Environmental and Health Impacts of Pesticides and Fertilizers and Ways of Minimizing Them

Envisioning A Chemical-Safe World

Chapter 1 of 12

Global drivers, actors and policies affecting pesticides and fertilizer use

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About

In December 2017, Resolution 4 of the 3rd Session of the United Nations Environment Assembly (UNEA 3) requested "the Executive Director to present a report on the environmental and health impacts of pesticides and fertilizers and ways of minimizing them, given the lack of data in that regard, in collaboration with the World Health Organization (WHO), the Food and Agriculture Organization of the United Nations (FAO) and other relevant organizations by the fifth session of the United Nations Environment Assembly". In response to this request, UNEP published a *Synthesis Report on the Environmental and Health Impacts of Pesticides and Fertilizers and Ways to Minimize Them*[1] in February 2022 (United Nations Environment Programme [UNEP] 2022).

The overall goal of the synthesis report is to provide the information base to enable other advocacy actions to be taken by stakeholders to minimize the adverse impacts of pesticides and fertilizers. Specific objectives of the synthesis report are to:

- Update understanding of current pesticide and fertilizer use practices;
- Present major environmental and health effects of pesticides and fertilizers, during their life cycle, and identify key knowledge gaps;
- Review current management practices, legislation and policies aimed at reducing risks in the context of the global chemicals, environmental and health agenda;
- Identify opportunities to minimize environmental and health impacts, including proven and innovative approaches.

This chapter on "Global drivers, actors and policies affecting pesticides and fertilizer use" is the 1st in a series of 12 chapters that make up a comprehensive compilation of scientific information. The chapters were developed to both inform and further elaborate on the information provided in the synthesis report. Please note that the disclaimers and copyright from the synthesis report apply

1 The Synthesis report is available at https://www.unep.org/resources/report/environmental-and-health-impacts-pesticides-and-fertilizers-and-ways-minimizing.

1 Global drivers, actors and policies affecting pesticides and fertilizer use

Key drivers affecting demand for pesticides and fertilizer use

The world population is growing and dietary habits are changing

The world population is expected to grow from about 7.8 billion in 2020 to 9.8 billion by 2050. Global income is increasing, and the global middle class is expanding.

Demand for food, feed, fibres, fuels and feedstocks is growing

Agricultural crops provide food, feed, fibres, biofuels, feedstocks and other products to support the needs of a growing human population. By 2050 demand for food is projected to grow by 60 per cent, meat production by nearly 70 per cent, aquaculture by 90 per cent and dairy by 55 per cent (IFIF 2021).

Cropland is also increasingly used for other purposes than food production, necessitating greater intensification of production of food crops. For example:

- The global commercial feed manufacturing market has an estimated annual turnover of over USD 400 billion and is expected to grow annually by 3.4 per cent between 2020 and 2027 (Data Bridge Market Research 2020).
- World natural fibre production in 2018 was estimated at 32 million tons,[1] with the size of the global fibres market expected to register high growth rates at least until 2025 (Grandview Research 2021).
- The global market value of biofuels worldwide is expected to grow from USD 136 billion in 2019 to USD 153 billion in 2024 (Statista 2021).

Pesticides and fertilizers provide important functions, and demand for them continues to grow

Pesticides are substances, or mixtures of substances with chemical or biological ingredients, intended to repel, destroy or control any pest or to regulate plant growth. Pesticides are among several tools available to manage pests for agricultural and public health purposes, but also in industrial and domestic settings. They have made an important contribution to the growth of agricultural productivity and food supply. Pesticides are sold and used because of the benefits they are expected to provide. These benefits include reduced crop losses, reduced prevalence of human vector borne diseases, improved shelf life of agricultural commodities, increased livestock yields,

1 In the present report ton indicates a metric ton.

reduced soil disturbance, and better protection of wooden structures, among others.

