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

Envisioning A Chemical-Safe World

Chapter 8 of 12

The regulatory and policy environment of fertilizer management and 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 "The regulatory and policy environment of fertilizer management and use" is the 8th 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.

The regulatory and policy environment of fertilizer management and use

8

8.1 Overview

The main harmful effects of fertilizer use addressed by international Conventions and policy instruments are greenhouse gas (GHG) emissions, air and groundwater pollution, and biodiversity loss. The 2019 International Code of Conduct for the Sustainable Use and Management of Fertilizers is intended to maximize the benefits of fertilizers and minimize the adverse effects (Food and Agriculture Organization of the United Nations [FAO] 2019a). [Chapter 8.2]

There is a regional imbalance in fertilizer use and in all regions, there are problems related to the misuse of fertilizers. Some regions have problems with overuse and others with underuse or inappropriate use.

There are more international partnerships and initiatives on nitrogen then on phosphorus. There may be a need to strengthen actions on phosphorus, so that they are closer to the level of the International Nitrogen Initiative, in order make phosphorus issues more visible. [Chapter 8.3]

Developed countries focus more on environmental issues than developing ones. There are more environmental initiatives in developed regions and countries; yet some developing regions and countries are major sources of environmental pollution (Alexandratos 1995).

The drive for policy change should distinguish between the needs of developed and developing countries, as their priorities in delivering on the 2030 Agenda for Sustainable Development can differ. Strategies for the implementation of policy instruments may also need to distinguish between developed and developing countries, and between different regions (Campbell *et al*. 2018). [Chapter 8.4]

There is also a need to harmonize regional policies and agreements with national ones (Joss *et al*. 2017; United Nations Economic Commission for Europe and African Development Bank [UNECA and AfDB] 2018; Wanzala-Mlobela *et al*. 2019). Lack of harmonization of standards across countries is a strong indication that national interventions, especially with regard to fertilizers, are still far from ideal (Joss *et al*. 2017; UNEP 2021). [Chapter 8.4.2]

There are gaps in information about the status of fertilizer policies at global, regional and national levels. In many cases, information on the progress made in implementing international and regional conventions at national level is not freely available to the public.

Shortcomings associated with fertilizer regulations exist in both developed and developing countries and national policies do not always cover all stages of the fertilizer life cycle (FAO 2019a). On fertilizer registration, low-income countries have the weakest performance and high-income countries performed best. The development and implementation of policies on fertilizer quality has progressed more in the case of inorganic fertilizers than in that of organic ones (World Bank 2017; World Bank 2019).

Countries have different priorities concerning fertilizer use and risks. They may use different combinations of instruments to achieve their goals. Fertilizers can be subject to legislation and regulations related to production, trade, distribution, marketing, safety and use. It can also be subject to legislation to protect air and water quality (FAO 2019a). [Chapter 8.5]

In some countries there are provisions in fertilizer legislation that aim to minimize environmental damage. In some there is also close collaboration between ministries addressing the food security agenda and the environmental agenda, which provides opportunities to exploit synergies and identify contradictions, overlaps and gaps in legislation. [Chapters 8.5.1, 8.5.2, 8.5.3]

More progress has been made on regulations for inorganic fertilizers than on those for organic fertilizers. Still, many countries have policies related to manure management, use and disposal of sewage sludge. [Chapters 8.5.1, 8.5.2]

The fertilizer industry is making contributions to sustainable nutrient management, for example by developing the 4R Nutrient Stewardship guidelines and helping to establish the Scientific Panel on Responsible Plant Nutrition (Johnson and Bruulsema 2014; International Fertilizer Association [IFA] 2020). [Chapter 8.6.1]

Implementing fertilizer regulations that take environmental concerns into consideration requires some of the tools and approaches discussed in Chapter 7, such as precision farming, decision support tools, and capacity development with regard to fertilizer use and management.

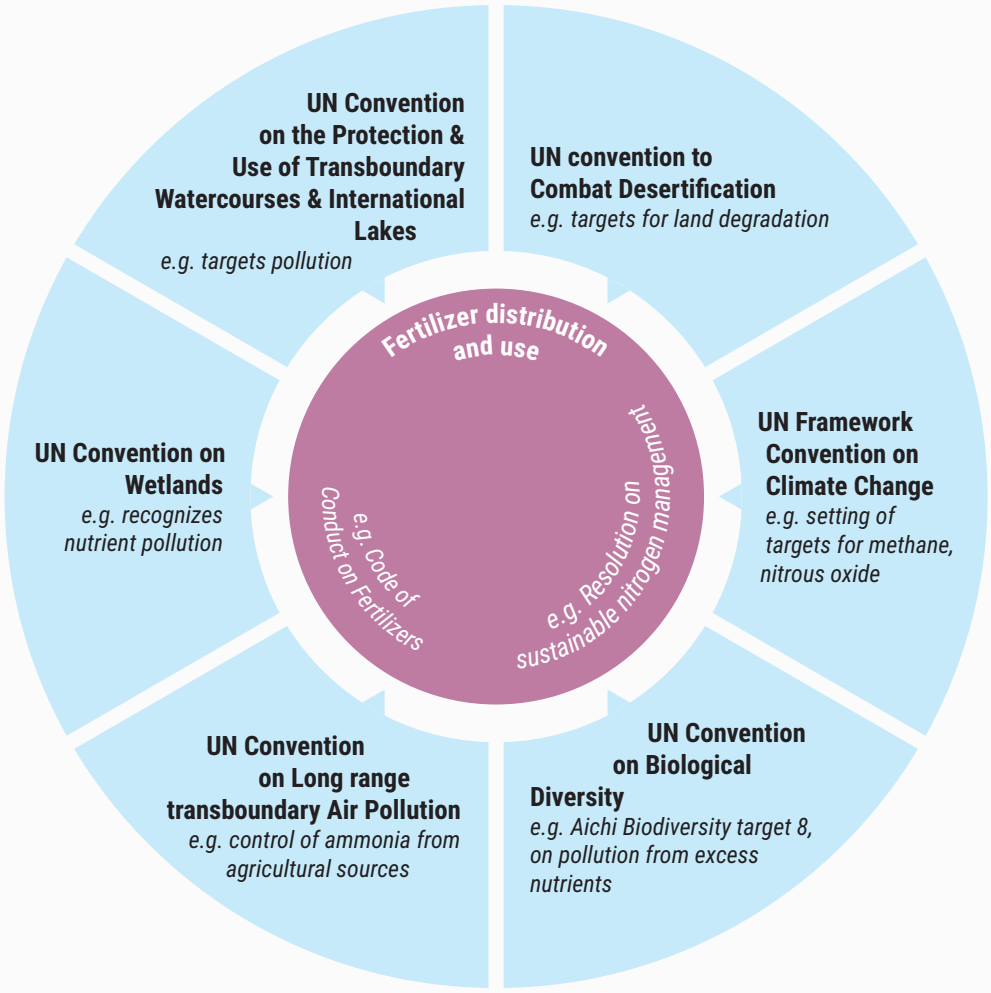
8.2 International conventions and policy instruments that address fertilizer distribution and use

The key Conventions addressing fertilizers (see Figure 8.2-1) are the three Rio Conventions established at the 1992 Earth Summit – the United Nations Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD) and the Convention on Wetlands (the Ramsar Convention) – together with the United Nations Convention to Combat Desertification (UNCCD), the Convention on Long-range Transboundary Air Pollution (including the Gothenburg Protocol), and the Convention on the Protection and Use of Transboundary Watercourses and International Lakes.

There is guidance on the safe transport and storage of potentially explosive fertilizers in the United Nations Economic Commission for Europe (UNECE) Industrial Accidents Convention, which is also described.

The management and use of fertilizers are mentioned, or alluded to, in several other international and regional Conventions and policy instruments. The recently published International Code of Conduct for the Sustainable Use and Management of Fertilizers (the Fertilizer Code) promotes practices that encourage judicious use of fertilizers. The Fertilizer Code addresses the misuse, overuse and underuse of fertilizers.

Figure 8.2-1 International Conventions with potential to influence fertilizer distribution and use



The Codex Alimentarius standards and guidelines on food quality consider fertilizers as potential food and water contaminants.

8.2.1 The United Nations Framework Convention on Climate Change

The 1992 United Nations Framework Convention on Climate Change (UNFCCC) serves as the foundation for international climate agreements. There are 197 Parties to the Convention (United Nations Convention on Climate Change [UNFCCC] 2020a). The ultimate objective of all agreements under this Convention is stabilization of greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate (UNFCCC 2020b).

The Kyoto Protocol to the UNFCCC was adopted in December 1997 and entered into force in February 2005 (UNFCCC 2020c). It set targets for emissions of the main greenhouse gases (carbon dioxide [CO_2], methane (CH_4), nitrous oxide [N_2O], hydrofluorocarbons [HFCs], perfluorocarbons [PFCs], sulphur hexafluoride [SF_6]). Fertilizers, including animal manure, are among the sources of CO_2, CH_4 and N_2O emissions.

The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body responsible for assessing the science related to climate change. It was created to provide policymakers with regular scientific assessments on climate change, its implications, and potential future risks, as well as to present adaptation and mitigation options (Intergovernmental Panel on Climate Change [IPCC] 2020). Some IPCC recommendations target fertilizers. For example, IPCC has suggested the

use of nitrification and urease inhibitors, precision farming, and improved manure management to reduce nutrient losses (Smith *et al*. 2014). A recent IPCC report on the current state of knowledge on climate change included improved fertilizer management and improved manure management among the practices that contribute to climate change adaptation and mitigation in cropland (IPCC 2019).

8.2.2 The United Nations Convention on Biological Diversity

The objectives of the United Nations Convention on Biological Diversity (CBD) are conservation of biodiversity, sustainable use of its components, and fair and equitable sharing of the benefits arising from the utilization of genetic resources (Secretariat of the Convention on Biological Diversity [CBD Secretariat] 2020a). The CBD covers ecosystems, species and genetic resources. Its Cartagena Protocol on Biosafety aims to ensure safe handling, transport and use of living modified organisms (LMOs) resulting from modern biotechnology that could have adverse effects on biological diversity, also taking into account risks to human health (CBD Secretariat 2000).

