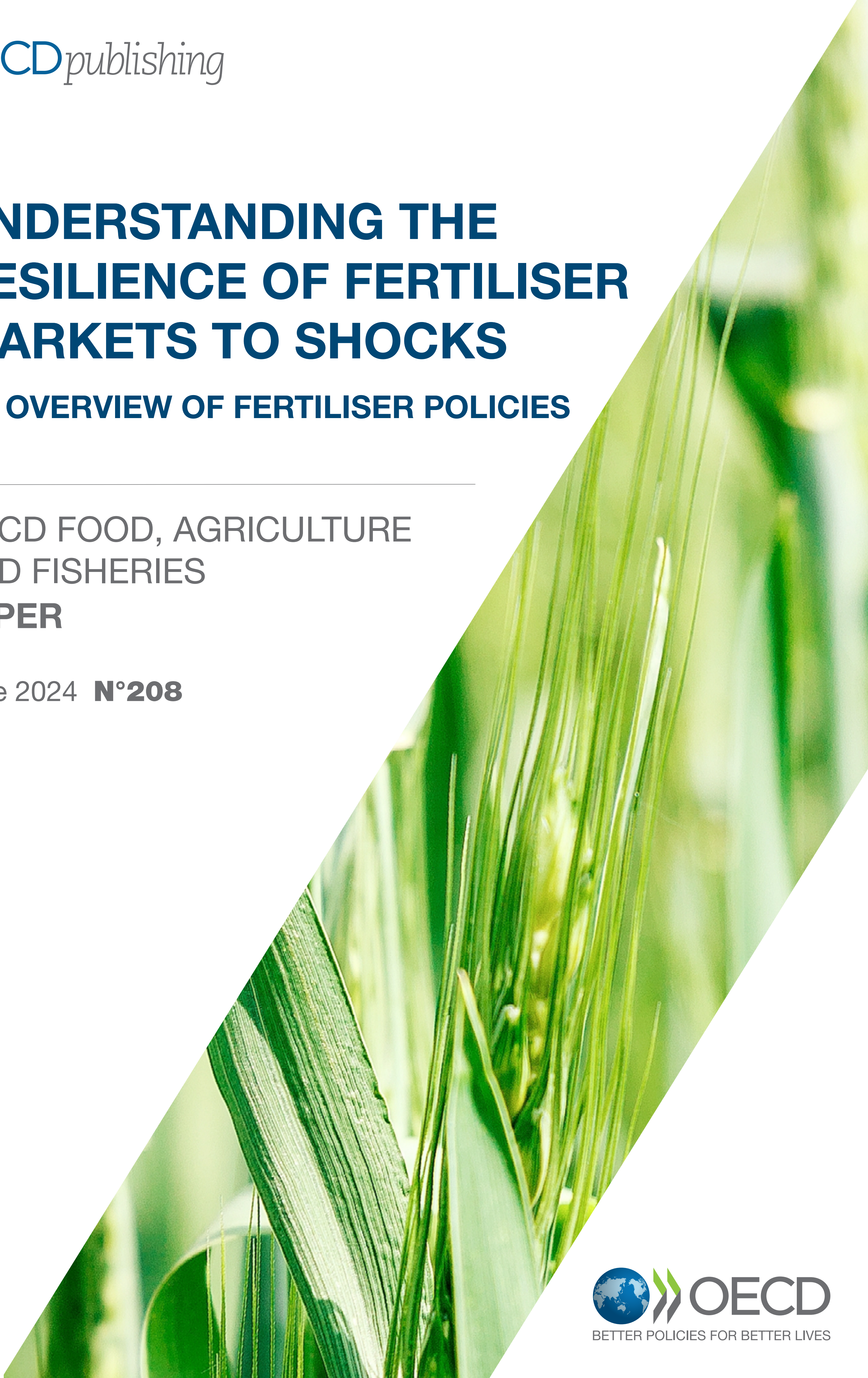
OECD publishing

UNDERSTANDING THE RESILIENCE OF FERTILISER MARKETS TO SHOCKS

AN OVERVIEW OF FERTILISER POLICIES

OECD FOOD, AGRICULTURE AND FISHERIES
PAPER

June 2024 **N°208**



OECD
BETTER POLICIES FOR BETTER LIVES

Understanding the Resilience of Fertiliser Markets to Shocks: An Overview of Fertiliser Policies

Darryl Jones and Annelies Deuss

In the wake of significant price increases in 2021 and 2022, countries introduced new or revised their fertiliser policies, further complicating the policy landscape in a highly concentrated market susceptible to supply disruptions. This report takes stock of the variety of policies in place and develops a framework for their classification and analysis. Key insights include the evolution and composition of farmer support estimates for mineral fertiliser use, the generally low or zero import tariffs reflecting high import dependence, and the non-transparent and frequently changing export restrictions imposed by major exporters. The analysis also shows a clear shift in policies from supporting mineral fertilisers to reducing their use or supporting organic fertiliser production and use. Yet, despite the potential of organic fertilisers, expanding their use and development will require substantial investment, changes in farm management, and policy adjustments.

Key words: Market concentration, policy framework, agricultural support, export restrictions, organic fertiliser

JEL codes: Q02, Q12, Q17, Q18, Q28

Acknowledgements

The authors are grateful to Olivia Du Bois (OECD) for research assistance. The authors thank Ellie Avery, Clara Frezal, Guillaume Gruère, Lee Ann Jackson, Marion Jansen, Edith Laget, Julia Nielson, Martin von Lampe (OECD), Laura Cross, Armelle Gruère, and Patrick Heffer (International Fertilizer Association) for their review and suggestions, and Michèle Patterson for preparing this report for publication. The authors also wish to thank the members of the OECD Joint Working Party on Agriculture and Trade for their valuable comments and direction.

Table of contents

Figures

Tables

Boxes

Key messages

Background

- The dramatic rise in prices in 2021 and 2022 led to increasing concerns about the supply and affordability of fertilisers. To deal with this market uncertainty and increase resilience to future shocks, countries have introduced new policies or revised their long-term plans for fertiliser use. These changes build on or extend existing policies, complicating efforts to draw a clear picture of the current landscape of fertiliser policies.
- This report develops a classification of the long-term objectives for fertiliser use and then identifies policy measures implemented to reach those objectives, helping to shed light on policy incoherence. The focus is on policies introduced since 2021, as well as policies that encourage the use or production of organic fertilisers.

What did we learn?

- Production of mineral fertilisers relies on specific natural resources found in very few countries. The market is thus highly concentrated both at the country and company level, increasing the susceptibility to supply disruptions.
- Historically, fertiliser policies were aimed at supporting mineral fertiliser use. In addition to policies to support use by farmers, governments also provided support to fertiliser manufacturers in the form of concessional loans, direct grants or tax concessions.
- In 2020-2022, the average annual total value of support to agricultural producers for fertiliser use in the economies covered by the OECD PSE database is estimated to be USD 27.1 billion (almost double that during the period 2015-19). This is equivalent to 6% of the total value of producer support globally and 9% of total budgetary support to agriculture.
- Tariffs on fertilisers are generally quite low, or even zero, reflecting the high degree of import dependence across countries. At the global level, the average applied MFN tariff rate on all fertiliser categories in 2021 was 1.9%, and 40% of WTO Members do not levy any duties on fertiliser imports.
- In recent years, large exporters of mineral fertilisers have introduced export restrictions (bans, quotas and taxes), some of which were not transparent, or subject to frequent change.
- Policies are also now shifting towards reducing mineral fertiliser use, including through policies that encourage the use or production of organic fertilisers (mainly budgetary support to farmers to offset increased costs associated with organic fertiliser use) and regulations directly limiting use of mineral fertilisers, along with increased resources for research and extension programmes to help farmers use mineral fertilisers more efficiently.
- While organic fertilisers can offer an alternative to mineral fertilisers, there are multiple challenges in relation to their composition, application, distribution and regulation. Overcoming these will require considerable capital investment and changes in both farm management practices and government policies.
- Future work could examine the effectiveness of specific fertiliser policies in terms of their impact on crop yields, and greenhouse gas emissions and other environmental outcomes. This could include comparison of policies within or across countries, based on the framework developed in this report.

Executive summary

The last 20 years have seen a steady growth in the use of mineral fertilisers, making world food supplies increasingly dependent on a market that is highly susceptible to shocks and supply disruptions. The war in Ukraine and the dramatic rise in fertiliser prices in 2021 and 2022 put this vulnerability on display and led to increasing concerns about the supply and affordability of fertilisers. To deal with this market uncertainty and increase the resilience to future shocks, countries have introduced new policies or have revised their long-term plans for fertiliser use.

While detailed country-level market information on fertilisers is widely available, there is, to date, no overall stocktaking or global comparison of fertiliser policies. Moreover, new fertiliser policies build on or extend existing policies, complicating efforts to draw a clear picture of the current landscape of fertiliser policies. Policy measures introduced in a certain country can also have conflicting objectives, with some measures supporting the use of mineral fertilisers and others limiting their use.

This report develops a framework for stocktaking and analysis that classifies long-term objectives for fertiliser use and then identifies policy measures implemented to reach those objectives, focusing on policies introduced since 2021. The framework is based on policy intent: policy measures are first classified according to whether the consequence of their stated purpose is to support or reduce the use of mineral fertilisers. Policies supporting mineral fertiliser use are further divided into two categories: whether they support mineral fertiliser use by farmers or assist domestic production via support to manufacturers. Policies aimed at reducing mineral fertiliser use by farmers are also separated into two broad categories: those that encourage the use or production of organic fertilisers, and all others.

This framework has multiple advantages. First, it links policy measures to longer-term policy objectives. This makes it easier to identify whether there is lack of policy coherence, where policies may be working against each other. Even though the policy discussion is framed in relation to mineral fertilisers, the design is such that is also provides perspective the influence policies may have on the opportunities and challenges for organic fertilisers.

Countries covered include the 38 OECD member countries and 14 additional countries, together accounting for 88% of world agricultural use of mineral fertilisers. These countries are split in two groups: the “major 26” and the “other 26”. The major 26 group is comprised of the top 20 agricultural users, producers, exporters or importers of mineral fertilisers measured on a total nutrient content basis. They account for around 82% of world agricultural use and global production of fertilisers. The other 26 group accounts for 6% of world agricultural use and 3% of global production.

There are two main types of fertilisers: organic and inorganic fertilisers. Inorganic fertilisers, or mineral fertilisers, are made from minerals or synthetic chemicals, whereas organic fertilisers are derived from plants or animals. The three most important nutrients, or macronutrients, provided by fertilisers are nitrogen (N), phosphorus (P) and potassium (K). Soils used for agriculture become depleted in these nutrients and therefore need to be fertilised. Because production of N-, P- and K-based mineral fertilisers relies on specific resources, such as fossil fuels, phosphate rock, and potash rock, which are found in just a handful of countries, fertiliser markets are highly concentrated both at the country- and firm-level, making them highly susceptible to supply disruptions and shocks.

Historically, specific policy objectives for fertilisers focused on supporting mineral fertiliser use by farmers and their domestic production. In more recent years, objectives have shifted to encouraging the use or production of organic fertiliser and reducing mineral fertiliser use by farmers. Food security concerns, possibly influenced by rising fertiliser prices, water pollution, biodiversity, and climate change have been recent drivers of this shift in many countries.

Many of the policy measures used by governments in response to rising international prices were aimed at mitigating the impact on domestic farmers, through export restrictions (in the case of producers) and additional support to farmers. Tariffs on fertilisers are generally quite low or even duty-free reflecting the high degree of import dependence. Various forms of export restrictions (bans, quotas, taxes) were used by large fertiliser exporters such as China and Russia to maintain domestic supply. Some of these restrictions were not transparent or frequently changed.

In the countries covered by the OECD Producer Support Estimate (PSE) database[1], over 20 policies were found to provide support to agricultural producers for fertiliser use, ranging from specific fertiliser subsidy measures through to broader concessional interest rate credit programmes which allowed farmers to purchase fertilisers, among other farm inputs. In 2020-2022, the annual average total value of support to agricultural producers for fertiliser use in the countries covered by the OECD PSE database is estimated to be USD 27.1 billion (almost double that during the period 2015-19). This is equivalent to 6% of the total value of producer support for these countries and 9% of total budgetary support.

Less direct policies introduced for the purpose of supporting mineral fertiliser use include online market price information systems for fertilisers or the introduction of public stockholding measures to increase the quantity of mineral fertiliser product available to farmers.

In addition to policies to support mineral fertiliser use by farmers, governments also provided support to fertiliser manufacturers in the form of concessional loans, direct grants or tax concessions.

In more recent years, government objectives have shifted towards reducing mineral fertiliser use in agricultural production. Several new measures have been introduced to encourage the use or production of organic fertilisers. Given the short period of time that has passed, these initial responses use budgetary transfers to achieve this goal. These can be paid to compensate farmers for the additional costs of organic fertilisers or to reduce the cost of producing the organic fertilisers. Other recent policy measures introduced to reduce mineral fertiliser use focus on providing additional resources for research and extension programmes to help farmers use mineral fertilisers more efficiently.

Organic fertilisers, which originate from agricultural sources, urban waste streams or manufacturing by-products, can provide an alternative source of nutrients. Unfortunately, comparable country-level information on their actual and potential use is not readily available. The high-level analysis undertaken in this report suggests that, in many countries, the quantity of nitrogen available in animal manure could provide a large proportion of current crop nutrient requirements. But most manure is left on pasture rather than applied to the soil, although manure application by farmers is much stronger in European countries than elsewhere. For most countries, the quantity of nutrients potentially available in urban wastewater or through food waste is considerably less than that currently applied in mineral fertilisers. Nevertheless, there may be sound economic and environmental reasons for better using these resources even if they cannot fully replace mineral fertilisers.

Although organic fertilisers are a promising alternative to mineral fertilisers, overcoming challenges associated with their use will require considerable capital investment and changes in both farm management practices and government policies. These challenges are divided into four broad themes: composition, application, distribution and regulation. Because the nutrient content composition of organic fertilisers is variable and often unknown, it can be difficult for farmers to match the nutrient needs of crops without creating environmental risks. Organic fertilisers also often pose higher application costs to achieve the same level of fertilisation. Furthermore, sources of organic fertilisers are often distant, imposing high transportation costs. There is a need for an appropriate regulatory framework to enable the production, sale, distribution and use of organic fertilisers in balance with environmental and social concerns. Finally, government policy can also disincentivise the application of organic fertiliser, as where subsidies for

[1] The OECD PSE database covers 54 countries, including the 38 OECD countries, the five non-OECD EU Member States, and 11 emerging economies (OECD, 2022[10]).

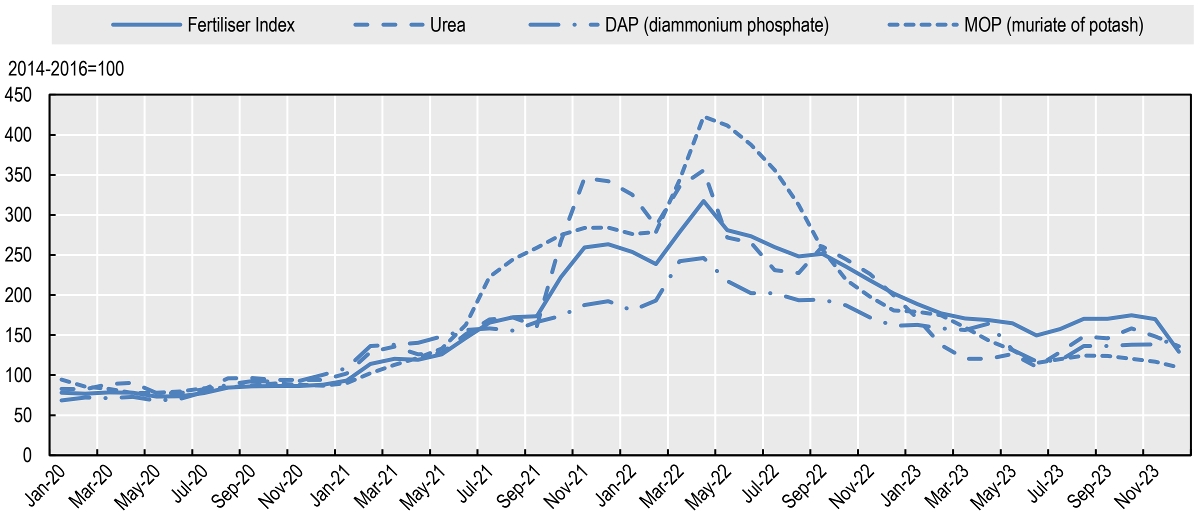
mineral fertilisers reduce their cost compared to organic alternatives or regulations prevent farmers from fully using the nutrients available in organic fertiliser.

Current fertiliser policies are insufficiently transparent and often conflict in a way that adds to market uncertainty. The stocktaking and framework developed in this report is a first step toward mapping the landscape of fertiliser objectives and policies. This framework could also provide the basis for future analysis that examines the effectiveness of certain fertiliser policies or their impact on crop yields, greenhouse gas emissions and other environmental outcomes. This analysis could compare policies within or across countries. The framework can also serve to identify whether there is policy incoherence in a country and how this might be streamlined.

1. Introduction

Between January 2021 and mid 2022 international prices for mineral fertilisers increased dramatically (Figure 1.1). Prices peaked in May 2022, which happened to coincide with the Northern Hemisphere spring demand (Cross and Gruère, 2022[1]). This level of fertiliser prices had not been seen since 2008. While prices have since declined due to better-than-expected mineral fertiliser supply, delayed farmer demand and falling natural gas prices, affordability continues to rank high among driving factors behind fertiliser use (Cross and Gruère, 2023[2]).

Figure 1.1. Fertiliser prices, January 2020 to December 2023 (index 2014-2016=100)



Note: DAP, spot, f.o.b. US Gulf; MOP, Brazil CFR granular spot price; Urea, (Ukraine), prill spot f.o.b. Middle East, beginning March 2022; previously, f.o.b. Black Sea.
Source: The World Bank's Pink Sheet (https://www.worldbank.org/en/research/commodity-markets).

As a result of the rapid price increase, considerable attention has been given to the workings of fertiliser markets and the implications for food security. Many have examined the causes of this latest price increase (The Economist, 2022[3]), (Crespi et al., 2022[4]). Others have evaluated the potential impact on production, particularly in developing countries (Hebebrand and Laborde, 2022[5]), (Alexander et al., 2023[6]), and on food price inflation and food insecurity (OECD/FAO, 2023[7]).

This report adds to this discussion by providing an overview of countries' plans for fertiliser use and the policies they implement to reach these objectives. Whereas some countries plan to increase mineral fertiliser use, others intend to limit their use. In addition, several countries want to expand the use of organic fertilisers. To meet their plans for fertiliser use, countries introduce diverse policy measures. This report documents these policy measures using a framework that considers the intent of the policy measure in relation to either supporting or limiting the use of mineral fertilisers, and the type of measure. The report mainly focuses on policies that have been introduced since 2021 and hence coincide with the recent episode of high prices and supply disruptions.

The sharp rise in market prices for mineral fertilisers has raised interest in the use of organic fertilisers as substitutes. Mineral fertilisers are produced from the fixation of nitrogen from the atmosphere into plant-available forms or mined from naturally occurring nutrient deposits. Organic fertilisers are a highly diverse family of products including animal manure, post-harvest plant residues, green manure, sewage. organic household waste and by-products of manufacturing processes. While mineral fertilisers generally contain high concentrations of a single, or two or three, plant nutrients, organic fertilisers provide a wide variety of nutrient in low concentrations (IFA, 2023[8]). The three most important nutrients, or macronutrients, are nitrogen (N), phosphorus (P) and potassium (K).[2] Each nutrient has unique physiological functions which cannot be replaced by any other nutrient.

To help understand policy responses and assess the potential for the use of organic fertilisers, it is important to consider the market situation. The impact of rising mineral fertiliser prices will differ depending on, for example, whether a country is an exporter or importer, the importance (intensity) of fertiliser use in agricultural production, and whether fertiliser use in agriculture has been growing over time. Furthermore, market issues such as supply disruptions and market concentration can also be a motive for policy intervention. Four countries account for almost 60% of total mineral fertiliser use by agriculture: the People's Republic of China (thereafter "China") (25%), India (15%), the United States (10%) and Brazil (8%)[3]. Global production of some mineral fertilisers is concentrated in a handful of countries.

This report is structured as follows. The next section of the introduction explains which countries are covered in this report. Part 2 discusses the market-related issues that are important for understanding policy objectives and measures. Part 3 summarises recent and ongoing policy objectives for fertilisers. Part 4 examines the policy measures, both domestic and trade, that are used. Information provided in Parts 3 and 4 was obtained via an internet-based desk top study, supplemented by material provided by delegates to the OECD Joint Working Party on Agriculture and Trade and for the 2023 *Agricultural Policy Monitoring and Evaluation Report* (OECD, 2023[9]). Part 4 also uses the OECD PSE database to examine the longer-term policy measures. The potential and challenges for the use of organic fertilisers in agriculture is discussed in Part 5. Part 6 concludes.

1.1. Country coverage

The report covers a total of 52 countries, comprising the 38 OECD member countries plus another 14: Argentina, Belarus, Brazil, China, India, Indonesia, Kazakhstan, Morocco, Pakistan, Philippines, Russia, South Africa, Ukraine and Viet Nam (Table 1.1). Eleven of these 14 countries (excepting Belarus, Pakistan and Morocco) were included because they are part of the annual agricultural policy monitoring and evaluation process undertaken by the OECD (OECD, 2022[10]). Belarus, Pakistan and Morocco were included because they are either the next most important producer, agricultural user, or exporter of mineral fertilisers not already covered. Over the three-year period 2019-2021, the 38 OECD member countries accounted for 28% of world agricultural use of mineral fertilisers by total nutrient content. This coverage increases to 88% with the additional 14 countries, which include the first, second, fourth, fifth and sixth largest users. Box 1 explains the market data used in this report.

To make the analysis manageable and to identify the major players, these 52 countries are split into two groups of 26: the "major 26" and "other 26" (Table 1.2). Countries included in the "major 26" group are all in the top 20 countries whether as an agricultural user, producer, exporter or importer of mineral fertilisers measured on a total nutrient content basis. The major 26 grouping accounts for 82% of total world agricultural use, with the other 26 grouping accounting for just 6%. Many of the major 26 countries are also the key producers and traders of mineral fertilisers. The major 26 grouping also accounts for 83% of global production and just over 70% of both exports and imports. Figure 2.5, Figure 2.8 and Figure 2.11 show the

[2] This report reports phosphorus and potassium in terms of P and K nutrient content rather than the traditional oxide forms: P_2O_5 and K_2O forms. P_2O_5 is converted to P by dividing by 2.29 and K_2O is converted to K by dividing by 1.21.

[3] These four countries account for 33% of global cropland (FAO, 2024[11])

top five users, producers, exporters, and importers of N-, P-, and K-based fertilisers, respectively. Several of the other 26 countries are completely reliant on imports for fertiliser supply, with no domestic production of fertilisers occurring, including Ireland, Sweden, and Denmark. While all 52 countries are included in the market (Part 2) and organic fertilisers (Part 5) discussion, the focus of the two policy related sections (Parts 3 and 4) is on the major 26 countries.

Box 1. Fertiliser market data from FAOSTAT

Fertiliser market data in this report is obtained from FAOSTAT (FAO, 2024[11]). A recent FAOSTAT analytical brief and methodological note explain the data collection and structure as follows (FAO, 2023[12]; FAO, 2023[13]):

"The main data source for the production and agricultural use of inorganic fertilizers is the Food and Agriculture Organization of the United Nations (FAO) fertilizers questionnaire (FAO, 2023[14]). Agricultural use of fertilizers refers to the use for crops, livestock, forestry, fisheries and aquaculture, excluding use for animal feed. Production data represent the tonnes of nutrients manufactured into fertilizer products in a country.

Trade data (imports and exports) were also obtained via questionnaire for the period 1961–2001, but from 2002 onwards they are obtained from the United Nations Commodity Trade Statistics (UN Comtrade) database (UNSD, 2023[15]).

Imputations to fill gaps, due to missing or non-usable data, are based mainly on the aggregation of product data converted to nutrients, on balances based on the equation "production + imports = exports + agricultural use + other uses", or on additional data (from associations, publications, etc.). In the process of imputation and quality control, data are also discussed with industry experts as part of an ongoing collaboration with the International Fertilizer Association (IFA), within the scope allowed by its confidentiality obligations. IFA provides fertilizer statistics through IFASTAT (IFA, 2023[16]).

The dataset 'Fertilizers by nutrient' provides data on the production, import, export and agricultural use of inorganic fertilizers, expressed by total content in tonnes of the primary nutrients: nitrogen (N), phosphorus (expressed in equivalent quantity of the oxide form P2O5) and potassium (also expressed in oxide form, as K2O). The domain also provides the ratio between the agricultural use of inorganic fertilizers, in total by nutrient (for N, P2O5 and K2O), and the area of cropland (the sum of arable land and permanent crops), population and value of agricultural production. It currently covers the period 1961–2021.

FAOSTAT also provides estimates for agricultural use of some organic fertilizers (which represent the other main category of fertilizers, comprising residues of plants and animals and human wastes). In particular, data on nitrogen inputs from livestock manure to agricultural soils are provided in the FAOSTAT domain 'Livestock manure'. Those estimates are compiled using FAO statistics on animal stocks and applying the Guidelines of the Intergovernmental Panel on Climate Change (IPPC, 2006[17]), as discussed in detail in the FAOSTAT brief on 'Livestock and environment statistics' (FAO, 2020[18])."

Table 1.1. Annual average agricultural use of mineral fertilisers by nutrient content in selected countries, 2019-2021

Country	EU27	OECD	Additional countries covered by PSE	Annual average agricultural use of mineral fertilisers by nutrient content, 2019-2021: 000 tonnes: N	P	K	Total nutrients	Share of total nutrients: N	P	K	World ranking: N	P	K	Total nutrients
Australia		Y		1,338	418	238	1,994	67%	21%	12%	17	8	19	14
Austria	Y	Y		107	12	29	148	72%	8%	19%	74	76	68	75
Belgium	Y	Y		153	6	51	209	73%	3%	24%	63	93	49	63
Canada		Y		2,814	498	581	3,893	72%	13%	15%	7	7	7	7
Chile		Y		222	61	74	358	62%	17%	21%	43	35	41	43
Colombia		Y		493	103	371	967	51%	11%	38%	28	24	14	27
Costa Rica		Y		90	8	38	135	66%	6%	28%	80	86	58	77
Czechia	Y	Y		309	21	19	349	89%	6%	5%	42	63	78	45
Denmark	Y	Y		220	15	59	295	75%	5%	20%	44	70	45	49
Estonia	Y	Y		43	5	11	59	74%	8%	18%	95	100	88	98
Finland	Y	Y		144	12	35	191	75%	6%	19%	64	78	61	66
France	Y	Y		2,006	183	391	2,580	78%	7%	15%	8	16	11	8
Germany	Y	Y		1,245	81	323	1,648	76%	5%	20%	19	30	16	18
Greece	Y	Y		199	28	43	269	74%	10%	16%	52	52	56	52
Hungary	Y	Y		437	49	84	570	77%	9%	15%	31	40	37	36
Iceland		Y		11	1	2	14	80%	5%	15%	125	130	120	128
Ireland	Y	Y		382	60	141	583	66%	10%	24%	36	36	26	35
Israel		Y		46	3	33	82	56%	4%	40%	93	110	66	90
Italy	Y	Y		582	94	105	781	74%	12%	13%	26	27	29	30
Japan		Y		356	141	184	681	52%	21%	27%	39	19	24	32
Korea		Y		218	45	89	353	62%	13%	25%	45	44	33	44
Latvia	Y	Y		83	13	28	125	67%	11%	23%	81	75	70	81
Lithuania	Y	Y		184	24	61	269	68%	9%	23%	55	59	44	53
Luxembourg	Y	Y		12	0	1	13	93%	3%	4%	123	136	142	130
Mexico		Y		1,346	231	207	1,783	75%	13%	12%	16	14	22	17
Netherlands	Y	Y		209	5	45	260	80%	2%	17%	47	95	55	56
New Zealand		Y		454	127	132	713	64%	18%	18%	30	21	27	31
Norway		Y		106	9	34	149	71%	6%	23%	76	82	63	73
Poland	Y	Y		953	146	427	1,525	62%	10%	28%	22	18	10	20
Portugal	Y	Y		101	17	31	148	68%	11%	21%	77	67	67	74
Slovakia	Y	Y		128	12	17	157	82%	8%	11%	67	77	79	69
Slovenia	Y	Y		28	3	8	40	72%	9%	20%	108	108	95	107
Spain	Y	Y		1,011	210	305	1,526	66%	14%	20%	20	15	17	19
Sweden	Y	Y		204	15	34	254	81%	6%	13%	50	71	65	58
Switzerland		Y		42	5	12	59	70%	9%	21%	99	96	87	97
Türkiye		Y		1,841	301	106	2,248	82%	13%	5%	10	12	28	11
United Kingdom		Y		1,005	77	217	1,299	77%	6%	17%	21	31	20	22
United States		Y		11,933	1,759	3,701	17,393	69%	10%	21%	3	4	3	3
Argentina			Y	1,446	366	46	1,858	78%	20%	2%	13	10	54	16
Brazil			Y	5,841	2,725	6,114	14,680	40%	19%	42%	4	3	2	4
China			Y	22,112	4,493	8,045	34,651	64%	13%	23%	1	1	1	1
India			Y	19,585	3,533	2,293	25,411	77%	14%	9%	2	2	4	2
Indonesia			Y	3,380	530	1,649	5,559	61%	10%	30%	6	5	5	5
Kazakhstan			Y	70	24	2	96	73%	25%	2%	86	57	122	86
Philippines			Y	725	93	204	1,023	71%	9%	20%	25	28	23	25
Russia			Y	1,853	287	379	2,520	74%	11%	15%	9	13	12	9
South Africa			Y	581	140	216	937	62%	15%	23%	27	20	21	28
Ukraine			Y	1,651	182	279	2,112	78%	9%	13%	11	17	18	13
Viet Nam			Y	1,573	328	478	2,379	66%	14%	20%	12	11	8	10
Pakistan				3,524	511	47	4,082	86%	13%	1%	5	6	52	6
Belarus				432	42	350	824	52%	5%	42%	33	46	15	29
Morocco				214	47	81	342	63%	14%	24%	46	43	38	46
											% of world total			
Total OECD member countries				31,055	4,799	8,266	44,120	70%	11%	19%	29%	24%	26%	28%
Total all 52 countries				94,043	18,099	28,451	140,593	67%	13%	20%	87%	90%	89%	88%
Total of major 26 countries				87,155	16,993	26,481	131,275	66%	13%	20%	81%	84%	83%	82%
Total of other 26 countries				6,888	1,107	1,970	9,317	74%	12%	21%	6%	5%	6%	6%
World total				108,114	20,197	31,997	160,307	67%	13%	20%	100%	100%	100%	100%

Note: Countries highlighted in blue are referenced as the “major 26” grouping of countries for the purpose of this report. The remaining are referenced as the “other 26” countries. EU Member states constitute seven of the “major 26” and eleven of the “other 26”.

