and governments invest little in their development. Government funding for IPM is also limited but even if it were to gain momentum, success is not guaranteed. Business-driven IPM, on the other hand, appears to be focused on the idea of selling a product (e.g. a biological control agent) rather than a comprehensive strategy for successful pest control, which would call for a change in field management practices, not merely the application of products.

4.4.1 IPM in developing countries

Developing countries have seen low adoption rates of IPM strategies (Alwang et al., 2019). One global survey of IPM professionals and practitioners identified the most difficult obstacles to overcome for the adoption of IPM strategies in developing countries around the world (Parsa et al., 2014):

- 1) collective action within a farming community;
- 2) shortages of effective non-chemical products;
- 3) the powerful influence of the pesticide industry; and
- 4) farmers' risk aversion.

Overall, participants in developing countries worried more about weaknesses in IPM itself, whereas respondents in developed countries were more concerned with the capacity for implementation (Peshin et al, 2014). There is currently no indication that adoption rates in developing countries will change significantly in the near future.

4.4.2 Case Study: IPM in Indonesia

In Indonesia, awareness of harm caused by pesticides increased after the 1970s Green Revolution, during which the wide use of broad-spectrum insecticides wiped out the population of predator insects feeding on the brown planthopper (BPH). As a result, the BPH population grew uncontrollably in the mid-1980s, damaging the rice crop. The crisis caused the Indonesian government to regulate the use of pesticide, reduce pesticide subsidies, and mandate IPM as the national policy for crop and plant protection and gradually reduced pesticide subsidies (Thorburn, 2015). From an initial cut in 1986, subsidies had been completely eliminated by January 1989.

The 1989 National Integrated Pest Management Programme, considered ground-breaking at the time, provided training in IPM for hundreds of thousands of farmers and agricultural officials across the country. The aim was to conserve 'natural enemies' and diminish the indiscriminate use of pesticides in the protection of food crops. It swiftly reduced reliance on pesticides and implemented more sustainable techniques. Following this example, other countries including the Philippines, Vietnam, Sri Lanka, Cambodia and Nepal adopted similar programmes (Resosudarmo, 2012).

However, despite early successes, Indonesia's implementation of IPM quickly faltered. As pest and disease problems persisted, pesticides continued to be used in part because of inadequate explanation and extension services provided to farmers (Winarto, 1995). By the end of 1999, Indonesia's IPM programme had collapsed, undermined by weakened political support and changing priorities in the wake of the Asian financial crisis of 1997–1998 and the resignation of President Suharto, a proponent. After 1999, Indonesia pursued an aggressive policy of deregulation, privatisation and trade liberalisation. This initially led to a significant spike in the price of agricultural inputs, placing a significant burden on farmers. The country's agriculture minister decided that Indonesia could deregulate pesticide imports and sales on the grounds that the IPM approach has been tried and had failed (Thorburn, 2015).

Within a few years of deregulation, the number of pesticide brands being sold in Indonesia had reached 2 700. More than 250 of these were for use on paddy and the majority was imported from China. Indonesian companies wishing to market them simply registered a trademark with the Agriculture Ministry's Pesticide Commission. By 2012, almost 400 companies were importing a total of more than 50 000 tons of several hundred different active ingredients to produce an array of products marketed to farmers and government agencies. Between 2000 and 2012, the total value of pesticide imports to Indonesia increased by a factor of six, from USD 50 million to just under USD 300 million (Thorburn, 2015). As a result, Indonesian farmers were using more pesticides than ever before. When pest problems occurred, the general response was to try a more expensive chemical, or to mix different formulations together in hope of creating a more powerful solution. The result has been the return of the BPH after increased pesticide use wiped out its natural predator. Since 2009, Indonesia has seen severe outbreaks in key rice producing regions of East, Central and West Java, with crop losses approaching or surpassing the 1985–1986 outbreak that led to the national IPM programme.

The lessons to be learned from Indonesia's experience with IPM are not about the reliability of IPM per se, but about the reliability of government-supported IPM programmes in the face of strong marketing by the pesticide manufacturers and traders of agricultural chemicals and seeds (Thorburn, 2015).

5 Pesticide policies and regulations

Various food standards have proliferated over the last decade, causing a major shift in the global value chain and triggering a new debate. On the one hand, standards should ensure long-term health and environmental safety while, on the other, they can serve as new forms of non-tariff barriers that may have an adverse effect on farmers in developing countries. The following section outlines some of these standards and considers the role that pesticides play in supporting or diminishing them.

5.1 International standards

5.1.1 The right to food

Along with the Universal Declaration of Human Rights, Article 11 of the International Covenant on Economic, Social and Cultural Rights underscores the importance of the right to adequate food for achieving an acceptable standard of living. Adequacy here includes the idea that food should not contain substances that pose a danger to human health (UN, 2020). The general comment No. 12 of the Committee on Economic, Social and Cultural Rights further stresses that states have the responsibility to guarantee the accessibility of their citizens to food that is safe and qualitatively adequate (UN, 1999). Therefore, food contaminated by pesticides and other hazardous chemicals does not comply with the definition of adequate food.