The CBD has the potential to influence fertilizer management. In the Strategic Plan for Biodiversity 2011-2020, Aichi Biodiversity Target 8 is: "By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity" (CBD Secretariat 2020b).

According to a scientific report on progress towards the Aichi targets (Leadley *et al*. 2014) which provided scientific evidence for the fourth edition of the *Global Biodiversity Outlook* (CBD Secretariat 2014), most countries had established national targets, or similar objectives related to Aichi Biodiversity Target 8 on pollution, in their national biodiversity strategies and action plans, with the majority of national targets referring to reduction of pollution generally and few referring specifically to reduction of excess nutrients.

A more recent report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES] 2019), intended to provide scientific evidence for the fifth edition of the *Global Biodiversity Outlook* (CBD Secretariat 2020c), concludes that some progress has been made on implementing policy responses and actions to conserve biodiversity. However, it emphasizes that the state of nature has continued to decline while progress on Aichi Target 8 and five other Aichi targets remains poor. According to this report, nutrient pollution continues to have adverse impacts on ecosystem functions and biodiversity despite increasing efforts to improve fertilizer use.

The Conference of the Parties to the CBD, at its 15th meeting in 2021, is expected to adopt a Post-2020 Global Biodiversity Framework which, among other things, will address all forms of pollution including excess nutrients.

The CBD is implemented in partnership with other biodiversity-related Conventions such as the UNCCD and the Convention on Wetlands (see below).

8.2.3 The United Nations Convention on Wetlands

The United Nations Convention on Wetlands (also known as the Ramsar Convention) provides the framework for national action and international cooperation with regard to the conservation and wise use of wetlands and their resources (Ramsar Convention on Wetlands 2018, 2020). This ensures that the benefits of wetlands contribute towards meeting the United Nations Sustainable Development Goals (SDGs), the Aichi Biodiversity Targets, the Paris Agreement on Climate Change (which entered into force in 2016), and other related international commitments. The Ramsar Convention recognizes that nutrient loads are among the major drivers of wetland degradation. As the only international treaty focused on wetlands, it provides a platform for collaboration and partnership in support of functional wetlands.

8.2.4 The United Nations Convention to Combat Desertification

The United Nations Convention to Combat Desertification (UNCCD), established in 1994, is a legally binding international agreement that links environment and development to sustainable land management. The Convention has a 2018-2030 Strategic Framework (United Nations Convention to Combat Desertification [UNCCD] 2017a). Implementation of the UNCCD is carried out at regional and national levels. Most countries have developed and submitted National Action Plans; alignment of sub-regional and regional action programmes has also been initiated (UNCCD 2020).

To disseminate sustainable land management (SLM) best practices, the UNCCD Secretariat works alongside the World Overview of Conservation Approaches and Technologies (WOCAT) to provide a network and database where specialists can share their knowledge about SLM practices and technologies (UNCCD 2016).

One of the key messages of the UNCCD *Global Land Outlook* (UNCCD 2017b) is that our food system focuses on short-term production and profit rather than on long-term environmental sustainability. The modern agricultural system has resulted in huge increases in productivity, holding off the risk of famine in many parts of the world. At the same time, it is based on monoculture, genetically modified crops, and intensive use of fertilizers and pesticides, all of which undermine long-term sustainability

The climate change mitigation and adaptation technologies considered to have the greatest impact, according to a report by UNCCD's Science-Policy Interface (SPI) (Sanz et al. 2017), include integrated soil fertility management practices (e.g., precision farming) and the use of both organic and inorganic fertilizers. This is a strong indication of the perceived role of fertilizers in sustainable land management.

8.2.5 The United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution

The Convention on Long-range Transboundary Air Pollution (LRTAP), which came into force in 1983, is a legally binding instrument on air pollution established within the framework of the United Nations Economic Commission for Europe (United Nations Economic Commission for Europe [UNECE] 1999). The Parties to the Convention are countries in North America, Europe and Central Asia.

There are eight protocols to this Convention concerning measures to reduce transboundary air pollution (UNECE 2019a). Those with the potential to influence fertilizer management and use include the Protocol concerning the Control of Emissions of Nitrogen Oxides (UNECE n.d.) and the Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (the Gothenburg Protocol) (UNECE 1999), which addresses four pollutants including ammonia and NOx.

The Task Force on Reactive Nitrogen (TFRN) has the long-term goal of developing technical and scientific information as well as options which can be used for strategy development across the UNECE to encourage coordination of air pollution policies on nitrogen in the context of the nitrogen cycle, and which may be used by other bodies outside the Convention, in consideration of other control measures (Convention on Long-range Transboundary Air Pollution Task Force on Reactive Nitrogen [CLRTAP-TFRN] 2020).

The Gothenburg Protocol to the LRTAP is intended to abate acidification, eutrophication and tropospheric (or ground level) ozone. It sets limits for sulphur, NOx, volatile organic compounds (VOCs) and ammonia and includes guidelines for measures to control ammonia emissions from agricultural sources (fertilizers, manures and animal housing) (UNECE 1999). A document prepared by TFRN to provide guidance to the Parties to the LRTAP Convention in identifying ammonia control measures for reducing emissions from agriculture addresses ammonia emission reduction measures in fertilizer and

manure application, along with manure storage techniques (Bittman et al. 2014).

Many Parties to the Convention are starting to put in place national legislation, especially to meet committed emissions ceilings (CLRTAP-TFRN 2020). Failure by countries to meet their ceilings for ammonia are likely due mainly to failure to reduce emissions related to fertilizers and manures. For example, in 2017 not all European Union (EU) Member States were in compliance with their ammonia ceilings and an overall increase in ammonia emissions of 2.5 per cent, between 2014 and 2017, was attributed to the agriculture sector (European Environment Agency 2019).

The revised Gothenburg Protocol, which is yet to enter into force, has been extended to include particulate matter ($PM_{2.5}$) among the pollutants covered (AirClim 2019). Since ammonia is one of the precursors of $PM_{2.5}$, reducing ammonia emissions from fertilizer and manure will contribute to reduced $PM_{2.5}$. (The relationship between ammonia, $PM_{2.5}$ and human health is discussed in Chapter 9.)

8.2.6 The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes

The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (the Water Convention) entered into force in 1996 (UNECE 2020a). It strengthens transboundary water cooperation and measures for the ecologically sound management and protection of transboundary surface waters and groundwaters. In 2003 the Convention was amended to allow accession by countries outside the UNECE region. The amended Convention entered into force in 2013. Most countries in Europe and three countries in Africa have acceded to the Convention and many other countries have begun accession processes.

The Convention allows for the establishment of joint bodies. Among the tasks of such bodies is the development of concerted action programmes for the reduction of pollution loads from both point sources (e.g., municipal and industrial sources) and diffuse sources (particularly from agriculture) Fertilizers are among the main agricultural sources of diffuse pollution.

Under the Convention the Protocol on Water and Health and the Protocol on Civil Liability were adopted in 1999 and 2003, respectively (Transboundary Water Resources Management in Southeastern Europe [TWRM] 2012). The objective of the Protocol on Water and Health is to promote the protection of human health and well-being, within a framework of sustainable development, through improving water management including the protection of water ecosystems, and through preventing, controlling and reducing water-related disease (United Nations Economic Commission for Europe and World Health Organization [UNECE and WHO] 1999). Under this Protocol, Parties are to take measures to protect water resources from pollution from agriculture and other sources. Each Party has the obligation to establish and publish its national targets and the respective target dates for each target area within two years of becoming a Party. Parameters for which targets have been developed in some countries include nitrates, microbes, and pesticides in drinking water (UNECE 2019b).

8.2.7 The UNECE Industrial Accidents Convention

The UNECE's Convention on the Transboundary Effects of Industrial Accidents (the Industrial Accidents Convention) provides principles and guidance materials for all countries to help ensure industrial safety and prevent major industrial accidents (UNECE 2020b). It specifically covers the storage and handling of hazardous substances, including ammonium nitrate (NH_4NO_3). However, there is a lack of reports on implementation and on the number of countries with policies targeting transport and storage of fertilizers such as ammonium nitrate and perhaps calcium ammonium nitrate (CAN).

8.2.8 The International Code of Conduct for the Sustainable Use and Management of Fertilizers

The International Code of Conduct for the Sustainable Use and Management of Fertilizers (the Fertilizer Code) was developed by the

Global Soil Partnership (GSP) (see Chapter 8.4) in response to a request by the Committee on Agriculture of the Food and Agriculture Organization of the United Nations (FAO) to increase food safety and the safe use of fertilizers (FAO 2019a). It was also developed in response to the third United Nations Environment Assembly (UNEA-3) declaration on soil pollution, while ensuring enhanced support to the implementation of the Voluntary Guidelines for Sustainable Soil Management (VGSSM) (FAO 2017a).

The Fertilizer Code addresses issues of global importance, thereby contributing to the implementation of the United Nations Sustainable Development Goals (SDGs). It is intended to maximize the benefits of fertilizers and minimize their negative effects by providing a framework and a set of recommended practices for stakeholders involved with fertilizers (FAO 2019a).

Stakeholders addressed by the Fertilizer Code include governments, policymakers, the private sector, researchers, academia and farmers.

Practices promoted by the Fertilizer Code include nutrient recycling, and agronomic and land management to improve soil health; it recommends regulation related to the sale, distribution and labelling of fertilizer products wherever appropriate (FAO 2019a). The Fertilizer Code also promotes capacity development and education programmes for all stakeholders involved in the fertilizer value chain, and encourages developed countries to assist others in developing infrastructures and capacity to manage fertilizers throughout their life cycle. An expected outcome of the Fertilizer Code is the effective and efficient use of fertilizers to meet agricultural demands while minimizing nutrient losses to the environment.