Source: FAO (2024[11]).

Table 1.2. Annual average agricultural use, production and trade of mineral fertilisers by total nutrient content in selected countries, 2019-21

				Annual average of mineral fertilisers by total nutrient content, 2019-2021							
				Agricultural use		Production		Exports		Imports	
Country	EU27	OECD	Additional countries covered by PSE	000 tonnes	World ranking	000 tonnes	World ranking	000 tonnes	World ranking	000 tonnes	World ranking
China			Y	34,651	1	40,309	1	9,231	3	4,814	4
India			Y	25,411	2	15,852	4	108	60	9,560	3
Russia			Y	2,520	9	20,965	2	14,272	1	116	75
United States		Y		17,393	3	15,962	3	2,535	8	10,958	2
Canada		Y		3,893	7	14,796	5	11,340	2	1,551	10
Brazil			Y	14,680	4	1,442	21	117	57	13,472	1
Belarus				824	29	7,254	6	5,455	4	117	74
Indonesia			Y	5,559	5	4,486	7	1,050	19	2,353	6
Pakistan				4,082	6	3,573	11	0	113	589	32
Morocco				342	46	3,843	8	3,460	5	382	42
Germany	Y	Y		1,648	18	3,480	12	3,052	6	1,226	19
Poland	Y	Y		1,525	20	2,599	13	1,035	20	1,390	12
France	Y	Y		2,580	8	238	52	332	35	2,596	5
Netherlands	Y	Y		260	56	1,634	18	2,459	9	854	25
Viet Nam			Y	2,379	10	1,323	23	376	32	1,227	18
Türkiye		Y		2,248	11	1,705	17	434	29	1,888	9
Australia		Y		1,994	14	618	40	189	45	2,156	7
Ukraine			Y	2,112	13	990	26	627	26	1,135	20
Israel		Y		82	90	1,988	15	1,964	11	96	80
Argentina			Y	1,858	16	528	42	0	109	1,419	11
Mexico		Y		1,783	17	615	41	201	43	1,344	13
Belgium	Y	Y		209	63	927	29	1,650	12	1,319	14
Spain	Y	Y		1,526	19	1,403	22	783	24	1,316	15
United Kingdom		Y		1,299	22	371	44	252	39	1,287	17
Lithuania	Y	Y		269	53	948	27	1,139	17	474	37
Norway		Y		149	73	751	33	1,028	21	300	49
Philippines			Y	1,023	25	166	59	22	75	928	23
Colombia		Y		967	27	193	55	33	68	806	27
Italy	Y	Y		781	30	328	48	221	40	949	22
South Africa			Y	937	28	228	53	175	47	884	24
Korea		Y		353	44	620	38	383	30	817	26
Finland	Y	Y		191	66	265	50	586	27	800	28
Chile		Y		358	43	745	34	572	28	455	38
New Zealand		Y		713	31	173	58	1	100	581	33
Japan		Y		681	32	619	39	112	59	700	30
Ireland	Y	Y		583	35	0	None	7	88	551	34
Hungary	Y	Y		570	36	342	47	171	48	518	35
Czechia	Y	Y		349	45	111	63	158	49	442	40
Sweden	Y	Y		254	58	0	None	137	54	381	43
Slovakia	Y	Y		157	69	328	49	366	33	195	60
Denmark	Y	Y		295	49	0	None	83	61	337	47
Greece	Y	Y		269	52	76	67	146	52	283	52
Estonia	Y	Y		59	98	0	79	146	53	248	55
Latvia	Y	Y		125	81	0	None	67	64	248	56
Kazakhstan			Y	96	86	247	51	112	58	159	67
Austria	Y	Y		148	75	0	None	16	78	222	58
Portugal	Y	Y		148	74	91	65	129	56	219	59
Costa Rica		Y		135	77	0	None	9	84	144	70
Switzerland		Y		59	97	0	None	2	94	106	77
Slovenia	Y	Y		40	107	0	None	31	69	91	83
Luxembourg	Y	Y		13	130	0	None	11	83	33	107
Iceland		Y		14	128	0	None	0	149	16	126
					% world		% world		% world		% world
Total OECD member countries				44,120	28%	51,925	29%	31,781	37%	37,895	42%
Total all 52 countries				140,593	88%	153,130	86%	66,787	78%	75,052	84%
Total of major 26 countries				131,275	82%	148,598	83%	63,090	74%	63,939	71%
Total of other 26 countries				9,317	6%	4,532	3%	3,697	4%	11,113	12%
World total				160,307	100%	178,402	100%	85,512	100%	89,576	100%

Notes: Countries highlighted in blue are referenced as the “major 26” grouping of countries for the purpose of this report. The remaining are referenced as the “other 26” countries. Countries are ordered in the table based on their largest total nutrient content volume, whether agricultural use, production, exports or imports.
Source: FAO (2024[11]).

2 Overview of the international mineral fertiliser market

Part 2 provides an overview of mineral fertiliser production, trade and use in the 52 selected countries. It begins with a short description of the production of the main mineral fertilisers and a summary of total world fertiliser use and trade trends over the past 20 years. The analysis then considers mineral fertiliser trends at the country level by major nutrient type (N, P and K). The focus of this discussion is on the elements that contribute to understanding the range of policy objectives and measures that countries introduce as discussed in Parts 3 and 4. These elements include the dependency on trade, the intensity of use, and change in use over time. The final section discusses some of the major trade-related market issues. Trade plays a crucial role in mineral fertiliser markets because production of some mineral fertilisers is highly concentrated in relatively few countries. While reference is made to the recent increase in mineral fertiliser prices and some of the factors that have contributed to this, a detailed examination of market developments and their impact on prices is beyond the scope of this study.

2.1. Production of the main mineral fertilisers

Plants need nutrients to grow and absorb them from the soil via the plant's root system. Each plant nutrient has unique physiological functions which cannot be replaced by any other nutrient. The three most important nutrients, or macronutrients, are nitrogen (N), phosphorus (P) and potassium (K). Soils used for agriculture become depleted in these nutrients and therefore need to be fertilised. Overall, soils have a higher capacity to retain P and K than N. As a result, failure to apply P and/or K could potentially have little effect on a crop if those nutrients had recently been applied to the soil.

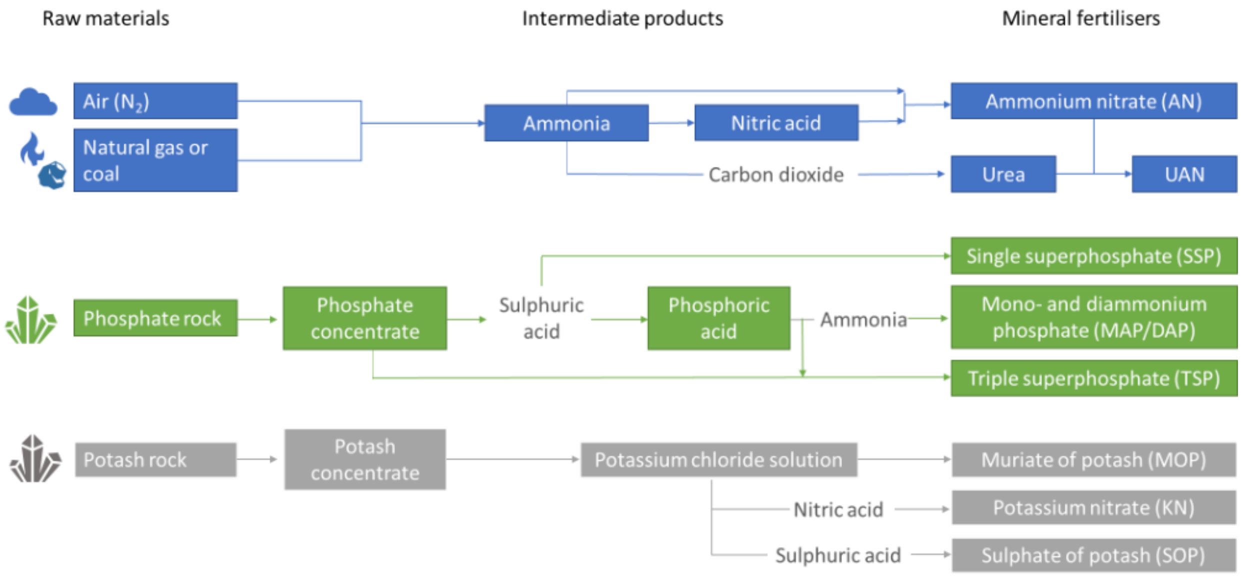
There are two main types of fertilisers: inorganic (made from minerals or synthetic chemicals) and organic (derived from plants or animals). In the case of inorganic fertilisers, nutrients are transformed from naturally occurring raw materials by industrial processing and then supplied as mineral fertilisers (Figure 2.1). This report uses the term mineral fertilisers to refer to inorganic fertilisers.

Nitrogen (N) is the most important macronutrient for plant growth and development and for high yields. Nitrogen-based mineral fertilisers are produced by first mixing nitrogen from the air with hydrogen from natural gas or coal at a high temperature and pressure to create ammonia. Ammonia is converted to other nitrogen compounds, the most important of which are nitric acid, ammonium nitrate (NA), urea, and urea ammonium nitrate (UAN).

Phosphorus (P) is vital for root development and drought resistance. Most of the phosphorus used in fertiliser comes from phosphate rock, a naturally occurring ore of marine sedimentary origin. Phosphate rock is primarily treated with sulphuric acid to produce phosphoric acid, which is either concentrated or mixed with ammonia to make a range of phosphate (P2O5) fertilisers. Phosphatic fertilisers include diammonium phosphate (DAP) and monoammonium phosphate (MAP).

Potassium (K) helps improve crop quality. Potassium is found in potash, a term that includes various mined and manufactured salts. Potassium Chloride (commonly referred to as Muriate of Potash or MOP) can be used directly as a fertiliser, combined with other important nutrients or converted into other forms of potash.

Figure 2.1. Production of the main fertiliser products

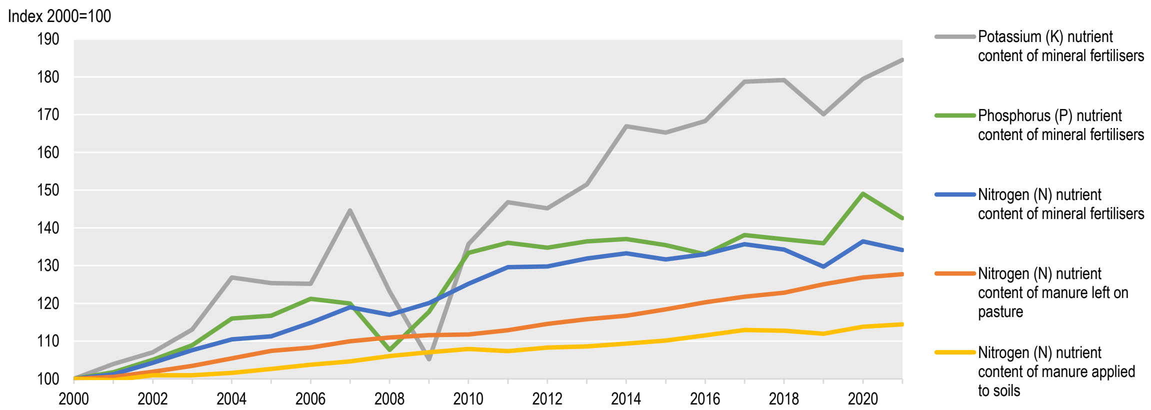


Source: Adapted from Fertilisers Europe (2023[19]).

2.2. Global trends in fertiliser use and trade

Over the past 20 years there has been a steady growth in total world agriculture use of mineral fertilisers (Figure 2.2). During a few years around the global financial crisis (GFC) in 2008-09 there was a dip in global use. Figure 2.2 compares the growth in total mineral fertiliser use since 2000 by the three major nutrient types with the nitrogen content of animal manure as a representative of organic fertilisers.[4] Animal manure is separated into two categories: that left on pasture by animals and that applied to soils by farmers.

Figure 2.2. Growth in world agricultural use of mineral fertilisers and animal manure by nutrient content, 2000-2021



Source: FAO (2024[11]).

[4] Comparative country-level data on the use of other forms of organic fertilisers is not available.

Growth has been particularly strong for the potassium (K) content of mineral fertilisers, which has grown by around 5% per annum (p.a.). Growth in agricultural use of phosphorus (P) and nitrogen (N) content of mineral fertilisers has been slightly slower at around 3% p.a. Growth in agricultural use of mineral fertilisers has been much stronger than for animal manure[5]. This is the case for both manure left on the pasture (2% p.a.) and manure applied to soils (1% p.a.).

Potassium use experienced a much larger fall in use during the GFC compared to both phosphorus and nitrogen, and phosphorus compared to nitrogen. These differentiated declines reflect the importance of nitrogen for crop yields and the capacity of soil to retain potassium and phosphorus. Farmers sometimes forego application of potassium and phosphorus in low affordability years if the soil content of their fields allows such short-term flexibility, which was the case in 2008-09 (Cross and Gruère, 2022[20]). A similar pattern of demand destruction was observed in 2022, i.e. potassium use fell relatively more than phosphorus, and phosphorus use more than nitrogen (Cross and Gruère, 2023[2]). Climate related events also had the effect of reducing fertiliser demand in 2022, including drought conditions in western Europe and severe flooding in Pakistan.

Almost half of world mineral fertiliser use by agriculture is on just three crops: maize (19%), wheat (15%) and rice (15%) (IFA, 2022[21]). Other cereal crops represent only 4% of the world total. Vegetables account for 10% of mineral fertiliser use; fruits, including tree nuts 5%; soybeans 6%; oil palm 3%; other oil crops 4%; fibre and sugar crops each 4%, and roots & tubers for 3%. Applications to grassland are estimated to account for 3%, but this share is likely underestimated due to information gaps for several countries. Changes in market demand for agricultural products flow through to fertiliser demand. A major reason for the recent growth in the application of potassium is the increase in production of high potassium consuming crops such as soybean and palm oil.

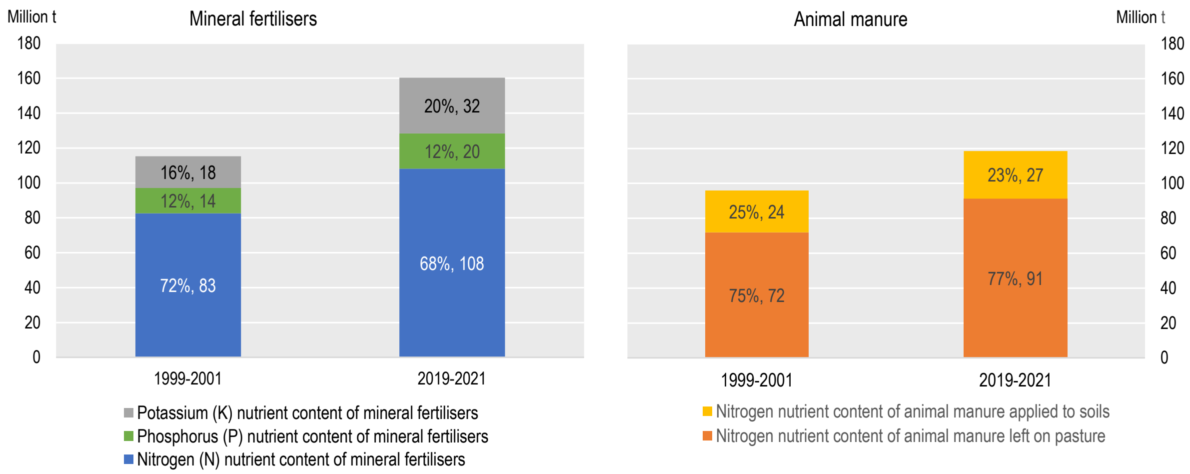
While growth in usage has been strongest for potassium over the past 20 years, nitrogen is the major nutrient applied through mineral fertilisers (Figure 2.3). In the three-year period 2019-21, an average of 108 million tonnes of nitrogen was applied each year, accounting for 68% of total nutrient content applied through mineral fertilisers. The proportion of potassium has increased from 16% to 20% of total mineral fertiliser nutrient use reflecting its more rapid growth in usage. At the total world level, almost 120 million tonnes of nitrogen is supplied through animal manure (both left on pasture and applied to soil). The vast majority (77%) of animal manure is left on pasture by animals rather than applied to soils through human activity. This figure also shows that animal manure remains important as a source of fertiliser (Teng et al., 2023[22]).

In recent years, around 80% of the potassium content of mineral fertilisers produced globally is exported, indicating a high level of trade dependency (Figure 2.4). This proportion has been decreasing slowly over the past 20 years, with year-to-year variations observed. Of the three nutrient types, nitrogen is the least exported, with total export volumes equivalent to just below 40% of production.[6] However, there has been a slow rise in trade dependency over the 2010s for both phosphorus and nitrogen-based fertilisers.

[5] Livestock manure estimates are compiled using official FAOSTAT statistics of animal stocks. The methodology can be found in FAO (2023[102]).

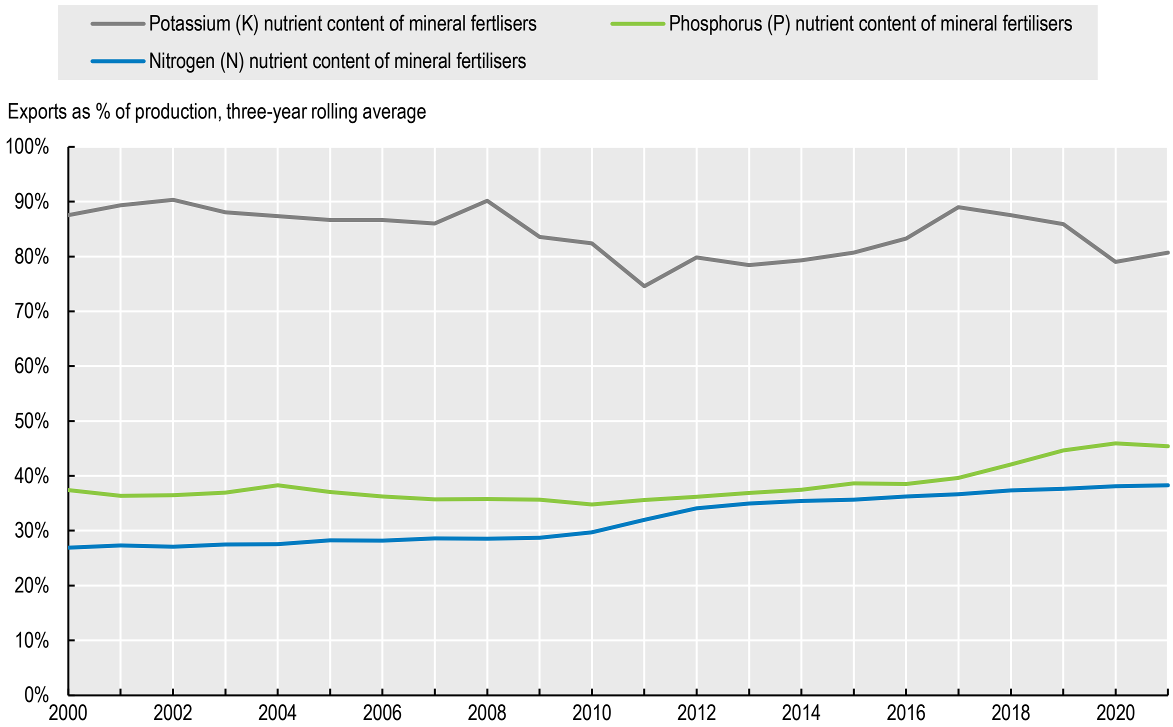
[6] This is relatively high compared to the share of production traded for most agricultural commodities. Only soybeans and milk powders have a share of production traded greater than 40% for commodities covered by the *OECD-FAO Outlook*. Most are less than 20% (OECD/FAO, 2023[7]).

Figure 2.3. World agricultural use of mineral fertilisers and animal manure by nutrient content, 1999-2001 and 2019-2021



Source: FAO (2024[11]).

Figure 2.4. World exports of mineral fertilisers as a share of production by nutrient content, 2000-2021



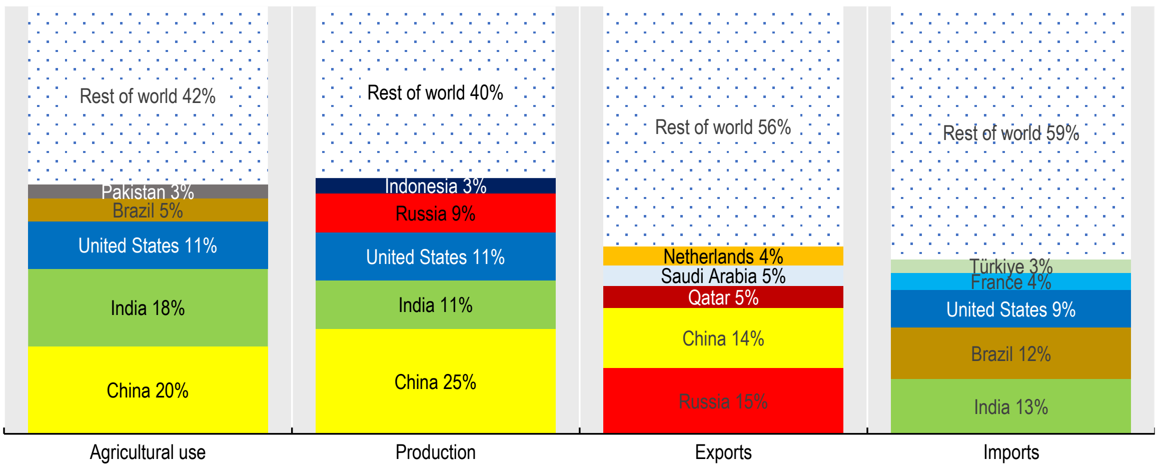
Source: FAO (2024[11]).

2.3. Nitrogen (N)-based mineral fertilisers

Nitrogen (N) is the most important macronutrient for plant growth and development and for high yields. Nitrogen-based mineral fertilisers are produced from ammonia (NH_3) (Figure 2.1). Current practice is to use fossil fuels as a feedstock to produce hydrogen and provide the energy required for the synthesis of ammonia. Most countries use natural gas, in China hydrogen is produced via coal gasification (Rosa and Gabrielli, 2022[23]).[7] Ammonia is further processed to create nitrogen-based fertilisers. Urea is the most common, accounting for almost 50% of total nitrogen use by nutrient content (IFA, 2023[16]). All other straight[8] nitrogen fertilisers such as ammonium nitrate (AN) or ammonium sulphate account for a further 25%. The remaining 25% of nitrogen content is applied through compound fertilisers containing two or more nutrients of N, P or K.

Given the importance of fossil fuels both as a raw material and power source for the synthesis process, the production of nitrogen fertilisers is concentrated in countries with access to fossil fuels, i.e. China, India, the United States, and Russia, along with several Middle Eastern countries that have very little domestic use for the product (Figure 2.5 and Table A A.1). Over the three-year period 2019-2021, Russia was the main exporter of mineral fertilisers containing nitrogen, responsible for 15% of global exports, followed by China (14%). Key importers of nitrogen fertilisers over the same period were India, Brazil and the United States. While China is a major producer and exporter, it is also the largest user of nitrogen fertiliser for agricultural production, accounting for more than one fifth of total world nitrogen use. India (18%), the United States (11%) and Brazil (5%) are other significant users of nitrogen.

Figure 2.5. Main agricultural users, producers, and traders of nitrogen-based fertilisers, 2019-2021



Source: FAO (2024[11]).

[7] The production of ammonia accounts for about 90% of the total energy consumption and CO_2 emissions of the nitrogen fertiliser industry (Rosa and Gabrielli, 2022[23]).

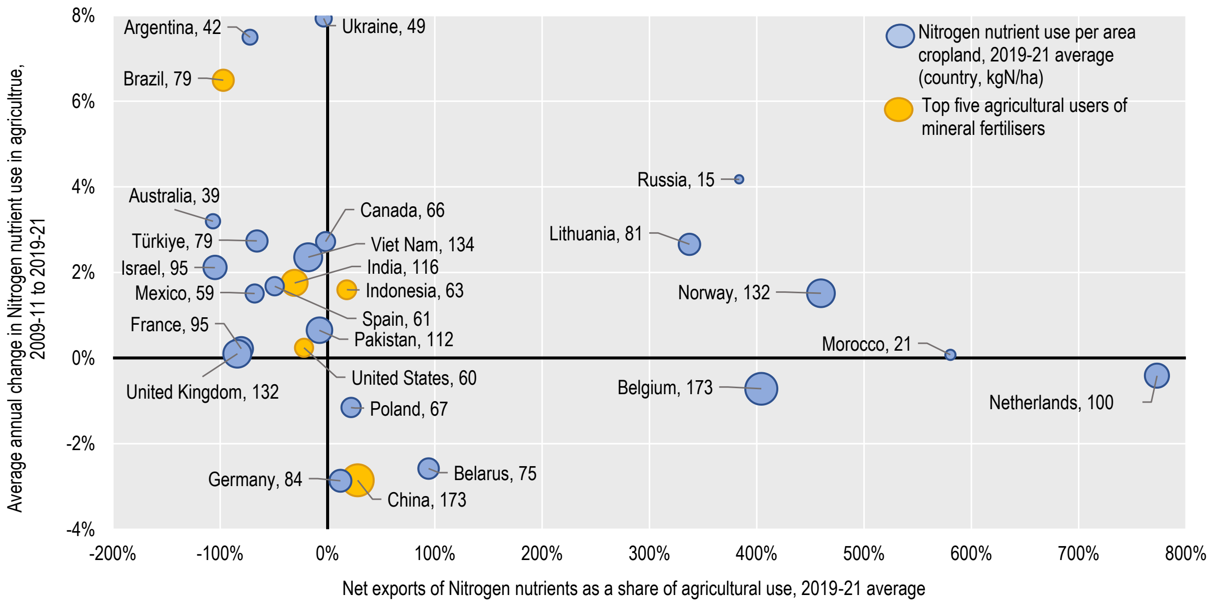
[8] This report follows the definitions used by the IFA. Straight fertilisers supply only one of the major plant nutrients in their formulation (although they can contain other nutrients such as sulphate). Compound fertilisers supply two or more of N, P and K and can be produced by blending two or more granular fertilisers, for example, by mixing basic fertilisers derived from ammonia with salts containing phosphorus or potassium.

Figures 2.6 and 2.7 show the same information for the major 26 and other 26 country groupings respectively. The horizontal axis provides an indication of the trade dependency of the country for nitrogen-based fertilisers. The further to the left, the more dependent a country is on imports. The size of the circle represents intensity of use (quantity of nutrient per area of cropland). The larger the circle, the greater the use of the nutrient for production in the three-year period 2019-2021. The vertical axis shows the change in nutrient use for agricultural production over the past decade. Countries below the 0% line have seen a drop in nutrient use, those above an increase. And the further away from 0%, the greater the decrease or increase.

Most (20) of the major 26 countries have experienced a rise in the agricultural use of nitrogen over the ten-year period 2009-2011 to 2019-2021 (Figure 2.6). It has grown by more than 6% p.a. in Ukraine, Argentina and Brazil. Conversely, the application of nitrogen through mineral fertilisers has fallen in six countries: China, Poland, Germany, Belarus, Belgium and the Netherlands. However, the intensity of nitrogen use (size of the circle) remains very high in these countries. India, Viet Nam, and the United Kingdom also have a high intensity of nitrogen use, with among these three countries use growing strongest in Viet Nam. Within the major 26 grouping, countries are spread across the trade spectrum indicating a relatively high degree of domestic manufacture of nitrogen fertilisers. All the major 26 countries have some local production. Of the five major users of nitrogen fertilisers (indicated in yellow), Brazil is the most dependent on imports. Seven countries, from Belarus through to the Netherlands, produce nitrogen fertilisers for the purpose of export.