Fertilizers provide nutrients that are essential to plants (i.e., nitrogen, phosphorus and potassium), maintain soil fertility, and support productive and nutritious crops. They help increase crop yields and therefore contribute to agricultural production (food/feed/fibres). In some cases fertilizers are used to improve the quality of food or feed, so that, for example, they are more nutritious for people and livestock. Without fertilizers there would be a need for more cropland than is currently the case. Through their use, it has been possible to support more people while saving forests and grasslands by reducing their conversion to cropland (Lassaletta *et al*. 2014; Ritchie 2021).

Global demand, production and use of pesticides and fertilizers have expanded steadily in the past decades. By 2016 about 4.1 million tons of pesticide active ingredients were used globally, twice the volume applied in 1990; about 190 million tons of nutrients from inorganic fertilizers were used in agriculture in 2018 (FAO 2020a). Demand for inorganic fertilizers is expected to reach 197 million tons of nutrients by 2024 (International Fertilizer Association 2020). The global pesticide market has increased steadily during the last decade, with a compound annual growth rate of sales value of 4.8 per cent (in both nominal and real values) between 2006 and 2016 (Agrow 2016; Phillips McDougal 2017; Agrow 2019; Agrow 2020). Without fundamental changes in pest and nutrient management, average annual growth in pesticide and fertilizer use is expected to continue in a similar manner. Combined global sales of pesticides and fertilizers continue to grow at about 4.1 per cent per year, and are projected to reach USD 309 billion by 2025 (Grand View Research 2017).

Intensification of the agri-food production system is continuing

Increased demand for crops has led to intensification of agricultural production, which is partly achieved by greater use of pesticides and fertilizers. For example, between 2002 and 2018 the global population increased by about 21 per cent (FAO 2020b) and cereal production by about 44 per cent (FAO 2020c), while pesticide use per hectare of cropland increased by about 30 per cent (FAO 2019). and inorganic fertilizer use per hectare by about 23 per cent for nitrogen, 13 per cent for phosphorus and 56 per cent for potassium (FAO 2020d) (Chapter 2 and Chapter 7). Similarly, livestock intensification has been achieved through the use of concentrated feeds, pharmaceuticals and vaccines (FAO 2012; Van Boeckel *et al*. 2015).