The Fertilizer Code was endorsed by FAO member countries at the 41st session of the FAO Conference in June 2019. Its principles will first be widely disseminated at the global level. The second step in implementation will involve national capacity development to strengthen technical and local extension services in order to adopt sustainable use and management of fertilizers. This will be followed by assessing countries' capacities for soil fertility management and fertilizer use; organizing trainings on sustainable use and management of fertilizers for extension services and governmental staff, retailers and agro-dealers; implementation of the Global Soil Doctors Programme for building the capacity of farmers on the sustainable management of soil fertility (FAO 2020a); implementing the activities of the Global Soil Laboratory Network on the harmonization of methods and data on soil fertility assessment and fertilizer quality control (FAO 2020b); and establishing balanced/precision fertilization recommendations. The last steps will involve strengthening the national and regional fertilizer quality control, regulatory systems and supply/distribution chains.

In the field, case studies will be established in priority countries with different issues related to fertilizers (overuse, underuse and inappropriate use) in order to understand how to better advise on the sustainable use and management of fertilizers at the national level before upscaling in countries/regions with similar issues.

8.2.9 The Codex Alimentarius

The Codex Alimentarius Commission is an intergovernmental body established by FAO and the World Health Organization (WHO) to protect the health of consumers and help ensure fair practices in the food trade (Codex Alimentarius 2020). It promotes coordination of all food standards work undertaken by international governmental and non-governmental organizations (NGOs), as well as promoting sustainable agriculture.

There are Codex Alimentarius guidelines for levels of contaminants and toxins in foods, and the production, nutrition and labelling of produced foods. Fertilizer is a potential source of some of the contaminants covered within the scope of the Codex. For example, guidance is provided on maximum cadmium levels for selected vegetables, pulses, cereals and sea foods, as well as chocolate (Codex Alimentarius 2019). Fertilizer may contain cadmium as a contaminant.

Inclusion on food labels of information about the environmental damage that can result from food production would make consumers more aware of the "pollution footprint" of their food choices.

The Codex Alimentarius, together with other initiatives, can help drive changes in the labelling of food products.

8.3 International partnerships and initiatives addressing fertilizer distribution and use

In this section a number of international partnerships and initiatives that have the potential to influence fertilizer distribution and use are described.

8.3.1 The Global Soil Partnership

The Global Soil Partnership (GSP), whose Secretariat is hosted by FAO, was established in 2012 (FAO 2020c). Global soil issues are addressed by multiple stakeholders within the GSP. The GSP structure includes the Intergovernmental Technical Panel on Soils, which provides scientific and technical advice and guidance on global soil issues to the GSP; Regional Soil Partnerships, which build on existing regional networks or collaborative processes and provide guidance on regional goals/priorities and their required implementation mechanisms; and a Plenary Assembly in which member countries and other partners decide on the sustainable soil management agenda (FAO 2020d).

The main achievements of the GSP are the Revised World Soil Charter (FAO 2015a), a report on the *Status of the World's Soils* (FAO 2015b), the Voluntary Guidelines for Sustainable Soil Management (VGSSM) (FAO 2017a), the Global Soil Organic Carbon Map (FAO 2017b), the International Code of Conduct for the Sustainable Use and Management of Fertilizers (FAO 2019), the Global Soil Laboratory Network (2020b), the Global Soil Information System (FAO 2020e), World Soil Day (FAO 2021), the development of a database on soil-related legal instruments called SoiLEX (FAO 2020f), RECSOIL (recarbonization of global soils) (FAO 2020g), among others.

8.3.2 The Global Partnership on Nutrient Management

The Global Partnership on Nutrient Management (GPNM) was formed in response to the need to reduce the amount of excess nutrients in the global environment, consistent with global development. It reflects a need for global advocacy and provides a platform for stakeholders to forge a common agenda on nutrient management (Global Partnership on Nutrient Management [GPNM] 2014). The GPNM provides support for the development and sharing of knowledge and the expansion of global and regional partnerships, particularly through the existing regional-level Nutrient Management Platforms and through planned regional GPNM platforms (GPNM n.d.).

GPNM members include the International Nitrogen Initiative (INI), the South Asia Cooperative Environment Programme (SACEP), the UK-China Sustainable Agriculture Innovation Network (SAIN), and private sector or industry organizations such as the International Fertilizer Association (IFA).

GPNM is one of the three partnerships established under the *Global Programme of Action for the Protection of the Marine Environment from Land-based Activity (GPA)*. The purpose of the GPA is to provide guidance to regional and national authorities on the prevention, reduction, control and/or elimination of marine degradation from activities carried out on land. The contaminants considered include sewage, heavy metals and nutrients (United Nations Environment Programme [UNEP] 2020a). The GPA is coordinated by UNEP and implemented primarily by governments, in partnership with all stakeholders.

Global TraPs was launched in 2011 and ended in 2015 (Global TraPs 2015). Its aim was to identify technologies and policy options needed to ensure that future phosphorus use is sustainable, improve food security and environmental quality, and provide benefits to the poor. This project was designed to provide a stakeholder forum. Through its framework academia, NGOs, advocacy groups and the private sector engaged in a multi-stakeholder dialogue. At the end of the project, in order to properly utilize the project's achievements, a proposal was made to turn it into a more permanent structure under the UNEP Global Partnership for Nutrient Management (GPNM) in 2014.

8.3.3 The International Nitrogen Initiative

The International Nitrogen Initiative (INI) is a scientific body established to review the current understanding of the nitrogen cycle and to identify options for optimizing the management of reactive nitrogen globally while minimizing its negative effects on human health and the environment (International Nitrogen Initiative [INI] 2020). INI was created and is sponsored by the Scientific Committee of Problems of the Environment (SCOPE) and the International Geosphere-Biosphere Programme (IGBP). It has regional centres in North America, Latin America, Africa, Europe, East Asia and South Asia.

To address the challenges associated with nitrogen and phosphorus, the members of INI adopted the Kampala Statement for Action on Reactive Nitrogen in Africa and Globally during the sixth International Nitrogen Conference held in Uganda in 2013 (INI 2014). The issues highlighted in the statement of action for sub-Saharan countries from that meeting included: improving soil fertility status; improving nutrient use and supply; acting on nutrient and fertilizer policy; and reducing the contribution of nitrogen to the degradation of water bodies and to air pollution. Globally, the key messages included: improving nitrogen management; reducing nitrogen losses from agriculture; reducing nitrogen losses from the industry, transport and energy sectors; improving waste treatment; and informing individuals and institutions.

8.3.4 The International Nitrogen Management System

The International Nitrogen Management System (INMS) is emerging through an international project supported by the Global Environment Facility (GEF) (United Nations Environment Assembly [UNEA] 2019a), implemented by UNEP, and executed by INI and its partners through the Centre for Ecology in the United Kingdom (INMS 2020a). This project will bring together the science community, the private sector and civil society to gather and synthesize evidence that can support international policy development to improve global nitrogen management (INMS 2020b). It is a key opportunity to pull together a global and critical mass of science evidence on the nitrogen cycle, and to develop a sustained process that gets science, governments, businesses and civil society working together to build common understanding and deliver real change.

In March 2019, Resolution 4/14 on sustainable nitrogen management, which calls for coordination of nitrogen policies from national to global levels, and for sharing and making available existing information and knowledge in the development of evidence-based decision-making towards sustainable nitrogen management, was tabled by India and adopted by the fourth session of the United Nations Environment Assembly (UNEA 2019b).

Thereafter, the fourth meeting of the INMS (INMS-4) held in April 2019 allowed for follow-up on the resolution (INMS 2019). It recognized the many opportunities for better nitrogen management associated with water, air, climate, biodiversity, soils, stratospheric ozone, food and energy, including the need to develop improved coordination between relevant multilateral environmental agreements. The meeting supported the proposal in the UNEA-4 nitrogen resolution to establish an Inter-convention Nitrogen Coordination Mechanism and identified next steps (INMS 2019).

In October 2019, UN Member States endorsed a proposed roadmap for action on nitrogen challenges, the Colombo Declaration on

Sustainable Nitrogen Management (the Colombo Declaration) (UNEP 2019). A key goal of the Colombo Declaration is to halve nitrogen waste by 2030. As part of the Declaration, more than 30 countries endorsed UN plans for a campaign on sustainable nitrogen management called Nitrogen for Life, which stems from the Sustainable Nitrogen Management Resolution. The Declaration urges countries to conduct comprehensive assessments of nitrogen cycling, covering policy, implementation, regulation, and scientific aspects at national level and to sensitize citizens to understand the natural nitrogen cycle and how human impacts alter its balance.

8.3.5 The Global Phosphorus Research Initiative

The Global Phosphorus Research Initiative (GRPI) was founded in 2008 by researchers at the University of Technology in Sydney, Australia, and Linköping University in Sweden (Global Phosphorus Research Initiative [GPRI] 2020). The initiative is a collaboration between independent research institutes in Europe, Australia and North America. This initiative undertakes research on global phosphorus security for future food production. It also facilitates networking, dialogue and awareness-raising among policymakers, industry, scientists and communities on the implications of global phosphorus scarcity and possible sustainable solutions. In the past decade or two concerns have been expressed about the possible depletion of the world's non-renewable phosphate rock resources. However, thorough estimates of world phosphate rock supply indicate that a phosphorus crisis is not imminent (van Kauwenbergh, Stewart and Mikkelsen 2013; United States Geological Survey 2020) (see also Chapter 7.3).

8.3.6 The Sustainable Rice Platform

The Sustainable Rice Platform (SRP) is a multi-stakeholder platform established in 2011 (The Sustainable Rice Platform [SRP] n.d.). The platform is co-convened by UNEP and the International Rice Research Institute (IRRI) to promote resource efficiency and sustainability in trade flows, production and consumption operations and supply chains in the global rice sector.