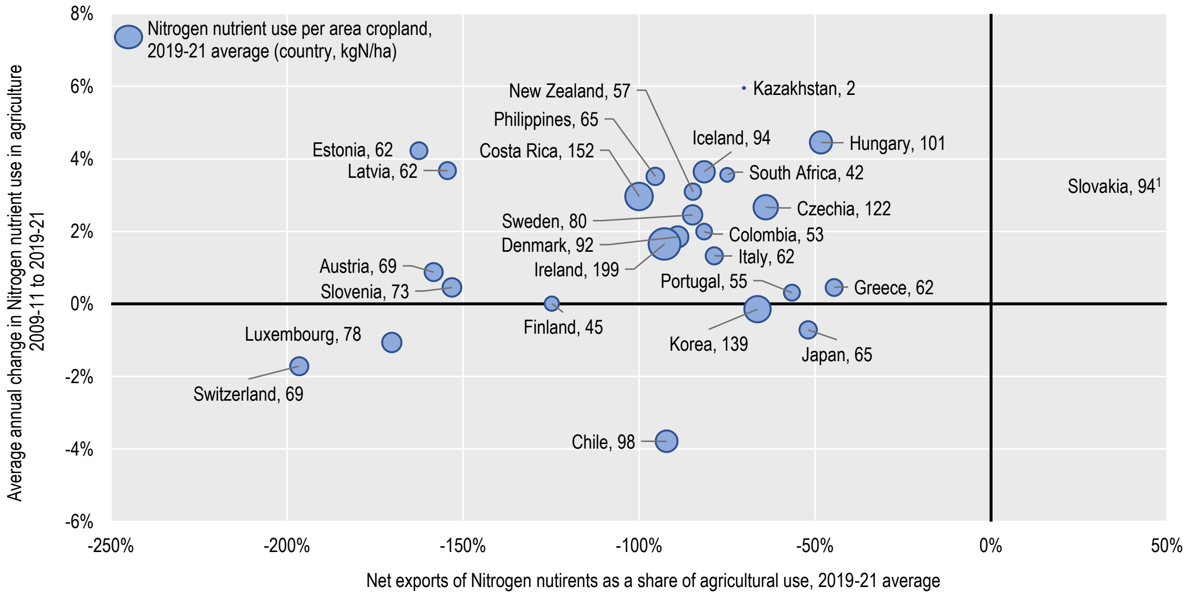
In comparison, all the other 26 countries, which use a relatively small quantity of total nitrogen, are highly dependent on imports of fertilisers containing nitrogen, apart from Slovakia (Figure 2.7). Ten of the other 26 are solely dependent on imports with no domestic production including Denmark, Ireland and Sweden. Several of the other 26 countries have a high intensity of nitrogen use, but the trends in use over time differ. The use of nitrogen fertiliser is decreasing in Chile, Switzerland, Luxembourg and Japan, but increasing in Kazakhstan, Hungary and Estonia.

Figure 2.6. Mineral fertiliser use by N nutrient content in selected major 26 countries, 2019-2021



Source: FAO (2024[11]).

Figure 2.7. Mineral fertiliser use by N nutrient content in selected other 26 countries, 2019-2021



Note: Country not included on the figure as net exports as a share of production falls outside the scale:
Slovakia: Net exports as a share of agricultural use: 156%; average annual change: 3.2%; use: 94kgN/ha.
Source: FAO (2024[11]).

2.4. Phosphorus (P)-based mineral fertilisers

Phosphorus (P) plays a vital role in photosynthesis and plant growth, and improves plant disease and drought resistance. The main source of phosphorus used in the production of mineral fertilisers is phosphate rock, a naturally occurring ore formed from fossilized marine animals. While phosphate rock can be applied directly, it is manufactured into mineral fertiliser through a process of acidification using sulphuric, phosphoric or nitric acid (Figure 2.1). The resulting phosphoric acid is usually then mixed with ammonia to make a range of compound fertilisers. Almost 90% of phosphorus applied by farmers is through compound fertilisers, of which diammonium phosphate (DAP) and monoammonium phosphate (MAP) are the most common (accounting for 50% of total phosphorus content) (IFA, 2023[16]). Straight phosphorus-based fertilisers (such as single or triple superphosphate) account for just 10% of use. The remaining 2% comes from direct application of phosphate rock or other sources.

Phosphate rock reserves are found in a handful of countries[9] which dominate the export of phosphorus content in mineral fertilisers (Figure 2.8 and Table A A.2). Over the period 2019-2021, China was responsible for 25% of global exports of phosphorus, followed by Morocco (19%), Russia (14%), and the United States (9%). During this time India and Brazil were the largest importers. The five largest users, China, India, Brazil, the United States, and Indonesia, apply almost two-thirds of total phosphorus in mineral fertilisers.

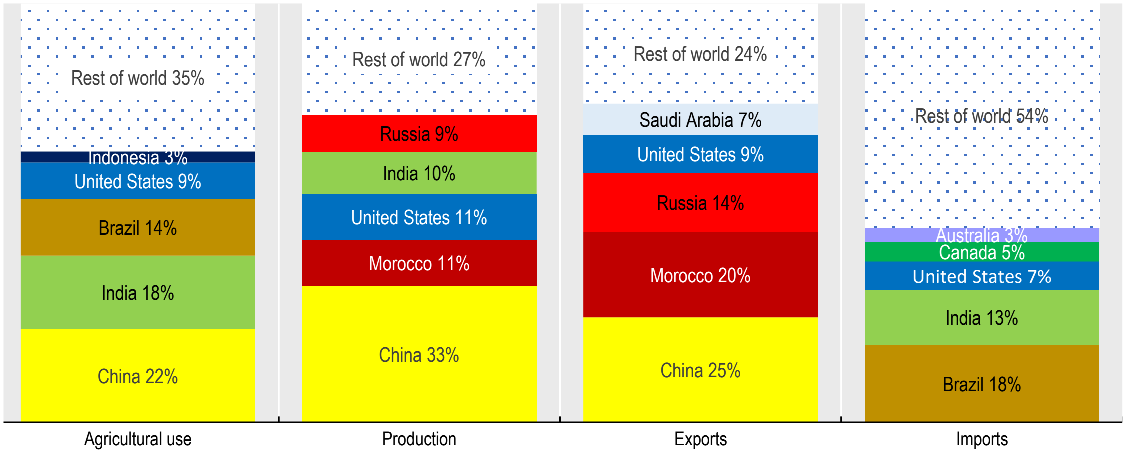
Most (17) of the major 26 countries have experienced a rise in agricultural use of phosphorus over the ten-year period 2009-2011 to 2019-2021 (Figure 2.9)[10]. The use of phosphorus for agricultural production has grown by more than 6% p.a. in Brazil, France, Mexico, Indonesia and Ukraine. Conversely, agricultural use of phosphorus has fallen by 4% p.a. or more in the Netherlands, Morocco, Belgium and Belarus. The

[9] In 2023, it was confirmed that enormous deposits of phosphate rock were discovered in Norway. The reserves are at least 70 billion tonnes, which is very close to the global reserves of 71 billion tonnes (The Economist, 2023[29]).

[10] Section 2.3 provides an explanation on how to interpret Figures 2.6 and 2.7, which have the same layout as Figures 2.9 and 2.10.

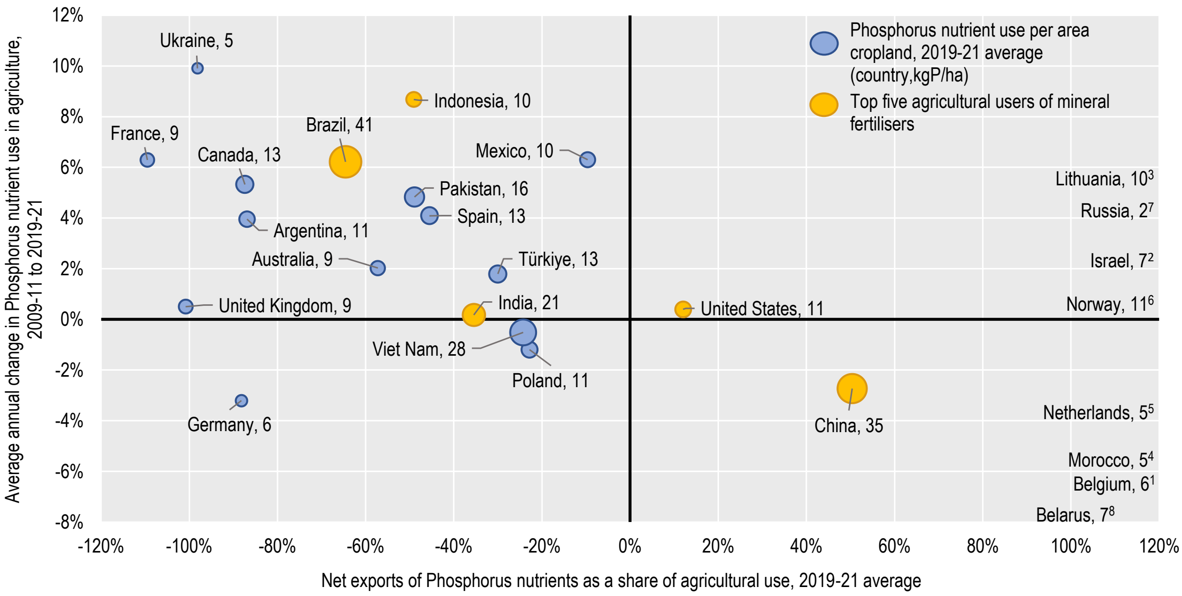
intensity of phosphorus use remains very high in Brazil and several Asian countries. Over the past decade, the use of phosphorus for agricultural production has been increasing in most of the other 26 countries (Figure 2.10). This includes Chile and Ireland, two countries with a relatively high intensity of phosphorus use. Again, relative to the major 26 grouping, the other 26 countries are more dependent on imports. More than half (15) having no domestic production compared to just one (United Kingdom) in the major 26 group.

Figure 2.8. Main agricultural users, producers and traders of phosphorus-based fertilisers, 2019-2021



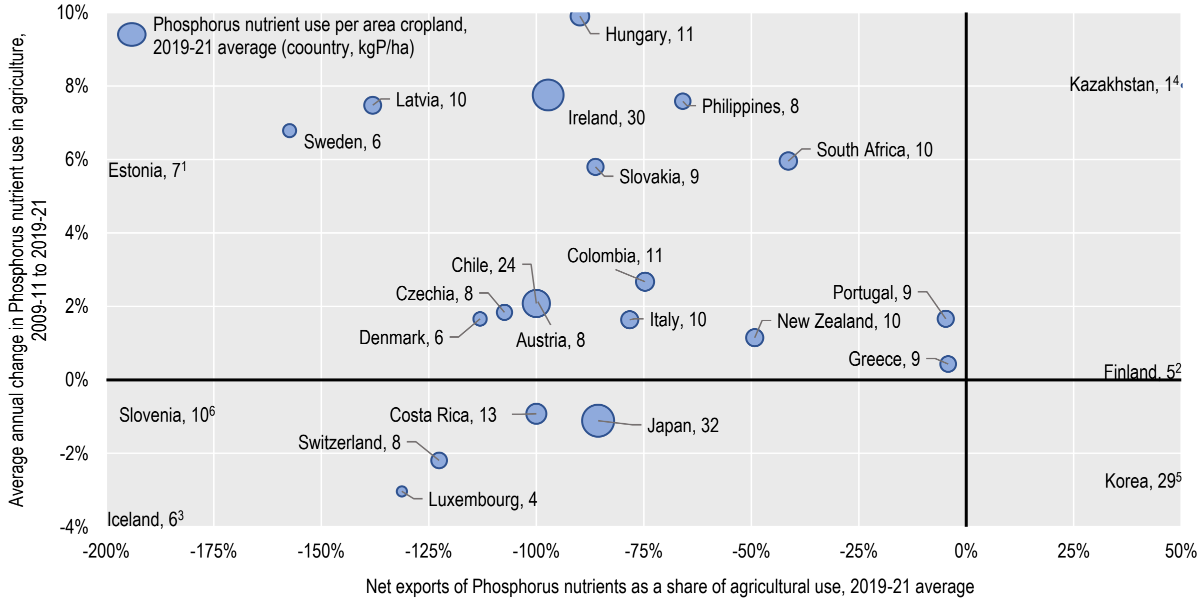
Source: FAO (2024[11]).

Figure 2.9. Mineral fertiliser use by P nutrient content in selected major 26 countries, 2019-2021



Note: Countries not included on the figure as net exports as a share of production or average annual change in use falls outside the scale:
1. Belgium: Net exports as a share of agricultural use: 1865%; average annual change: -6.3%; use: 6 kgP/ha.
2. Israel: Net exports as a share of agricultural use: 5093%; average annual change: 2.2%; use: 7 kgP/ha.
3. Lithuania: Net exports as a share of agricultural use: 451%; average annual change: 4.6%; use: 10 kgP/ha.
4. Morocco: Net exports as a share of agricultural use: 4096%; average annual change: -4.7%; use: 5 kgP/ha.
5. Netherlands: Net exports as a share of agricultural use: 919%; average annual change: -3.9%; use: 5 kg/ha.
6. Norway: Net exports as a share of agricultural use: 1624%; average annual change: 0.8%; use: 11 kg/ha.
7. Russia: Net exports as a share of agricultural use: 458%; average annual change: 4.6%; use: 2 kgP/ha.
8. Belarus: Net exports as a share of agricultural use: 103%; average annual change: -9.3%; use: 7 kg/ha.
Source: FAO (2024[11]).

Figure 2.10. Mineral fertiliser use by P nutrient content in selected other 26 countries, 2019-2021



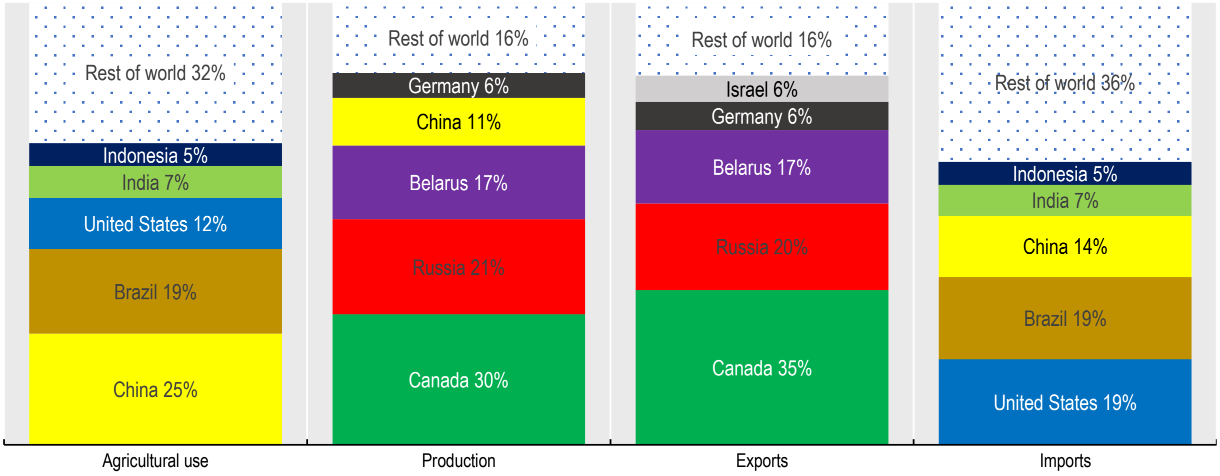
Note: Countries not included on the figure as net exports as a share of production and/or average annual change in use falls outside the scale:
1. Estonia: Net exports as a share of agricultural use: -266%; average annual change: 5.9%; use: 7 kgP/ha.
2. Finland: Net exports as a share of agricultural use: 477%; average annual change: 0.2%; use: 5 kgP/ha.
3. Iceland: Net exports as a share of agricultural use: -368%; average annual change: -11.1%; use: 6 kgP/ha.
4. Kazakhstan: Net exports as a share of agricultural use: 51%; average annual change: 8.0%; use: 1 kgP/ha.
5. Korea: Net exports as a share of agricultural use: 74%; average annual change: -2.8%; use: 29 kgP/ha.
6. Slovenia: Net exports as a share of agricultural use: -234%; average annual change: -1.0%; use: 10 kgP/ha.
Source: FAO (2024[11]).

2.5. Potassium (K)-based mineral fertilisers

Potassium (K) improves crop quality by helping plants survive against stress, pests and diseases. Potassium-based fertilisers are commonly called “potash”, in reference to early methods of making a form of potassium carbonate by leaching wood ash in iron pots (U.S. Geological Survey, 2018[24]). Today they are manufactured from salt deposits that contain potassium in water-soluble form, which are processed to remove impurities (Figure 2.1). Potassium chloride (Muriate of Potash or MOP) is used directly as a straight potassium-based mineral fertiliser, and accounts for almost 60% of potassium nutrient content applied (IFA, 2023[16]). Potassium chloride can be further processed into other straight potassium fertilisers, such as potassium sulphate and potassium nitrate, or mixed with other nutrients. Around 40% of potassium is applied through compound fertilisers.

The production of potassium-based fertilisers is highly concentrated in four countries. Canada, Russia, Belarus and China together account for 79% of global production over the period 2019-2021 (Figure 2.11 and Table A A.3). China uses most of what it produces domestically, and imports a significant quantity to meet demand. The other three countries account for 72% of global exports. Key importers of potassium in mineral fertilisers are the United States (19% of global imports), Brazil (19%) and China (14%). China, Brazil, the United States, India and Indonesia are the five largest users, applying 68% of total potassium used for agricultural production.

Figure 2.11. Main agricultural users, producers and traders of potassium-based fertilisers, 2019-2021



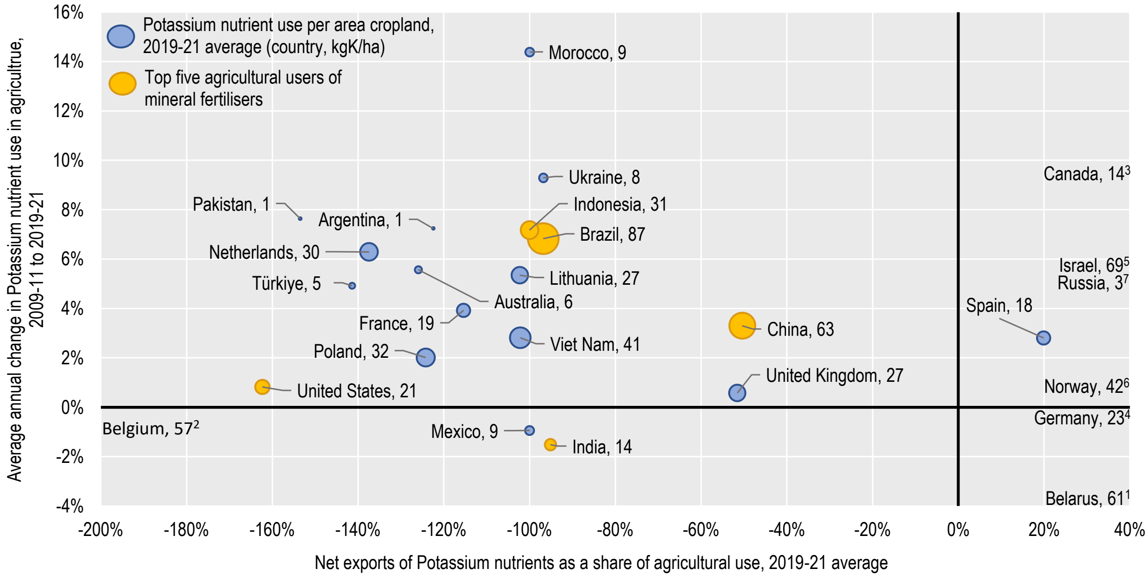
Source: FAO (2024[11]);

All the major 26 countries, except for India, Mexico, Belgium and Germany, have experienced a rise in the agricultural use of potassium-based mineral fertilisers over the ten-year period 2009-2011 to 2019-2021 (Figure 2.12)[11]. Growth has been higher than 6% p.a. in Morocco, Canada, Ukraine, Pakistan, Argentina, Indonesia and Brazil. Brazil, Israel and China are the countries with a high intensity of potassium use. In comparison to both nitrogen and phosphorus, the major 26 grouping is even more trade dependent on imports for the supply of potassium nutrients to meet demand. A dozen of the major 26 have no domestic production.

This is also true for the other 26 grouping of countries, where 22 of the 26 have no domestic production of potash mineral fertilisers (Figure 2.13). Most of the other 26 countries have also experienced a rise in the application of potassium over the 2010s, with Iceland, Luxembourg, Italy and Korea being notable exceptions. Ireland, Costa Rica and Korea are three other countries with relatively high intensity of potassium use. But their trend in use is very different: decreasing by 3% p.a. in Korea, but increasing by 3% p.a. and 6% p.a. in Cosa Rica and Ireland, respectively.

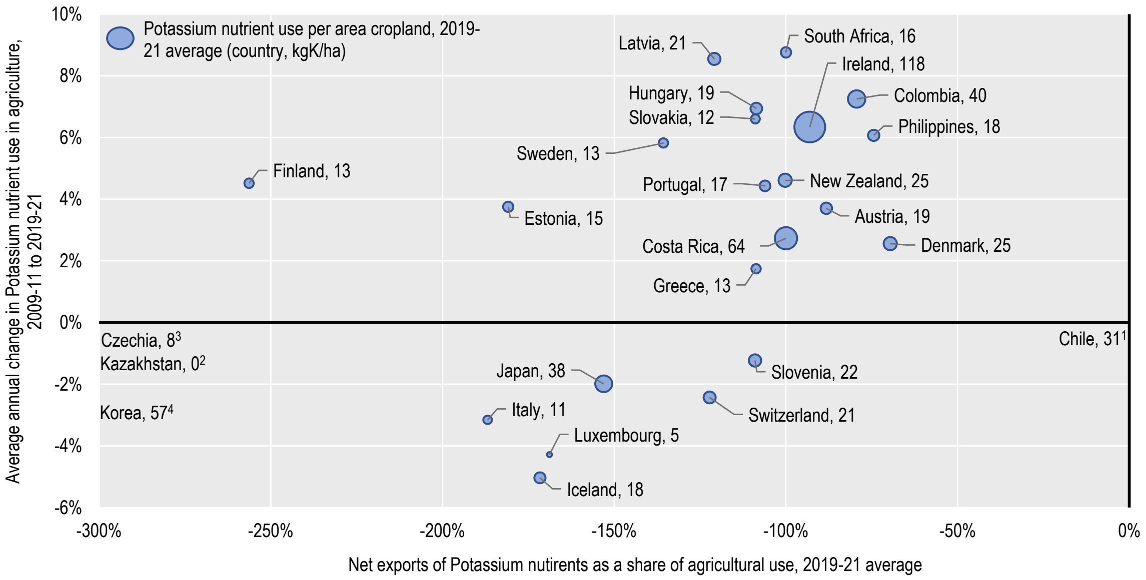
[11] Section 2.3 provides an explanation on how to interpret Figures 2.6 and 2.7, which have the same layout as Figures 2.12 and 2.13.

Figure 2.12. Mineral fertiliser use by K nutrient content in selected major 26 countries, 2019-2021



Note: Countries not included on the figure as net exports as a share of production or average annual change in use falls outside the scale:
1. Belarus: Net exports as a share of agricultural use: 1396%; average annual change: -5.7%; use: 61 kg/ha.
2. Belgium: Net exports as a share of agricultural use: -779%; average annual change: -0.9%; use: 57 kg/ha.
3. Canada: Net exports as a share of agricultural use: 1768%; average annual change: 9.5%; use: 14 kg/ha.
4. Germany: Net exports as a share of agricultural use: 541%; average annual change: -0.1%; use: 23 kg/ha.
5. Israel: Net exports as a share of agricultural use: 5323%; average annual change: 5.9%; use: 69 kg/ha.
6. Norway: Net exports as a share of agricultural use: 274%; average annual change: 0.7%; use: 42 kg/ha.
7. Russia: Net exports as a share of agricultural use: 1511%; average annual change: 5.1%; use: 3 kg/ha.
Source: FAO (2024[11]).

Figure 2.13. Mineral fertiliser use by K nutrient content in selected other 26 countries, 2019-2021



Note: Countries not included on the figure as net exports as a share of production or average annual change in use falls outside the scale:
1. Chile: Net exports as a share of agricultural use: 514%; average annual change: -0.3%; use: 31 kg/ha.
2. Kazakhstan: Net exports as a share of agricultural use: -491%; average annual change: -1.4%; use: 0 kg/ha.
3. Czechia: Net exports as a share of agricultural use: -338%; average annual change: -0.6%; use: 8 kg/ha.
4. Korea: Net exports as a share of agricultural use: -361%; average annual change: -3.0%; use: 57 kg/ha.
Source: FAO (2024[11]).

2.6. Market issues associated with mineral fertilisers

This final section of Part 2 briefly discusses two interrelated issues associated with the global mineral fertiliser market: supply disruptions and market concentration. The COVID-19 pandemic followed by Russia's large-scale aggression against Ukraine have brought these to the forefront. What makes these issues important is that the purchase of mineral fertilisers is a significant farm cash cost, particularly for cropping farms.

Mineral fertiliser markets can be susceptible to supply disruptions for three reasons: access to minerals, use of energy and logistic factors. Access to minerals is a potential cause of supply disruptions for phosphorus and potassium based mineral fertilisers. For example, a recent study noted that while there are sufficient accumulations of mineable and processable phosphate rock for centuries to come, these deposits are unevenly distributed across the globe – while some countries have plenty of sizeable mineable deposits others have none (Argus Consulting Services, 2023[25]). This can be seen when comparing the contribution of the top three countries to global mineral fertiliser exports by nutrient type (Table 2.1). Just three countries – China, Morocco and Russia – account for 59% of phosphorus mineral fertiliser exports. As evidence of this potential supply disruption, in 2014 the European Commission declared phosphate rock a "critical raw material" i.e. an essential resource with significant risk to supply (HCSS, 2012[26]). Phosphate rock has retained this status in the most recent assessment (European Commission, 2020[27]).

Table 2.1. Contribution of top 3, top 5, top 10 and top 20 countries to total exports and total imports of mineral fertilisers by nutrient content, 2019-2021

	N content of mineral fertiliser exports	N content of mineral fertiliser imports	P content of mineral fertiliser exports	P content of mineral fertiliser imports	K content of mineral fertiliser exports	K content of mineral fertiliser imports
Top 3	35%	33%	59%	38%	70%	52%
Top 5	44%	41%	76%	46%	83%	64%
Top 10	60%	53%	84%	60%	91%	74%
Top 20	81%	68%	94%	74%	96%	84%

Source: FAO (2024[11]).

The Russian invasion of Ukraine in February 2022 and on-going conflict has drawn attention to this susceptibility. For example, the conflict has restricted the ability to ship mineral fertilisers from ports on the Black Sea, requiring product to be diverted to other ports such as those on the Baltic Sea. It has also led to the damage of the Togliatti-Odesa pipeline through which ammonia was exported from Russia.[12] While international sanctions imposed by the European Union (EU), the United States, Canada and others in response to the Russian invasion exempt fertilisers provided sanctioned persons are not involved, EU sanctions imposed in 2021 ban the import of potash from Belarus and forbid shipments of Belarussian potash through EU territory to other markets.

In response to these developments, large fertiliser importers looked to secure supplies from alternative sources (Hebebrand and Glauber, 2023[28]). Brazil, for example, the second largest importer of potassium-based fertilisers managed to increase imports from Canada to help offset the decline from Belarus. Other countries, less worried by US dollar sanctions, have increased imports from Russia and Belarus, reducing their demand from third countries. For example, exports of urea and phosphates from Russia to India increased significantly in 2022 and exports of potash from Belarus have pivoted east, utilising rail networks through Russia to China (Cross and Gruère, 2023[2]). However, as of July 2023, the transit of ammonia

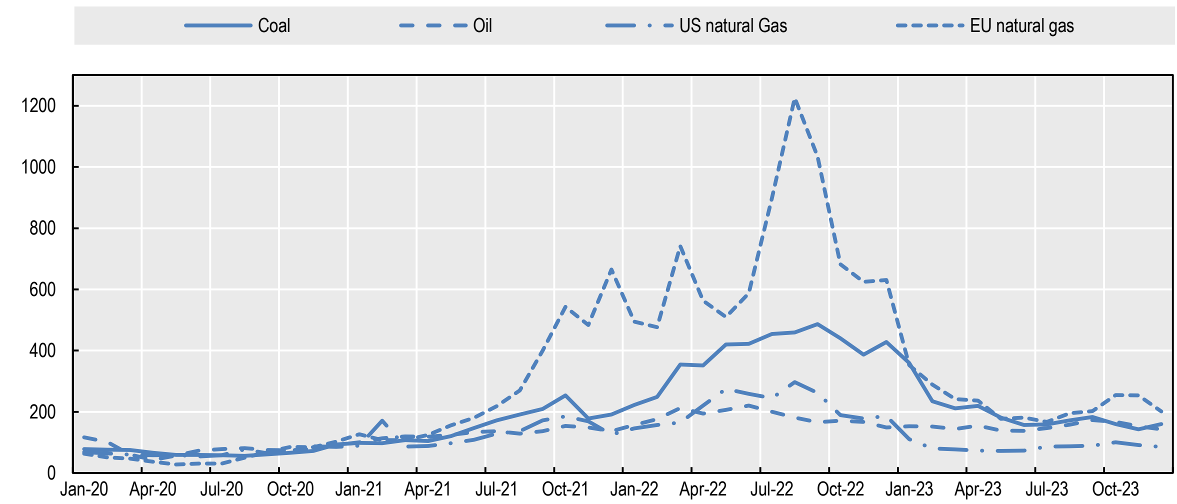
[12] Before the war, the 2 500km (1 530mile) pipeline – which runs from the Russian city of Togliatti to three Black Sea ports in southern and western Ukraine – exported 2.5 million tonnes of ammonia annually.

through Ukraine by pipeline has not yet restarted. Higher prices have stimulated some companies to increase their production capacities and exports, including potash from Canada and Laos, phosphate from Morocco, Brazil and the United States, and urea from Nigeria and Brunei (Cross and Gruère, 2022[1]). They also encourage the search for mineral resources, with new phosphate reserves recently announced in Norway (The Economist, 2023[29]).