The standard of adequate food entails the importance of sustainability, meaning that food should be accessible to present and future generations. At the same time, food production should be carried out in a healthy environment without exposure to harmful substances. Other documents on human rights, including the International Covenant on Civil and Political Rights, the UN Declaration on the Rights of Indigenous Peoples, underscore the obligation of states to ensure the presence of a safe and healthy environment with regular access to clean food and water (UN, 2017).

5.1.2 Hazardous chemicals

While the success of the current environmental regulations in the area of pesticides has been limited, some arrangements have been more effective than others. For instance, the Vienna Convention for the Protection of the Ozone Layer has reduced usage of hazardous pesticides by replacing methyl bromide with less-hazardous alternatives. The Stockholm Convention on Persistent Organic Pollutants (POPs) has been ratified by 184 parties as of 2020 and restricts 12 initial and 16 newly added POPs deemed harmful for human health and the ecosystem (Stockholm Convention on Persistent Organic Pollutants and UNEP, 2017).

The Rotterdam Convention fosters information sharing between states about hazardous chemicals entering international trade and about the regulatory actions taken in member countries, while acknowledging that countries will differ in their ability to assess and manage potential risks posed by hazardous chemicals and pesticides (pesticides are the largest group of chemicals dealt with in the convention). Furthermore, the convention intends to support developing countries to make sound regulatory decisions. Though more limited in scope than the Stockholm Convention, it has improved the ability to make informed decisions (Jansen et al., 2014).

5.1.3 Maximum Residue Limits

MRLs are the most implemented standards when it comes to food safety, as they represent the maximum concentration of the pesticide residue in commodities. The primary source for the MRLs principle is the Codex Alimentarius, which sets the levels based on the recommendations of FAO and WHO.

Apart from the FAO and WHO, several international arrangements also support the standard on MRLs. For instance, the Agreement on the Application of Sanitary and Phytosanitary Measures sets and monitors the basic standards for food safety by using scientific mechanisms. While giving individual governments the freedom to set their own standards, it encourages them to adhere to the internationally established rules, guidelines and recommendations. Encouraging countries to follow the MRLs determined by the Codex Alimentarius is the agreement's core principle. Despite the existing framework provided by the Codex, the MRLs vary across countries significantly (FAO and WHO, 2020). For example, the EU sets the lowest residue levels across different products, while the US allows some of the highest levels for certain pesticides.

The lack of consensus regarding MRLs ultimately undermines pesticide controls and could encourage the persistence of unhealthy products, along with damage to the environment and human health.

5.1.4 Production and distribution

Pesticide production and distribution also come under the International Code of Conduct introduced by WHO and FAO. Article 3 of the code stresses the responsibility of individual governments to adhere to the provisions of the code that sets standards for the production, distribution sale, and advertisement of pesticides. The code emphasises reducing the health and environmental impacts of hazardous chemicals, and urges the involved parties to shift to more sustainable agricultural practices. Only pesticides of adequate quality should be supplied, and packaged with labelling designed for each specific market. Furthermore, the Code of Conduct encourages governments with efficient pesticide regulating mechanisms to provide technical assistance to countries with limited regulatory capacity.

Nonetheless, the standards introduced by the code remain voluntary, leaving relevant stakeholders able to determine whether their actions constitute acceptable practices. While most pesticide manufacturers have decided to adhere to the proposed framework, some have not. At the national level, it is possible to give the code a binding status as has been done in Costa Rica through the judicial power.

5.1.5 Voluntary initiatives and regional agreements

The Strategic Approach to International Chemicals Management (SAICM) proposes another non-binding practice for pesticide management. Established in 2006 in Dubai, SAICM promotes chemical safety worldwide and seeks to ensure sound pesticide management in the life cycle. The SAICM policy framework focuses on risk reduction, knowledge and information, governance, capacity-building and illegal international traffic. Another significant initiative, the Responsible Care Global Charter promotes the ethical management of chemicals worldwide. As of 2020, CEOs from 580 global manufacturing companies, representing around 96 % of the global pesticide manufacturing industry, have signed the charter. While these initiatives have had moderate success, their non-binding nature remains the primary constraint on their effectiveness.

These global international initiatives coexist with regional agreements on the use of pesticides and sustainable crop production. For example, ASEAN has been developing voluntary Good Agricultural Practices (GAP) to enhance the standards for the production, harvesting and post-harvest handling of agricultural products,

including the maximum residue limit of pesticides. Today, ASEAN has established a total of 775 harmonised MRLs for 61 pesticides (ASEAN, 2020).

5.2 Registration and approval

Given the, at best, moderate success of international standards, most regulation comes down to country-by-country efforts, and pesticide management remains a daily struggle in developing countries (UN, 2017). Health, environment, and biodiversity are factors that may be nominally considered, but in practice are given diminished importance by local agriculture ministries, which must prioritise yields. Therefore, consideration of the latter plays the dominant role in the approval process.

5.2.1 Approval times

The lengthy process for official registration and market approval can slow the introduction of less hazardous pesticides in developing countries as the work of reviewing extensive datasets and test results is often done by very small teams. In Africa, 30 % of countries have only three to five people working on pesticide registrations; 25 % of South-East Asian countries have one to two, while 50 % have 11 to 20. Among European states, 86 % have more than 20 (WHO, 2018). Most countries lack the inspection capacity or do not own the equipment to measure the MRLs levels (UN, 2017). The effectiveness and accessibility of pesticides hinders control measures, especially in developing countries.