8.3.7 The Sustainable Agriculture Initiative Platform

The Sustainable Agriculture Initiative (SAI) Platform was created in 2002 by Nestlé, Unilever and Danone (Sustainable Agriculture Initiative Platform [SAI Platform] 2020). The aim of the Platform is to support the development of sustainable agriculture worldwide. The main activities are building capacity for sustainable agriculture and communicating about sustainable agriculture to stakeholders (Sustainable Agriculture Initiative Platform [Sustainable Agriculture Initiative Platform 2020). The Platform has a membership of at least 106 companies and regional initiatives in Australia, Brazil and China. It recommends integrated crop management practices that include careful use of fertilizer. For example, for sustainable production of cereals in Europe, well-balanced fertilization that takes into account soil resources, crop nutrient needs, climatic conditions and surface, groundwater and contamination risks is recommended (Sustainable Agriculture Initiative Platform Platform 2006).

8.3.8 The International Environmental Product Declaration System

The International Environmental Product Declaration (EPD) System (EPD 2020) is a global programme for type III environmental declarations operating in accordance with International Organization for Standardization (ISO) standard ISO 14025. EPDs are based on scientific principles. They are independently verified and registered documents that communicate transparent and comparable information about the life-cycle environmental impact of products, including fertilizers. For example, EPD for arable crops contain information on estimates of direct emissions of ammonia, N2O and NO for different types of inorganic fertilizers and for animal manure (EPD 2013). The EPD System website has a library of EPDs and Product Category Rules (PCRs) that are available to the public. The programme is open for companies and organizations in any country.

8.3.9 The Sustainability Consortium

The Sustainability Consortium was created in 2009 by Walmart, the University of Arkansas and Arizona State University in the United States (The Sustainability Consortium [TSC] 2020). The Consortium is a global non-profit organization working to transform the consumer goods industry by partnering with leading companies to define, develop, and deliver more sustainable products. The consortium offers tools and services for use in addressing product sustainability, for both buyers and suppliers. Among the tools the Consortium has available on its website are key performance indicators for use in measuring the sustainability of coffee production e.g., on fertilizer use and other factors. In addition, the Consortium shares information, for example on best practices in agricultural data collection and field-level sustainability projects.

8.3.10 The World Trade Organization

Many countries are either signatories of WTO agreements or are under observer status (UNECA and AfDB 2018). The WTO discourages protectionist policies and countries are encouraged to open up their domestic markets to goods and services from other countries.

Enforcement of the WTO agreements could contribute to reduction in amounts of fertilizers used. Policies which support domestic prices, or subsidize production can encourage high production of crops. For example, the increase in production of rice, maize and wheat in China has been partially attributed to the market price support policy (Yu 2017). The WTO Agriculture Agreement encourages the use of national policies that cause minimal trade distortion. (WTO n.d). However, it is more lenient in the case of developing and least developed countries than in that of developed countries. For example, developing countries do not have to reduce their subsidies or tariffs as much as developed countries. Since farmers' decisions on crop management are to a large extent based on expected profits, removal of price support policies could result in reduced production and reduced use of inputs.

In 2016 the United States complained that the domestic support China offered to agricultural producers, particularly those producing rice, maize and wheat, appeared to be inconsistent with the WTO Agreement on Agriculture. In early 2019 the WTO ruled in favour of the complaint by the United States and gave China up to 31 March 2020 to implement the proposed recommendations (Hopewell 2019). Scrutiny by other countries of the economic support China provides to agricultural producers will likely contribute to lower producer prices in China and could contribute to a reduction in fertilizer use of. Currently, however, the key factor expected to contribute to reduced growth in the use of inorganic fertilizer in China is the zero growth environmental policy of 2015, which targets both pesticides and fertilizers (Jin and Zhou 2018).

8.4 Regional conventions, legislation and policy instruments linked to fertilizer distribution and use

Developed countries tend to give greater priority to environmental issues than do many developing countries, and most of the former have taken measures to reduce or prevent threats to the environment associated with agriculture. However, since developing countries are generally food insecure and have high poverty levels, environmental measures are commonly in direct competition for scarce resources (Alexandratos 1995).

There is an increasing need to achieve the Sustainable Development Goals (SDGs) associated with environmental issues and those associated with food security and livelihoods (Campbell *et al*. 2018). However, trade-offs may need to be

made between policies targeting environmental protection and those targeting food security. For example, in many developing countries there is need to increase use of nitrogen to meet Sustainable Development Goal (SDG) 1 (poverty reduction), SDG 2 (zero hunger) and SDG 3 (health), but too much nitrogen pollutes surface and groundwater and increases the need to meet SDGs 6 (clean water and sanitation), 13 (climate change), 14 (life below water) and 15 (life on land) (Campbell *et al*. 2018).

This section discusses regional partnerships that are part of international initiatives, followed by regional initiatives specific to Africa, Europe, North America, Latin America and Asia.

8.4.1 Regional partnerships that are part of International initiatives

Regional Soil Partnerships

Seven Regional Soil Partnerships (RSPs) covering Africa, Asia, Europe, Latin America and the Caribbean, the Pacific, the Near East and North Africa, and North America were formed between 2012 and 2019. The membership comprises stakeholders in these regions. The RSPs provide guidance on regional goals/priorities and their required implementation mechanisms. They also facilitate links with national and local soil management programmes. The Partnerships work in collaboration with FAO Regional Offices (FAO 2022).

International Nitrogen Initiative regional centres

The International Nitrogen Initiative is coordinated by a steering committee, led by a chair and six regional centre directors representing, Africa, Europe, Latin America, North America, South Asia and East Asia (INI n.d.). The regional centres are tasked with assessing, creating awareness of, and developing solutions to nitrogen issues in each region. They work in collaboration with relevant research institutions and universities in the regions. The triennial INI conferences held in 2004 (China), 2007 (Brazil), 2010 (India), 2013 (Uganda) and 2016 (Australia) produced nitrogen declarations that summarize and update the scientific evidence in order to advocate international action on sustainable nitrogen management. The first European Nitrogen Assessment was published by the European regional centre of INI and its partners in 2011. The Indian Nitrogen Group and the South Asian Nitrogen Centre of INI published the Indian Nitrogen Assessment in 2017. The International Nitrogen management System (INMS) is working towards publication of the first International Nitrogen Assessment by 2021.

8.4.2 Initiatives specific to regions

Africa

At the continental level, the African Union (AU) is the leading organization that influences national decisions. In the 2006 *Abuja Declaration on Fertilizer for the African Green Revolution*, AU Member States resolved to increase annual fertilizer use on cultivated land in Africa from 8 kg to 50 kg of nutrients per hectare by 2015 (New Partnership for Africa's Development [NEPAD] 2011). The African Development Bank (AfDB) was charged with the responsibility of establishing and managing the Africa Fertilizer Financing Mechanism (AFFM). The key function of AFFM was to provide financing required to debottleneck the use of fertilizers. The amount of NPK fertilizer applied on cultivated land in SSA has doubled from 8 kg to 17 kg of nutrients per hectare (Roy 2019).

Efforts to implement the Declaration by the Regional Economic Communities include developing and adopting resolutions on the harmonization of fertilizer policies and regulations and promoting national and regional fertilizer production and intraregional trade (NEPAD 2011). However, all sub-Saharan economic regions still have some way to go, according to a recent publication by Wanzala-Mlobela *et al*. (2019). The authors point out that in the *Economic Community of West African* States (ECOWAS) 13 countries have developed at least an implementing regulation and two have put in place a registration system. Other regional communities are even further behind in this process.

Again according to Wanzala-Mlobela *et al*. (2019), the *East African Community (EAC)* has guidelines

on how harmonization of fertilizer policies and regulatory frameworks should be undertaken in the region and is in the process of developing legislation to govern the fertilizer sector. The *Common Market for Eastern and Southern Africa (COMESA)* has developed a framework document delineating the key policy areas and recommendations with regard to national fertilizer policy and harmonization. The *Southern African Development Community (SADC)* region started to develop a harmonized system for labelling fertilizers, but progress has slowed.

Apart from economic communities, there are organizations that contribute to sustainable use of fertilizers. For example, the *African Fertilizer and Agribusiness Partnership (AFAP)* supports the agricultural inputs and agribusiness value chain by providing financial assistance to agro-dealers (Africa Fertilizer and Agribusiness Partnership 2019). It promotes the use of high quality and affordable balanced fertilizers, supports dialogue among stakeholders, and provides policy support to governments. Another example is the *African Organisation for Standardisation (ARSO)*. Established by the African Union and the United Nations Economic Commission for Africa (UNECA), it has a key mandate to harmonize standards in Africa (African Organisation for Standardisation 2020).

Europe

The new *EU Fertilising Products Regulation* entered into force in 2019 and will apply as of the summer of 2022 (European Union [EU] 2019; EU 2020). One of its main objectives is to encourage large-scale fertilizer production from domestic organic or secondary raw materials, in line with the circular economy model, by transforming waste into nutrients for crops (European Commission [EC] 2016; European Council 2019).

Unlike the previous Fertilizer Regulation, which succeeded in harmonizing the EU inorganic fertilizer market, the new regulation not only covers inorganic fertilizers, but also organic and organo-mineral fertilizers and microbial plant biostimulants. In addition, it addresses environmental concerns by setting harmonized limits for a range of contaminants (Table 8.4-1) (EU 2019).

The purpose of the EU *Sewage Sludge Directive* of 1986 is to regulate use of sewage sludge in agriculture in such a way as to prevent harmful effects on soil, vegetation, animals and man (EU 1986). The European Commission is currently assessing whether the Directive should be reviewed. It has launched a study to gather existing information on the environmental, economic, social and health impacts of practices of sewage sludge use on land that are currently in use (EC n.d.).

The *European Sustainable Phosphorus Platform (ESPP*) was formed in 2013 through a declaration signed by over 150 organizations (European Sustainable Phosphorus Platform 2019). The Platform ensures knowledge sharing, experience transfer and networking about opportunities in phosphorus management; facilitates discussions between the market, stakeholders and regulators; addresses regulatory obstacles; contributes to policy proposals; circulates information through newsletters, a website, conferences and publications; and promotes platform members' activities. The members represent a wide range of actors across the whole value chain of phosphorus stewardship: phosphorus mining and processing, water and waste treatment, food, feed and agriculture, phosphorus reuse and recycling, innovation and technology providers, knowledge institutions, NGOs, and governmental organizations.