Trade in agricultural commodities is changing

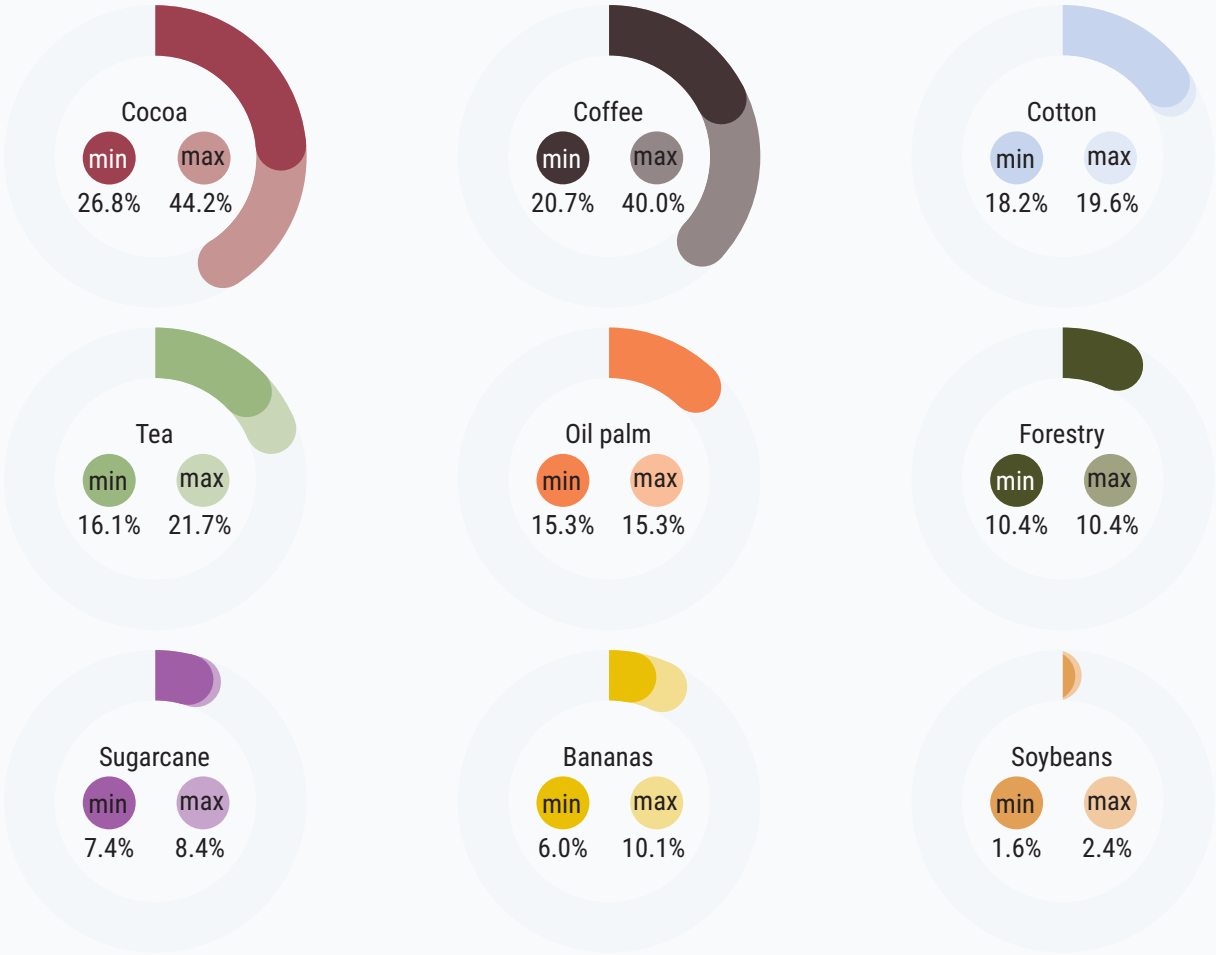
Increasing demand for agricultural products, including from middle income countries, is shaping trade patterns for crops and crop-based goods. This demand therefore affects pesticide and fertilizer use in exporting countries. Since the beginning of the millennium, trade in agricultural products has more than tripled to reach USD 1.33 trillion (Bellman, Lee and Hepburn 2019).

In addition to increases in scale, the geography of global food trade flows is shifting towards South-South trade, which currently accounts for roughly one-quarter of total agricultural trade flows. Most current growth in trade can be attributed to a few countries, including Brazil, China, India and Turkey. By 2030 Brazil is expected to surpass both the European Union and the United States as an agricultural exporter. China has become one of the largest importers of agricultural products, together with India, Mexico and Nigeria. In the future the largest demand is projected to come from Asia, followed by Africa (Bellmann, Lee and Hepburn 2019).

Sustainable agriculture is increasing, but it still covers a small share of cultivated land

While the use of voluntary sustainability standards in the agriculture sector continues to grow, it is estimated that only about 1 per cent of total agricultural cropland has been certified between 2000 and 2011 (Tayleur *et al*. 2017). Crops that tend to be certified at a relatively high rate include major commodities such as coffee, cocoa, tea and oil palm. Staple foods like maize (corn), rice and wheat are rarely certified (Figure 1.1). (Tayleur *et al*. 2017).

Figure 1.1 Certified share of cultivated land for selected crops. Meier *et al.* (2020), p. xiv.