Table 2. Estimated pesticide registration timeline, selected countries

India	12 months
Brazil	2 months
Mexico	6 months
Nigeria	80 working days

Source: WHO, 2018.

Many countries claim that their approval and registration process for new crop protection products are relatively short. However, insights from experts suggest that regulators in many developing countries often take years to approve new pesticides and then sometimes even longer for them to reach the market, a factor that partly explains why older products are more likely to be available than newer ones. Moreover, these older pesticides have usually recouped their development cost and so can be offered at a lower cost, making them more attractive in low-income countries.

However, while long registration times can slow the introduction of new products, in practice a lengthy approval process also increases the chances that it will be implemented in accordance with FAO guidelines, and also staffed adequately to mitigate the issues described above.

Personnel employed by different government ministries or agencies will have to study the application for factors such as ecotoxicological issues, human health, and efficacy. This easily takes time as experts may have to look up additional sources, formulate questions and wait for answers from other experts or the applicant, along with finding time for expert meetings. This is an issue for all new registrations, not only for the potentially less dangerous ones. Speeding up the approval process can only be done with more resources available to have dedicated regulators who can gradually build their expertise and are not distracted by other tasks and issues.

An additional factor can be the completeness of the application when submitted. Anecdotal evidence from Central America suggests that applicants often fail to submit a complete dossier, and that this is what causes delays in the procedure. Furthermore, different views exist between applicant and regulatory officials on whether a particular file in a dossier is legitimate and admissible or not. Pesticide manufacturers could contribute to shortening the approval time by supplying complete documents.

Pesticide risk regulation is subject to continuous improvement in many developing countries. One effect is, at least in some cases, that old pesticides have been registered under old norms and criteria, while the registration of new applications takes place under new norms and criteria. This takes more time as the process has become more laborious, but also stands as a contribution to positive health and food security. Building regulatory capacity should include attention for proper procedures and work environments that help to withstand pressure from businesses on the regulatory process. Costa Rica, for example, stopped allowing business representatives free access to regulatory offices. Official meetings can only be requested if there is a clear agenda and comprehensive minutes made, with different officials present in the meeting room.

5.2.2 Brazil: a polarised debate

A Brazilian effort illustrates how divisive legislating over pesticides can be. Almost two decades ago, in 2002, a bill (PL 6.299) was put forward by a member of the legislature, Tereza Cristina, who is currently the minister for agriculture under President Jair Bolsonaro and a promotor of pesticide industry interests. This bill, which has been approved by the Brazilian lower legislative house but has yet to be enacted, calls for the centralisation of pesticide registration and risk assessment under the ministry of agriculture, thus removing these functions from health and environmental agencies. It also proposes a change in the official terminology: the word 'agrototoxic' would be replaced by 'phytosanitary defensive' and establishes that pesticides already approved in three other Organization for Economic Cooperation and Development (OECD) countries are automatically approved on a 'temporary special registration' basis in Brazil as well. This would occur irrespective of whether these places are comparable to Brazil in terms of climatic conditions and agricultural practices.

In 2016, largely in reaction to PL 6.299, another bill (PL 6670), setting out a National Policy for Agrototoxic Reduction was proposed by the head of the Commission for Environment and Sustainable Development. This bill proposes measures to phase out the use of pesticides and start a transition towards more sustainable agriculture. The debate between supporters of each bill has been intense and polarising in recent years. On one hand, the pesticides lobby argues that the process for the registration and commercialisation of pesticides is highly inefficient, posing an obstacle to the development and approval of more sustainable products. On the other hand, environmentalists argue that the new rule will lead to an increase in pesticide use and perpetuate an unfair and unsustainable agricultural model.

Irrespective of the approval of PL 6.299/2002, some 475 new pesticides were approved in Brazil during 2019, representing a sharp increase relative to the pace of approval of previous years. These substances are mostly chemical and not biological (92 % against 8 %), and about a third contain active substances which have been listed by the European Chemicals Association as banned or severely restricted in the EU. Most of the new registration requests concern generic pesticides already on the international market with only a few recently developed and potentially safer.

5.3 Tightening national regulations

Recent developments suggest that concerns about the health and environmental impacts of pesticide are increasing among elite groups in developing countries, probably related to greater awareness of the risk associated with pesticides and the growing extent of their use (Möhring et al., 2020).