The 1991 EU *Nitrates Directive* is intended to protect water quality in Europe by preventing nitrates from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices (EC 2010). The Nitrates Directive restricts the use of fertilizers and manure in situations where there is a high risk of leaching and run-off, sets limits on the amount of nitrogen in manure applied per hectare of agricultural land (the limit is 170 kg nitrogen per hectare for livestock manure), and promotes balanced fertilization (i.e., balancing nitrogen and phosphorus inputs with plant demand) (van Grinsven et al. 2015).

Table 8.4-1 Maximum limits for heavy metals and pathogens in fertilizers and biostimulants in the new EU Fertilising Products Regulation.

	Organic fertilizers	Organo-mineral fertilizers	Inorganic macronutrient fertilizers	Biostimulants
Contaminants				
Cadmium	1.5 mg/kg dry matter	3 mg/kg dry matter if fertilizer has <5% P_2O_5; 60 mg/kg of dry matter if fertilizer has ≥5% P_2O_5	3 mg/kg dry matter if fertilizer has <5% P_2O_5; 60 mg/kg of dry matter if fertilizer has ≥5% P_2O_5	1.5 mg/kg dry matter
Hexavalent chromium (mg/kg dry matter)	2	2	2	2
Mercury (mg/kg dry matter)	1	1	1	1
Nickel (mg/kg dry matter)	50	50	100	50
Lead (mg/kg dry matter)	120	120	120	120
Inorganic arsenic (mg/kg dry matter)	40	40	40	40
Biuret (g/kg dry matter)	absent	12	12	
Perchlorate (mg/kg dry matter			50	
If these nutrients are not intentionally added				
Copper (mg/kg dry matter)	300	600	600	600
Zinc (mg/kg dry matter	800	1,500	1,500	1,500
Pathogens				
Salmonella spp.	Absence in 25 g or 25 ml	Absence in 25 g or 25ml	Absence in 25 g or 25 ml	Absence in 25 g or 25 ml
Escherichia coli or	1,000 in 1 g or 1 ml	1,000 in 1 g or 1 ml	1,000 in 1 g or 1 ml	Absence in 1 g or 1 ml
Enterococcacea	1,000 in 1 g or 1 ml	1,000 in 1 g or 1 ml	1,000 in 1 g or 1 ml	10 colony forming unit (CFU)/g
Listeria monocytogenes, Vibrio spp., Shingella spp. or Staphylococcus aureus				Absence in 25 g or 25 ml

EU Member States have made progress in implementing this Directive (Table 8.4-2). The existence of infringement procedures against countries (EC 2018) could be contributing to this progress.

Aquatic ecosystems are protected against eutrophication by the *Water Framework Directive* and the *Marine Strategy Framework Directive* (van Grinsven *et al*. 2015).

The Water Framework Directive (WFD), adopted in 2000, requires Member States to achieve good environmental status by 2015 for all water bodies, including marine waters up to one nautical mile from shore (Boesch 2019). The WFD also requires that nutrient concentrations do not exceed the levels established (van Grinsven, Tiktak and Rougoor 2016). Implementation of measures to meet the requirements of the WFD has included the design of river basin management plans (RBMPs) by Member States (van Grinsven, Tiktak and Rougoor 2016). The potential to meet the

Table 8.4-2 Progress made on implementing the EU Nitrates Directive (EC 2018; EC 2019b).

Step	Progress made
Water monitoring for nitrate concentrations and trophic status	Uneven efforts deployed in water monitoring by Member States; large number of new stations with no trends across the EU
Designation of nitrate vulnerable zones (NVZs)	Areas with potential water pollution that are not included in any NVZ exist; sometimes the designed territory is limited to the area around the monitoring stations
Establishment of codes of good agricultural practices (CGAPs) and voluntary implementation of the CGAPs	All members have established CGAPs
Establishment of action programmes	Several members have adopted action programmes at regional level
Review and possible revision of the designation of NVZs and of action programmes at least every four years	NVZs defined in 2003 and changed in 2007 and 2011; review of NVZs done in 2015, and new NVZs declared in 2016
Submission to the European Commission of a progress report every four years	Member States submit reports; the latest was finalized in 2017

Water Framework Directive goals successfully has been associated with mainstreaming water policy into other policy sectors, particularly agricultural policy (Carvalho *et al*. 2019).

The EU *Marine Strategy Framework Directive* (MSFD), adopted in 2008, aimed at achieving and maintaining good environmental status in European seas by 2020.

In 1974, the Baltic Sea countries joined the *Convention on the Protection of the Marine Environment of the Baltic Sea, also known as the Helsinki Convention*. The Baltic Marine Environment Protection Commission, or Helsinki Commission (HELCOM), implements the Convention's plans and directives (Baltic Marine Environment Protection Commission 2020). The contracting parties are Denmark, Sweden, Finland, Germany, Poland, Lithuania, Latvia, Estonia, the Russian Federation and the EU. A key objective of the Commission is to reduce emissions of nitrogen and phosphorus to the Baltic Sea. The Commission has set targets for the reduction of nitrogen and phosphorus loads (Boesch 2019).

The *Convention for the Protection of the Marine Environment of the North-East Atlantic, also known as the OSPAR Convention,* entered into force in 1998 (OSPAR Secretariat 2020a). It replaced the Oslo and Paris Conventions. The 15 countries in the OSPAR Commission are Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom. The OSPAR Eutrophication Strategy (based on the OSPAR Convention) aims to combat eutrophication in the OSPAR maritime area by achieving reduction at source of nitrogen and phosphorus inputs in areas where these inputs are likely to cause pollution (OSPAR 2020b).

The *Mediterranean Action Plan, also known as the Barcelona Convention*, was adopted by Mediterranean countries and the European Economic Community in 1976 (Boesch 2019). It was amended in 1995 as the *Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean*, which entered into force in 2004. Contracting Parties are committed to the adoption of measures against land-based pollution, protection of biological diversity, and monitoring of pollution.

The *Bucharest Convention on the Protection of the Black Sea against Pollution* was adopted in 1992 by the six countries which are Parties to the Convention (Bulgaria, Georgia, Romania, the Russian Federation, Turkey and Ukraine) (EC 2020a). The strategic plans for the Convention

include avoiding excessive nutrient loading. A large share of these nutrients are from diffuse sources.

Emissions of ammonia are regulated by the EU *National Emission Ceilings Directive* (van Grinsven *et al*. 2015). Recently introduced standards for pig and poultry production, based on best available techniques, are aimed at contributing to implementation of the National Emission Ceilings Directive, as well as the Nitrates Directive and the Water Framework Directive (EC 2017).

In 2019 the European Parliament announced the *European Green Deal* strategy (Climate Home News 2019). Plans for its implementation are now under development. The strategy "aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use" (European Commission [EC] 2019a). The Green Deal will contribute to realizing the United Nations 2030 Agenda for Sustainable Development and the Sustainable Development Goals. It has the potential to influence nutrient management, for example through its Farm to Fork Strategy (whose purpose is to increase sustainability in the food chain), the circular economy strategy and the biodiversity strategy (European Council 2019).

The European Commission proposed the *Product Environmental Footprint (PEF)* and *Organization Environmental Footprint (OEF)* methods as common ways to measure environmental performance (EC 2015; EC 2020b). This approach was tested with more than 280 companies and organizations between 2013 and 2018 (EC 2020). *The Single Market for Green Products Initiative* contributes to meeting the Resource Efficiency Roadmap's goal of providing the right incentives for consumers to choose the most resource efficient products through appropriate price signals and clear environmental information (EC 2020b).

The EU *Common Agricultural Policy* was originally intended to increase agricultural production, ensure food security, protect farmers' quality of life and stabilize markets while maintaining reasonable prices for consumers. The scope has expanded with time to include such issues as environmental development and pollution, rural development, land management, animal welfare, and farmer training (FAO 2020i).

The *European Initiative for Sustainable Development in Agriculture* is an alliance of national organizations in six European countries (France, Luxembourg, Hungary, the Netherlands, Sweden and United Kingdom) founded in 2001 [European Initiative for Sustainable Development in Agriculture [EISA] 2011). It aims at developing and promoting sustainable farming systems and has a network of demonstration farms. It also has an Integrated Farming Framework for self-assessment and follow-up of internal developments by farmers. With regard to resource management, the guidelines in the EISA framework include information on the storage and use of inorganic and organic fertilizers.

The *European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI)* is a policy instrument that promotes more stakeholder and demand-driven research and innovation in agriculture (Moeskops 2014). It was launched in 2012 to contribute to the EU's Europe 2020 strategy for smart, sustainable and inclusive growth (EIP-AGRI 2015). EIP-AGRI includes several elements that are supportive of organic farming and agroecological innovation (Moeskops 2014).

The *European Food Sustainable Consumption and Production Round Table* was set up in 2009 by the European Commission and business associations representing the food and beverage supply chains. Addressing the issue of uncoordinated application of methodologies and guidelines for assessing and labelling the environmental performance of food and drink products has been a major objective (EC 2014). A key output is the ENVIFOOD Protocol, a food and drink specific guidance document published in 2013 (Saouter *et al*. 2014). The Protocol is intended for use as complementary guidance to the Product Environmental Footprint (PEF) and Organizational Environmental Footprint (OEF) guides.

The *Roadmap to a Resource Efficient Europe* provides a framework explaining how policies interrelate and build on each other, in which future actions can be designed and implemented

coherently. It also outlines the inter-linkages between key sectors and resources and their associated EU policy initiatives. This Roadmap establishes the milestones for resource efficient and sustainable growth (EC 2011).

North America

The *Boundary Waters Treaty*, signed by Canada and the United States in 1909, is an agreement between the two countries that neither will pollute boundary waters, or waters that flow across the boundary, to an extent that would cause injury to health or property in the other country (International Joint Commission 2020). It provides general principles for preventing and resolving disputes over shared waters. Canada and the United States created the International Joint Commission, whose main responsibilities are to approve projects that affect water levels and flows across the boundary and to investigate transboundary issues and recommending solutions.