The high use of energy to manufacture fertilisers is a second potential cause of supply disruptions. This particularly affects the production of nitrogen-based fertilisers where natural gas is also used as a raw material. Around three times as much energy is needed to produce nitrogen-based fertilisers compared to phosphorus-based mineral fertilisers (Daramola and Hatzell, 2023[30]). Natural gas typically represents 60%-80% of nitrogen fertiliser production costs (Fertilizers Europe, 2023[31]). Countries with gas and coal reserves, like Russia, China and Qatar have a competitive advantage in the production of nitrogen-based fertilisers.

The surge in natural gas prices in the middle of 2021, especially in Europe (Figure 2.14), resulted in a reduction in ammonia production. IFA estimated that when EU natural gas prices reached their peak in August 2022, 70% of European ammonia capacity had been shut down for economic reasons (Cross and Gruère, 2022[1]). Some nitrogen plants in Europe continue to operate below capacity in mid-2023: while input (natural gas) costs have dropped, the fall in output prices for mineral fertilisers continues to make production uneconomic (Cross and Gruère, 2023[2]). Coal price increases in China also led to a rationing of electricity usage, causing some fertiliser production plants to decrease production (USDA, FAS, 2022[32]).

Figure 2.14. Spot energy price indexes, 1 January 2020 to 31 December 2023 (2017=100)



Source: The World Bank (2024[33]).

Several logistic factors can cause supply disruptions to emerge. Ammonia requires special storage arrangements for transportation, needing refrigerated vessels or pressurized containers. This both limits transport options and raises costs. For example, freight accounts for 22% of the cost of ammonia shipped from Trinidad and Tobago to the US Gulf (and up the Mississippi River by barge); and more than 50% of the cost of ammonia shipped from Russia Togliatti to the Gulf (USDA, AMS, 2022[34]). While the sea shipment of dry bulk fertiliser does not face this challenge, once landed, moving fertiliser inland can be expensive, particularly for landlocked developing countries (IFDC, 2022[35]).

Another logistic challenge arises at the consumer end of the chain. Farmer demand for fertiliser is seasonal and reflects the times when crops and pastures are fertilised. The recent sharp rise in fertiliser prices would not have been experienced uniformly. Further, to produce efficiently, farmers want to minimise storage requirements and downtime in refilling fertiliser equipment. Growing farm sizes, larger cropped areas per farm and associated machinery and input requirements are raising this challenge (Petersen, Scanlan and Burton, 2023[36]). However, larger farms allow the delivery of bigger volumes (truckload) rather than in bags which can be much cheaper (Gentile et al., 2019[37]). Many farmers postponed their fertiliser purchases in 2022 because they hoped for a decline in prices or lacked financing. This mostly impacted phosphorus and potassium demand (Cross and Gruère, 2022[1]).

The preceding analysis has drawn attention to the concentration of mineral fertiliser production at the country level. But there is also a high level of market concentration at the company level (Table 2.2). This can occur both in production and distribution of fertilisers. For example, a handful of companies control the channels through which farmers in the United States obtain fertilisers (USDA, AMS, 2022[34]). Four companies supply 75% of nitrogen fertilisers to US farmers and two companies supply most potash fertiliser in North America. This is also the case at the global level, particularly for potassium and phosphorus. Nutrien, a Canadian-based company, controls more than one-third of global potassium production. Eight firms account for just over half of global production capacity in phosphorus fertilisers. While there are hundreds of companies producing nitrogen-based fertilisers, total global production and trade is dominated by a relatively small proportion which can translate into market dominance when there is little domestic production.

Table 2.2. Major fertiliser manufacturing companies

Name	Ownership	Revenue	Position
Nutrien Ltd	Publicly listed on NYSE	USD 37.9 b (2022)	A Canadian based company, Nutrien is the **largest producer of potassium-based mineral fertilisers** (>20 million tonnes of potassium chloride) and one of the largest producers of nitrogen and phosphate globally. With a history that goes back nearly 50 years, the company has over 23,500 employees and can produce almost 30 million tonnes of fertiliser. It was formed in January 2018 through the merger of Agrium Inc. and Potash Corporation of Saskatchewan Inc..
CF Industries Holdings, Inc	Publicly listed on NYSE	USD 6.6 b (2023)	Founded in 1946 and based in Illinois, United States, CF is the world's **largest manufacturer of nitrogen-based fertilisers**. It operates nine manufacturing complexes comprising 17 ammonia plants across United States, Canada, and the United Kingdom. The company has an annual average capacity to produce 10.5 million tons of ammonia, 4.8 million tons of urea, 7.3 million tons of UAN, and 2.2 million tons of AN.
OCP Group	State-owned	USD 11.3 b (2022)	Founded in 1920, and based in Morocco, OCP has grown to become the **world's largest producer of phosphate** and phosphate-products. It operates four phosphate mines and two processing plants with a capacity for more than 12 million tonnes. OCP has access to more than 70% of the world phosphate rock reserves and employs nearly 23,000 people.
Mosaic Company	Publicly listed on NYSE	USD 19.1 b (2022)	Based in Florida, United States, Mosaic was formed in October 2004 by a merger between IMC Global, a fertiliser company formed in 1909, and Cargill's crop nutrition division. It employs approximately 13,000 people in eight countries. Mosaic is the largest producer of finished phosphate products, with 17 million tonnes capacity.
Yara International ASA	Publicly listed on Oslo SE (one-third owned by Norwegian government)	USD 24.1 b (2022)	Established in 1905 as Norsk Hydro – the world's first producer of mineral nitrogen fertilisers – it de-merged as Yara International ASA on 25 March 2004. Based in Oslo, Norway, Yara has more than 17,000 employees with production sites on six continents (60 countries). It is one of the largest producers of nitrogen-based fertilisers, with capacity to produce 9 million tonnes of ammonia annually.
ICL Group Ltd	Publicly listed on both the NYSE and the TASE	USD 10.0 b (2022)	ICL Group (formerly Israel Chemicals Ltd) is a multi-national manufacturing company producing fertilisers, metals and chemicals. It is the world's sixth largest potash producer, with a capacity to produce 6 million tonnes of potash annually.

Name	Ownership	Revenue	Position
K+S AG	Publicly listed on FWB.	USD 6.0 b (2022)	Originally founded in 1889, K+S AG is a German chemical company. It is Europe's largest supplier of potash fertiliser, with an annual capacity of 6.7 million tonnes.
Belaruskali	State-owned	Not available	Belaruskali is the one of largest producers of potash fertilisers in the world, with annual production capacity of 14 million tonnes. It is the largest state-owned company in Belarus, the largest single taxpayer and important source of foreign exchange earnings for the country.
PhosAgro	Publicly listed on both the MCX and LSX.	USD 8.8 b (2022)	PhosAgro is a Russian chemical holding company producing fertilisers, phosphates and feed phosphates. It is Europe's largest producer of phosphate-based fertilisers.
Qatar Fertilizer Company Limited (QAFCO)	100% owned subsidiary of Industries Qatar QPSC	Not available	Qatar Fertilizer Company Limited (QAFCO), founded in 1969, is a leading global nitrogen-based fertiliser producer with six manufacturing facilities with annual capacity to produce 3.8 million tonnes of ammonia and 5.6 million tonnes of urea. Industries Qatar QPSC operates in three distinct business segments: petrochemicals, fertilisers and steel.
Sociedad Química y Minera (SQM)	Publicly listed on both the NYSE and the SSE	USD 10.7 b (2022)	A global mining company operating in Chile. SQM leverages its caliche ore deposits to produce a wide range of nitrate-based products for agricultural uses, including potassium nitrate, sodium nitrate, sodium potassium nitrate, potassium sulphate and potassium chloride fertilisers. The company sold approximately 2.1 million tonnes of these fertilisers in 2021.
Saudi Arabian Mining Company (Ma'aden)	Publicly listed on the Tadawul (50% owned by Saudi government)	Not available	Operates the largest phosphate mining facility in the world. The Wa'ad Al Shamal Minerals Industrial City, an integrated phosphate fertiliser production complex, is a USD 8 billion joint venture investment between Ma'aden (60%), chemical manufacturer SABIC (15%) and the Mosaic Company (25%).

Source: Various internet sources, including Wikipedia.

Reasons for the high concentration of global production in a small number of companies include the specific location of natural resources and economies of scale associated with manufacturing, rather like the oil industry. Another reason for the high concentration of production is the policy choice made by some governments to control production through state owned enterprises such as in Viet Nam (OECD, 2015[38]).

Concerns have been documented about the high level of company concentration in the mineral fertiliser market. A study of urea prices found that prices are generally higher in more concentrated markets (Hernandez and Torero, 2013[39]). Simulations in this study indicate that a 10% increase in competition could increase fertiliser use by 13–19% and rural incomes by 1–2% in regions like sub-Saharan Africa. In Costa Rica, the presence of just three companies in the fertiliser market has been linked to a low level of price transmission from falling international prices to domestic agricultural producers (WTO, 2019[40]). Conversely, the existence of many distributors, competing to buy and sell fertilisers, has ensured the Philippine fertiliser market is well integrated with the world market (OECD, 2017[41]).

Rising fertiliser prices over the past two years have led to an increase in corporate profits (Institute for Agriculture and Trade Policy, 2022[42]). According to company filings, the combined profits of nine of the world's biggest fertiliser companies (Nutrien, Yara, Mosaic, ICL Group, CF Industries, PhosAgro, OCI, K+S, OCP) were just under USD 13 billion in 2020, and quadrupled to USD 55 billion in 2022.

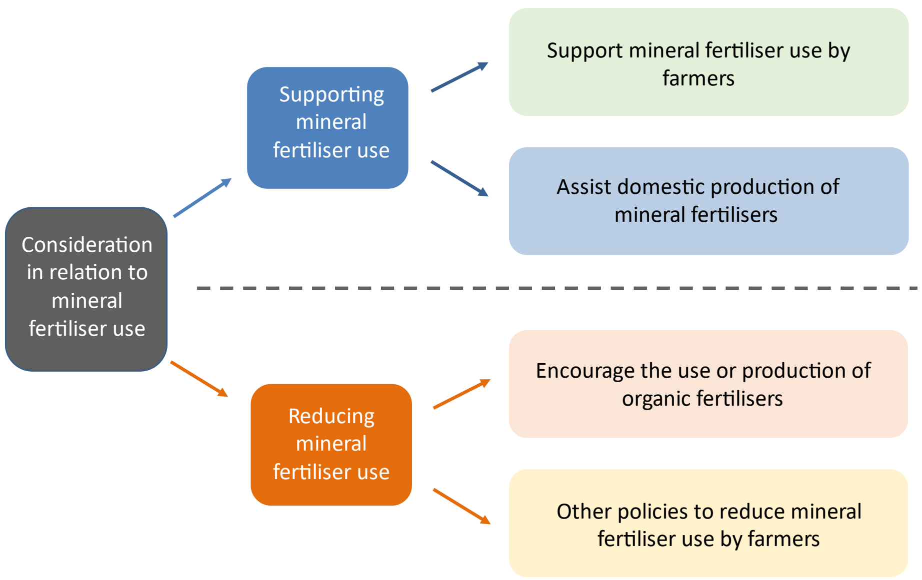
3 Policy objectives for fertilisers

The intent of Part 3 of the report is to document the specific high-level, long-term policy objectives (and targets where set) for fertiliser use that have been established at the country level. There are sometimes specific goals set at a state, province or regional government level, but these are not included. Furthermore, the focus is on documenting the goals that are explicitly set for fertilisers, whether for total, mineral or organic fertilisers. It does not therefore document the long-term goals and objectives that are set for other policy areas which can have implications for fertiliser markets, such as increasing the area of organic agriculture[13] or reducing nutrient losses or greenhouse gas emissions, unless an explicit fertiliser goal is set. Neither does it document the policy objectives for each individual policy measure. It also does not include objectives that relate to the operation of a well-functioning market such as appropriate labelling, advertising and import certification. Such objectives are common across most countries.

3.1. Framework for analysing policy objectives and measures

A common framework is used to provide a consistent basis for discussion and analysis of both policy objectives (Part 3) and the myriad policy measures that are applied (Part 4). The framework is based on policy intent (Figure 3.1). Policy objectives and measures are first separated according to whether the consequence their stated purpose is to support or reduce the use of mineral fertilisers.

Figure 3.1. Framework for classifying policy objectives and measures by purpose



[13] For example, both the Farm to Fork Strategy (European Commission, 2020[99]) and the EU Biodiversity Strategy for 2030 (European Commission, 2020[100]) contain an objective to have at least 25% of the EU's agricultural land under organic farming by 2030 (compared to 2018). The CAP Strategic Plans (CSPs) developed by each EU member state as part of CAP 2023-27 were required to be consistent with these two strategies. Of the 28 CSPs, 21 have set national target values for organic farming. Four Plans (Austria, Belgium-Walloon, Germany and Sweden) have set a higher target of 30% of their utilised agricultural area (UAA) expected to be farmed under organic practices by 2030 (European Commission, 2023[70]).

Policies supporting mineral fertiliser use are separated into two categories: whether they support mineral fertiliser use by farmers or assist domestic production hence benefiting manufacturers. In terms of policies that have the intent of reducing mineral fertiliser use by farmers, these are also separated into two broad categories: those that encourage the use or production of organic fertilisers, and all others. This distinction is made to support the consideration of the potential and challenges of organic fertilisers in Part 5. Within each of these four broad groups, the discussion of policy measures in Part 4 are separated by type of measure, e.g. tariffs, export restrictions, subsidies.

Such a framework allows for policy measures to be considered in relation to the policy objectives. It also makes it easier to identify whether there is lack of policy coherence, where policies may be working against each other. This report develops the framework and takes stock of the different types of policies and policy objectives, but it is beyond the scope of this report to conduct an in-depth analysis of the coherence of the various national policies. This could be pursued in future work.

In addition, by framing the policy discussion in relation to mineral fertilisers, the framework provides some perspective on the influence policies may have on the opportunities and challenges for organic fertilisers (Part 5). However, like with all frameworks there are limitations. A major one in this case is that some policy measures that are introduced to directly support the use of mineral fertilisers in one country may hinder the use of fertilisers in others. Export restrictions are a case in point.

3.2. Summary of policy objectives for mineral fertilisers

Table 3.1 summarises, using the four-group framework, the specific high-level, long-term policy objectives (and targets where set) for fertilisers that have been found. Specific policy objectives for fertilisers may exist within the selected 52 countries considered in this study, but these have not yet been identified to date. Based on the search, several of the major 26 grouping do not have specific national policy objectives for fertilisers, e.g. Australia, Norway and the United Kingdom.

India and Indonesia have specific policy objectives to increase mineral fertiliser use by farmers. These have been in place for many years. Other countries, particularly in Asia such as Viet Nam, have had similar objectives in the past to stimulate agricultural production. But explicit objectives to increase fertiliser use appear to only remain in India and Indonesia.

Five countries have been identified with objectives to assist domestic mineral fertiliser production. Such a policy objective has existed for many years in India and Pakistan. Mexico introduced an objective to rehabilitate fertiliser production plants in 2019 as part of its National Development Plan 2019-2024. Brazil and the United States have both announced this objective in response to the current period of high prices, but motivated by different market reasons. For Brazil, it is primarily to reduce dependence on fertiliser imports. For the United States, it is a temporary measure aimed at spurring competition in the domestic market and supporting the development of innovative, sustainable production methods and efficient-use technologies.

In terms of specific objectives for increasing organic fertiliser use or production, these have been more recently introduced and primarily in Asian countries. Indonesia, Japan and Viet Nam have set explicit targets in terms of the volume of organic fertilisers used while China has set the target in terms of the land area to which they are applied.

Table 3.1. Policy objectives for fertilisers in selected countries

Country	Year	Name of strategy/policy/programme	Specific fertiliser related objective stated, including specific target (if set)
Support mineral fertiliser use by farmers			
Indonesia	1971	Fertiliser subsidy programme	General objectives have been to provide relatively cheap mineral fertilisers to farmers to increase agricultural productivity, preserve national food security, and increase farmers income
India	2010	Nutrient Based Subsidy Policy	Boost consumption of P&K fertilisers to encourage a balanced fertiliser use. The Ideal balance/ratio of N:P:K nutrient use defined as 4:2:1
Assist domestic mineral fertiliser production			
Pakistan	2001	Fertilizer Policy 2001	To provide investors in new fertiliser plants in Pakistan a gas price that enables them to compete in the domestic market with fertiliser exporters of the Middle East so that indigenous production can support the agricultural sector's requirement by fulfilling fertiliser demand
India	2003	New Pricing Scheme	To maximise indigenous production of nitrogenous fertilisers based on utilization of indigenous feedstock to reach self-sufficiency in urea production to ensure easy availability of fertilisers to farmers at affordable prices and to promote balanced nutrient application which is essential for the sustained agricultural growth
Mexico	2019	National Development Plan 2019-2024	The rehabilitation of fertiliser production plants to support agricultural producers
Brazil	2022	2022-2050 National Fertiliser Plan	Reduce the percentage of imported fertilisers used in Brazilian agriculture from around 85% to 45% by 2050. The Plan also has targets for increasing the number of manufacturers, auctioning of mining rights, etc.
United States	2022	Fertilizer Production Expansion Program	Support additional domestic fertiliser production to support farmers and spur competition in the domestic market
Encourage the use or production of organic fertilisers			
China	2022	14th Five-Year National Agriculture Green Development Plan 2021-25	Five percentage point increase in the proportion of land which uses organic fertilisers
Indonesia	2022	Enhanced Nationally Determined Contribution (NDC) under the Paris Agreement	Increase the application of organic fertilisers to 1.287 million tonnes by 2030[1]
Japan	2022	Food Security Reinforcement Policy Framework	Double manure compost and sewage sludge use for fertiliser thereby increasing the ratio of these domestic materials in fertiliser use (on a phosphorus basis) from 25% in 2021 to 40% by 2030
Viet Nam	2022	Action Plan to Increase Production and Use of Organic Fertilisers	Raising the proportion of organic fertiliser products authorised for circulation to 25% in 2025 by increasing the amount of production by 1.25 times to 5 million tonnes per year
India	2023	PM (Prime Minister's) Programme for Restoration, Awareness, Nourishment and Amelioration of Mother Earth	Reduce the use of chemical fertilisers by incentivising states to adopt alternative fertilisers, achieving a balanced use of mineral and organic fertilisers, and reducing the budget burden of mineral fertiliser subsidy programmes
Other policies to reduce mineral fertiliser use by farmers			
China	2015	Action to Achieve Zero growth of Chemical Fertiliser Use by 2020	Achieve annual growth rates of chemical fertiliser use of less than 1% from 2015 to 2019 and strive to achieve 0% growth for major crops by 2020
China	2021	14th Five-Year National Agriculture Green Development Plan 2021-25	Reduce usage of fertilisers and increase application efficiencies
Japan	2021	Strategy for Sustainable Food Systems ("Green Food System" Strategy)	Reduce chemical fertiliser use by 20% by 2030 and 30% by 2050 from 2016 base fertiliser year (July-June) volume of 900,000 tonnes NPK
European Union	2022	The Farm to Fork (F2F) Strategy and EU Biodiversity Strategy for 2030	Reduce the use of fertilisers by at least 20% by 2030 (same objective included in both)

1. Indonesia: The note to the commitment states that the application of synthetic nitrogen fertiliser will reduce by 0.15 tonnes for every tonne of organic fertiliser applied.

Several countries have put in place specific goals to reduce the use of mineral fertilisers for the purpose of protecting the environment. In 2015, China set a goal to reduce growth in mineral fertiliser usage to zero by 2020, and in 2018 reported that it had achieved its target three years in advance. In 2021, China established a goal to decrease fertiliser use. Japan and the European Union have both set goals to reduce fertiliser use by 20% by 2030 as part of broader environmental strategies for the agricultural sector.

Table 3.1 highlights one specific policy objective for each programme. It should be noted that a programme can have multiple policy objectives. Table 4.1 shows that the “European Commission’s Communication on ensuring availability and affordability of fertilisers” covers the four broad long-term policy objectives. Another example is the US Fertilizer Production Expansion Program (FPEP), a temporary program which aims to “assist domestic mineral production”, but also “encourages the use or production of organic fertilisers” due to its inclusion of nutrient alternatives and indirectly supports “other policies to reduce mineral fertiliser use by farmers” by awarding projects that provide nutrient alternatives that will lead to less mineral fertiliser use. In addition to assisting domestic mineral production, the Brazilian National Fertiliser Plan also proposes measures to augment the supply of organic and organomineral nutrients and focuses on the reuse solid waste and "remineralizers," such as rock dust, which can enhance the effectiveness of chemical fertilisers.

4 Policy measures for fertilisers

Part 4 of the report details the policy measures associated with fertilisers in the selected countries. Many policies have been introduced since 2021 to deal with the recent episode of high prices and supply disruptions, and to increase resilience against future shocks. These include export restrictions by key exporting countries, fertiliser subsidies, grants to increase domestic production, and targeted financial support. In addition to documenting more recent policies, this section also considers the longer-term policy measures that are in place. This section uses the same four-group framework for organising the discussion as Section 3.1. As an example, Table 4.1 uses the framework to categorise policy measures contained in the European Commission’s Communication on ensuring availability and affordability of fertilisers issued in November 2022[14].

Table 4.1. Use of the policy framework to categorise policy measures contained in the European Commission’s Communication on ensuring availability and affordability of fertilisers

Support mineral fertiliser use by farmers
• The Commission will work with Member States to examine the expediency of making use of the agricultural reserve worth EUR 450 million for the financial year 2023 for farmers affected by high input costs. • Improve market transparency in the EU’s fertiliser market by way of a new market observatory, to be established in 2023. • Suspend trade tariffs on urea.
Assist domestic production of mineral fertilisers
• Member States may prioritise the continued and undisputed access to natural gas for fertiliser producers in their national emergency plans in the event of gas rationing. • The amended Temporary Crisis Framework for State aid enables a specific support to fertiliser producers, subject to safeguards. • The Commission will encourage Member States to support investments in renewable hydrogen and biomethane for ammonia production. • Suspend trade tariffs on ammonia.

[14] Even though the EU’s Carbon Border Adjustment Mechanism (CBAM) will affect fertiliser markets and use, it is not covered in this report since it does not fall within the framework that considers policies that directly support or reduce the use of mineral fertilisers.

Encourage the use or production of organic fertilisers • The revised Fertilising Products Regulation ensures better access in the market for organic fertilisers. • The Commission will work with member States to ensure that relevant interventions such as nutrient management plans, soil health improvement, precision farming, organic farming, use of leguminous crops in crop rotation schemes are widely adopted by farmers
Other policies to reduce mineral fertilise use by farmers • The Commission will work with member States to ensure that relevant interventions such as nutrient management plans, soil health improvement and precision farming are widely adopted by farmers. • The Commission will adopt an Integrated Nutrient Management Action Plan in the first quarter of 2023 aiming at action at EU and national level to promote more efficient use of nutrients

Source: European Commission (2022[43]).

4.1. Policies supporting mineral fertiliser use by farmers

Many of the policy measures supporting mineral fertiliser use by farmers can be described as market-based instruments in that they provide their incentive by reducing the price paid by farmers for mineral fertilisers. This can be achieved through several mechanisms. Governments can change prices by lowering taxes that apply whether they are at the border (tariffs) or domestically (e.g. VAT). They can alter the domestic price through influencing the quantity of product available. For example, restricting the quantity of product that can be exported through various export restrictions (quotas, taxes, etc) increases the quantity available on the domestic market, lowering domestic prices (but raising international prices). They may also do this through the release of public stockholdings of fertilisers. Governments can more directly intervene in the market by setting minimum prices or supplying subsidised fertilisers through marketing channels. As an alternative to policy measures that impact directly on market prices, governments also support mineral fertiliser use by providing concessional interest rate credit programmes which allow farmers to purchase fertilisers among other farm inputs.

4.1.1. Import tariffs

Applied most-favoured-nation (MFN) tariffs imposed on fertilisers (HS Chapter 31) are generally quite low, indicating support for users such as farmers as opposed to producers of fertilisers. At the global level, the average applied MFN tariff rate on all fertiliser categories in 2021 was 1.9% (FAO/WTO, 2022[44]). Furthermore, 40% of WTO members do not levy any duties on fertiliser imports, while another 35% keep applied tariffs on average below 2.5%. For the selected 52 countries considered in this report, China (9.6%) and India (7.5%) have the highest average applied MFN tariffs at the HS chapter 31 level (Table 4.2). Eleven countries (Australia and countries below in the table) do not apply any tariffs to imports of fertilisers, including major users such as the United States and Canada.[15] Average applied MFN has been constant at these levels for the past decade or more in all countries except Russia where it has dropped from 10% in 2011 to 6.3% in 2017 and where it has been ever since.

When it comes to fertiliser sub-categories within HS chapter 31, most countries which apply tariffs have a relatively even tariff profile, with some exceptions. Notably, applied MFN tariffs are relatively higher for HS 3102 (N-based fertilisers) and HS 3105 (Other including compound fertilisers) in China, the European Union, and Türkiye. India and Brazil apply relatively higher tariffs on HS 3101 (animal or vegetable fertilisers) and HS 3103 (P-based fertilisers) than the other categories of fertilisers. Tariffs are relatively higher for HS 3103 in Israel and Viet Nam.

[15] On 3 March 2022, the federal government of Canada implemented a 35% tariff on all Russian imports, including fertiliser.

While low applied tariffs provide little policy room to decrease farmer costs through tariff reductions, a few countries took steps to temporarily reduce tariffs in response to recent international fertiliser price increases. On 16 December 2022, the European Union temporary suspend tariffs on urea (HS 3102.10.00) for a period of six-months until 17 June 2023. Notably, temporary duty exemption does not apply to imports from Russia and Belarus. The objective is to alleviate costs for EU fertiliser producers and farmers while stabilizing and diversifying supply origins. Other countries taking similar such steps included Brazil, Colombia, Israel and Korea.

Table 4.2. Average applied MFN and bound tariffs for fertilisers in the selected 52 countries, 2023

	HS Chapter 31		Average applied MFN tariff at 4-digit heading in Chapter 31				
Country1	Average applied MFN	Average bound tariff	HS 3101 Animal or vegetable fertilisers	HS 3102 Mineral or chemical, nitrogenous	HS 3103 Mineral or chemical, phosphatic	HS 3104 Mineral or chemical, potassic	HS 3105 Other (including compound fertilisers such as MAP and DAP)
China	9.6	9.7	4.5	9.1	4.0	3.0	15.5
India[2]	7.5	4.5	10.0	7.8	10.0	8.3	5.6
Belarus[3]	6.5	n.a.	6.5	6.5	6.5	6.5	6.5
Kazakhstan	6.3	6.4	6.5	6.3	6.5	5.4	6.5
Russia	6.3	6.4	6.5	6.3	6.5	5.4	6.5
Chile	6.0	25.0	6.0	6.0	6.0	6.0	6.0
Korea	5.9	6.5	6.5	6.3	6.5	2.2	6.5
Israel	5.5	10.7	4.0	4.4	8.0	4.0	6.6
Ukraine	5.0	6.5	5.0	5.1	5.0	3.6	5.4
Türkiye	4.8	11.5	0.0	6.5	3.2	0.0	5.9
European Union	4.6	4.6	0.0	6.1	3.2	0.0	5.7
Morocco	2.5	40.0	2.5	2.5	2.5	2.5	2.5
Argentina	2.4	15.0	4.0	1.6	4.0	1.0	3.2
Philippines	2.3	10.0	3.0	1.9	3.0	1.0	3.0
Indonesia	2.1	36.4	5.0	1.1	0.0	3.3	3.1
Viet Nam	1.7	6.2	0.0	1.0	5.0	0.0	2.0
Brazil	1.2	12.8	3.2	0.6	3.2	0.8	1.1
Pakistan	0.1	40.0	3.0	0.0	0.0	0.0	0.0
Switzerland	0.0	1.6	0.0	0.0	0.0	0.0	0.0
Australia	0.0	9.2	0.0	0.0	0.0	0.0	0.0
Canada	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Colombia	0.0	35.0	0.0	0.0	0.0	0.0	0.0
Costa Rica	0.0	42.9	0.0	0.0	0.0	0.0	0.0
Iceland	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Japan	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mexico	0.0	28.8	0.0	0.0	0.0	0.0	0.0
New Zealand	0.0	0.4	0.0	0.0	0.0	0.0	0.0
Norway	0.0	0.0	0.0	0.0	0.0	0.0	0.0
South Africa	0.0	9.8	0.0	0.0	0.0	0.0	0.0
United States	0.0	0.0	0.0	0.0	0.0	0.0	0.0

1. Countries are listed according to average applied MFN rate. Blue indicates countries classified in the “major 26” group. The remaining countries are in the “other 26” group.
2. Due to unbound tariff lines India's average bound rates are lower than the average applied rates.
3. Belarus is not a WTO Member. The tariff rates shown are those applying to imports from countries outside the Eurasian Economic Union
Source: WTO Secretariat (2024[45]).