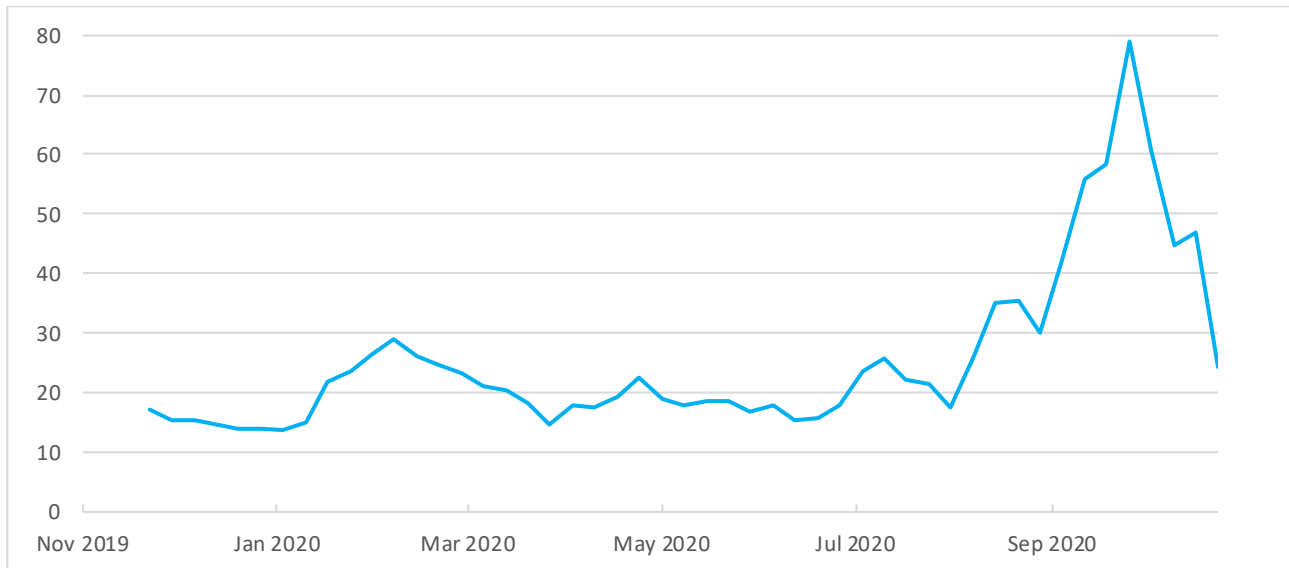
5.3.1 Brazil: Paraquat ban

Brazil's 2017 decision to ban Paraquat, the sixth best-selling active pesticide ingredient in the country, took effect in September 2020. Paraquat is estimated to be the second leading cause of death in agriculture. It is used on several crops, especially for soybean desiccation as well as to control two common grass species in Brazil – 'bufa' (*Cenchrus ciliaris*) and 'amargoso' (*Digitaria insularis*).

Paraquat was classified as extremely toxic to human health and banned in Brazil by the country's health regulator. A few days later, on 7 October, the deadline for ending Paraquat use was extended, so that farmers could still use their stocks of Paraquat-based products in the 2020-2021 harvest. Many farmers purchased greater amounts of Paraquat in anticipation of the ban, so its full impact is expected to be felt only in the following harvest.

Currently, there are no alternatives that are as cheap and efficient as Paraquat, which was being produced by many companies as the patent had already lapsed. The most likely substitutes are Diquat (Syngenta – 'Reglone') and Glufosinate (BASF – 'Finale'), however, both are considered less effective for pest control. In terms of safety, the ban on Paraquat is extremely important given its high toxicity and use in suicide attempts.

Figure 6. One-year moving average of Google searches in Brazil for 'Paraquat'



Source: Google Trends¹⁴

¹⁴ According to Google Trends: 'Numbers represent search interest relative to the highest point on the chart for the given region and time. A value of 100 is the peak popularity for the term. A value of 50 means that the term is half as popular'.

5.3.2 Additional developments

Recent developments in some of the most important agricultural production countries suggest a slow shift toward less acute human toxicity in pesticide substances. Nonetheless, limited regulatory controls in some jurisdictions are likely to allow small-scale farmers to purchase counterfeit products.

Table 2 (below) shows broadly representative examples of how pesticide regulation in developing countries has been renewed and improved. In some cases regulatory change has resulted from civil society advocacy about health and environmental concerns, in others from a desire to make exports more attractive through better regulatory controls (Arancibia et al., 2019; Nikol et al., 2020).

Table 3. Key regulatory developments in selected developing countries

Country	Development
Brazil	The June 2020 launch of the National Program for Inputs for Organic Agriculture (Bioinsumos) aims to stimulate the adoption of less toxic/natural technologies via credit lines. The Program will cover 'pheromone, allelochemical and product formulated based on copper, boron, sulfur, mineral oil and compounds, derivatives of plant, animal and mineral origin, including biological control agents, which comply with the legislation of organic production, intended for the use in the production, storage and processing of agricultural products, in pastures or in planted forests, whose purpose is to change the composition of flora or fauna, in order to preserve them from the harmful action of living beings considered harmful, including processes and technologies derived from that product'.
China	Chinese policymakers recognise that overuse of pesticides and the unintended uses of hazardous pesticides continue to be serious problems. Beijing has declared a policy of zero increase in pesticide use by 2020. New pesticide regulations were also issued in 2017 to reduce the number of agencies involved in pesticide regulation and created a Pesticide Management Office under the Ministry of Agriculture and Rural Affairs.
India	India's proposed Pesticides Management Bill, 2020, which is supposed to replace the Insecticides Act of 1968, is the country's most important development related to pesticides in recent years. The bill, which has been in circulation and discussion since 2008, would set up a Central Pesticides Board to advise the central and state government on pesticides, and regulate their production, sale, and use. It will issue licences to the manufacturers and retailers of pesticides, empowering the central government to ban hazardous pesticides. However, activists and concerned scientists argue that the bill has several significant gaps
Indonesia	In 2017, the Ministry of Environment and Forestry updated the registration and notification procedure for hazardous substances. The B3 group of hazardous and toxic substances can no longer be manufactured or imported without submitting a specific application form through a designated online system. The necessary list of documents includes import permit, notification of approval from the country of origin, Safety Data Sheets (SDS) and certificate of analysis (UNFCCC, 2018).
Kenya	A Pesticide Bill was introduced in 2019 to upgrade Kenya's Pest Control Products Act by creating an independent Pesticide Control Products Authority in order to improve the monitoring of the pesticide industry qualification. The aim is to integrate Kenya into the