The *Great Lakes Water Quality Agreement* (amended in 1978, 1987 and 2012) is a commitment between the two countries that provides a framework for identifying binational priorities and implementing actions that improve water quality in the Great Lakes (Government of Canada 2013; United States Environmental Protection Agency [US EPA] 2020). The agreement includes nutrients, for example phosphorus loadings, among threats to the quality of waters of the Great Lakes.

The key regional policy targeting eutrophication is the *Gulf of Mexico Hypoxia Action Plan*, which aims to reduce nitrogen and phosphorus loads (van Grinsven *et al*. 2015). The Action Plan sets out a national strategy in the United States to reduce, mitigate, and control hypoxia in the Northern Gulf of Mexico and improve water quality in the Mississippi River Basin. The activities of the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force include coordinating and supporting nutrient management activities from all sources, restoring habitats to trap and assimilate nutrients (US EPA 2019). According to a study by van Meter *et al*. (2018), an important cause of failure to reduce nutrient loading to surface waters is the existence of nutrient legacies within intensively managed watersheds. The authors of this study concluded even if nitrogen use became 100 per cent effective, it would still take decades to meet the Action Plan's target nitrogen loads because of nutrient legacies..

The *North American Free Trade Agreement (NAFTA)* is an agreement between Canada, the United States and Mexico. Fertilizers and other selected commodities traded among the three countries are subject to zero duty (The Fertilizer Institute [TFI] 2018).

Latin America

Three of the largest trading blocks in Latin America are the Pacific Alliance, the Common Market of the South (the Mercado Común del Sur, or MERCOSUR) and the Andean Community (CAN).

The Pacific Alliance was formed in 2011 and is made up of Chile, Colombia, Mexico and Peru. Its mandate includes establishing alliances with the public and private sectors for the implementation of its Action Plan, providing support for emission reduction, and economic growth that takes into account environmental degradation (Pacific Alliance 2019). Among the objectives of the Alliance are promoting a common agenda on shared environmental priorities and contributing to the implementation of the SDGs within the framework of the 2030 Agenda (Pacific Alliance 2019).

The member countries of *MERCOSUR* are Argentina, Brazil, Paraguay, Uruguay and Venezuela. Bolivia is in the process of becoming a member. MERCOSUR has also signed trade agreements with other countries and with groups of countries. The Mercosur trading block was formed in 1991 to address free movement of goods, services, and factors of production between countries. The needs addressed in the environmental policy of MERCOSUR include sustainable management of natural resources; control of potentially adverse activities; adoption of minimization and treatment practices; cleaner technologies and recycling; and monitoring of shared ecosystems (Virasoro 1996).

The Andean Community (CAN) is a trading bloc of four countries: Bolivia, Colombia, Ecuador and Peru. Chile, Argentina, Brazil, Paraguay and Uruguay are associate members, while Panama, Mexico and Spain are Observers. In 2012 CAN approved the Andean Environmental Agenda for 2012-2016, which included actions on climate change, biodiversity and water resources (Ripley 2019).

Asia

The *South Asia Co-operative Environment Programme (SACEP)* is an intergovernmental organization established in 1982 by the governments of countries in South Asia to promote and support the protection, management and enhancement of the environment in the region (South Asia Co-operative Environment Programme [SACEP] 2019). The members are Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. The target areas for projects carried out by the organization include environmental education, environmental legislation, biodiversity, air pollution, and protection and management of the coastal environment.

Intergovernmental efforts to combat transboundary air pollution are encouraged by the Malé Declaration on control and prevention of air pollution and its likely transboundary effects for South Asia (SACEP 2019). A desk study commissioned by SACEP on nutrient loading to the South Asian seas formed the basis for its active involvement in regional intergovernmental cooperation on nutrient losses from fertilizers and other sources contributing to pockets of coastal eutrophication (Bay of Bengal Large Marine Ecosystem 2014). This led to the involvement of SACEP as the regional partner of the INI and INMS project to facilitate the South Asian Nitrogen Assessment. The UNEA-4 sustainable nitrogen resolution was originally drafted and adopted during the INI-INMS South Asian Nitrogen Assessment meeting organized by SACEP in Maldives in September 2017. SACEP later mobilized the support of all governments in the region and requested them to table the resolution at the United Nations, an action which was eventually spearheaded by the Government of India.

The *South Asian Nitrogen Hub* was established in 2019 under the UK Global Challenge Research Fund (GCRF) to address the challenge that nitrogen pollution presents with regard to the environment, food security, human health and the economy in South Asia (UK Research and Innovation [UKRI] 2019). The Hub is a partnership of 32 research organizations, with project partners from the UK and South Asia; the eight SAREC countries are members. This partnership is led by the Centre for Ecology and Hydrology in the United Kingdom. Areas of research covered include improving nitrogen management in agriculture; improving the use of manure, urine and natural nitrogen fixation processes; and reducing pollution by recycling of nutrients.

The South Asian Nitrogen Hub was developed with input from the INI chair, the INI South Asian Nitrogen Centre, the Indian Nitrogen Group, the Sustainable India Trust and SACEP, and was refined at the United Nations Environment Assembly (UNEA-3) (UKRI 2019). The SACEP/INMS/UN Environment link will enable the Hub to reach global partners.

The Association of Southeast Asian Nations (ASEAN) was established in 1967 to promote economic cooperation and the welfare of people in the region. Issues targeted by ASEAN include food insecurity and pollution. For example, its Regional Soil and Nutrient Management Expert Group released Guidelines on Soil and Nutrient Management (SNM) in 2017 (Assocation of Southeast Asian Nations [ASEAN] 2017). In addition, the ASEAN Centre for Biodiversity (ACB) facilitates cooperation and coordination among the 10 ASEAN Member States, and with regional and international organizations, on the conservation and sustainable use of biological diversity. It is considered possible that reducing pollution from excess nutrients will contribute to improved biodiversity (ASEAN 2020).

The *Indian Nitrogen Group (ING)* is a network of nitrogen researchers and experts (UNEP n.d.). It has begun to identify research areas, and will work in collaboration with other bodies to harmonize national regional and international concerns and priorities with regard to reactive nitrogen.

8.5 National policies and legislation on fertilizers

This section presents information from global reviews and studies that are specific to fertilizers, followed by a regional fertilizer study on Africa. It also presents relevant information extracted from global studies on water regulations, air regulations and carbon tax schemes. Finally, it provides information on selected countries (e.g., those that use fertilizers intensively, or have environmental regulations with regard to fertilizers) in order to learn from their experiences.

In general, fertilizer legislation aims to ensure that farmers receive good quality fertilizers and that environmental damage is minimized. Fertilizers can be regulated through specific fertilizer legislation or other legislation (Box 8.5-1). Fiscal policies target the availability of fertilizers to farmers and can therefore encourage or discourage their use.

Box 8.5-1 Regulating fertilizers

The objectives of fertilizer regulations include provision of food and feed and the protection of air, soil, water bodies and consumers. Fertilizers are subject to various types of legislation and regulations related to production, trade, distribution, marketing, safety and use, which can vary among, or within, countries (FAO 2019a).

Countries differ (e.g. in their economic situations and agroecological conditions) and have different priorities concerning fertilizer use and risks. Consequently, they may use different combinations of instruments to achieve their goals. Regulation of the manufacturing, trade and use of fertilizers may be related to different sectors and policies. Depending on the interests to be protected, national fertilizer legislation may cover all fertilizers or just formulated products. It may regulate only the production and/or use of fertilizers, or provide rules applicable to all stages of their life cycle. Some countries develop legislation that establishes a registration mechanism for formulated fertilizers that mirrors the classical regulatory framework for pesticides, while others put more emphasis on risks arising from certain substances used in fertilizers such as ammonium nitrate.

Fertilizers can be directly regulated by specific fertilizer legislation (addressing, for example, the registration/authorization of fertilizers on the market and their quality, labelling and packaging) or can be addressed in general agrochemicals or agricultural inputs legislation. There are also other laws that may influence the regulatory framework for fertilizers and introduce specific rules or restrictions. They include, among others:

- *health legislation* or *occupational safety legislation* that addresses, for example, risks arising from the application and use of fertilizers;
- *food safety and quality legislation* including, for example, standards for potentially toxic trace elements, and *biofortification legislation* that includes, for example, guidance on agronomic biofortification;
- *food security legislation* that provides an enabling environment for fertilizer use;
- *environmental protection legislation* that restricts or regulates the use of certain substances including fertilizers (this legislation may cover, for example, air, soil, water or biodiversity);
- *water legislation*, for example on safe drinking water and the protection of surface and ground water
- *climate change related legislation*, for example on reducing agricultural emissions, and *legislation to combat desertification*;
- *soil legislation* that includes, for example, guidance on soil fertility management;
- *waste management legislation* that addresses the disposal of fertilizer waste, and *sewage legislation* covering treatment and disposal;
- *fisheries and aquaculture legislation* for the protection of aquatic species;
- *livestock management legislation* addressing animal production practices and manure management.
- *explosives legislation* that includes, for example, materials not intended for use as explosives but which have the potential to explode.

Whether dedicated fertilizer legislation is required in a country will largely depend on national policy priorities, as well as the comprehensiveness and effectiveness of existing legal instruments.

8.5.1 Legislation on inorganic fertilizers

Global overview

A recent source of data on national legislation on fertilizers is the 2017 report on *Enabling the Business of Agriculture* (EBA) project by the World Bank Group and its partners. The main focus of the EBA project is on measuring and monitoring regulations that affect the functioning of agriculture and agribusinesses (World Bank 2017).

The report covers 62 countries representing all regions (mainly Africa, Asia, Europe and Latin America) and income groups. The main topics covered are seed, fertilizer, machinery, finance, markets, transport, information and communication technology, and water. The topics covered under fertilizer are fertilizer registration, quality and control, and importing.