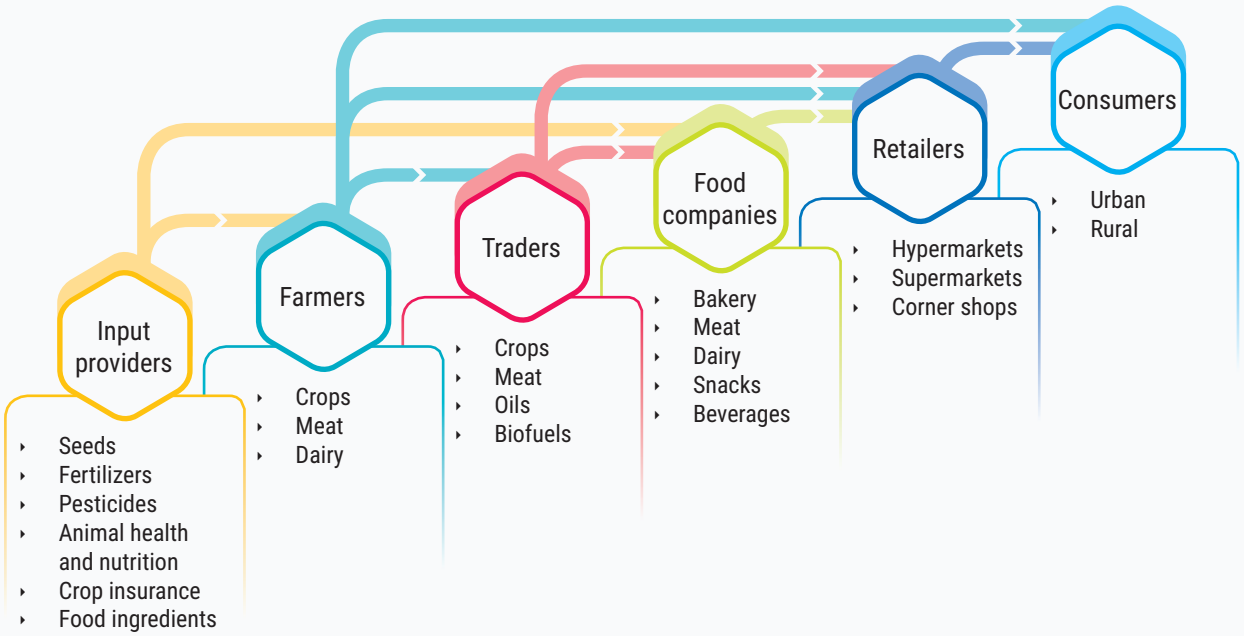
Actors in the value chain affecting pesticides and fertilizer use

Diverse actors affect the demand for and impacts of pesticides and fertilizers

The production and use of pesticides and fertilizers are shaped by diverse actors in the value chain of the global agri-food system and other, non-agricultural value chains. Key actors include consumers, farmers, the pesticide and fertilizer industries, and other corporate actors such as retailers, food companies and textile companies. Figure 1.2 provides an overview of the value chain from input companies (e.g., the pesticide and fertilizer industry) to the consumer.

Given their purchasing power, downstream actors can exert market pressure to foster the sustainable use and management of pesticides and fertilizers. For example, textile companies may require their suppliers to source certified organic cotton and support cotton producers shifting towards sustainable cotton production. While food companies play a particularly important role in driving change, they do not appear to be rising to the sustainability challenge. Only one global food company was among the top 100 most sustainably managed companies identified in a recent *Wall Street Journal* survey which evaluated 5,500 publicly traded companies based on environmental, social and governance (ESG) metrics (Cardello 2019).

Figure 1.2 The agriculture and food value chain.