4.1.2. Export restrictions

Several countries have imposed restrictions such as bans, quotas and duties on the export of fertilisers since 2021 (Table 4.3). Russia has imposed quantitative restrictions on the export of both nitrogen-based and compound fertilisers (Table 4.4). Originally introduced in late 2021 for six months, various extensions to the period of application have been announced. The latest export quota listed in this table remained in place until the end of May 2024. In addition, multiple adjustments to the export volumes allowed have been made, thereby complicating matters and destabilising markets through uncertainty. Exports to the Eurasian Economic Union, which comprises Armenia, Belarus, Kazakhstan, Kyrgyzstan, and Russia, are not subject to the quota restrictions.

Table 4.3. Imposition of export measures since 2021

Country	Bans	Quotas	Licensing / registration	Taxes/duties
China		✓	✓	
Türkiye			✓	
Russia	✓	✓	✓	✓
Ukraine	✓		✓	

Table 4.4. Export quotas imposed on fertilisers by Russia

Time period	Initial export restrictions in place[1]	Adjustments
1 December 2021 to 31 May 2022	Announced 3 November 2021 Export quota of 5.9 million tonnes for nitrogen fertilisers; and 5.35 on certain compound fertilisers	Announced 25 January 2022 Export quota of 280,000 tonnes for urea (3102.10) between 1 February and 31 May Announced 1 February 2022 Two-month export ban for ammonium nitrate fertilisers (3102.30) between 2 February and 1 April 28 March 2022 Export ban on ammonium nitrate extended for one-month to 1 May
1 July to 31 December 2022	Announced 31 May 2022 Export quota of 8.3 million tonnes for nitrogen fertilisers; and 5.9 million tonnes on certain compound fertilisers	Announced 28 November 2022 Export quota increased to 9.06 million tonnes for nitrogen fertilisers
1 January 2023 to 31 May 2023	Announced 23 December 2022 Export quotas of: 4.62 million tonnes for urea (3102.10), 1.25 million tonnes for 3102.80; 2.69 million tonnes for 3105.20 1.74 million tonnes for 3105.40 0.45 million tonnes for 3105.59 and 0.25 million tonnes for 3102.30 from 1 January to 31 March.	Announced 27 January 2023 Export quota increased to 0.6 million tonnes for 3102.30 from 27 January to 31 March. Export quota increased to 0.58 million tonnes for 3105.59 Announced 27 March 2023 Export quota increased to 0.667 million tonnes for 3102.30 between 27 and 31 March.
1 June 2023 to 30 November 2023	Announced 29 May 2023 Total export quota of 16.3 million tonnes, with the Ministry of Industry and Trade to distribute volumes among exporters.	23 November 2023 Total export quota of 16.95 million tonnes on mineral fertilisers (9.81 million tonnes for nitrogen fertilisers; and 7.14 million tonnes for multi-nutrient fertilisers) extended from 1 December 2023 until 31 May 2024

Export quota restrictions do not apply to non-Russian members of the Eurasian Economic Union: Armenia, Belarus, Kazakhstan, and Kyrgyzstan.
Source: Information gathered from Global Trade Alert (2023[46]).

According to official government announcements, the export quotas were introduced for the purpose of ensuring enough domestic supply of fertilisers and prevent food price inflation. While total Russian urea and potash exports were down between January-August 2022 compared to the same period in 2021, they recovered in the remaining part of the year (Hebebrand and Glauber, 2023[28]). While such measures may have lowered prices for Russian farmers, the restrictions – whether real or perceived – have in part contributed to increases in international prices. This has resulted in a huge increase in Russia's revenue from fertiliser exports. In the first ten months of 2022, the value of Russian fertiliser exports increased 70% to USD 16.7 billion compared to the same period in 2021 (Bounds, 2023[47]).

In addition to export quotas, Russia also introduced export taxes. On 30 November 2022, the government of Russia issued Decree No. 2188, imposing export duties on fertilisers. The export duty applied only to the goods with a customs value of exceeding USD 450 per tonne and was charged at a rate equal to 23.5% of the difference between fertilisers' customs value and USD 450. The export tax applied to the fertilisers classified under HS Codes 3101, 3102, 3103, 3104, and 3105. The intervention was temporary and lasted from 1 January 2023 to 31 December 2023.

In October 2021, various fertilisers including urea, ammonium chloride, DAP and various compound fertilisers were added to the list of category "B" goods subject to compulsory inspection upon export by Chinese authorities. The specifics of these inspections are unknown, and the restrictions imposed by China are opaque. Nevertheless, China's phosphate exports rose in the first half of 2021 before dropping off in November, after the requirement for inspection certificates was introduced. While no official information is available, reporting indicates that state-trading corporations were requested to lower fertiliser exports in the second half of 2021 and that an export quota of 3 million tonnes was imposed in the second half of 2022 on phosphate exports (Chow and Patton, 2022[48]). Fertiliser exports from China fell following the introduction of these restrictions (Hebebrand and Glauber, 2023[28]). For example, Chinese exports of DAP, which typically accounts for 30% of global DAP trade, fell by 43% in 2022 compared with 2022, with exports of urea from China declining by 47%. However, trade data for the first six months of 2023 show a 35% increase in the total volume of fertiliser exports from China (USDA FAS, 2023[49]), suggesting a relaxing of these restrictions.

Other countries to impose export restrictions include Ukraine and Türkiye. On 12 March 2022, Ukraine initially imposed an export ban on all mineral fertilisers (HS codes 3102, 3103, 3104 and 3105) until the end of 2022 because of concerns of domestic supply shortages in the context of the war. On 26 July 2022, the government announced that it would end the export ban on mineral fertilisers and introduce export licencing requirements instead. Export licensing for fertiliser exports came into force on 1 January 2023. On 12 October 2021, the Turkish government introduced export licensing requirements for fertilisers (HS codes 3101, 3102, 3103, 3104 and 3105) (Ministry of Trade of Türkiye, 2021[50]).

4.1.3. Support provided directly to farmers

Previous editions of the annual OECD Agricultural Policy Monitoring and Evaluation reports (OECD, 2023[9]) and related country-level Producer Support Estimates (PSE) (OECD, 2022[10]) were reviewed for policies that provided support to fertiliser use. Policy measures were identified using a word search of both the individual country PSE spreadsheets and associated "cookbooks", supplemented by scans of the annual monitoring reports and specific country reviews. The review focused on policies listed within the PSE and not the General Services Support Estimate (GSSE) category of the database. It included

27 countries and the EU for which country-level PSEs are calculated, consisting of 17 OECD members[16] and 11 others,[17] and covered the period 2000 to 2022.[18]

Over 20 policies were found to provide support to producers for fertiliser use (Table 4.5). These ranged from specific fertiliser subsidy measures through to broader concessional interest rate credit programmes which allowed farmers to purchase fertilisers among other farm inputs. In these latter cases, a proportion of the support was allocated to fertilisers. This allocation was based on various sources, including specific programme reviews, where found, or farm budget information. These were then converted to USD as a common currency unit to allow comparison.

Table 4.5. Policy measures supporting fertiliser use within the OECD PSE database, 2000-2022

Country	Name of policy measure/programme as listed within (OECD, 2023[9])	Direct support or preferential credit	Attribution to fertiliser
Countries within the Major 26 grouping in the PSE database[1]			
Argentina	FINAGRO and FONDAGRO	Preferential credit	25%
Australia	Drought assistance programmes (various iterations)	Preferential credit	10%
Brazil	Preferential interest subsidy on working capital loans	Preferential credit	35%
Canada	Advance Payments Program	Preferential credit	10%
China	Input subsidy programme (until 2007), Agricultural input comprehensive subsidies (2006-2014), Agricultural Production Development (2015 onwards) [NB just the input support component of this programme, not the per ha component]	Direct support	30%
European Union[2]	Credit payments for the purchase of variable inputs	Preferential credit	25%
India	Fertiliser Subsidy and Lime Gypsum and Micro-Nutrients (National Food Security Mission)	Direct supporting	100%
Indonesia	Fertilizers	Direct support	100%
Israel	No policy measures supporting fertiliser use in PSE database		
Mexico	PROAGRO (2013-18) Fertiliser Programme (since 2019)	Directly supporting	100%
Norway	No policy measures supporting fertiliser use in PSE database		
Russia	Interest subsidy on short-term loans for crop production, Compensation of production costs to producers affected by natural disasters	Preferential credit	25%
Türkiye	Fertiliser subsidy and Fertiliser payment	Directly supporting	100%
Ukraine	Fertiliser subsidy, Disaster relief payments, Input subsidy based on "VAT accumulation" and Seed Subsidy	Directly supporting	10%
United Kingdom	No policy measures supporting fertiliser use in PSE database		
United States	No policy measures supporting fertiliser use in PSE database		
Viet Nam	Input subsidies within Program 135 (to support development of poor communes in remote and mountainous areas)	Directly supporting	25%
Countries within the Other 26 grouping in the PSE database[3]			
Chile	Soil Recovery Program	Direct support	25%
Colombia	Agricultural financing (until 2010), Rural Capitalization Incentive (2013-2018), Implicit subsidy through credit programmes of FINAGRO (whole period) and Implementation of strategies for financial inclusion in the national agricultural sector (2019 onwards); Improvement of soil fertility and recovery of degraded soils (1996-2009)	Preferential credit	25%

[16] The European Union (EU) is treated as one country for the purpose of indicator calculations, given the common policy for agriculture applied throughout the Union, and specifically: the EU12 for 1986-94 including ex GDR from 1990; EU15 for 1995-2003; and EU25 for 2004-06 and EU27 from 2007 onwards.

[17] The most recent versions of the report do not contain a country chapter on the Russian Federation, nor any tables with support indicators in the Statistical Annex. However, aggregate data for the 11 emerging economies and for all 54 countries covered in this report continue to include those for Russia.

[18] Of the 52 countries included in this report three are not covered by the OECD PSE database: Belarus, Morocco and Pakistan.

Country	Name of policy measure/programme as listed within (OECD, 2023[9])	Direct support or preferential credit	Attribution to fertiliser
Costa Rica	Development Banking System - credits to agriculture, and Rural Credit provided by INDER	Preferential credit	25%
Iceland	No policy measures supporting fertiliser use in PSE database		
Japan	Support for soaring fertilizer prices	Directly supporting	100%
Kazakhstan	Mineral fertilizer and chemicals subsidy (national budget then sub-national)	Direct support	75%
Korea	Payments to fertiliser use	Directly supporting	100%
New Zealand	No policy measures supporting fertiliser use in PSE database		
Philippines	Production Support Services for national programmes for Rice, Maize and High Value Crops	Directly supporting	25%
South Africa	No policy measures supporting fertiliser use in PSE database		
Switzerland	No policy measures supporting fertiliser use in PSE database		

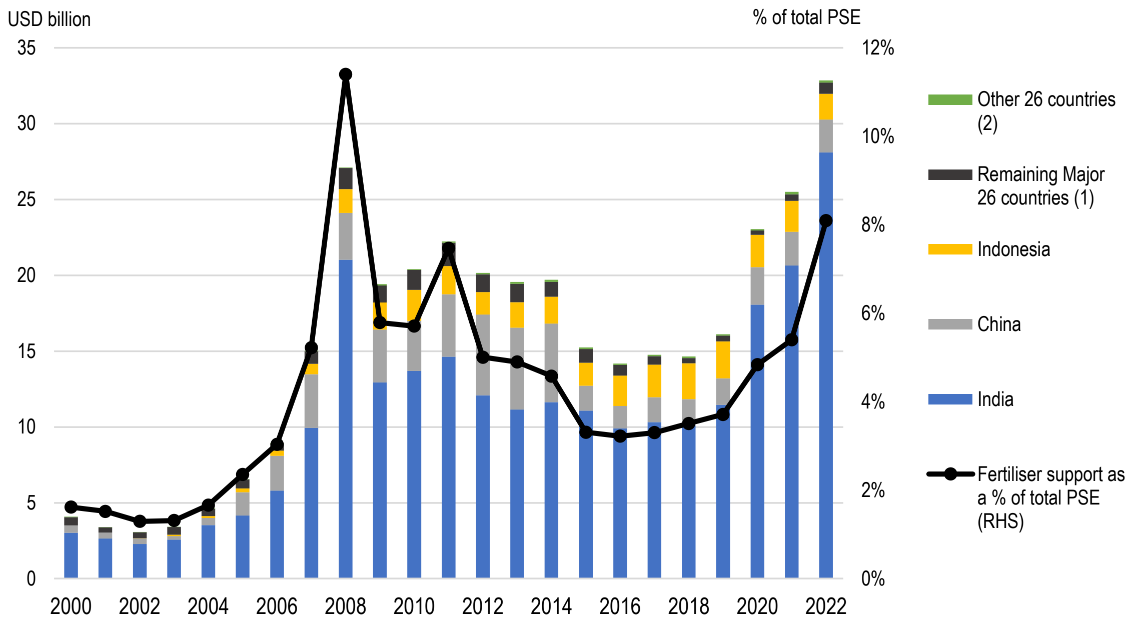
1. There are three countries in the Major 26 grouping for which PSEs are not calculated: Belarus, Morocco and Pakistan. The other seven countries (Belgium, France, Germany, Lithuania, the Netherlands, Poland and Spain) are EU Member states.
2. Only a single European Union value is provided. The EU cookbook indicates that this support includes Poland and Germany (Major 26 countries) plus others in the Other 26 grouping. The total value of fertiliser support for the EU is included within the Major 26 category.
3. The other 15 countries in the Other 26 grouping not listed are all EU Member states.
Source: OECD (2022[10]).

In 2020-2022, the average annual total value of support to agricultural producers for fertiliser use in the 27 countries and the European Union reviewed is estimated to be USD 27.1 billion (Figure 4.1). This is equivalent to 6% of the total value of producer support for the 27 countries and the EU and 9% of total budgetary support. The current level of support is almost double than during the period 2015-19 when it averaged around USD 15 billion per year and represented around 3% of support to producers. And it is significantly higher than twenty years ago when it represented less than 2% of producer support. The current monetary value of fertiliser support to producers is close to that provided in 2008, but at that time it represented almost 12% of total producer support (11% of budgetary support). Fertiliser subsidies to farmers were used to help farmers through the last period of high fertiliser prices during the GFC. They are also being used to assist farmers get through the current period.

The value of support to agricultural producers for fertiliser use is dominated by India.[19] Over the three-year period 2020-22, the annual average value of fertiliser subsidies provided by the government of India totalled more than USD 22 billion, equivalent to 82% of the total estimated value. Changes in the value of fertiliser subsidies in India explain the annual variations seen in the total. Spending has risen rapidly from USD 10 billion in 2018 to USD 28 billion in 2022. China and Indonesia are the other two countries that make a significant contribution to the total. During 2020-2022 both countries provided around USD 2 billion in support to producers for fertiliser use, equivalent to about 8% of the total each. The remaining 23 countries in the major 26 group, including Türkiye, Brazil and Mexico accounted for around 2% of the total. Support for fertiliser use by the other 26 group accounted for less than 1% of the total, around USD 135 million. Almost 35% of this total is provided to farmers in Kazakhstan.

[19] More information about fertiliser subsidies in India, China and Indonesia (and other countries) can be found in OECD (2023[9]).

Figure 4.1. Producer support for agricultural fertiliser use in selected countries, 2000-2022



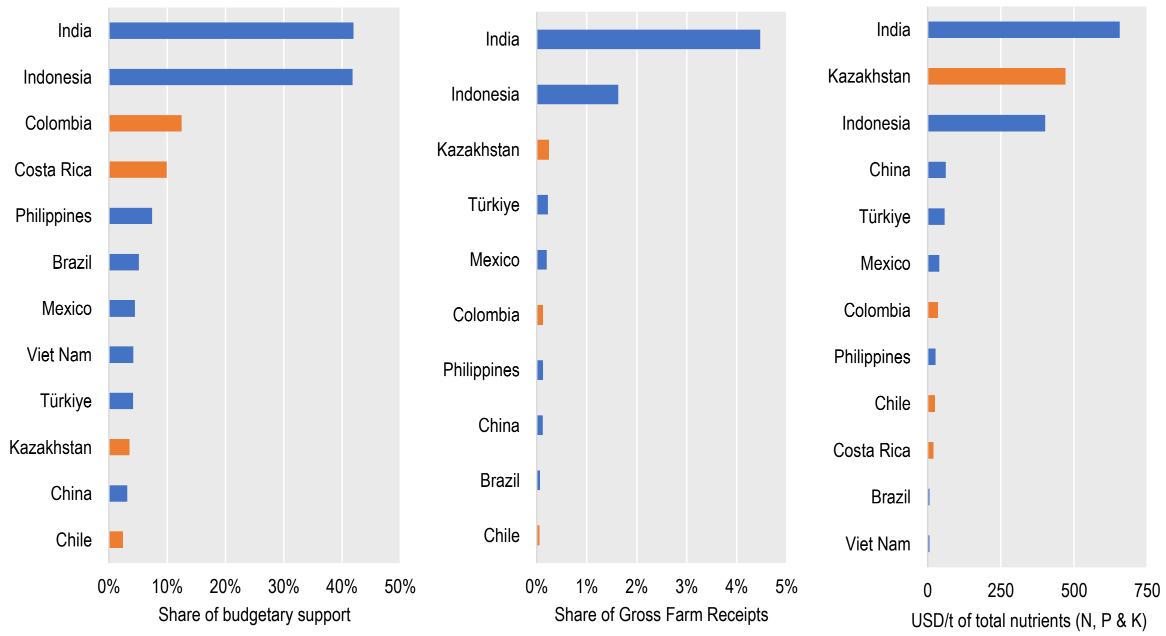
1. The group "Remaining Major 26 countries" consist of 20 countries, being the Major 26 countries less India, China and Indonesia which are separately identified, and Belarus, Morocco and Pakistan, for which PSEs are not calculated.
2. The "Other 26 countries" represent the sum of support provided in the 11 countries listed in Table 4.5.
Source: OECD (2022[10]).

The relative importance of support provided to producer support for fertiliser use, measured in relation to total budgetary support to producers, gross farm receipts[20] and per tonne of mineral fertiliser nutrient content used varies between countries (Figure 4.2). Fertiliser subsidies are by far the most important policy measure through which the governments of India and Indonesia support their agricultural producers. The value of fertiliser support in both countries represents more than 40% of total budgetary transfers in 2020-2022. Although not large in monetary terms, financial support provided to agricultural producers for fertiliser use represents around 10% of total budgetary transfers in Colombia and Costa Rica. In terms of its relative importance for agricultural producers, the value of fertiliser support is most significant in India. The value of fertiliser support provided by the Indian government represents almost 4.5% of gross farm receipts in 2020-2022. In Indonesia, it is just over 1.5%. While China is one of largest providers of support for fertiliser use by farmers in absolute terms, this amount is not large in relation to total budgetary support or gross farm receipts. In many cases, the countries that provide a relatively large share of their producer support for fertiliser use are developing countries with many poor farmers.

In relation to its impact on fertiliser markets, the value of fertiliser support is likely to be strongest in India, Kazakhstan, and Indonesia. In Indonesia, for example, the value of fertiliser subsidies is equivalent to about USD 400 per tonne of total nutrients (N, P and K) applied. In Kazakhstan it is around USD 470 per tonne and over USD 650 per tonne in India. China (USD 62/tonne) and Türkiye (at USD 58/tonne) are the next highest. The value of support to producers for fertiliser use in the Latin American countries of Colombia, Mexico, Chile and Costa Rica all fall in the range of USD 20-40 per tonne.

[20] Gross farm receipts are the sum of the value of commodity production and budgetary transfers.

Figure 4.2. Support for agricultural fertiliser use in selected countries as a share of budgetary support, gross farm receipts and per tonne of nutrients applied, 2020-2022



Note: Blue indicates countries classified in the major 26 group. Orange indicates countries classified in the other 26 group.
Source: OECD (2022[10]) and FAO (2024[11]).

Two fertiliser subsidy schemes operate in India, one for urea (the main form in which nitrogen is applied by Indian farmers), and one for phosphorus and potassium-based fertilisers (Government of India, 2023[51]). For urea, the government sets a Maximum Retail Price (MRP) and pays manufacturers the necessary subsidy to achieve this. The current MRP has remained fixed at INR 242 (USD 3) per 45 kg bag and INR 268 (USD 3.4) per 50 kg bag since March 2018, and will remain at this level until March 2025. In mid-2023 the actual cost of a 45 kg bag was around INR 2200 (USD 28), almost ten times higher (Government of India, 2023[52]). For phosphorous and potassium-based fertilisers, the government sets Nutrient Based Subsidy (NBS) rates that are paid to manufacturers, who are expected to pass the subsidy on to farmers. Since 2021, NBS rates for phosphorus have increased by more than 300% while rates for potassium have increased by just 150%. As a result, the application of potassium by Indian farmers has contracted significantly more than for phosphorus and nitrogen (Cross and Gruère, 2023[2]). A recent OECD scenario report explores the implications of eliminating fertiliser support in India on both fertilisers and commodities markets, within and outside India (Box 2).

Box 2. Scenario analysis on the interconnected dynamics of fertiliser and agricultural markets

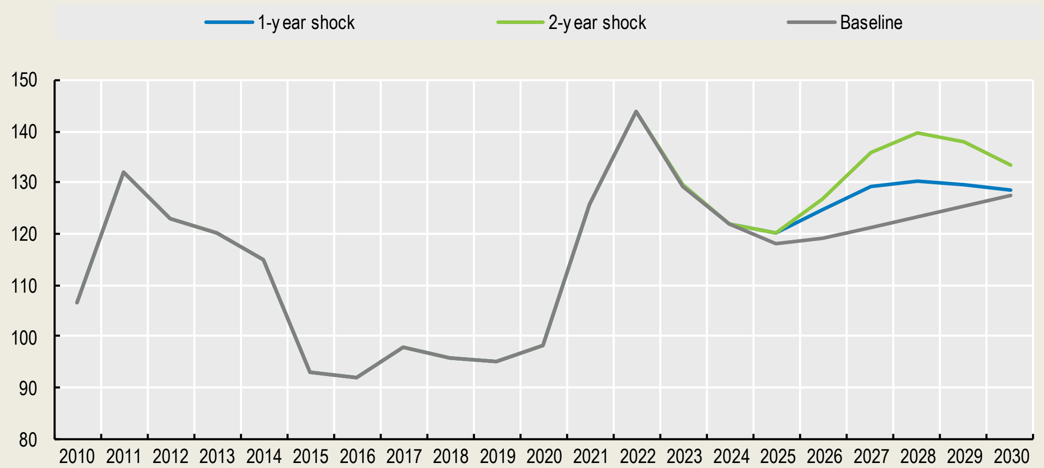
Given their far-reaching impacts on food systems, economic stability and the environment, fertiliser markets are extensively regulated. Using the Aglink-Cosimo partial equilibrium model, a recent OECD report sheds light on the complex relationships between fertiliser, policies, and their repercussions on agricultural markets, food security, and environmental sustainability over the medium term (Adenäuer, Laget and Cluff, 2024[53]). This report presents two separate scenario analyses:

- A first scenario examining potential response to a 20% reduction of N, P, and K fertilisers supply.
- A second scenario looking at a hypothetical elimination of fertiliser support in India.

Modelling the impact of supply shortages of fertilisers

Supply shortages of fertilisers are a major concern for many countries not only since the war between Russia and Ukraine started, but also due to the broader geopolitical uncertainties affecting global trade and commodity markets. The results of the supply shortage scenario indicate that the existence of stocks somewhat mitigates the negative short-term impacts on yields However, prolonged shortages can have lasting adverse effects on the agricultural sector. Even modest reductions in yields would result in significant production shortfall driving up food prices. Figure 1 shows that in a scenario where all three fertilisers are simultaneously affected within a single year (blue line), the FAO food price index could rise by as much as 6% between 2025 and 2028. In contrast, a scenario involving two consecutive shocks (green line) would lead to a more pronounced increase, pushing prices up to 13% over the same period.

Figure 1. FAO food price index



Source: Aglink-Cosimo simulations.

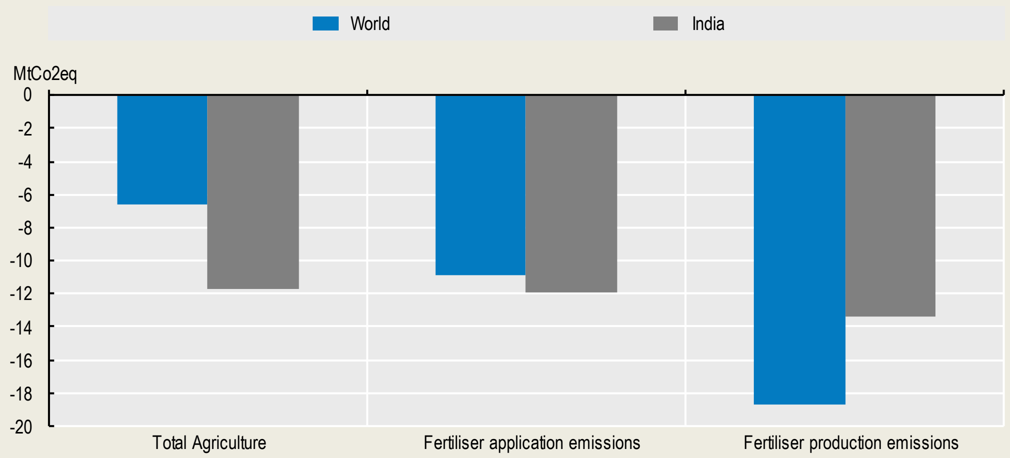
Modelling the impact of eliminating fertiliser support in India

According to the latest Agricultural Policy Monitoring and Evaluation (OECD, 2023[54]), the consistent increase in total support directed to agriculture over the past 20 years has been driven by emerging economies (accounting for 58% of the current USD 851 billion total support per year) – with India accounting for 15%.

The second scenario analysis shows that eliminating fertiliser support in India prompts a rapid reduction in domestic fertiliser use, which leads to a decrease in agricultural production and exports, while simultaneously causing an increase in imports. The decline in nitrogen prices and rise in rice prices, influenced by India's substantial role as both a nitrogen user and rice supplier, have only a modest impact on global food prices and minor adverse impacts on food security worldwide.

Results suggest that global agricultural greenhouse gas emissions would decrease by a notable 7 million tonnes of CO2 equivalent (Figure 2), due to the substantial reduction in fertiliser application in India and the moderated increase in fertiliser use elsewhere. This highlights the crucial link between domestic policies and global environmental sustainability goals.

Figure 2. Change of emissions in Scenario vs Baseline (2030)



These scenario analyses underscore the significant and wide-ranging consequences of fertilisers for agricultural markets, highlighting the crucial role of domestic policies in upholding the resilient and sustainability of agricultural ecosystems.

Source: Adenäuer, Laget and Cluff (2024[53]).

The current fertiliser subsidy scheme in Indonesia has been in place since 2003 (OECD, 2012[55]). The subsidy is paid directly to five state-owned fertiliser manufacturers, who are required to sell the subsidised fertiliser products at a Highest Retail Price (HET)[21] to around 16 million farmers who are registered in the RDKK[22]. HETs are set each year by the government. In response to the recent crisis and rising costs, the government changed three parameters of the scheme in 2022 (Rafani and Sudaryanto, 2023[56]). First, it reduced the range of fertiliser products covered: from urea, ZA, SP36, NPK and organic, to only urea and NPK (including NPK special formula). Second, it decreased the number of commodities that farmers could use subsidised fertilisers to produce from 70 to just nine: rice, corn, soybean, chili, onion, garlic, coffee, sugar cane and cocoa. These nine are considered strategic in terms of minimising inflationary pressures. Finally, it increased the HETs. For example, the HET for urea was raised 25% from IDR 1 800 (USD 0.12) per kg to IDR 2,250 (USD 0.15) per kg.

Between 2006 and 2014, China provided an agricultural input payment to farmers, paid per hectare but with the rate of subsidy calculated based on input prices of materials like diesel oil and fertilisers (OECD, 2018[57]). It was introduced in response to the sharp rise in input costs during the mid-2000s. In 2016, this payment was merged with two other payments into the “support and protection payment” programme. This has two components: a per hectare “farmland quality subsidy” to protect arable land fertility and preserve grain production capacity, and a “moderate-scale operation subsidy,” to encourage operators to enlarge their operations and adopt new technology (Fan et al., 2023[58]). While no longer directly linked to fertiliser use, input prices are considered by the Chinese government in determining the level of support provided through the agricultural production development programme (People's Republic of China, 2022[59]). China announced three additional tranches of support during 2022 to help compensate producers for the increasing costs of agricultural inputs: CNY 20 billion (USD 3 billion) in March 2022; CNY 10 billion (USD 1.5 billion) in May 2022; and CNY 10 billion (USD 1.5 billion) in August 2022.