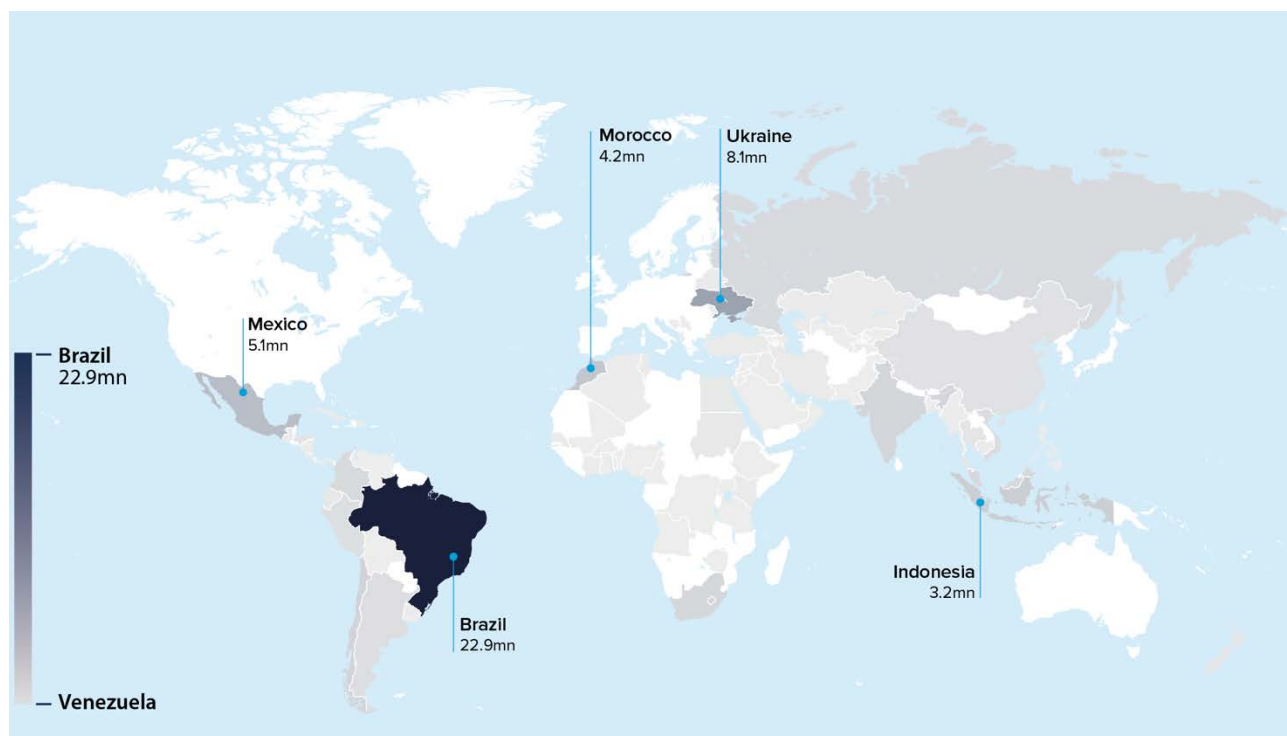
	Global Harmonized System of Hazard Warnings. The Kenyan pesticide industry is currently regulated by Chapter 346 of the Pest Control Products Act (PCPA) issued in 1985.
Vietnam	The 2017 Decree No. 113/2017/ND-CP specifies the regulations and restrictions regarding pesticide production and use. This is Vietnam's first update on pesticide management since 2008. The new decree specifies the list of active substances needed to be placed under control and sets requirements for the manufacturers and traders. The decree creates five categories for the substances and sets respective regulatory measures. For instance, for the substances listed under Annex 5, producers shall declare them annually in reports; as for the importers, companies have to submit a particular online application form before going through customs. The application asks the importers to present the data about the sale and purchase invoices of chemicals and safety data sheets in Vietnamese (ChemSafetyPro, 2017).

6 Exports of pesticides banned in the EU

Within the EU, many pesticides are banned or restricted due to their negative impacts, as outlined in Regulation (EC) No 1107/2009 and Regulation (EC) No 396/2005 (European Commission, 2019). Nevertheless, pesticide companies headquartered within the EU export large amounts of pesticides banned for use within the bloc to developing countries where regulations regarding their use are less strict.

Manufacturers headquartered in the EU planned to export 81 615 tonnes of pesticides banned for use within the bloc in 2018. Over half, 42 636 tonnes, would go to developing countries, according to an investigation by NGOs that obtained data from the European Chemicals Agency and regulators in Belgium, France, the United Kingdom, and Germany (Unearthed and Public Eye 2020). The top twenty destinations were Brazil, Mexico, Indonesia, Malaysia, Colombia, Ukraine, Peru, South Africa, the Russian Federation, Morocco, India, Chile, Honduras, Vietnam, Ecuador, Egypt, Thailand, Cuba, Turkey, and Guatemala.