The global agri-food market is controlled by a small number of corporations

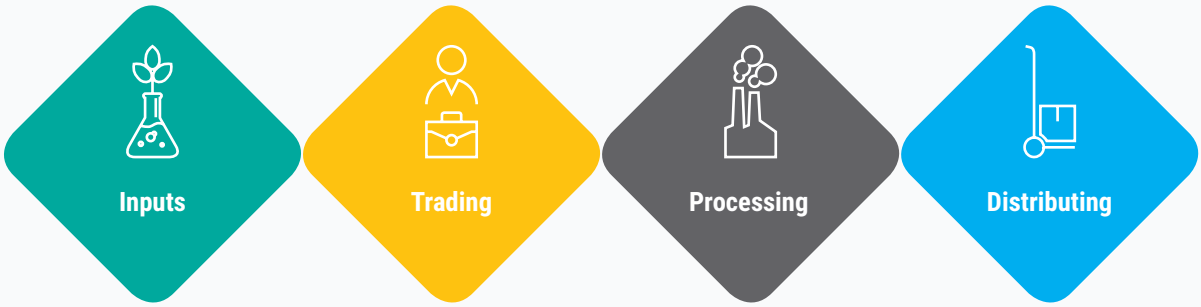
A small number of corporations control important segments of the global agri-food market (Figure 1.3). Three companies control over half the seed market, four traders control over 90 per cent of global grain trade, 10 retailers share 40 per cent of global food sales, and four (conglomerates of) companies currently represent about 65 per cent of the global pesticide market (Bellmann, Lee and Hepburn 2019). The same companies also often have important activities in the areas of seeds and genetically modified crops, leading to a concentration of research, development and marketing capacities with regard to agricultural inputs. At the same time, the share of off-patent ("generic") pesticides has increased from about 40 per cent in the early 2000s to about 70 per cent of the current global pesticide market (AgbioInvestor 2019).

Large and small farms face challenges that require distinct solutions

Of the 570 million farms in the world, 84 per cent are smaller than 2 hectares. In most low and lower-middle income countries farm sizes have decreased during the last 40 years, while they have increased in high income countries (Lowder, Skoet and Raney 2016). About 1 per cent of farms operate 70 per cent of the world's farmland, creating concerns that inequality is growing because agricultural production is increasingly dominated by a few major companies (International Land Coalition 2020). Access to agrochemicals (including pesticides and fertilizers), as well as knowledge about their proper use, are determined to a large extent by income, geographic location, and policies, as is access to relevant technologies.

The ways pesticides and fertilizers are used, and therefore affect the environment and health, greatly differ between smallholder and industrialized agriculture. Due to continued divergence in farm sizes and wealth status (which is particularly prevalent in low and lower-middle income countries), risk reduction measures need to take into account the specific situations and conditions of smallholder and industrial scale farming.

Figure 1.3 Concentration of actors in the food production chain. Bellmann, Lee and Hepburn (2019).



56%

Seeds

3 companies control 56% of the market: Bayer/ Monsanto, Corteva Agriscience (DowDupont), ChemChina/ Syngenta.

60%

Pesticides

4 companies share 60% of global pesticides market: ChemChina/Syngenta, Bayer/Monsanto, BASF, Corteva Agriscience (DowDupont).

90%

Traders

4 major traders control as much as 90% of the global grain trade: Bunge, Archer Daniels Midland, Cargill, Louis Dreyfus.

$1.1 billion

Food and beverages

10 companies own the biggest product brands and manufacture most of consumer shopping carts, collectively generating revenues of more than $1.1 billion a day: Associated British Foods, Coca-Cola, Danone, General Mills, Kellogg's, Mars, Mondelez International, Nestlé, PepsiCo, Unilever.

40%

Retailers

10 retailers share 40% in worldwide sales. In most OECD economies, one retailer controls between 15-30% of national supermarket sales: Tesco (UK), E.Leclerc (France), WalMart (USA), Edeka (Germany).