[21] *Harga Eceran Tertinggi* (HET).

[22] *Rencana Definitif Kebutuhan Kelompok* (RDKK) is a definitive plan needs group of farmers set up in each village to establishes local fertiliser requirements.

One-off payments of support have also been provided to farmers in the EU in response to rising input costs. On 23 March 2022, the European Commission adopted a Temporary Crisis Framework (TCF) to enable Member States to grant state aid out to 31 December 2022 in the context of Russia's invasion of Ukraine (European Commission, 2022[60]).[23] The TCF was superseded on 9 March 2023 by the Temporary Crisis Transition Framework (TCTF) which extended the allowable timeframe for the provision of state aid measures until 31 December 2023.[24] On 20 November 2023, the European Commission amended the TCTF and adopted a limited prolongation of certain sections of the framework until 30 June 2024 (European Commission, 2023[61]).

In total more than 200 crisis measures have been approved (European Commission, 2023[62]). Almost all EU member states have introduced at least one state aid grant scheme that provides payments to agricultural producers to compensate them for higher input costs in general, with combinations of animal feed, electricity, fertilisers, fuel and gas being mentioned. At least five measures have been introduced for the purpose of compensating farmers for higher fertiliser prices specifically (Table 4.6).

Table 4.6. EU Member states providing state aid for the purpose of compensating farmers for higher fertiliser prices

Country	Date	Total value of support (EUR million)	Link to fertilisers
Poland	April 2022	836	Co-finance the purchase of mineral fertilisers brought in the period from 1 September 2021 to 15 May 2022 through a per hectare payment rate
Spain	December 2022	300	Per hectare payment to compensate farmers for the increase in fertiliser prices
Greece	December 2022	60	The aid will be equal to 10.95% of the total value of the purchase of fertilisers made by each beneficiary in the period from 1 October 2021 to 30 September 2022 (growing season)
Slovenia	July 2022	15	The purpose of the scheme is to cover part of the additional costs that the eligible beneficiaries incurred due to the price increase of fertilisers
France	August 2023	10	Direct grants for small and medium-sized enterprises active in the primary agricultural production of fruits and vegetables located in the French outermost regions and departments (French Guyana, Guadeloupe, La Reunion, Martinique and Mayotte) and Saint-Martin, that registered purchases of fertilisers and soil conditioners used for their production of fruit and vegetables during 2022 and are affected by the current crisis (the 'beneficiaries'). The estimated number of beneficiaries is around 10 000.

Source: European Commission (2023[62]), European Commission (2023[63])

4.1.4. Other measures to support fertiliser use by farmers

Governments have also implemented policy measures that are not directly received by farmers but have been introduced for the purpose of supporting mineral fertiliser use. A few governments have taken steps to improve information available to farmers regarding fertiliser prices. Online market price information systems for fertilisers have been initiated by the European Union, the United Kingdom and Colombia. The Swedish project *Greppa näringen* (Focus on Nutrients) provides, *inter alia*, advice to farmers to reduce

[23] Specifically, the TCF enabled Member States to (i) grant limited amounts of aid to companies (including farmers) affected by the current crisis or by the related sanctions and countersanctions; (ii) ensure that sufficient liquidity remains available to businesses; and (iii) compensate companies for the additional costs incurred due to exceptionally high gas and electricity prices.

[24] The TCTF added a fourth and added a fourth purpose for granting crisis support: (iv) incentivise additional reduction of electricity consumption. The "Transition" aspect allows Member States to grant certain forms of state aid until 31 December 2025 to foster the transition to a net-zero economy. As of 16 September 2023, six transition measures had been approved (European Commission, 2023[62]).

losses of nutrients to air and water from livestock and crop production and on the safe use of crop protection products.

Some countries have used existing or introduced new public stockholding measures to increase the quantity of mineral fertiliser product available to farmers.

- China: Released 1 million tonnes of national potash fertiliser reserves in March 2023 to meet production needs during this year's spring farming period.
- Switzerland: On 20 December 2021, the Federal Department of Economic Affairs, Education and Research (EAER) released 20% of its total strategic reserve of 17 000 tonnes of nitrogen fertilisers (which is about one-third of annual use).
- Japan: In December 2022, following the government's designation of fertiliser as one of the eleven "specified important goods" in the Enforcement Order of the Economic Security Promotion Act, MAFF established a contingency reserve system for imported ammonium phosphate and potassium chloride. The target is to store by 2027 an amount equivalent to three months demand for ammonium phosphate and potassium chloride. Payments will be made to fertiliser manufacturers and importers to cover storage costs.
- Greece: Established a registry for food and farming supplies, including fertiliser, so that the government understands key supply levels.

Several countries took steps to improve the security of import supply though bilateral diplomacy. For example, a memorandum of agreement was signed in November 2022 between the Philippines Department of Agriculture (DA) and the Philippine International Trading Corporation (PITC) to import fertiliser at low cost through government-to-government arrangements including with China and Russia. A total of PHP 4.1 billion (USD 74 million) was allocated, enabling the purchase of about 2.3 million bags of urea to be given in-kind to farmers.

4.2. Policies assisting domestic production of mineral fertilisers

The PSE database focuses on measures that directly support farmers. Several countries provide support to producers of mineral fertilisers. When these benefits are not designed to be passed on to farmers, they are not included in the PSE. For example, the government of Viet Nam encourages domestic fertiliser production through subsidised prices for natural gas, electricity and coal, all fixed by the government and made available to the large state-owned chemical companies, including the PetroVietnam Group (PVN) and the Vietnam National Chemical Group3 (Vinachem) and their subsidiaries. Analysis indicates that the subsidies are not passed on to farmers in the form of lower domestic prices which are slightly higher than the import price (Thang, 2014[64]).

Russia's fertiliser makers have in general benefited from the rising global energy prices, since their gas prices are fixed by the government. On 15 November 2021, VEB.RF, the state-owned Russian development bank, announced the disbursement of a RUB 15.2 billion (USD 209 million) syndicated loan to Kuibyshevazot. The loan will finance a new nitric acid and ammonium nitrate solution production facility. Nitric acid and ammonium nitrate solution are inputs in the company's final products, which are mainly ammonia and nitrogen fertilisers, and industrial gases, including nitrogen.

In September 2022, the new FPEP, a temporary program, was announced to increase American-made fertiliser production in response to rising prices. FPEP will provide grants to help eligible applicants increase or expand the manufacturing and processing of fertiliser and nutrient alternatives in the United States and its territories. In 2022, the US Department of Agriculture (USDA) made available USD 500 million under the FPEP to spur domestic competition and combat rising fertiliser costs caused by the war in Ukraine. The USDA received applications from more than 350 businesses seeking to increase fertiliser production. In October 2023, the USDA announced an additional, up to, USD 400 million in additional

FPEP funding to finance even more projects that will promote competition in agricultural markets. During the first 18 months of the FPEP, the USDA has awarded 33 projects for a total of over USD 121 million invested[25].

Since 2018, the Indian government has supported the establishment or revival of six urea production facilities. Consequently, domestic urea production capacity has increased from 22.5 million tonnes in 2014/15 to 28.4 million tonnes in 2022/23. The construction of a further eight Nano liquid urea plants, with a combined production capacity of 19.5 million tonnes in conventional urea terms, is being supported by the government. The aim is to make India self-sufficient by 2025/26 (Government of India, 2023[52]).

The government of Brazil is planning several steps to increase domestic fertiliser production as part of its National Fertilizer Plan (USDA FAS, 2022[65]). To increase production of phosphorus and potassium fertilisers it envisions at least five auctions of mining areas for each nutrient by 2030. It will also be seeking to attract at least two more nitrogen fertiliser producers to Brazil by 2030 and another four by 2050. As an immediate step, Brazil reduced tariffs on sulphuric acid from 3.6% to 0% (USDA FAS, 2022[66]).

Fertiliser manufacturers in the European Union are likely to have benefited from state aid support provided under the TCF and TCTF described above. These will have included direct grants, concessional loans and tax reductions. For example, a EUR 5 billion scheme was approved to provide direct grants for the additional natural gas and electricity prices paid by French energy intensive companies[26]. Unfortunately, analysis has not been done on the extent of support provided to fertiliser manufacturers through these measures.

Ongoing OECD work measures the support that governments provide to top companies in 15 key industrial sectors (OECD, 2023[67]). This notably includes the production of fertilisers, with detailed information collected for about 30 globally significant producers of fertilisers over the period 2005-22. A first version of the database (known as the OECD MAGIC database) is expected to be launched in the second half of 2024, together with quantitative analyses of the scope, scale, and market impacts of industrial subsidies. Related work has examined the energy subsidies obtained by an illustrative sample of energy-intensive businesses, which include some producers of fertilisers (OECD, 2023[68]).

4.3. Policies encouraging organic fertiliser use by farmers or production

Many policy measures have been implemented over several decades to support the development of organic farming (OECD, 2003[69]). The focus of this brief survey is on recent policy measures that specifically target organic fertiliser use by farmers or support its production.

Japan has introduced several such measures in 2022. Support payments will be provided to farmers that cover up to 70% of the increased cost that they incur by adopting practices that reduce mineral fertiliser use by 20%. Approved practices include the use of livestock manure and sewage sludge compost, cover cropping, and mineral fertiliser application based on soil analysis. It has also introduced a subsidy scheme to partially cover the capital costs incurred by livestock farmers and compost manufacturers in building facilities for the manufacture and palletization of compost. A total budget of approximately JPY 90 billion has been allocated for this. It has also begun research on the use of sewage treatment sledge as alternative to nitrogen fertilisers.

[25] The full list of awards can be consulted at https://www.rd.usda.gov/media/file/download/usda-rd-fpep-chart-10162023.pdf.

[26] See https://www.economie.gouv.fr/hausse-prix-energie-dispositifs-aide-entreprises.

Several EU Member States are implementing support measures using the Eco-schemes element of the new Common Agricultural Policy (CAP) (European Commission, 2023[70]).[27] For example, Portugal, in its CAP Strategic Plan (CSP), has set up an eco-scheme with the objective of replacing synthetic fertilisers by organic ones, using livestock effluents (manure and slurry), or other organic fertilisers. The beneficiary must ensure more than 25% organic fertilisation, considering the specific crop needs for nitrogen and phosphorus based on a nutrient management plan. Bulgaria, Croatia, Cyprus[28], Greece and Slovenia also plan to promote organic fertilisers as an alternative to synthetic ones, that in some cases includes adaptation of the use of fertilisers to the crops' needs based on a fertilisation plan.

Another way in which mineral fertilisers can be replaced by organic processes is by growing nitrogen-fixing crops that do not require nitrogen fertilisers. Canada, the world's second largest producer of pulses, has reduced the need for external nitrogen input through the expansion of pulse acreage and the use in crop rotations over the past two decades. Twelve EU Member States are increasing the financial contribution to coupled support for protein crops and legumes in their CSP.[29] Four are introducing new coupled support for these crops: Belgium-Walloon, Estonia, Portugal, Slovenia. The support area is expected to grow from 4.2 million hectares in 2022 to almost 7.1 million hectares in 2027 (European Commission, 2023[70]).

Several EU Member States provide support to assist farmers with the capital costs associated with using organic fertilisers. For example, Germany provides funding to allow farmers expand their storage capacity for organic fertiliser and purchase machinery for its precision application. Finland is also providing aid for investments in recycled nutrients. Under its Low Carbon Agricultural Programme (ABC Programme), Brazil has created a credit line to support the construction of facilities for bio-fertiliser production units. Under the temporary FPEP (see also Sections 3.2 and 4.2), the United States also funded organic fertiliser proposals.

In June 2023, the Indian government approved a new subsidy measure to promote organic fertiliser application (Government of India, 2023[71]). A Market Development Assistance subsidy of IDR 1,500 (USD 18) per tonne will be paid to support the marketing of organic fertiliser produced as a by-product from biogas plants operating under the Galvanizing Organic Bio-Agro Resources Dhan (GOBAR-Dhan) scheme. This subsidy will be provided over a three-year period beginning 1 April 2023, with a total budget of IDR 14.51 billion (USD 174 million). The aim of the GOBAR-Dhan initiative is to support villages effectively manage their cattle and biodegradable waste, improving village cleanliness and generating wealth and energy from waste. It was launched in April 2018 and is being pursued as a national programme priority. At the beginning of 2023, just over 500 biogas plants are functioning under the scheme, with the plan to double that number.

The Philippines is placing emphasis on research and education to encourage farmers to use organic fertilisers in place of mineral fertilisers. The Department of Agriculture has been conducting research to show that combinations of organic fertilisers and/or bio-stimulants with mineral fertilisers can result in high yields and lower costs. It has also been promoting farmers to use of "Bio N," a microbial-based fertiliser developed in the 1980s in the Philippines that can replace 30-50% of crop nitrogen requirements.

---

[27] Eco-schemes are a new tool of the CAP. They will either support 'new' (i.e., not previously applied) environment- and climate-friendly practices on Member States' farmland, or increase the area on which such practices are applied, or both.

[28] Note by the Republic of Türkiye: The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Türkiye recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Türkiye shall preserve its position concerning the "Cyprus issue".

Note by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Türkiye. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

[29] Bulgaria, Estonia, France, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Portugal, Slovakia and Spain.

4.4. Other policies reducing mineral fertiliser use by farmers

Other policy measures that decrease mineral fertiliser use by farmers can be arranged into three broad categories: regulations, knowledge generation and transfer, and cross-compliance measures.

4.4.1. Regulations

There are a wide range of regulations that directly limit mineral fertiliser use. These can impose limits on the quantity, timing and location of where fertiliser can be applied. For example, New Zealand has recently introduced a cap on the nitrogen content of mineral fertilisers used on pastoral land (MFE, 2023[72]). The Resource Management (National Environmental Standards for Freshwater) Regulations 2020 implement part of the Government's Essential Freshwater reform and set requirements for activities posing risks to freshwater and freshwater ecosystems. The regulations, which came into effect on 1 July 2021, apply to pastoral land of 20 ha or more and put a synthetic nitrogen fertiliser cap of 190kgN/ha/year. Anything above this level requires a resource consent. While all affected farmers need to record or retain evidence of fertiliser use, dairy farmers are required to provide a report by the end of July each year.

In the EU, the Good Agricultural and Environmental Conditions (GAEC) standards require the establishment of buffer strips along watercourses to 'protect river courses against pollution and run-off'. A 'buffer strip' is an area where fertilisers and plant protection products cannot be applied and must be three metres wide or more. Member States define this bottom width and may add other criteria. In their CSPs, 19 Member States set a minimum width of three metres, while nine Plans set a minimum width of more than three metres, e.g. five, six or up to ten metres (European Commission, 2023[70]).

Some European countries have gone further than these standards. For example, revisions to the German Fertiliser Application Ordinance in both 2017 and 2020 imposed stricter rules for nitrogen application. Since February 2020, farmers have not been permitted to apply urea without combining it with urease inhibitor or incorporating it into the soil within four hours (Cross and Gruère, 2023[2]). These stricter requirements are a factor behind the 27% fall in the application of nitrogen in mineral fertilisers in Germany between 2008-10 and 2018-20 (Figure 2.6).

Farmers can be compensated for some of these restrictions. For example, the restrictions eligible for compensation by the Water Framework Directive (WFD) payments include restrictions on fertilisation and the use of pesticides (often in drinking water protection areas). Five CSPs include WFD payments (Austria, Denmark, Spain, Italy and Lithuania). The premia range from EUR 50 per hectare - e.g. for respecting fertiliser limits on arable land, as well as a shortened application periods of nitrogen fertilisers, and extended recording obligations - to EUR 1,478 per hectare for more important restrictions. The support under this instrument ranges from 0.2% to 9.4% of rural development funds (EAFRD and national co-financing). The Commission recommended Member States to make more use of this tool for environmental protection but representing around 1% of total public rural development expenditure at EU level, it remains rather underutilised. (European Commission, 2023[70]).

4.4.2. Knowledge generation and transfer

A range of policy measures decreasing mineral fertiliser use by farmers can be classified under the "Agricultural knowledge and innovation system" category of the PSE/GSSE system (OECD, 2016[73]). This category is further broken into two sub-categories: Agricultural knowledge generation (budgetary transfers for research and development) and Agricultural knowledge transfer (budgetary transfers for vocational schools, generic training and advice to farmers, data collection and information dissemination). It is not possible within the PSE database to specifically identify government expenditure relating to mineral fertilisers through this category on a consistent basis across all countries. There are some examples highlighted in OECD reviews that indicate the existence of such support measures. For example, a review of agricultural policies in Costa Rica noted that the *Universidad Estatal a Distancia* (UNED) conducts adaptation-related projects, frequently in co-ordination with Ministry of Agriculture and Livestock on efficient fertiliser application (OECD, 2017[74]).

Since 2021, many countries have announced specific new programmes to improve the efficiency of mineral fertiliser use. In terms of Agricultural knowledge generation, the most significant is the Global Fertilizer Challenge launched by President Biden in June 2022 (The White House, 2022[75]). The Challenge seeks to strengthen food security and reduce agricultural emissions by advancing fertiliser efficiency and alternatives in low-and middle-income countries. In March 2023, it was announced at COP27 that USD 135 million in funding had been raised.

New digital tools have been announced to assist farmers with nutrient management decisions, including mineral fertiliser application. In the European Union, the digital platform is called FaST. It will combine existing data with manual input from farmers to provide customised recommendations on crop fertilisation through a nutrient management plan. The target is to make FaST available from 2024 at the latest. A similarly named tool called FRST has been initiated in the United States. The aim of FRST is to bring clarity and consistency to fertiliser recommendations for farmers, researchers, agronomists, and private laboratories.

Alongside FRST, the United States launched in August 2022 the Nutrient Management Economic Benefits Outreach Campaign. Staff from the Natural Resources Conservation Service, USDA, will develop nutrient management plans to help producers use nutrient resources effectively and efficiently to adequately supply soils and plants with necessary nutrients while minimizing transport of nutrients to ground and surface waters. A key driver for this campaign is the estimate that too much nitrogen is being applied to 28% of cropland, costing farmers a total of USD 2.6 billion.

The Mexican Ministry of Agriculture has also embarked on a new training programme. Announced in July 2022, Mexican farmers will be trained on the correct use and dosage of fertilisers, and on the use of organic fertilisers. Canada has also recently introduced a suite of climate programs that aim to support the development and adoption of beneficial management practices (BMPs) and technologies that store carbon, reduce greenhouse gases, and enhance climate resiliency. These include the Agricultural Climate Solutions – On-Farm Climate Action Fund, the Agricultural Climate Solutions – Living Labs, and the Agricultural Clean Technology program. Introduced for the purpose of reducing greenhouse gas emissions, these programs include support for the development and adoption of BMPs and technologies that may reduce fertiliser application rates. This includes support for farmers in developing and adopting farm-specific nutrient management plans and other best management practices or technologies that reduce the potential for nitrogen losses to the environment. Additionally, Canada invests in pre-commercial science and research to accelerate the pace of innovation through the AgriScience Program, which includes a focus on greenhouse gas reduction and carbon sequestration and may support science and research aimed to improve fertiliser efficiency. Since December 2020, Canada has set an ambitious national target to reduce GHG emissions associated with fertiliser application by 30% below 2020 levels by 2030. This target does not represent a mandatory reduction in fertiliser use but rather is intended to build upon the sector's work to date and aims to reduce fertiliser-related emissions while maintaining the sector's competitiveness and maximizing food production.

4.4.3. Cross-compliance

A final category of policies limiting mineral fertiliser use are those associated with cross-compliance requirements. Cross-compliance is a tool linking payment schemes to respect for a wide array of mandatory requirements and fostering adherence to them. Restrictions on mineral fertiliser use is a common requirement. Switzerland has been amongst the forerunners in introducing environmental cross-compliance conditions (OECD, 2015[76]). Since 1999, all direct payments have been based on stringent proof of ecological performance (PEP) (Performances écologiques requises). A main PEP requirement is balanced nutrient use, defined as a maximum 10% surplus of nitrogen and phosphorus as shown by a farm's nutrient balance (based on crop requirements). Many other counties including European Union member states, Japan and Norway have cross-compliance requirements that impose some limitation on mineral fertiliser use.

5 Potential and challenges for the use of organic fertilisers

Organic fertilisers – sometimes referred to as bio-based fertilisers (BBFs) – are a highly diverse family of products. Some originate from agricultural production including animal manure, post-harvest plant residues and green manure. Others from urban wastes including sewage, organic household waste and by-products of manufacturing processes such as meat-and-bone meal. Some organic fertilisers are used directly without processing; others go through elaborate procedures before application. A common characteristic is that they all contain carbon and a wide range of nutrients, generally in low concentrations. The final part of this report briefly discusses the potential for organic fertilisers and outlines some of the major challenges associated with their use.[30] These challenges are divided into four broad themes: composition, application, distribution and regulation. The relevance and intensity of these challenges will vary between countries and between regions within countries. These challenges can increase the cost of using organic fertilisers relative to mineral fertilisers.

5.1. Potential for the use of organic fertilisers

The availability of raw materials that can be used for organic fertilisers is abundant (Kurniawati et al., 2023[77]). The European Commission, for example, estimates that organic fertilisers could replace 30% of mineral fertiliser in the EU (European Commission, 2018[78]). Unfortunately, comparable country level information on both the potential and actual usage of these raw materials as organic fertilisers is not readily available except for animal manure.[31]

As noted in Section 2.2, at the world level, the total quantity of nitrogen available in animal manure (both left on pasture and applied to soil) is slightly larger than the total quantity of nitrogen applied through mineral fertilisers (a ratio of 1.1:1). Anecdotal evidence suggests that animal manure is the most common form of organic fertiliser currently used (Patil, 2023[79]) (Padilla, Cañete and Simbuian, 2017[80]). The high-level analysis undertaken in this report suggests that animal manure has more potential than human wastewater in terms of matching the current level of nutrients applied through mineral fertilisers.

Figures 5.1 and 5.2 are designed to be compared with the figures presented in the discussion of mineral fertiliser use by nutrient type in Sections 2.3 to 2.5. Like those figures, Figures 5.1 and 5.2 show the same information for the major 26 and other 26 country groupings respectively. Each of the three elements presented provide a different perspective on the potential for animal manure to be used as a substitute for mineral fertilisers. Each of the elements should be considered when the discussing the substitution potential.

[30] The report does not discuss the benefits, particularly the environmental ones, associated with organic fertiliser use, such as improved soil health and higher plant and species diversity. Nor does it discuss the pros and cons of organic agriculture which involves a much broader range of farm management practices than simply applying organic fertilisers.

[31] For example, after a first edition in 1996, the second and latest version of the "Global Atlas of Excreta, Wastewater Sludge, and Biosoilds Management" was published in 2008 (UN-Habitat, 2008[84]).

The horizontal axis shows, for each country, the ratio between the total quantity of nitrogen available in animal manure (whether used as fertiliser or not) and the total quantity of nitrogen applied through mineral fertilisers. The further to the right, the greater the potential for animal manure to be used as a substitute based on the quantity of raw material available. The size of the circle provides an indication of current animal manure management practice, being the proportion of total animal manure that is applied to soils by farmers. The larger the circle, the greater the potential for more immediate substitution on the basis that there is already manure management practices and investment in place so that animal manure can be applied to match crop requirements. The vertical axis shows how the quantity of animal manure available has changed over the past decade. The further to the top, the greater the potential for substitution on the basis that the source of raw material is growing.

The ratio of animal manure to mineral fertiliser use varies considerably between countries in the 26 major grouping: from 3.1 in Morocco to only 0.2 in Canada and Ukraine (Figure 5.1). Canada and Ukraine are two of many countries which have experienced a decline in the quantity of animal manure over the past decade. This is also a notable feature of countries within the other 26 grouping, including many EU countries (Figure 5.2). Indonesia and Türkiye are exceptions and experienced a large increase in animal manure availability.

The nitrogen content of animal manure is considerably less than that applied through mineral fertilisers in three of the five major mineral fertiliser using countries – China (0.5), India (0.5) and the United States (0.5). In 2020, animal manure was applied to less than 8% of the total area planted in the seven major field crops in the United States, and predominately to corn (Teng et al., 2023[22]). The potential is much harder to be realised in India than the other two because a much smaller percentage (25%) of animal manure is currently applied to soils by farmers.[32] In these countries there is a greater need to explore other raw material sources for organic fertilisers aside from animal manure.

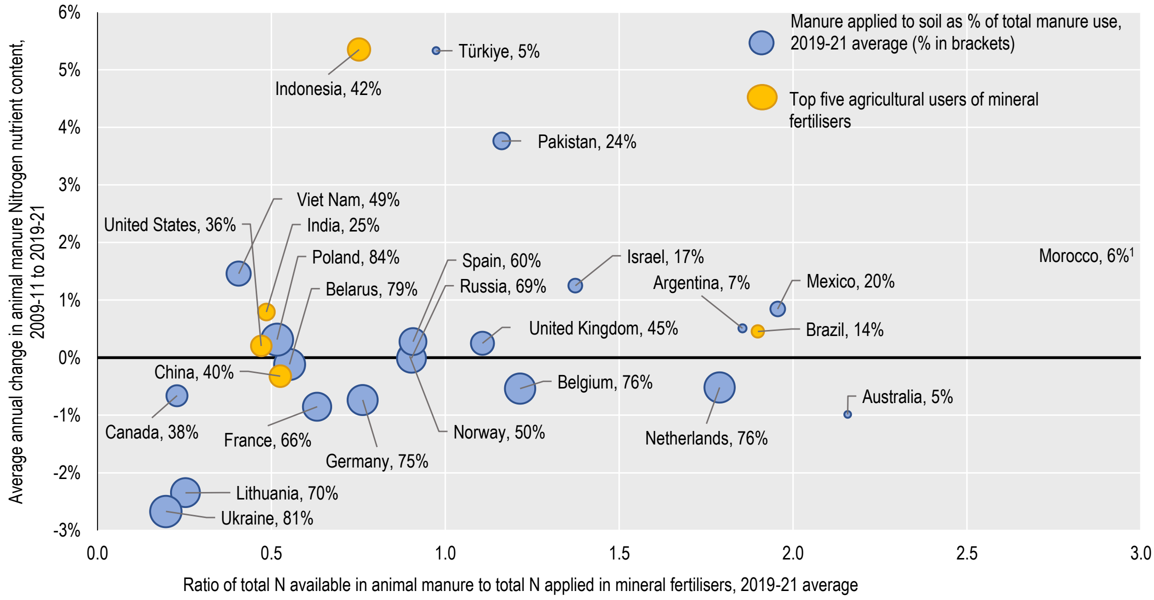
In contrast, the nitrogen nutrient content of animal manure available in Brazil is almost twice that applied through mineral fertilisers. This suggests a greater potential for animal manure to supply plant nutrient requirements. However, the small share (14%) of animal manure applied to soils in total animal manure in Brazil indicates considerable investment and changes in farm management practice will be required for this potential to be realised. This is a similar situation for the South Hemisphere countries of Argentina, Australia, New Zealand and South Africa. Considering all three elements of potential, the Netherlands and Switzerland, and to a lesser extent Portugal and Austria are the countries with the most potential to use animal manure to supply crop nitrogen nutrient requirements.

Urban wastewater systems generate huge amounts of residues in the form of sewage sludge. Further treatment of this sewage sludge to reduce toxic compounds, pathogens and undesirable odour results in organic material suitable for land application, referred to as biosolids.[33] Biosolids production is unavoidable, roughly proportional to population size, and therefore will continue to increase with an increasing global population (Marchuk et al., 2023[81]).

[32] The use of animal manure for non-agricultural uses such as energy for cooking can contribute to the low proportion of animal manure applied to soils by farmers.

[33] Biosolids is the term created in 1991 by the *Name Change Task Force* at Water Environment Federation (WEF), the water and wastewater industry's main trade and lobby organization in the United States. It was created to distinguish treated sewage sludge from raw sewage sludge and thereby facilitate land application of treated sewage sludge by making it more acceptable to the public (Qin, Zhenli and Stoffella, 2012[101]).