Figure 7. Destinations of pesticides banned for use in the EU and exported to developing countries



Source: Unearthed and Public Eye (2020).

6.1 Company attitudes

EU-based pesticide manufacturers regularly face criticism for being involved in the international sale of pesticides banned for use in the EU. Typical corporate responses include claims that 'pesticides are needed to ensure food security' and that they follow local laws decided upon by sovereign countries'. In general, companies argue that pesticides are safe if used correctly, despite real-world settings showing that correct use is too difficult for many users in developing economies to achieve. The manufacturers also cite different climatic and environmental conditions in developing countries as the reason why pesticides banned for use in the EU can still be exported, and point to new, less dangerous pesticides now in development.

6.1.1 Corporate concerns

Interviews with industry representatives suggest that pesticide producers view themselves as competing in an increasingly crowded sector in which the rise of generics, which now account for about 60% of global pesticide sales, is pushing down prices and eroding the market share held by the biggest firms. At the same time, EU regulatory requirements are raising the cost of developing and obtaining regulatory approval for new (less toxic) active ingredients. As a result, corporate profitability considerations mean that the number of new active ingredients released has been falling steadily. In this environment, manufacturers with major R&D capabilities will attempt to maximise revenue streams from existing product lines by resisting efforts to ban export of these products.

6.1.2 Stringent standards

An important argument for pesticide producers is that the development and approval of new substances is very costly, takes a long time and can have an uncertain outcome. Therefore, the safest strategy for companies is to keep selling established products. In particular, the pesticide industry points to EU standards that are too high, making them costly to meet. EU permitted MRLs are tougher than the UN Codex Alimentarius standards. Most major companies are also invested in the development of biological pesticides. However, the EU regulations on these products are as strong as for conventional products, making their development and approval similarly costly. In contrast, the EU perception emphasises a rigorous and precautionary approach to food safety.

6.1.3 Lobbying strategies

Pesticide manufacturers have for decades engaged in sophisticated multi-million dollar lobbying efforts. Along with traditional lobbying of politicians, the strategy has included direct outreach to academics and scientists, and pursuing other indirect public relations efforts such as encouraging media publications to cover agriculture-related stories in a favourable manner and hiring third-party groups to produce studies that subvert or diminish the arguments of their critics.

The successful lobbying efforts have contributed to hard lines being drawn between stakeholders working in the global agriculture sector, with NGOs that seek to promote pesticide-free agriculture often refusing to directly engage with pesticide manufacturers or groups perceived as acting as their agents.

Lobbying by the pesticide industry is now split mainly between CropLife, which mainly represents the research-based companies, and AgroCare which represents the post-patent crop protection industry made up of producers and traders of generic pesticides. Similar splits have occurred at the national level in many developing countries (Jansen, 2017).

CropLife produces position papers that generally emphasises the industry's adherence to accepted principles, such as sustainability, evidence-based governance, and a willingness to collaborate with multilateral bodies, together with an emphasis on the positive aspects of pesticides. With their technical knowledge of the chemicals used in their products, the companies represented by CropLife have been closely involved in the development of standards and the management of data that are needed for the handling and registration of pesticides (e.g. as related to the FAO/WHO joint expert meetings). In 2020, the FAO and CropLife announced plans to strengthen their cooperation.

6.1.4 Portfolio updates

Some of the major manufacturers are seeking to boost development of biological pest control products that are more friendly to the environment. In October 2020, for example, Syngenta, headquartered in Switzerland, announced the acquisition of Valagro, an Italian biostimulants products manufacturer and R&D firm. BASF, based in Germany, has also announced a push into biologicals. However, even if safer or biological products are prioritised by the leading manufacturers, bringing them to market in developing countries remains a lengthy process that is potentially less lucrative than returns offered from their current portfolio of crop production tools, even if these are more hazardous. Still, development of biological products is not simply 'greenwashing' by pesticide manufacturers, which are aware that the composition of their product portfolios cannot remain stagnant for the long-term. New pesticide products are difficult and expensive to make, and given short-term profitability considerations, manufacturers have deprioritized making more biologicals when their traditional products are still available and in demand.

6.2 Potential for EU imports to be contaminated

Around the world, people are exposed to the residues of pesticides left in food. Developing countries in particular lack the resources and expertise to enforce legislation on pesticide residues. Therefore, the potential for food imported by EU Member States to be contaminated with pesticides banned within the bloc is high.

In its 2019 report on pesticide residues in food, the European Food Safety Agency (EFSA) found that 7.6% of samples from third countries exceeded MRLs. This was higher than the rate for EU-produced food, at 2.6%. If such imports are found to repeatedly exceed legal limits, they are placed on a list of high-risk imports that require further controls. If the situation in these countries does not improve, imports of these products from the given country can be suspended. The most effective way to ensure 'safer', residue-free imports is to implement better monitoring and control systems in the countries of origin (Zikankuba et al., 2019).