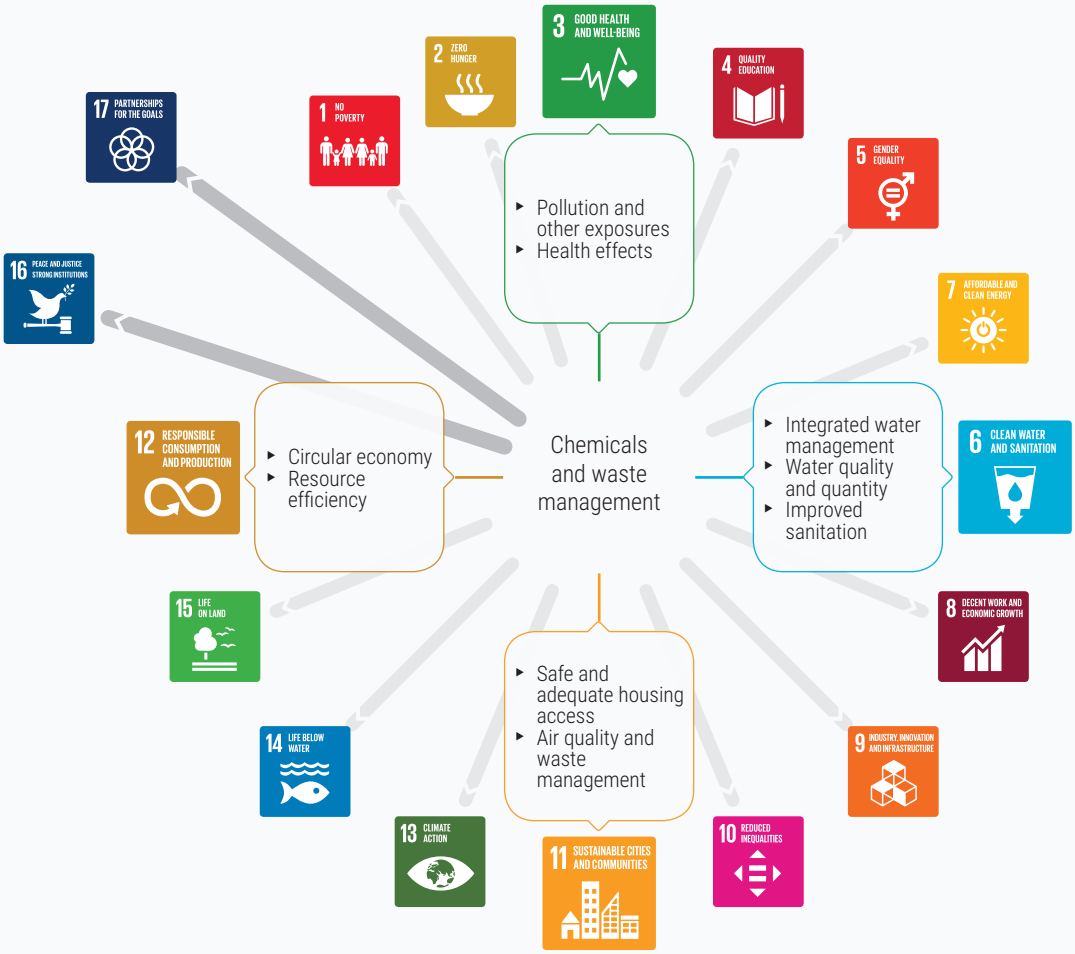
The international sustainable development context and policy instruments

The 2030 Agenda for Sustainable Development: Linkages with pesticides and fertilizers

The 2030 Sustainable Development Agenda was adopted in 2015 as a universal global framework to encourage action by all stakeholders to achieve sustainable development by the year 2030. The 2030 Agenda emphasizes that development needs to be compatible with all three dimensions of sustainability: economic, social and environmental. Sustainable development is therefore integrated, indivisible and needs to be implemented as a whole (rather than in a fragmented manner). Figure 1.4 shows linkages between chemicals and waste and the 17 Sustainable Development Goals (SDGs). Several of the SDGs are directly relevant to the sound management of pesticides and fertilizers. For example, SDG 12 on Sustainable Consumption and Production, Target 12.4, calls for achieving the environmentally sound management of chemicals and all wastes throughout their life cycle by 2020. This goal has not been achieved, according to UNEP's *Global Chemicals Outlook* (GCO-II) (United Nations Environment Programme 2019). In addition, SDG 3 on Good Health and Well-being, Target 3.9, calls for reducing the number of deaths and illnesses from hazardous chemicals by 2030.