Figure 5.1. Agricultural use of animal manure (N nutrient content) in selected major 26 countries, 2019-2021

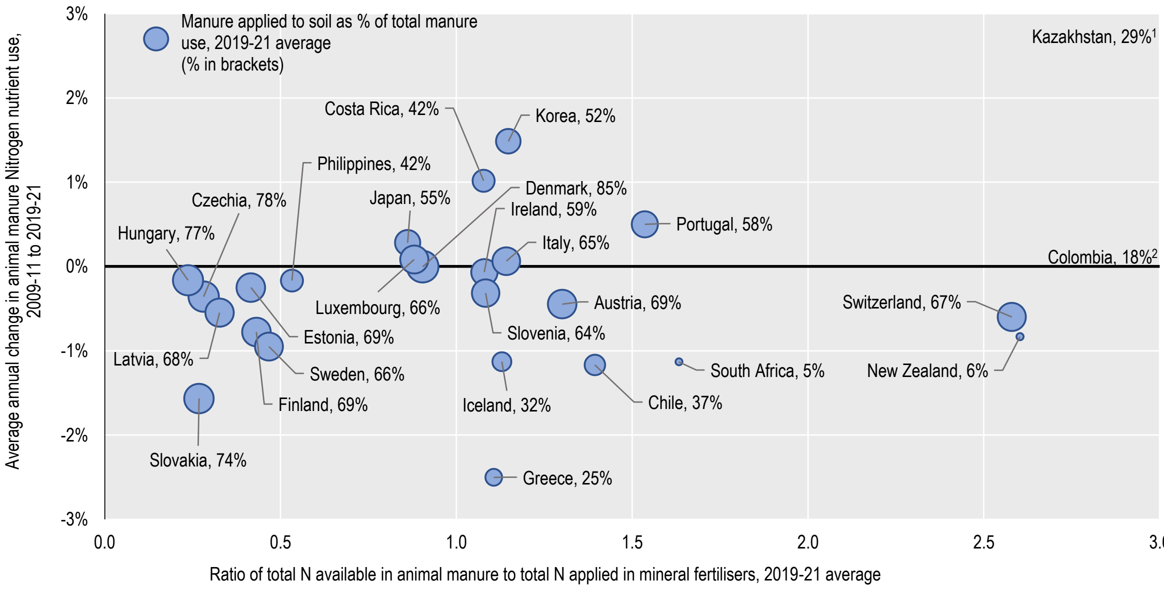


Note: Country not included on the figure as ratio of total N available in animal manure to total N applied in mineral fertilisers falls outside the scale:

1. Morocco: ratio of animal manure to mineral fertiliser: 3.1; average annual change in animal manure: 1.7%; manure applied to soils as share of total animal manure: 6%.

Source: FAO (2024[11]).

Figure 5.2. Agricultural use of animal manure (N nutrient content) in selected other 26 countries, 2019-2021



Note: Countries not included on the figure as ratio of total N available in animal manure to total N applied in mineral fertilisers falls outside the scale:

1. Kazakhstan: Ratio of animal manure to mineral fertiliser: 9.8; average annual change: 2.8%; manure applied to soils as a share of total animal manure: 29%.

2. Colombia: Ratio of animal manure to mineral fertiliser: 3.0; average annual change: 0.4%; manure applied to soils as a share of total animal manure: 18%.

Source: FAO (2024[11]).

Three components are needed to assess the potential of urban wastewater to substitute for mineral fertilisers. First, volumes of total wastewater generated was obtained from a recent United Nations report on progress towards Sustainable Development Goal 6.3.1 (Table A A.4) (UN Habitat and WHO, 2021[82]). These were then converted to a solids volume. Generally, solids production rates range between 0.2 and 0.3 kg/m3 (0.8 to 1.2 dry tons/ MG) of wastewater treated. In the absence of historic or plant-specific data, a rule-of-thumb approximation for solids produced in a typical wastewater treatment plant is 0.24 kg/m^3 of wastewater treated (Turovskiy and Mathai, 2006[83]). Finally, an estimate is made of the nutrient content available in these solids. Typically, wastewater sludge contains the following percentages of the major plant nutrients: 1-8 % N, 0.5-5 % P_2O_5, and <1% K_2O (UN-Habitat, 2008[84]). Using the benchmark assumptions, nutrient values are calculated based on 3.5% N, 1.5% P and 0.2% K. These are then compared to the nutrient content applied through mineral fertilisers to obtain one measure of the potential for urban wastewater to be used as a substitute based on the quantity of raw material available.

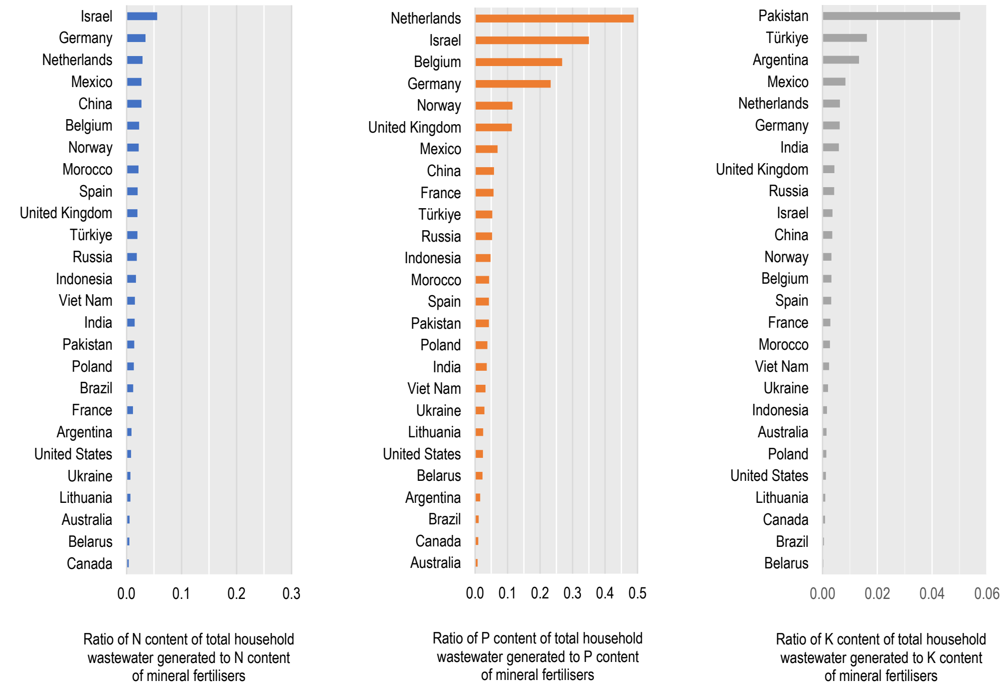
The results vary between countries depending on factors such as population levels and the nutrient content of fertilisers applied (Figure 5.3 and Figure 5.4). By this measure alone, the potential to use urban wastewater as a substitute for nitrogen appears to be strongest in Japan which has a ratio of over 0.25. None of the other 51 countries exceed 0.1. The potential for urban wastewater in relation to phosphorus much broader. The ratio exceeds 0.25 in the Netherlands, Israel, Japan and Switzerland. In relation to potassium the potential for urban wastewater appears much more limited. Kazakhstan and Pakistan have the highest ratios, but these are still below 0.2.

For most countries, the potential for wastewater to supply current crop nutrient requirements appears to be very limited. These estimates are likely to overestimate the potential based on current levels of investment as they are based on the total household wastewater generated rather than the total collected and safely treated. The proportion of household wastewater generated that is then collected and safely treated varies considerably between countries, from 100% in Korea to less than one-third in India (Table A A.4). Considerable investment in wastewater collection and treatment systems will be required in some countries to make use of this source of organic fertiliser.

In terms of actual practice, the proportion of biosolids currently applied to land or used in agriculture is quite varied. The proportion of biosolids applied to land in the European Union is about 35% (Hušek, Moško and Pohořelý, 2022[85]). In Australia, the share of biosolids used in agriculture has increased from 55% in 2010 to 73% in 2021, but in New Zealand just 3% of biosolids are used in agriculture (Australian & New Zealand Biosolids Partnership, n.d.[86]). One-quarter of biosolids produced in the United States is applied to agricultural land (US Environmental Protection Agency, 2023[87]). The main alternative use of biosolids is to either dispose of it in landfill or incineration.

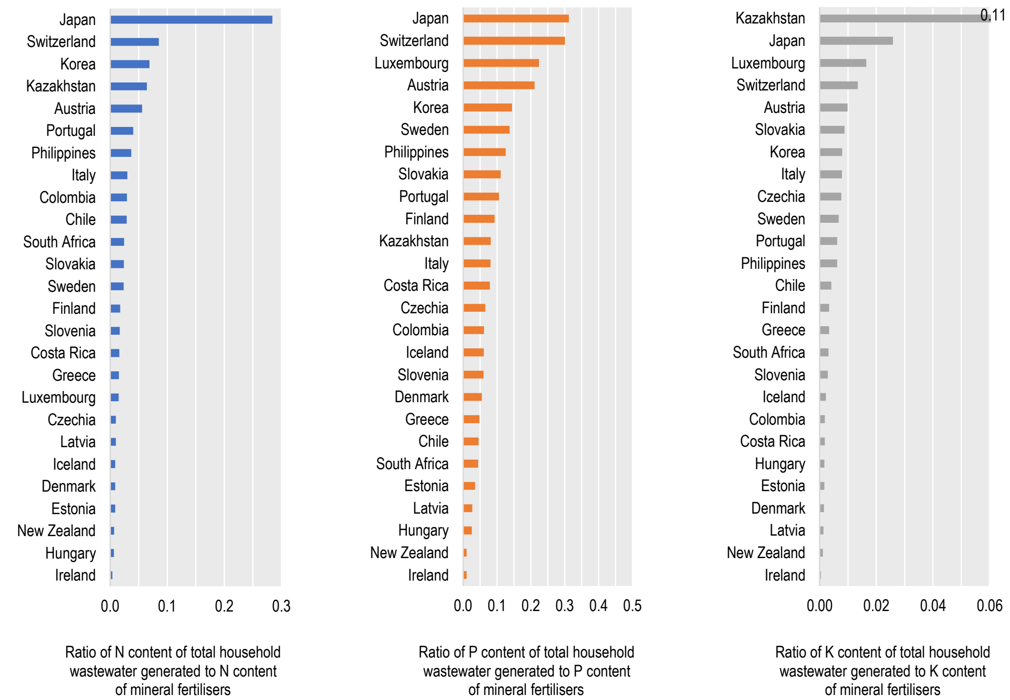
Food and garden waste (often referred to as biowaste) is another potential raw material source. In 2017, the EU-28 generated 86 million tonnes of biowaste, 60% being food waste (European Environment Agency, 2020[88]). Over 55% (47.5 million tonnes) of this biowaste was separately collected and treated by either composting or through anaerobic digestion in 18 EU countries. It is estimated that the 11.6 million tonnes of compost and 4.14 million tonnes of digestate produced from this biowaste recycled over 129 000 tonnes of N and 18 300 tonnes of P. This is equivalent to 1.6% of N and 2.3% of P applied through mineral fertilisers in these 18 countries.

Figure 5.3. Potential of household wastewater to replace mineral fertilisers used in agricultural production for N, P and K in selected major 26 countries, 2021



Source: Authors' calculations based on UN Habitat and WHO (2021[82]) and FAO (2024[11]).

Figure 5.4. Potential of household wastewater to replace mineral fertilisers used in agricultural production for N, P and K in selected other 26 countries, 2021



Source: Authors' calculations based on UN Habitat and WHO (2021[82]) and FAO (2024[11]).

5.2. Challenges for the use of organic fertilisers

While raw material sources are available to produce organic fertilisers, there are several challenges associated with their use in agriculture. These challenges are divided into four broad themes: composition, application, distribution and regulation. These challenges can increase the cost of using organic fertilisers relative to mineral fertilisers.

5.2.1. Composition

There are several challenges relating to organic fertiliser composition. Mineral fertilisers are made with standardised and concentrated amounts of specific nutrients, allowing farmers to consistently give optimal nutrient doses to crops. Organic fertilisers, on the other hand, have variable nutrient content that changes over time. For example, the nutrient content of animal manure can be highly variable, and is affected by many factors such as animal type, animal diet and dilution of slurry with dirty water or rainwater. Uncertainty in nutrient content and unpleasant odour for neighbours are two important barriers to the use of organic fertiliser identified among Danish farmers (Case et al., 2017[89]). Information available in the scientific literature suggests that the fertiliser replacement value of organic fertilisers can often be <40–60% of that using straight N fertilisers such as urea or ammonium nitrate (Marchuk et al., 2023[81])

A related composition issue is that organic fertilisers can have a low nutrient value-to-mass ratio. In the case of animal manure, this is partly because of its water content, which can be up to 90% the total weight. The low quantity of nutrients per tonne makes manure application and transportation time-intensive and costly. For example, if a farmer wishes to supply 90 kg/N to grow maize this can be supplied through the application of 200 kg of urea or 9 tonnes of animal manure.[34]

Furthermore, the nitrogen and phosphorus levels in organic fertilisers often do not match the nutrient needs of crops. Organic fertilisers typically have low N:P ratios in terms of crop requirements (Marchuk et al., 2023[81]). Applying enough organic fertiliser to meet a crop's needs for one nutrient has the potential to create environmental risk from the unused nutrients left on the soil. Excess manure nutrients can leave the fields via run-off and degrade water quality, or they can enter the air (Teng et al., 2023[22]). Blending organic fertilisers with mineral fertilisers can be used to correct for imbalance and/or inconsistent chemical composition between different batches to achieve a desirable nutrient ratio.

This challenge is compounded by the fact that the nitrogen content of organic fertilisers is normally present in two forms: (i) ammonium, which is readily available for plant uptake; and (ii) in organic compounds, which need to be mineralized in the soil before they can be converted to a form that plants can absorb. Therefore, the amount of ammonium relative to the total nitrogen content will determine the nitrogen available in the year of application. This ratio varies by type of organic fertiliser. In general, slurries and poultry manures contain more ammonia (40-60% of the total N content) compared with farmyard manures or spent mushroom compost (20-30%) (Teagasc, 2023[90]). For biosolids, between 15–50% of the N and P are available within the first year (Marchuk et al., 2023[81]). As the conversion rate also changes according to soil moisture and temperature, it is impossible to predict the nutrient release rate or time the application, increasing the chance of losses. This can result in a fall in productivity and profitability, at least in the short-term.

Technologies are available to increase the plant availability of nutrients in organic fertilisers so that they can have a more immediate impact on production (Forrestal, 2019[91]). For example, through the process of anaerobic digestion organic-N and organic-P are mineralized producing N-NH4 + and mineral P that are readily plant available. After anaerobic digestion about 60%-75% of nitrogen is present in ammoniacal forms depending on organic matrices used and digester retention time. Moreover, anaerobic digestion at

[34] Assumes the animal manure applied contains 2% nitrogen of which 50% is available to plants in the first season of application.

least partially deodorizes the final product, making it more attractive for the end-users. Anaerobic digesters can also be used to generate renewable natural gas from manure (Teng et al., 2023[22]). This can be captured and used as a source of energy, thereby reducing greenhouse gas emissions. Other technologies include liquid solid fraction separation, mineral concentration through ultrafiltration, evaporation or reverse osmosis, and microwave. New technologies are also emerging for the recovery of biosolids (Hušek, Moško and Pohořelý, 2022[85]).

However, implementing such technologies requires considerable capital investment. The relatively high capital cost of anaerobic digesters has limited the use of this technology to larger operations in the United States such as dairies with at least 500 cows (Teng et al., 2023[22]). In addition to construction costs, anaerobic digesters require constant maintenance and supervision to maintain the temperatures, consistency, and acidity needed for decomposition. Trained operators must supervise the process to prevent leakage, explosion, asphyxiation, or hydrogen sulphide poisoning.

A final composition-related issue is the presence in some organic fertilisers of substances which can cause contamination or toxicity. For example, manure-based fertiliser derived from intensive animal farming has risks to antibiotic exposure which remains as residues or pollutants in organic fertilisers and posed a high, short-term risk to plants but not to soil invertebrates (Kurniawati et al., 2023[77]). Direct land application of chicken litter could be harming animal, human, and environmental health due to contamination of *Eschericia coli*, Coliform bacteria, *Actinobacillus* and *Salmonella.* The biggest threat associated with biosolids is the presence of micro-pollutants, including heavy metals and pathogens, which must be removed before application (Chojnacka, Moustakas and Witek-Krowiak, 2020[92]). One group of emerging contaminants which has received increasing attention is microplastics and nano-plastics (Marchuk et al., 2023[81]). Due to the presence of undesirable substances, appropriate treatment processes must be used.

5.2.2. Application

A second group of challenges relate to the application of organic fertilisers. Produced in a range of concentrated and stable pellet, powder and liquid forms, mineral fertilisers are compact, easy to transport and can be stored for a long time. They can be kept and used when needed to precisely provide readily available plant nutrients. Due to being quite volatile, organic fertilisers generally need to be used soon after production and are difficult to store for long periods.

The availability to plants of nutrients from manure-based organic fertilisers depends on the application method, speed of incorporation and weather conditions at the time of application. This is of particular significance for nitrogen recovery from organic fertilisers with high ammonia content (Teagasc, 2023[90]). Application in cool, moist weather conditions will increase the amount of ammonium nitrogen that is taken up by the crop. Ammonia losses to the air are highest when soil and air conditions are dry and warm, and is a critical challenge for ensuring high mineral fertiliser replacement values from organic fertilisers globally (Forrestal, 2019[91]). Injecting manure below the soil surface or incorporating manure shortly after surface application conserves more nutrients and increases the fertiliser value. Surface application without incorporating or applying manure through an irrigation system results in less nutrient retention and lower fertiliser value.

With a low nutrient value-to-mass ratio, manure is more costly to transport, store, and apply than chemical fertilisers. The additional labour and time required to apply manure helps to explain why small-scale farmers are generally more likely than large-scale farmers to apply manure to their crops (Teng et al., 2023[22]). Operators of large farms may face labour constraints, and thus prefer commercial fertilisers, which can be applied more precisely and quickly than manure. This pattern may also be partly explained by specialisation. Larger crop farms are less likely to integrate animals into their operation, so they are less likely to have manure available for application.

5.2.3. Distribution

A third challenge arises because of the distance between the source of organic fertiliser (whether urban environments or livestock) and the demand for organic fertiliser, particularly by crop farmers. In recent decades, producers have become increasingly specialised in either crop or livestock production (Teng et al., 2023[22]). And in some countries, livestock production has largely moved from pasture-based to concentrated feeding operations. In some regions, concentrated animal production—where animals are kept in barns or enclosed lots—has resulted in the local supply of manure nutrients exceeding the nutrient needs of local crops. That means farmers often must transport manure longer distances to match its nutrient value with crop needs (Roguet et al., 2020[93]). The cost to transport manure creates an incentive to over-apply manure nutrients on nearby land. According to data from USDA's Agricultural Resource Management Survey (ARMS), 78% of applied manure comes from crop and livestock integrated farms. Only 14% of applied manure is purchased from other farmers, and 8% is obtained for free. In India, the dominance of small farmers who graze cattle on their pasture limits the potential for animal manure to be a source (Patil, 2023[79]). There is currently little storage and distribution networks set up to distribute manure in India.

Manure is expensive to transport, and local animal production largely determines the type of manure applied to regional crops. For example, in the United States because most pigs are produced in the Midwest, pig manure is applied predominately to corn and soybeans. Most chickens are raised in the Southeast, so most animal waste applied to crops grown primarily in the South, such as cotton and peanuts, originates from poultry farms. Beef cattle are produced mainly in the Great Plains, so this is the animal manure most applied to wheat acreage. Dairies, located in the Western, Midwestern, and Northeastern United States, supply the largest share of manure applied to corn, barley, and oats. (Teng et al., 2023[22])

These distribution issues can be compounded by government policy. Part 4 showed that government budgetary support for the use of mineral fertilisers is considerable in some countries. In India, for example, it is estimated that the market price of cow manure, in nutrient content terms, is four times higher than subsidised mineral fertilisers, excluding transport and application costs, and almost two times higher for poultry manure (Patil, 2023[79]).

5.2.4. Regulation

A final group of challenges relate to the need for an appropriate regulatory framework that allows and enables the production, sale, distribution and use of organic fertilisers while safeguarding the human health and environmental concerns. For example, until very recently, only mineral fertilisers could be traded freely between countries within the EU single market. Regulation (EU) 2019/1009 of 5 June 2019 laying down the rules on the making available of fertilising products on the EU market came into application on 16 July 2022 (European Commission, 2022[94]). The regulation opens the single EU market to organic fertilisers for the first-time, establishes limit values for toxic contaminants, and allows optional harmonisation. This offers the opportunity to bring regions with surpluses and regions with shortages of fertilisers into contact with each other, resulting in a net reduction in the need for external inputs.

Under the EU Nitrates Directive (91/676/EEC) farmers may not spread more than 170 kg nitrogen per hectare per year derived from manure in their fields in areas which action programmes apply. These areas are Nitrates Vulnerable Zones (NVZ), areas draining into waters identified as affected or at risk of being affected by nitrates pollution.[35] However, in recognition that growing conditions are different due to climatic variability, the Nitrates Directive allows EU Member states to request a derogation from this requirement

[35] They may, instead of designating NVZs, opt to apply their action programme throughout their entire territory. Austria, Denmark, Finland, Germany, Ireland, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Romania, Slovenia and Belgium (limited to Flanders) have followed this approach.

(Dumont et al., 2016[95]). During the period 2016-2019, derogations were granted to Belgium (region of Flanders only), Denmark, Ireland, Italy (regions of Lombardia and Piemonte only) and the Netherlands (European Commission, 2021[96]). For example, Ireland's derogation permits grassland farmers to apply up to 250 kgs of manure nitrogen per hectare. The use of biosolids for plant nutrient supply can be restricted by regulated application rates for other compounds present in the product such as metals.

But this challenge extends beyond government regulations. For example, Global GAP is the most widely adopted standard for quality assurance of horticultural crops and the use of human sewage sludge is not allowed on certified farms (GlobalGAP, 2022[97]). Interviews with stakeholders along the Kenyan horticultural export chain showed that Global GAP certified farmers were not willing to use biosolids on their farms even if local regulations recognise treated sludge as a valid input to agriculture (Moya, Parker and Sakrabani, 2019[98]).

6 Conclusion

The global mineral fertiliser market is characterised by extremes. Nitrogen is the dominant nutrient, accounting for almost 70% of total nutrients used for agricultural production. Just three crops – maize, wheat and rice – account for almost half of the total nutrients applied. Global production of phosphorus and potassium is highly concentrated in a small number of countries due to the uneven global distribution of mineral resources. While nitrogen fertilisers are manufactured in many countries, global production is dominated by countries with access to fossil fuels because of its relatively high share of production cost. Consequently, most countries are highly dependent on imports of mineral fertilisers. There is also a high level of market concentration at the company level, with a few large companies dominating global production and sometimes local distribution networks.

These characteristics make fertiliser markets more susceptible to supply disruptions. These can be triggered by a wide range of events. Conflict, such as that resulting from Russia's invasion of Ukraine, can restrict the supply of fertilisers from countries possessing the mineral resources, triggering higher world prices for all farmers. Higher fossil fuel prices can lead to a drop in domestic nitrogen production, requiring greater imports and therefore raising demand on the global market. Natural weather events can disrupt the domestic delivery of fertilisers to farmers to meet seasonal demand requirements, raising competition on the local market for the limited supply available.

The purpose of this report is to provide an overview of government policy objectives and measures for mineral fertilisers, particularly in response to the rapid rise in fertiliser prices that began in 2021. Whereas some countries plan to increase mineral fertiliser use, others intend to limit their use. In addition, several countries are seeking to expand the use of organic fertilisers.

An understanding of the mineral fertiliser market in a country can help explain government policy responses. Three high-level market factors were used in this report: trade dependency, intensity of use, and the long-term trend in use. Table 6.1 summarises these factors for the top five agricultural users of mineral fertilisers, who together account for 60% of total nutrients applied for agricultural production.

To meet their plans for fertiliser use, countries introduce diverse policy measures. This report documents these policy measures using a framework that considers the intent of the policy measure in relation to either supporting or limiting the use of mineral fertilisers, and the type of measure. Policy objectives and measures can be split into four broad groups according to whether they: support mineral fertiliser use by farmers, assist domestic production of mineral fertilisers, encourage the use or production of organic fertiliser, or are other policies to reduce mineral fertiliser use by farmers. The first two groups aim to support mineral fertiliser use, whereas the latter two groups intend to reduce the use of mineral fertilisers.

Table 6.1. Summary of market factors for the five major mineral fertiliser users

Country	Trade dependency	Intensity of use	Change in use over the past decade
China	High level of domestic production of N, P and K, although some P imports required	High intensity of use for all nutrients	Decrease in use of N and P, but increasing for K
India	Highly dependent on fertiliser imports particular for P and K	High intensity of use for N, low intensity for P and K	Increase in N use, stable P and falling K use
United States	High level of domestic production of N, dependent on imports of P and K	Lower intensity of use for all nutrients	Relatively stable use of N and P, some growth in K
Brazil	Highly dependent on fertiliser imports for all nutrients	Lower intensity of use for N but high for P and K	Large increase in use of N, P and K
Indonesia	High level of domestic production of N, highly dependent on imports of P and K	Lower intensity of use for all nutrients	Increase in use of N, P and K

Historically specific policy objectives for fertilisers, if set by governments, focused on the first two types. Both India and Indonesia have had for many years a specific policy objective to support mineral fertiliser use by farmers. In response to the recent increase in fertiliser prices, several EU countries (including Greece and Poland) provided support for the purchase of fertilisers. However, policy objectives to assist domestic production of mineral fertilisers have recently been introduced in Mexico, Brazil and the United States. The ambitious intentions of the 2022-2050 National Fertiliser Plan of Brazil result from its high trade dependence and rapidly growing use. But these three examples do appear to be an exception and are mostly temporary or relatively small-scale.

In more recent years, objectives, when set by governments, have shifted to the latter two categories that seek to reduce mineral fertiliser use in agricultural production. China was one of the first to do so in 2015, responding to problems resulting from a high intensity of use. Environmental concerns such as water pollution and biodiversity have been a major reason for this shift in objective focus for many countries[36]. India, while maintaining support for increased mineral fertiliser use wishes to see the greater adoption by farmers of organic fertilisers for the purpose of environmental improvement. In support of its broader climate change commitments, Canada has established a national target to reduce emissions from fertiliser application by 30 percent below 2020 levels by 2030. This target does not represent a mandatory reduction in fertiliser use but builds on efforts within the Canadian agricultural sector to reduce fertiliser-related emissions while maintaining the sector's competitiveness and maximizing food production. Food security concerns, possibly influenced by rising fertiliser prices, have been a more recent driver, such as the objectives to increase organic fertiliser use and production in Japan and Viet Nam.

Many of the policy measures used by governments, in response to rising international prices, were attempts to reduce the price increase for domestic farmers. Tariffs on fertilisers are generally quite low or even duty-free reflecting the high degree of import dependence. China, which has a high level of domestic production, imposes some of the highest tariffs. Nevertheless, a few countries such as the European Union, Brazil, Israel and Korea temporarily reduced or suspended these low tariffs. Various forms of export restrictions were used by China, Russia, Türkiye and Ukraine to maintain domestic supply. Some of these restrictions were not very transparent, e.g., in China, or frequently changed, e.g., Russia. As an alternative method to increase supply, China and Switzerland released reserve supplies of mineral fertilisers. Japan is establishing such a contingency mechanism for future events. Online market price information systems for fertilisers have been initiated the European Union, the United Kingdom and Colombia.

Other responses to support farmers focused on providing additional budgetary payments to limit or offset the increase in costs incurred. India maintained its MRP for urea and increased its NBS rates for phosphorus and potassium requiring a large increase in subsidy payments. China provided three additional

[36] The environmental issues associated with the excessive use of fertilisers has been examined thoroughly in the literature. Examples include Bayramoglu and Chakir (2016[104]), and OECD (2018[103]).

payment allocations to farmers through its “support and protection payment” programme. Poland, Spain, Greece and Slovenia introduced state aid payments under the European Union’s Temporary Crisis Framework for the specific purpose of compensating farmers for higher fertiliser prices. In contrast, Indonesia, which is a major fertiliser subsidy provider, has reduced the range of mineral fertiliser products covered, the commodities eligible for using subsidies fertiliser and raised retail prices.

Budgetary support has also been provided to assist fertiliser manufacturers in the form of concessional loans, direct grants or tax concessions. The European Union has directed this support to providing compensation for the additional input costs incurred, such as higher electricity and natural gas prices. Other countries, such as India, Russia and the United States, have targeted this additional funding at increasing future production of mineral fertilisers through either expanding existing facilities or building new plants. It should be noted though that some of this funding is time-limited.

Several new policy measures have been introduced to encourage the use or production of organic fertilisers. Given the short period of time that has passed, these initial responses use budgetary transfers to achieve this goal. These can be paid to compensate farmers for the additional costs of organic fertilisers, such as in Japan, or paid to reduce the cost of producing the organic fertiliser, such as in India and several European Union Member States. In terms of other recent policy measures introduced to reduce mineral fertiliser use, these focus on the allocation of additional resourcing for research and extension programmes to help farmers use mineral fertilisers more efficiently. For example, both the European Union and the United States have announced new digital tools (termed FaST and FRST respectively) for nutrient management decision making.

Organic fertilisers, which originate from agricultural sources, urban waste streams or manufacturing by-products, can provide farmers with an alternative source of nutrients to mineral fertilisers. Unfortunately, comparable country-level information on the actual and potential use of these sources is not readily available. The high-level analysis undertaken in this report suggests that, in many countries, the quantity of nitrogen available in animal manure could provide a large proportion of current crop nutrient requirements. But most manure is left on pasture by animals rather than applied to the soil by farmers. The practice of manure application by farmers is much stronger in European countries than elsewhere. For most countries, the quantity of nutrients potentially available in urban wastewater or through food waste is considerably less than that currently applied in mineral fertilisers. Nevertheless, there may be sound economic and environmental reasons for better using these resources even if they cannot fully replace mineral fertilisers.