The European Commission's Directorate-General for Health and Food Safety carried out an audit in Vietnam during March 2017 to evaluate the country's controls of pesticides used on plant-based exports intended for the EU. According to the findings, the measures and legislation were sufficient, but the implementation of controls was poor and there was evidence of poor training of local farmers on the safe use of pesticides. At the time of the audit, there was no evidence of effective measures to control the use of pesticides on fruit and vegetables intended for the EU. Even though some measures were taken by individual exporters of Vietnamese produce to control the use of pesticides, MRL compliance could not be guaranteed by the local authorities (European Commission, 2017). EU regulatory practice mandates that specific products from specific countries with previously high MRLs should be subject to additional testing.

6.3 EU efforts to halt exports of banned pesticides

The European Commission's communication on *Chemicals Strategy for Sustainability Towards a Toxic-Free Environment* dated 14th October 2020 is an integral part of the European Green Deal, and a sign of interest in a shift to the sustainable use of pesticides. The communication notes that '84% of Europeans are worried about the impact of chemicals present in everyday products on their health, and 90% are worried about their impact on the environment'.

EU Member States are increasingly considering a change in their approach to allowing the export to developing countries of pesticides that have already been banned within the bloc (European Commission, 2020). From 2022, France will no longer allow the export of plant protection products that have been banned

in the EU for health and environmental reasons. Pesticide manufacturing companies strongly oppose the move, claiming it would result in severe economic consequences for them (Libération, 2019).

6.3.1 European standards

Currently, EU-wide standards include the Rotterdam Convention of Prior Informed Consent Procedure (PIC), which enables states to share information regarding the import and export of certain hazardous pesticides. The PIC regulation (EU) 649/2012 applies to banned and severely restricted industrial chemicals, biocides and pesticides such as benzene, chloroform, atrazine and permethrin and obligates export-oriented EU companies to comply with two types of requirement: Export Notification and Explicit Consent (ECHA, 2020). In the former stage, EU-based exporters should notify the country's Designated National Authority (DNA) before the export occurs to receive an official notification from the European Chemicals Agency. In the latter stage, the exporting company should also acquire explicit consent from the importing country's DNA. Nonetheless, the Prior Informed Consent Procedure still leaves EU-based companies free to export pesticides listed as dangerous to human health and environment to the non-EU countries.

Meanwhile, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal aims to protect human health and the environment from the adverse effects of hazardous waste. The convention is signed by 188 parties and includes restrictions and bans on the production of hazardous waste and promotes its disposal in places considered safe by environmentally sound management principles (Basel Convention and UNEP, 2020).

The recent launch of the European Green Deal/Farm-to-Fork Strategy specifically states that the EU will 'engage actively with trade partners to accompany the transition towards the most sustainable use of pesticides', promoting alternative plant protection products and methods.

6.3.2 Stricter controls on the horizon

Representatives of some Members States are expressing interest in a broader, EU-wide ban on exports of products that are banned for use within the EU, a move that would have ramifications across the global pesticide industry. At present, individual governments have established specific strategies to regulate pesticide use, authorisation, testing and monitoring and as a result policies and levels of protection vary significantly.

Currently, the EU has a systemic approach to the use of pesticides. These policies influence future pesticide use in the EU and therefore long-term strategies of pesticide manufacturers involved in exports. Regulation (EC) No 1107/2009 of the European Parliament and the REACH initiative has established a common framework for authorisation and use of all active substances (EUR-Lex, 2009). All plant protection products (which include pesticides), cleaning products, paints, etc. should undergo a two-step authentication procedure to be approved for commercial use. The key precondition for approval is not having any harmful effect on human or animal health and no unacceptable effect on the environment (ECHA, 2020). Furthermore, the 2019/1021 Regulation of the European Parliament and the Council on Persistent Organic Pollutants (POP) bans or severely restricts the use and production of POPs within the territory of the EU. Chemical substances that fall under the category of POPs include pesticides, industrial chemicals and unintentional by-products of industrial processes (ECHA, 2020). POP regulation aims to guarantee human health and environmental protection by replacing pesticides with more eco-friendly alternatives.

Regulation (EC) No 128/2009 further establishes a framework for the sustainable use of pesticides in the EU (EUR-Lex, 2009). Based on this regulation, since 2009 EU Member States have introduced national action plans

to reduce the environmental and health risks of pesticide use. These policies have only had limited effects on the reduction of pesticide risks in most member states so far, but they set the tone for moving towards a more sustainable use of pesticides (Möhring et al., 2020). This will include systems that rely less on the use of pesticides and instead use biological alternatives, smart technologies, resistant varieties and agroecological practices to reduce pest pressure. In this environment, companies that currently rely on revenues from synthetic pesticides will in the future have to focus on the production of biological alternatives and the provision of services to enhance pest control to farmers (such as the use of data and innovative prognosis systems).

As controls ramp up, further restrictions on the export of pesticides banned for use in the EU could be coupled with the option for countries to request them in cases of food-related emergencies. Such exceptions are granted in EU Member States. For instance, Article 53 of Regulation (EC) No 1107/2009 allows member states to authorise the placing on the market of plant protection products in exceptional circumstances (EUR-Lex, 2009). Exemptions are usually given in circumstances where plant production is under a significant threat, and the usage of banned pesticides remains an absolute necessity. Such situations often occur in cases when other available products have been banned or resistances against products have emerged, further underlining the need for a holistic regulation of pesticides (Möhring et al., 2020). The EU's exceptions have been criticised: in 2018, 82 % of the exemption applications did not provide any economic evidence of a threat to plant production. Nonetheless, building flexibility into the controls will help reduce uncertainty and ease the transition to less harmful agriculture practices.