SDGs and targets for which the sound management of pesticides and fertilizers is essential include access to food, clean energy (e.g., use of biofuels), health, and safe housing (e.g., use of bio-based building materials and household pesticides). Some SDGs and targets

Figure 1.4 Linkages between chemicals and waste and the Sustainable Development Goals. Based on Inter-Organization Programme for the Sound Management of Chemicals (IOMC) (2018), p. 3.



also help to strengthen an enabling environment for the sound management of pesticides and fertilizers, for example those concerned with access to information, education and financing.

Given its global importance, implementing the 2030 Sustainable Development Agenda presents an opportunity for collaborative action among many diverse actors and at all levels to minimize the adverse impacts of pesticides and fertilizers.

Global instruments and initiatives to manage pesticides and fertilizers

Over many years the international community has put in place a range of policy instruments and initiatives to manage pesticides and fertilizers Insights from the report and the proposed options for action may also provide an opportunity to strengthen relevant international instruments, as appropriate.

Two international legally binding instruments address a limited number of pesticides. The Stockholm Convention on Persistent Organic Pollutants regulates the entire life cycle of the substances listed under it. The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade includes provisions for using the prior informed consent procedure in regard to the import of the substances listed under it and for facilitating exchange of information on them. In addition, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal facilitates sound management and disposal of hazardous wastes including waste pesticides and fertilizers.

Table 1.1 Examples of linkages between pesticides and fertilizers and global conventions and policy frameworks.

Cluster	Global conventions and policy frameworks	Linkages with pesticides and fertilizers
Climate change	United Nations Framework Convention on Climate Change	• Fertilizers contribute to global greenhouse gas emissions • Certain (Intergovernmental Panel on Climate Change) recommendations target fertilizers
Biodiversity	Convention on Biological Diversity	• The Aichi Biodiversity Targets cover excess nutrients, sustainable agricultural production, and elimination of incentives (including subsidies) harmful to biodiversity
Desertification	United Nations Convention to Combat Desertification	• The convention links environment and development to sustainable land management (SLM) • Improving soil organic carbon is one of the SLM options
Food security and nutrition	Rome Declaration on Nutrition (FAO and WHO 2014b); United Nations Decade of Action on Nutrition, 2016-2025 (United Nations 2020)	• Eradicate hunger and prevent all forms of malnutrition • Enhance sustainable food systems • Legislative frameworks for food safety and quality, including for the proper use of agrochemicals

Key voluntary global instruments include the International Code of Conduct on Pesticide Management (FAO and WHO 2014a), which provides guiding principles for sound management of the entire life cycle of pesticides, and FAO's International Code of Conduct for the Sustainable Use and Management of Fertilizers (FAO 2019), which promotes the judicious use of fertilizers and addresses their misuse, overuse and underuse. SAICM focuses on some major global concerns about pesticides not specifically covered by the conventions mentioned above, such as Highly Hazardous Pesticides (Strategic Approach to International Chemicals Management 2021).

Other major global agreements and policies relevant for pesticides and fertilizers

Although not immediately obvious, the adverse impacts of pesticides and fertilizers may compromise the achievement of agreed global goals such as those addressing climate change, biodiversity loss and desertification (Table 1.1).

National and regional policy frameworks relevant to pesticides and fertilizers

Legislation, policies and collaborative platforms are crucial for effective pesticide and fertilizer use and management, at both the national and regional levels. National pesticide legislation and policies now exist in most countries in the world. Fertilizer legislation is less well developed, particularly in low and middle income countries. Increasingly, regional collaboration among countries supports sound management of pesticides, while regional fertilizer use and nutrient management appear to be driven more by non-governmental stakeholders such as scientific bodies.

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