This study considered factors associated with fertilizer registration, importation and distribution, and quality control. In addition, data on time and cost to register fertilizer products were collected. Factors associated with fertilizer registration, importation and distribution, and quality control were scored. The total scores, or indices, for each of these three groups of factors ranged from 0 (the worst-case scenario) to 7 (the frontier, i.e., the best performance).

In general, the worst performing countries were in sub Saharan Africa. These countries had rudimentary regulatory frameworks for registering fertilizer. They also had the lowest scores for the quality control indicator, driven by absence of laws prohibiting mislabelled and open-bag fertilizers, lack of appropriate penalties, and absence of labelling requirements in at least one of the country's official languages. EU countries performed well across all fertilizer indicators, principally due to strong rules adopted and harmonized at the EU and European level. For example, Bosnia and Herzegovina, the Netherlands and Spain all performed well on fertilizer quality and importing and distribution indices (World Bank 2017). The 2019 report on *Enabling the Business of Agriculture* (EBA) is in agreement with the 2017 report. Low-income countries showed the weakest performance on registering fertilizer, followed by lower-middle income and higher-middle income countries, while high income countries performed best (World Bank 2019).

Reviews of regulations associated with occupational hazards, for example during manufacture, transport and storage, seem to be lacking. However, safety management practices in fertilizer factories have increasingly become more stringent to curb industrial accidents (International Fertilizer Association [IFA] 2014) and some countries have regulations restricting the use of potentially explosive fertilizers. According to a report by the National Academies of Sciences, Engineering and Medicine (2018), ammonium nitrate is listed among precursor chemicals in some countries (e.g., Australia, Canada, Singapore and EU Member States). The report further adds that some countries, including the United Kingdom (Northern Ireland) and Turkey, have banned ammonium nitrate from their markets, while the United Kingdom has banned possession of ammonium nitrate fertilizers that contain more than 27.5 per cent nitrogen by mass.

Regional studies

The present report provides information from a regional study carried out in Africa. Information on studies carried out in other regions is lacking or was not available.

On the recommendation of the African Fertilizer Financing Mechanism (AFFM) Governing Council, the United Nations Economic Commission for Europe (UNECA) took the lead in the exploration of existing and potential production, cross-border trade, trade flows, and consumption for inorganic fertilizer in Africa (UNECA and AfDB 2018). The study, carried out around 2016, found that in most African countries fertilizer policies encouraged private sector involvement in fertilizer manufacture and blending to ease access to and reduce the cost of fertilizers; encourage or call for the harmonization of policies with those at the regional levels; and encourage periodic soil analyses and fertilizer trials in order to update fertilizer recommendations

(UNECA and AfDB 2018). About one-third of African countries have formal fertilizer policy and regulatory frameworks to guide the fertilizer sector, but the rest do not have coherent fertilizer policies (Wanzala-Mlobela *et al*. 2019).

Although farmers use little fertilizer in most countries in Africa, there is a need to reduce or minimize the potential risks that fertilizers pose to the environment and human health. Addressing these risks through policies, however, faces many challenges. Many formal policies and regulations are outdated and are often not specific to fertilizers, but cover other agrochemicals as well (Wanzala-Mlobela *et al*. 2019). Enforcement is another challenge due to poor inspection capacity, inadequate laboratory equipment for testing, and the logistics involved (UNECA and AfDB 2018). Conducting soil testing and fertilizer trials can also be expensive. Registration at the regional level can reduce fertilizer costs (UNECA and AfDB 2018).

Fertilizer factories and blending facilities are subject to environmental impact assessment (UNECA and AfDB 2018).

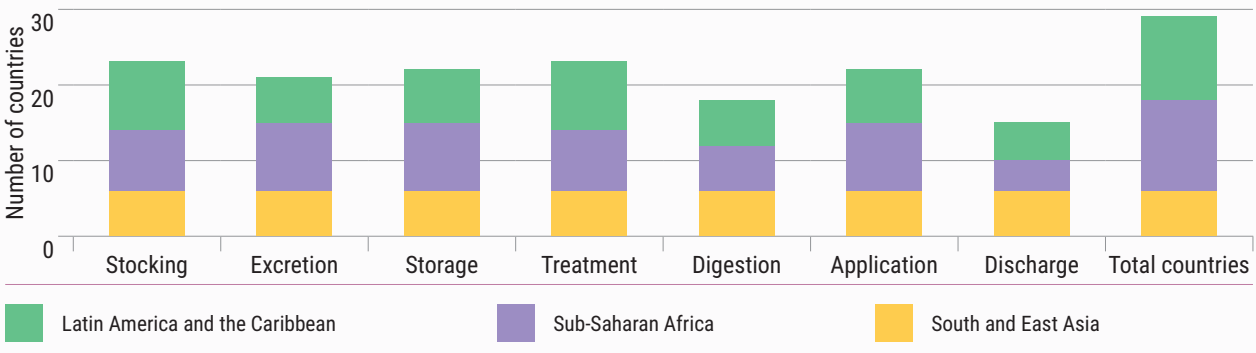
8.5.2 Legislation on organic fertilizers

Global or regional reviews of inorganic fertilizer policies appear to be lacking, despite the existence of regulations on processed organic fertilizers in some countries and regulations concerning farmers' management of organic fertilizers in many countries.

One report on the organic fertilizer industry was accessed: a study on the compliance of different organic phosphorus sources with the EU Sewage Sludge Directive by plants in Finland, Germany and Sweden (Sarvi, Ylivainio and Turtola 2017). According to that report, allowable limits for heavy metal concentrations differed among countries and among some products.

Regarding use of organic inputs, some regional studies have been carried out on manure. A study by Ndambi *et al*. (2019) on manure management practices and policies in 13 countries in sub-Saharan Africa concluded that policies do not always explicitly mention livestock manure management, but that manure is often considered a component of waste management. It concluded that animal waste is often regarded as a source of pollution and a potential human health risk rather than as a resource to be utilized and that, even when policies encouraging its use as a resource exist, enforcement can be a challenge since countries take limited action to promote good practices or to enforce legislation on manure management. In another study carried out in Latin America, SSA, and South and East Asia (Teenstra *et al*. 2014), 30 out of 34 countries surveyed had national policies related to manure management. However, enforcement of regulations was found to vary across the countries surveyed, with several policies targeting specific rather than all elements of manure management (Figure 8.5-1). In cases where different ministries were involved in

Figure 8.5-1 Number of countries addressing components of manure management in their policies reported in the study carried out by Teenstra *et al*. (2014).



Note: Data are for 29 countries (11 in Latin America, 12 in sub-Saharan Africa and six in South and East Asia).

designing manure policies, such policies were sometimes contradictory.

Christodoulou and Stamatelatou (2016) reviewed existing legislative frameworks and policies for sewage sludge management in several developed countries (Australia, Japan, New Zealand, the United Kingdom, the United States and the EU-27). All of these countries had laws on the use and disposal of sewage sludge, including its use as a fertilizer, but these laws had different restrictions. The most common parameter inspected was heavy metals. Some countries had regulations on phosphorus recovery from sewage sludge and other selected sources of phosphorus.

8.5.3 Legislation to protect air and water quality

In some countries fertilizer legislation has provisions that aim to minimize environmental damage (e.g., to biodiversity, air and water) (Food and Agriculture Organization of the United Nations and United Nations Environment Programme 2020). Data on the number of countries with such legislation in place are lacking. However, many countries have legislation to protect air and water quality, and some of this legislation includes provisions targeting pollution from fertilizers. The present report therefore considers legislation on the protection of air and water quality as part of wider "fertilizer legislation".

A 2021 report by UNEP found that in 2020 out of 195 countries, 64 (about one third) did not have any ambient air quality standards embedded within a legal instrument (UNEP 2021). Joss *et al*. (2017) reported that ambient air quality standards for PM2.5 and PM10 complied poorly with World Health Organization (WHO) guideline values. One of the study's conclusions was that these regulatory discrepancies amplify the differences in air quality and related health effects globally. Since particulate matter is associated with energy production and economic development, making progress on reducing its effects will require integrated strategies involving different disciplines (Davidson, Phalen and Solomon 2005). Lack of harmonization of standards across countries is a strong indication that national interventions, especially in regard to fertilizers, are still a long way off.

In the study by Joss *et al*. (2017), 117 out of 194 countries (60 per cent) had standards for at least one pollutant. The study also reported that for PM2.5 39 member states had short-term and 62 had long-term air quality standards, but compliance of these guidelines' with WHO guidelines was poor. Implementation of guidelines in countries is lagging. Adoption of WHO guidelines varies by pollutant, with WHO guidelines for NO2 being more likely to be adopted in law than that guidelines for ozone. Around 9 per cent of countries have ambient air quality standards for PM2.5 that meet WHO guidelines and 53 per cent of countries have standards for $PM_{2.5}$ that are less stringent that WHO AQGs according to UNEP (2021).

Information on the use of such measures to address air pollution from fertilizer production and fertilizer use is lacking. Nevertheless, it is likely that countries that manufacture fertilizers either have at least considered having standards for the fertilizer industry or apply such standards. For example, in the Republic of Indonesia a decree that provides for a standard for the quality of emissions from the fertilizer industry (Republic of Indonesia 2004). In the United States, the fertilizer industry is one source of some of the pollutants listed in the federal Clean Air Act (Hodge 1994). For example, phosphoric acid manufacturing and phosphate fertilizer production standards were promulgated in 1999 and at least 13 facilities are subject to at least one of the rules (US EPA n.d.).

Many countries have legislation on drinking water quality. WHO collected data on national and regional water quality regulations in 104 countries and territories and compared them with the WHO guidelines (World Health Organization [WHO] 2018). Among the contaminants studied were cadmium, nitrates, nitrites, Enterococci, *Escherichia coli*, Cryptosporidium, Giardia, Salmonella and helminths, which can be found in fertilizers and can affect human health (see Chapter 9 on health effects). Most of the countries studied (≥96 out of 104) had guidelines on cadmium, nitrates, nitrites and E. coli and ≤5 countries had standards for Cryptosporidium,

Giardia, Salmonella and helminths. National cadmium standards were above the WHO guidelines in slightly more than 50 per cent of countries, and standards for nitrates and nitrites were below the WHO guidelines in about for 30 per cent and 50 per cent of countries, respectively (WHO 2018).