7 Recommendations

This report examines the role that pesticides play and, for the foreseeable future, are likely to continue to play in shaping the availability and accessibility of food production in developing countries. The high likelihood of continued reliance on pesticides in the medium term makes it all the more urgent for concrete steps to be taken by the EU to help reduce the health and environmental risks of pesticides used in developing countries, and to encourage a rapid shift away from HHPs. In parallel, EU policy can increase momentum for the shift towards less toxic alternatives to pesticide use. Ultimately, chemical pesticides will still have a role to play, but this should be a last resort rather than a first-choice strategy. Major food importers, such as the EU, can use their weight to encourage and incentivise this shift.

Recommendation 1: Collaborate with the Rotterdam Convention to strengthen capacity building programmes and the use of the knowledge base maintained by the Convention.

Understaffed regulatory offices in developing countries often seek information about regulatory decisions made elsewhere, e.g. in the EU. The Rotterdam Convention maintains a very useful database for this purpose, which is not known about widely. Furthermore, the reporting of regulatory decisions by developing countries to the Convention should be further improved through capacity-building programmes.

Recommendation 2: Fulfill a role in supporting collaboration among developing countries to strengthen pesticide risk regulation.

Multi-country initiatives such as the *Postgraduate Diploma in Pesticide Risk Management* of the University of Cape Town, the web-based *Pesticide Discussion Forum*, and *The Arusha Call for Action on Pesticides* are initiated by and reach regulatory officials and researchers in sub-Saharan African countries and are crucial to knowledge and capacity development. Individual research institutes in the EU collaborate with these initiatives. The EU should strengthen such collaboration and encourage similar cooperation with organisations within the EU. Furthermore, the EU could focus its collaboration on giving more attention to regulating pesticide formulations (instead of active ingredients only) and the use of pesticide mixtures. Finally, the EU should ensure that test methods used in the regulatory process are validated for, adapted to, or replaced by test methods that are suitable for the specific conditions in developing countries. For example, the tropical conditions in many countries should be taken into account when developing test methods.

Recommendation 3: Explore the options to make regulatory risk data more transparent and publicly accessible. This could require long-term changes in the organisation and funding of the underlying risk research and the structure of the intellectual property rights of risk data.

Regulatory officials in developing countries face constraints in obtaining all risk data even when this is mandatory by local regulations. Particularly, studies with potentially unfavourable conclusions are often not included in the application dossier and do not come to the attention of the regulatory officials. If those studies were to become accessible, e.g. via the knowledge base of the Rotterdam Convention or the EU's own knowledge bases, they would be resources for sound decision-making based on all available information.

Recommendation 4: Strengthen research and extension in the fields of agroecology, organic farming and IPM, in particular supporting network initiatives on these themes among local universities and farmer associations in developing countries.

Food security in developing countries cannot be guaranteed over the long term if made dependent on pesticide products only. IPM, organic farming, and agroecology stimulate new ecosystem knowledge and new pest and disease control technologies better adapted and less disruptive to local ecosystems. The

development of the more complex, advanced and diverse knowledge underlying these technologies requires constant collective efforts to be sustained and expanded. Only strong locally rooted but nationally and internationally collaborating knowledge networks are able to develop the very diverse responses required to address pest and disease problems, in particular those of resource-poor farmers. In other words, rather than betting on top-down, 'single-bullet' solutions from leading companies and top research institutes, the EU should support initiatives that build knowledge networks at the national level in interaction with local farming realities, diverse ecosystems, and local and regional producer-consumer networks. Such local knowledge networks will be better able to adapt for local use the new, more environmentally friendly crop protection products developed by industry or knowledge networks elsewhere and to advise on their regulation.

Recommendation 5: Stop all exports of crop control products banned in the EU.

Although it is possible that the conditions of use elsewhere generate lower risks than in the EU, this is in most cases highly unlikely. The reverse would be more likely: the conditions of use in the EU allow for safe use while these conditions cannot be met in developing countries, making the use of such products unsafe there. Hence, it is recommended that products that can potentially cause harm, and are therefore banned in the EU, should not be sold outside the EU. Besides upholding this basic ethical principle, the EU should also consider such a ban because permitting such exports to continue damages the reputation of the EU. Halting these exports would increase the acceptance of the EU's approach to proper chemical regulations in developing countries.

Recommendation 6: Only allow the export of severely restricted pesticides if these are regulated accordingly and used properly in the importing country.

In many developing countries, crop protection products whose use is severely restricted in the exporting country are used without any restriction or, when formally restricted, in practice not used according to prevailing regulations. In collaboration with developing country governments, the EU could explore whether companies could be held liable for health or environmental damage in case of use without restrictions.

Recommendation 7: Support developing countries in developing an efficient process of re-evaluating pesticide registrations according to contemporary good regulatory practices in line with the FAO/WHO Code of Conduct.

With improved pesticide regulations, it becomes clear that older registrations often do not comply with contemporary criteria. A massive re-evaluation of such older registrations is needed.

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