A lack of guidelines in some countries, discrepancies between national and WHO guidelines, and poor compliance with national guidelines demonstrate that much still needs to be done with regard to legislation to protect air and water quality.

8.5.4 Fiscal policy instruments

Subsidies

In general, developed countries (unlike developing ones) do not provide significant direct fertilizer subsidies to farmers (Mamun, Martin and Tokgoz 2019). Many developing countries subsidize fertilizers to increase food production and improve farmers' incomes. Countries with fertilizer subsidies include Bangladesh, India, the Republic of Indonesia and Pakistan in Asia, and Malawi, Nigeria, Rwanda, Tanzania and several other countries in Africa (Africa Fertilizer and Agribusiness Partnership [AFAP and IFDC] 2017; UNECA and AfDB 2018). Fertilizer subsidies were estimated to amount to about United States dollars (USD) 1 billion in SSA by Jayne *et al.* (2016).

In some African countries in 2016, the proportion of subsidized fertilizers ranged from <25 per cent (e.g., in South Africa) to 100 per cent (e.g., in Ethiopia) (UNECA and AfDB 2018) (Figure 8.5-2.). In non-OECD countries coupled subsidies account for about a quarter of total support provided to the agriculture sector (Mamun, Martin and Tokgoz 2019).

Excessive and imbalanced use of nutrients contributes to soil degradation and water pollution (Gulati and Banerjee 2015). Subsidies, which have frequently been associated with imbalanced use of nutrients and fertilizer market distortions, can also be a burden on governments' budgets (Huang, Gulati and Gregory 2017). They may reduce funds that might have been available for other development priorities (UNEP 2020).

Figure 8.5-2 Amounts of fertilizer used in selected countries in Africa supplied through subsidy programmes and not from subsidized programs (thousands of tonnes). AFAP and IFDC (2017); UNECA and AfDB (2018).

Note: For Ethiopia, there is no direct subsidy program but a "hidden" subsidy exists.

Removing fertilizer subsidies – both those paid to fertilizer producers and those paid to farmers – increases fertilizer costs for farmers, especially smallholders. For example, removing all fertilizer support was predicted to lead to a decline in fertilizer use in China, India, the Republic of Indonesia and the Russian Federation (Bartelings *et al*. 2016). Removing subsidies can also influence farmers' decisions about the types of fertilizers they purchase. If fertilizer support policies were removed in India and the Republic of Indonesia, domestically produced nitrogen would become less cost attractive than imported phosphorus and potassium (Bartelings et al. 2016), contributing to more balanced and efficient fertilizer use. Experience shows that in order to transition to more sustainable practices, the process of phasing out or reforming the policy process needs to be well managed (UNEP 2020).

Some countries make direct payments to farmers who use practices known to contribute to environmental protection. For example, farmers in the EU receive payments for using farming practices that are beneficial with regard to soil quality, carbon sequestration and biodiversity (European Court of Auditors 2017).

Taxes

Environmental taxes can promote environmentally friendly behaviour and generate revenues that may be used to promote further environmental protection (Office for National Statistics of the United Kingdom 2018). However, very few countries have environmentally related fertilizer taxes (OECD n.d.). Still, in countries where carbon pricing is either being implemented or under consideration, applying a tax to fertilizers (e.g., to fertilizer manufacturing and transportation) will probably increase fertilizer prices. Currently, about 29 countries have implemented some form of carbon pricing, as carbon taxes and emission trading schemes/emission trading systems, covering about 8 per cent of global carbon emissions (World Bank 2020). However, carbon pricing does not currently appear to be applied to fertilizer in any country (OECD n.d.).

Government interventions that encourage high commodity prices (e.g., price support and high import tariffs) encourage production, while interventions that depress prices (e.g., commodity price ceilings and low import tariffs) can discourage investments in crop production (Lencucha *et al*. 2020). For example, in SSA the use of inorganic fertilizer has been shown to be strongly correlated with cereal prices (Sheahan and Barrett 2017).

Total support in agriculture

According to a recent Organisation for Economic Co-operation and Development (OECD) report on 54 countries (36 OECD member countries, the five non-OECD EU Member States, and 13 emerging economies), total support for agriculture in these countries averaged USD 708 billion/year from 2017 to 2019 (OECD 2020). About 75 per cent of total support (USD 536 billion) went to farmers and the remainder to the general services sector and consumer subsidies. Six countries implicitly imposed about USD 89 billion/year in taxes on farmers by artificially depressing prices. Noting that GHG emissions are increasing, the authors suggest that policy efforts should focus on environmental measures and on making food systems more resilient. They also emphasize that many agricultural policies are not well aligned with governments' sustainable food production and environmental health objectives.

8.5.5 Links between policies and sectors

At the national level, looking at the food security agenda alongside the environmental agenda will allow for regulations that support both agendas. The FAO and UNEP publication *Legislative Approaches to Sustainable Agriculture and Natural Resources Governance* (FAO and UNEP 2020) provides examples of countries with arrangements whereby the Ministry of Agriculture collaborates with the Water Ministry and other ministries. Such collaborations offer opportunities to enhance the sustainability of agricultural systems. They also present opportunities to exploit synergies among sectors. Analyses of existing regulatory frameworks at national level can indicate the existence of gaps, contradictions and overlap among legislations (FAO and UNEP 2020).

8.6 Corporate responsibility and stewardship

8.6.1 4R Nutrient Stewardship

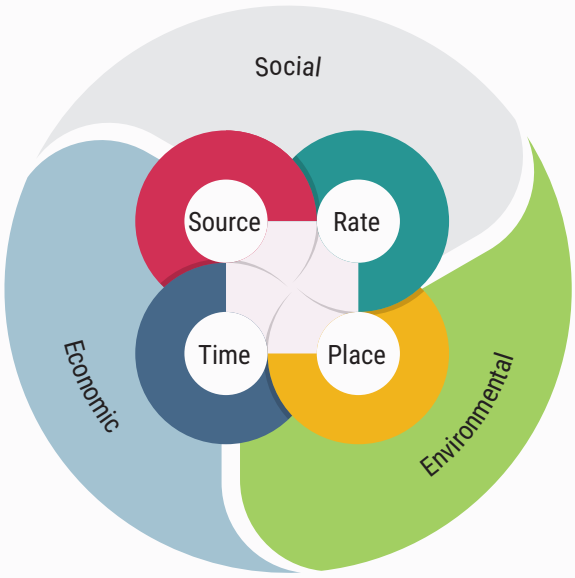
The 4R Nutrient Stewardship guidelines were developed by the fertilizer industry as a process to guide fertilizer Best Management Practices (BMPs) in all regions of the world (Johnson and Bruulsema 2014). The 4R philosophy, which is science-based, offers enhanced environmental protection, increased production, increased farmer profitability, and improved sustainability (Nutrient Stewardship 2017).

4R nutrient stewardship provides a framework for increasing crop yields sustainably and profitably while protecting the environment. This framework promotes application of the right fertilizer source (or product) (matching the fertilizer to crop needs and soil properties), at the right rate (matching the amount of fertilizer applied to crop needs), at the right time (making fertilizer nutrients available to the crop when they are needed) and in the right place (putting fertilizers where crops can use them) (Figure 8.6-1). (For the 4R approach, also see Chapter 7.) Choosing the right practices is supported by scientific principles (Johnson and Bruulsema 2014). For efficient fertilizer use, 4R nutrient stewardship recommends using these practices in combination with good agronomic practices.

Nutrient stewardship aims at establishing and increasing the adoption of the 4Rs as a strategy for economic, social, and environmental sustainability (Nutrient Stewardship 2017).

The International Fertilizer Association (IFA) product stewardship programme (IFA 2020) includes 12 Safety, Health and Environment (SHE) Principles, a certification programme (Protect and Sustain) for implementing product stewardship practices, and benchmarks that companies can use to assess their SHE performance relative to that of their peers. Recently IFA extended its sustainability portfolio to nutrient stewardship, starting with the adoption of IFA's Nutrient Stewardship Commitments in 2019. It is developing a code of practice for nutrient stewardship. In 2019 IFA also helped to establish the Scientific Panel on Responsible Plant Nutrition to meet the growing need for scientific research and expertise in order to further improve nutrient stewardship

Figure 8.6-1 The 4R Nutrient Stewardship concept. Johnson and Bruulsema (2014).



Fertilizers Europe is an association made up of 17 fertilizer manufacturers from countries across the European Union and eight national fertilizer associations. Its product stewardship programme "ensures the highest standard of fertilizer safety and environmental performance from production to application", including product development, sourcing of raw materials, additives and third party products, manufacturing, packaging, transportation, storage, marketing and sales, product application and farmer services (Fertilizers Europe 2022).

The fertilizer industry established the 4R Research Fund to help create sustainability indicators and environmental impact data for implementation of 4R nutrient stewardship across North America (Nutrient Stewardship 2017). The 4R Research Fund provides needed resource support with a focus on measuring and documenting the economic, social and environmental impacts of 4R nutrient stewardship. The Fund is within the Foundation for Agronomic Research (FAR) and is managed by The Fertilizer Institute (TFI). It includes representation from Fertilizer Canada and agricultural industry members.

8.6.2 The Sustainability Consortium

The Sustainability Consortium (TSC) is a global non-profit organization working to transform the consumer goods industry by partnering with leading companies to define, develop and deliver more sustainable products. It consists of manufacturers, retailers, suppliers, service providers, NGOs, civil society organizations, governmental agencies and academics. (The Sustainability Consortium 2020). It offers tools and services to help address product sustainability for agricultural and non-agricultural commodities. The results of the TSC 2016 Impact Report Analysis indicated that a large proportion of farmers do not collect data associated with sustainability (Slay, Reijs and Raster 2016). The fact that only 20 per cent of respondents collected data on fertilizer usage, GHG emissions and soil erosion was considered to represent a significant potential risk, but also an opportunity to improve both cost and sustainability.

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