There are several challenges associated with the use of organic fertilisers by farmers. In comparison to mineral fertilisers, the nutrient content of organic fertilisers can be variable and even unknown to the farmer, making it more difficult to match the nutrient needs of crops without creating environmental risks. They also generally have a lower nutrient content, resulting in higher application costs to achieve the same level of fertilisation. Organic fertiliser can contain substances which cause contamination or toxicity, and can create odour problems for neighbours. Many of these composition and application related issues can be overcome but these can require considerable capital investment and changes in farm management practices. The distance between the source of organic fertiliser and point of demand can be another challenge, particularly for animal manure. Finally, government policy can disincentivise the application of organic fertiliser. Subsides for mineral fertilisers can make it cheaper to use than organic alternatives while regulations can prevent farmers from fully using the nutrients available in organic fertiliser.

Future work could examine the effectiveness of certain fertiliser policies or their impact on crop yields, greenhouse gas emissions and other environmental outcomes. This analysis could compare policies within or across countries. The stocktaking and framework developed in this report can provide the basis for such analysis. It can serve to identify whether there is policy incoherence in a country and how this might be addressed.

References

Adenäuer, M., E. Laget and M. Cluff (2024), "Fertile Futures: Scenario Analysis on the Interconnected Dynamics of Fertiliser and Agricultural Markets", *OECD Food, Agriculture and Fisheries Papers*, No. 207, OECD Publishing, Paris, https://doi.org/10.1787/b1606a57-en. [53]

Alexander, P. et al. (2023), "High energy and fertilizer prices are more damaging than food export curtailment from Ukraine and Russia for food prices, health and the environment", *Nature Food*, Vol. 4, pp. 84-95, https://doi.org/10.1038/s43016-022-00659-9. [6]

Argus Consulting Services (2023), *Phosphate Rock Resources & Reserves - Report Prepared for International Fertilizer Association*, https://www.fertilizer.org/wp-content/uploads/2023/04/2023_Argus_IFA_Phosphate_Rock_Resources_and_Reserves_Final.pdf. [25]

Australian & New Zealand Biosolids Partnership (n.d.), *Australian Biosolids Statistics*, https://www.biosolids.com.au/guidelines/australian-biosolids-statistics/. [86]

Bayramoglu, B. and R. Chakir (2016), "The impact of high crop prices on the use of agro-chemical inputs in France: A structural econometric analysis", *Land Use Policy*, Vol. 55, pp. 204-211, https://doi.org/10.1016/j.landusepol.2016.03.027. [104]

Bounds, A. (2023), "Russian fertiliser export revenue surged 70% in 2022 as prices jumped", *Financial Times*, https://www.ft.com/content/c10bcdb9-d01d-4a01-a4a1-38736e263a1e. [47]

Case, S. et al. (2017), "Farmer perceptions and use of organic waste products as fertilisers – A survey study of potential benefits and barriers", *Agricultural Systems*, Vol. 151, pp. 84-95, https://doi.org/10.1016/j.agsy.2016.11.012. [89]

Chojnacka, K., K. Moustakas and A. Witek-Krowiak (2020), "Bio-based fertilizers: A practical approach towards circular economy", *Bioresource Technology*, Vol. 295, https://doi.org/10.1016/j.biortech.2019.122223. [92]

Chow, E. and D. Patton (2022), *China issues phosphate quotas to rein in fertiliser exports - analysts*, https://www.reuters.com/article/china-fertilizers-quotas-idUSKBN2OQ0KY. [48]

Crespi, J. et al. (2022), *An Examination of Recent Fertilizer Price Changes*, https://www.card.iastate.edu/products/publications/pdf/22sr117.pdf. [4]

Cross, L. and A. Gruère (2023), *Public Summary Medium-Term Fertilizer Outlook 2023 - 2027*, https://www.ifastat.org/market-outlooks. [2]

Cross, L. and A. Gruère (2022), *Public Summary Medium-Term Fertilizer Outlook 2022 - 2026*, https://www.fertilizer.org/wp-content/uploads/2023/01/2022_IFA_medium_term_outlook_public_summary.pdf. [20]

Cross, L. and A. Gruère (2022), *Public Summary Short-Term Fertilizer Outlook 2022-2023*, https://www.fertilizer.org/resource/public-summary-short-term-fertilizer-outlook-2022-2023/. [1]

Daramola, D. and M. Hatzell (2023), “Energy demand of nitrogen and phosphorus based fertilisers”, *ACS Energy Letters*, Vol. 8, pp. 1493-1501, https://pubs.acs.org/doi/pdf/10.1021/acsenergylett.2c02627. [30]

Dumont, B. et al. (2016), *Rôles, impacts et services issus des élevages en Europe*, https://www.inrae.fr/sites/default/files/pdf/esco-elevage-eu-rapport-complet-en-francais.doc.pdf. [95]

European Commission (2023), *Approved 28 CAP Strategic Plans (2023-2027) Summary overview for 27 Member States Facts and Figures*, https://agriculture.ec.europa.eu/system/files/2023-06/approved-28-cap-strategic-plans-2023-27.pdf. [70]

European Commission (2023), *France - TCTF: Exception scheme for fruit and vegetablesfarms in the French outermost regions due to the price increases of fertilisers and soild conditioners*, https://agriculture.gouv.fr/telecharger/139007. [63]

European Commission (2023), *List of Member State measures approved under Temporary Crisis Transition Framework*, https://competition-policy.ec.europa.eu/system/files/2023-09/State_aid_TCTF_decisions.pdf. [62]

European Commission (2023), *Temporary Crisis and Transition Framework*, https://competition-policy.ec.europa.eu/state-aid/temporary-crisis-and-transition-framework_en. [61]

European Commission (2022), *Communication from the Commission on Ensuring availability and affordability of fertilisers*, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022DC0590(01). [43]

European Commission (2022), *Safe and effective fertilising products on the EU market*, https://eur-lex.europa.eu/EN/legal-content/summary/safe-and-effective-fertilising-products-on-the-eu-market.html. [94]

European Commission (2022), *State aid: Commission adopts Temporary Crisis Framework to support the economy in context of Russia’s invasion of Ukraine*, https://ec.europa.eu/commission/presscorner/detail/en/statement_22_1949. [60]

European Commission (2021), *Report on the implementation of Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultrual sources based on Member State reports for the period 2019-2019*, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC1000. [96]

European Commission (2020), *A Farm to Fork Strategy for a fair, health and environmentally-friendly food system*, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0381. [99]

European Commission (2020), *EU Biodiversity Strategy for 2030 Bringing nature back into our lives*, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0380. [100]

European Commission (2020), *Study on the EU’s list of Critical Raw Minerals (2020) Final Report*, EC, https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwi88f796M79AhXmV6QEHazJApgQFnoECA4QAQ&url=https%3A%2F%2Fec.europa.eu%2Fdocsroom%2Fdocuments%2F42883%2Fattachments%2F1%2Ftranslations%2Fen%2Frenditions%2Fnative&usg=AOvVaw11beRfMw0F00. [27]

European Commission (2018), *Circular Economy: Agreement on Commission proposal to boost the use of organic and waste-based fertilisers*, https://ec.europa.eu/commission/presscorner/detail/en/IP_18_6161. [78]

European Environment Agency (2020), *Bio-waste in Europe - turning challenges into opportunities*, https://doi.org/10.2800/630938. [88]

Fan, P. et al. (2023), "The effect of agricultural subsidies on chemical fertiliser use: Evidence from a new policy in China", *Journal of Environmental Management*, Vol. 344, https://doi.org/10.1016/j.jenvman.2023.118423. [58]

FAO (2024), *FAOSTAT*, https://www.fao.org/faostat/en/#home (accessed on February 2024). [11]

FAO (2023), *FAOSTAT Dataset Information: Livestock Manure*, https://fenixservices.fao.org/faostat/static/documents/EMN/EMN_e.pdf. [102]

FAO (2023), *FAOSTAT Domain Fertilisers by Nutrient. Methodological Note*, https://fenixservices.fao.org/faostat/static/documents/RFN/RFN_EN_README.pdf. [13]

FAO (2023), *Fertiliser questionnaire*, https://www.fao.org/foodagriculture-statistics/data-collection/en/. [14]

FAO (2023), *Inorganic fertilizers 2000-2021*, FAO, https://doi.org/10.4060/cc6823en. [12]

FAO (2020), *Livestock and environment statistics: manure and greenhouse gas emissions. Global*, http://www.fao.org/3/cb1922en/cb1922en.pdf. [18]

FAO/WTO (2022), *Global fertilizer markets and policies: A joint FAO/WTO mapping exercise*, https://www.fao.org/3/cc2945en/cc2945en.pdf. [44]

Fertilisers Europe (2023), *How fertilisers are made*, https://www.fertilizerseurope.com/fertilizers-in-europe/how-fertilizers-are-made/ (accessed on March 2023). [19]

Fertilizers Europe (2023), *Energy cost*, https://www.fertilizerseurope.com/industry-competitiveness/energy-cost/. [31]

Forrestal, P. (2019), *Towards increasing the mineral fertiliser replacement value of bio-based fertilisers*, https://ec.europa.eu/eip/agriculture/sites/default/files/fg19_minipaper_4_nue_en.pdf. [91]

Gentile, E. et al. (2019), *Fertilizers and pesticides: Price differences between Switzerland and neighbouring countries*. [37]

Global Trade Alert (2023), , https://www.globaltradealert.org/. [46]

GlobalGAP (2022), *Intergrated Farm Assurance Smart: Principles and Criteria for Frtuir and Vegetables*, https://www.globalgap.org/.content/.galleries/documents/220929_IFA_Smart_PCs_FV_v6_0_Sep22_en.pdf. [97]

Government of India (2023), *Ministry of Chemicals & Fertilizers, Department of Fertilizers*, https://www.fert.nic.in/. [51]

Government of India (2023), *Policy on Promotion of Organic Fertilizers - Regarding*, https://www.fert.nic.in/sites/default/files/What-is-new/Policy%20on%20Promotion%20of%20Organic%20Fertilizers%20-%20Regarding%20%28Letter%20dated%2020th%20Sept%2C%202023%29.pdf. [71]

Government of India (2023), *Unique package for farmers announced*, https://pib.gov.in/PressReleasePage.aspx?PRID=1935893. [52]

HCSS (2012), *Risks and Opportunities in the Global Phosphate Rock Market - Robust Strategies in Times of Uncertainty*, The Hague Centre for Strategic Studies No 17 | 12 | 12, https://www.phosphorusplatform.eu/images/download/HCSS_17_12_12_Phosphate.pdf. [26]

Hebebrand, C. and J. Glauber (2023), *The Russia-Ukraine war after a year: Impacts on fertilizer production, prices, and trade flow*, https://www.ifpri.org/blog/russia-ukraine-war-after-year-impacts-fertilizer-production-prices-and-trade-flows. [28]

Hebebrand, C. and D. Laborde (2022), *High fertilizer prices contribute to rising global food security concerns*, https://www.ifpri.org/blog/high-fertilizer-prices-contribute-rising-global-food-security-concerns. [5]

Hernandez, M. and M. Torero (2013), “Market concentration and pricing behavior in the fertilizer industry: A global approach”, *Agricultural Economics*, Vol. 44/6. [39]

Hušek, M., J. Moško and M. Pohořelý (2022), “Sewage sludge treatment methods and P-recovery possibilities: Current state-of-the-art”, *Journal of Environmental Management*, Vol. 315, https://doi.org/10.1016/j.jenman.2022.115090. [85]

IFA (2023), *IFASTAT*, https://www.ifastat.org/. [16]

IFA (2023), *Organic and Mineral Fertilizer: Difference and Similarities*, https://www.fertilizer.org/about-fertilizers/organic-and-mineral-fertilizers/. [8]

IFA (2022), *Fertilizer use by crop and country for 2017-2018 period*, https://doi.org/doi:10.5061/dryad.2rbnzs7qh. [21]

IFDC (2022), *Fertilizer logistics in East Africa*, https://ifdc.org/2022/08/05/fertilizer_logistics_in_east_africa/. [35]

Institute for Agriculture and Trade Policy (2022), *The Fertiliser Trap: The rising cost of farming’s addiction to chemical fertiliser*, https://www.iatp.org/the-fertiliser-trap. [42]

IPPC (2006), *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, IGES, Japan. [17]

Kurniawati, A. et al. (2023), “Opportunities and challenges of bio-based fertilizers utilization for improving soil health”, *Organic Agriculture*, https://doi.org/10.1007/s13165-023-00432-7. [77]

Marchuk, S. et al. (2023), “Biosolids-derived fertilisers: A review of challenges and opportunities”, *Science of The Total Environment*, Vol. 875, https://doi.org/10.1016/j.scitotenv.2023.162555. [81]

MFE (2023), *Synthetic nitrogen fertiliser cap: Implementation guidance on Essential Freshwater policies and regulations*, https://environment.govt.nz/acts-and-regulations/freshwater-implementation-guidance/agriculture-and-horticulture/synthetic-nitrogen-fertiliser-cap-in-place-from-1-july/. [72]

Ministry of Trade of Türkiye (2021), *Notification on Good registration for export amendments to be made in (Communique No: export 2006/07) related notification (export 2021/8)*, https://www.resmigazete.gov.tr/eskiler/2021/10/20211012-2.htm. [50]

Moya, B., A. Parker and R. Sakrabani (2019), "Challenges to the use of fertilisers derived from human excreta: The case of vegetable exports from Kenya to Europe and influence of certification systems", *Food Policy*, Vol. 85, pp. 72-78, https://doi.org/10.1016/j.foodpol.2019.05.001. [98]

OECD (2023), *Agricultural Policy Monitoring and Evaluation 2023: Adapting Agriculture to Climate Change*, OECD Publishing, Paris, https://doi.org/10.1787/b14de474-en. [9]

OECD (2023), *Agricultural Policy Monitoring and Evaluation 2023: Adapting Agriculture to Climate Change*, OECD Publishing, Paris, https://doi.org/10.1787/b14de474-en. [54]

OECD (2023), *Government support in industrial sectors: A synthesis report*, OECD Publishing, Paris, https://doi.org/10.1787/1d28d299-en. [67]

OECD (2023), *Measuring distortions in international markets: Below-market energy inputs*, OECD Publishing, Paris, https://doi.org/10.1787/b26140ff-en. [68]

OECD (2022), *Producer and Consumer Support Estimates, OECD Agriculture statistics (database)*, https://doi.org/10.1787/agr-pcse-data-en. [10]

OECD (2018), *Human Acceleration of the Nitrogen Cycle: Managing Risks and Uncertainty*, OECD Publishing, Paris, https://doi.org/10.1787/9789264307438-en. [103]

OECD (2018), *Innovation, Agricultural Productivity and Sustainability in China*, OECD Publishing, https://doi.org/10.1787/9789264085299-en. [57]

OECD (2017), *Agricultural Policies in Costa Rica*, OECD Publishing, https://doi.org/10.1787/9789264269125-en. [74]

OECD (2017), *Agricultural policies in the Philippines*. [41]

OECD (2016), *OECD's Producer Support Estimate and related indicators of agricultural support: Concepts, Calculations, Interpretation and Use (The PSE Manual)*, https://www.oecd.org/agriculture/topics/agricultural-policy-monitoring-and-evaluation/documents/producer-support-estimates-manual.pdf. [73]

OECD (2015), *Agricultural Policies in Viet Nam*, OECD Publishing, https://doi.org/10.1787/9789264235151-en. [38]

OECD (2015), *OECD Review of Agricultural Policies: Switzerland 2015*, OECD Publishing, https://doi.org/10.1787/9789264168039-en. [76]

OECD (2012), *OECD Review of Agricultural Policies: Indonesia 2012*, OECD Publishing, https://doi.org/10.1787/9789264179011-en. [55]

OECD (2003), *Organic Agriculture: Sustainability, markets and policies*, OECD Publishing. [69]

OECD/FAO (2023), *OECD-FAO Agricultural Outlook 2023-32*, OECD Publishing, https://doi.org/10.1787/08801ab7-en. [7]

Padilla, N., D. Cañete and V. Simbuian (2017), "Organic Fertilizer Value Chain Opportunities and Challenges in Cagayan Valley, Philippines", *Journal of Advanced Agricultural Technologies*, Vol. 4/2, pp. 128-133, https://doi.org/10.18178/joaat.4.2.128-133. [80]

Patil, S. (2023), *India's move to organic fertilizer: Ambitions and realities*, https://www.spglobal.com/commodityinsights/en/market-insights/blogs/agriculture/051023-fertecon-india-organic-farming-chemical-fertilizers. [79]

People's Republic of China (2022), *Premier stresses spring farming to ensure grain security*, http://english.www.gov.cn/premier/news/202203/25/content_WS623c95eec6d02e5335328411.html. [59]

Petersen, E., C. Scanlan and M. Burton (2023), "Agronomic factors are the dominant influence on nitrogen fertilizer strategies in dryland cropping systems", *Agronomy for Sustainable Development*, Vol. 43/14, https://doi.org/10.1007/s13593-023-00867-y. [36]

Qin, L., H. Zhenli and P. Stoffella (2012), "Land application of Biosolids in the USA: A Review", *Applied and Environmental Soil Science*, Vol. Biosolids Soil Application: Why a New Special on an Old Issue?, https://doi.org/10.1155/2012/201462. [101]

Rafani, I. and T. Sudaryanto (2023), *Update on Fertilizer Subsidy Policy in Indonesia: Perspective and Challenges*, https://ap.fftc.org.tw/article/3378#:~:text=The%20fertilizer%20subsidy%20policy%20in,optimize%20the%20use%20of%20fertilizers. [56]

Roguet, C. et al. (2020), "Spécialisation territoriale et concentration des productions animales européennes : état des lieux et facteurs explicatifs", *INRA Productions Animales*, Vol. 28/1, pp. 5-22, https://doi.org/10.20870/productions-animales.2015.28.1.3007. [93]

Rosa, L. and P. Gabrielli (2022), "Energy and food security implications of transitioning synthetic nitrogen fertilizers to net-zero emissions", *Environmental Research Letters*, Vol. 18/1, https://doi.org/10.1088/1748-9326/aca815. [23]

Teagasc (2023), *Organic Manures*, https://www.teagasc.ie/crops/soil--soil-fertility/organic-manures/. [90]

Teng, L. et al. (2023), "Increasing the value of animal manure for farmers", Vol. AP-109, U.S. Department of Agriculture, Economic Research Service, https://www.ers.usda.gov/publications/pub-details/?pubid=106088. [22]

Thang, T. (2014), *Fertilizers in Vietnam*, http://cantholib.org.vn:81/View.aspx?p=F65657C9E995862737E6B646A7B9E9754537. [64]

The Economist (2023), *A huge Norwegian phosphate rock find is a boon for Europe*, https://www.economist.com/europe/2023/06/08/a-huge-norwegian-phosphate-rock-find-is-a-boon-for-europe. [29]

The Economist (2022), *Why fertiliser prices are soaring*, https://www.economist.com/the-economist-explains/2022/05/31/why-fertiliser-prices-are-soaring. [3]

The White House (2022), *FACT SHEET: President Biden to galvanize global action to strength energy-secutiry and tackle the climate crisis through the Major Economies Forum on Energy and Climate*, https://www.whitehouse.gov/briefing-room/statements-releases/2022/06/17/fact-sheet-president-biden-to-galvanize-global-action-to-strengthen-energy-security-and-tackle-the-climate-crisis-through-the-major-economies-forum-on-energy-and-climate/. [75]

The World Bank (2024), *Pink Sheet Commodity Prices*, https://www.worldbank.org/en/research/commodity-markets (accessed on March 2024). [33]

Turovskiy, I. and P. Mathai (2006), *Wastewater sludge processing*, John Wiley & Sons, Inc. [83]

U.S. Geological Survey (2018), *Mineral Resource of the Month: Potash*, https://www.earthmagazine.org/article/mineral-resource-month-potash/. [24]

UN Habitat and WHO (2021), *Progress on wastewater treatment – Global status and acceleration needs for SDG indicator 6.3.1*, https://unhabitat.org/sites/default/files/2021/08/sdg6_indicator_report_631_progress_on_wastewater_treatment_2021_english_pages.pdf. [82]

UN-Habitat (2008), *Global atlas of excreta, wastewater sludge, and biosolids management: Moving forward the sustainable ans welcome uses of a global resource*, https://unhabitat.org/global-atlas-of-excreta-wastewater-sludge-and-biosolids-management. [84]

UNSD (2023), *Trade data. In: UN Comtrade database*, https://comtrade.un.org/. [15]

US Environmental Protection Agency (2023), *Basic information about Biosolids*, https://www.epa.gov/biosolids/basic-information-about-biosolids#uses. [87]

USDA FAS (2023), *China Trade Data Update - 1st Half CY2023*, https://gain.fas.usda.gov/#/home. [49]

USDA FAS (2022), *Brazil agriculture seeks remedies for potential fertilizer disruptions, BR2022-0017*, https://gain.fas.usda.gov/#/home. [65]

USDA FAS (2022), *Brazil lowers agricultural tariffs to fight inflation, BR2022-0033*, https://gain.fas.usda.gov/#/home. [66]

USDA, AMS (2022), *Access to Fertilizer: Competition and Supply Chain Concerns*, https://www.regulations.gov/document/AMS-AMS-22-0027-0001. [34]

USDA, FAS (2022), *Impacts and repercussions of price increases on the global fertilizer market*, https://www.fas.usda.gov/data/impacts-and-repercussions-price-increases-global-fertilizer-market. [32]

WTO (2019), *Trade Policy Review, Costa Rica, Report by the Secretariat*, https://www.wto.org/english/tratop_e/tpr_e/s392_e.pdf. [40]

WTO Secretariat (2024), *Based on World Tariff Profiles*. [45]

Annex A.

Table A A.1. Top 20 users, producers and traders of mineral fertilisers by N content, 2019-2021

	Agricultural use			Production			Exports			Imports		
Country		Quantity (N)			Quantity (N)			Quantity (N)			Quantity (N)	
Ranking	Country	M tonnes	% total	Country	M tonnes	% total	Country	M tonnes	% total	Country	M tonnes	% total
1	China	22.1	20%	China	29.6	25%	Russia	7.1	15%	India	6.1	13%
2	India	19.6	18%	India	13.8	11%	China	6.5	14%	Brazil	5.7	12%
3	United States	11.9	11%	United States	13.4	11%	Qatar	2.4	5%	United States	4.1	9%
4	Brazil	5.8	5%	Russia	11.2	9%	Saudi Arabia	2.2	5%	France	1.9	4%
5	Pakistan	3.5	3%	Indonesia	4.2	3%	Netherlands	2.0	4%	Türkiye	1.6	3%
6	Indonesia	3.4	3%	Canada	3.8	3%	Oman	1.6	3%	Australia	1.5	3%
7	Canada	2.8	3%	Egypt	3.5	3%	Egypt	1.5	3%	Thailand	1.4	3%
8	France	2.0	2%	Pakistan	3.3	3%	United States	1.5	3%	Argentina	1.0	2%
9	Russia	1.9	2%	Saudi Arabia	2.9	2%	Algeria	1.4	3%	Canada	1.0	2%
10	Türkiye	1.8	2%	Qatar	2.6	2%	Morocco	1.4	3%	Mexico	1.0	2%
11	Ukraine	1.7	2%	Poland	2.1	2%	Belgium	1.2	3%	Germany	1.0	2%
12	Viet Nam	1.6	1%	Iran (Islamic R	1.8	2%	Germany	1.1	2%	United Kingdom	0.9	2%
13	Argentina	1.4	1%	Netherlands	1.6	1%	United Arab Emirates	1.0	2%	Spain	0.9	2%
14	Bangladesh	1.4	1%	Oman	1.6	1%	Indonesia	1.0	2%	Philippines	0.7	1%
15	Thailand	1.4	1%	Morocco	1.5	1%	Canada	1.0	2%	Ukraine	0.7	1%
16	Mexico	1.3	1%	Germany	1.4	1%	Malaysia	1.0	2%	Poland	0.7	1%
17	Australia	1.3	1%	Türkiye	1.3	1%	Lithuania	0.9	2%	Italy	0.6	1%
18	Egypt	1.3	1%	Viet Nam	1.1	1%	Poland	0.9	2%	South Africa	0.6	1%
19	Germany	1.2	1%	Algeria	1.0	1%	Iran (Islamic Republic o	0.8	2%	Belgium	0.6	1%
20	Spain	1.0	1%	Ukraine	1.0	1%	Trinidad and Tobago	0.7	2%	Romania	0.5	1%
	Top 20	88.6	82%	Top 20	102.8	85%	Top 20	37.4	81%	Top 20	32.6	69%
	World	108.0	100%	World	120.6	100%	World	46.2	100%	World	47.5	100%

1. Blue indicates countries classified in the major 26 grouping and are included in Figure 2.6.
2. Orange indicates countries classified in the other 26 group and are included in Figure 2.7.
Source: FAO (2024[11]).

Table A A.2. Top 20 users, producers and traders of mineral fertilisers by P content, 2019-2021

	Agricultural use			Production			Exports			Imports		
Country		Quantity (P)			Quantity (P)			Quantity (P)			Quantity (P)	
Ranking	Country	M tonnes	% total	Country	M tonnes	% total	Country	M tonnes	% total	Country	M tonnes	% total
1	China	4.5	22%	China	6.8	33%	China	2.4	25%	Brazil	1.8	18%
2	India	3.5	18%	Morocco	2.3	11%	Morocco	1.9	20%	India	1.3	13%
3	Brazil	2.7	14%	United States	2.3	11%	Russia	1.3	14%	United States	0.6	7%
4	United States	1.8	9%	India	2.1	10%	United States	0.9	9%	Canada	0.4	5%
5	Indonesia	0.5	3%	Russia	1.8	9%	Saudi Arabia	0.7	7%	Australia	0.3	3%
6	Pakistan	0.5	3%	Saudi Arabia	0.9	4%	Israel	0.2	2%	Argentina	0.3	3%
7	Canada	0.5	2%	Brazil	0.8	4%	Lithuania	0.2	2%	Indonesia	0.3	3%
8	Australia	0.4	2%	Türkiye	0.3	1%	Belgium	0.2	2%	Bangladesh	0.3	3%
9	Bangladesh	0.4	2%	Indonesia	0.3	1%	Norway	0.2	2%	Pakistan	0.2	3%
10	Argentina	0.4	2%	Pakistan	0.2	1%	Jordan	0.1	2%	France	0.2	2%
11	Viet Nam	0.3	2%	Australia	0.2	1%	Mexico	0.1	1%	Ukraine	0.2	2%
12	Türkiye	0.3	1%	Viet Nam	0.2	1%	Tunisia	0.1	1%	Türkiye	0.2	2%
13	Russia	0.3	1%	Poland	0.2	1%	Netherlands	0.1	1%	Mexico	0.1	2%
14	Mexico	0.2	1%	Mexico	0.2	1%	Australia	0.1	1%	Spain	0.1	2%
15	Spain	0.2	1%	Israel	0.2	1%	Finland	0.1	1%	Thailand	0.1	1%
16	France	0.2	1%	Jordan	0.2	1%	Belarus	0.1	1%	Viet Nam	0.1	1%
17	Ukraine	0.2	1%	Norway	0.2	1%	Türkiye	0.1	1%	Romania	0.1	1%
18	Poland	0.1	1%	Egypt	0.1	1%	Poland	0.1	1%	Japan	0.1	1%
19	Japan	0.1	1%	Lithuania	0.1	1%	Korea	0.1	1%	Germany	0.1	1%
20	South Africa	0.1	1%	Belgium	0.1	1%	Viet Nam	0.1	1%	Poland	0.1	1%
	Top 20	17.4	86%	Top 20	19.5	94%	Top 20	8.8	94%	Top 20	7.2	75%
	World	20.2	100%	World	20.8	100%	World	9.4	100%	World	9.6	100%

1. Blue indicates countries classified in the major 26 group and are included in Figure 2.9.
2. Orange indicates countries classified in the other 26 group and are included in Figure 2.10.
Source: FAO (2024[11]).

Table A A.3. Top 20 users, producers and traders of mineral fertilisers by K content, 2019-2021

Country Ranking	Agricultural use			Production			Exports			Imports		
		Quantity (K)			Quantity (K)			Quantity (K)			Quantity (K)	
	Country	M tonnes	% total	Country	M tonnes	% total	Country	M tonnes	% total	Country	M tonnes	% total
1	China	8.0	25%	Canada	10.9	30%	Canada	10.3	35%	United States	6.2	19%
2	Brazil	6.1	19%	Russia	8.0	21%	Russia	5.8	20%	Brazil	6.0	19%
3	United States	3.7	12%	Belarus	6.2	17%	Belarus	4.9	17%	China	4.5	14%
4	India	2.3	7%	China	4.0	11%	Germany	1.9	6%	India	2.2	7%
5	Indonesia	1.6	5%	Germany	2.1	6%	Israel	1.8	6%	Indonesia	1.7	5%
6	Malaysia	0.7	2%	Israel	1.8	5%	Jordan	1.1	4%	Malaysia	0.8	2%
7	Canada	0.6	2%	Jordan	1.3	4%	Chile	0.4	1%	Belgium	0.7	2%
8	Viet Nam	0.5	1%	Chile	0.7	2%	China	0.4	1%	Poland	0.6	2%
9	Thailand	0.4	1%	Spain	0.6	2%	Spain	0.4	1%	Viet Nam	0.6	2%
10	Poland	0.4	1%	Poland	0.3	1%	Belgium	0.3	1%	France	0.5	1%
11	France	0.4	1%	United States	0.3	1%	Netherlands	0.3	1%	Thailand	0.5	1%
12	Russia	0.4	1%	Brazil	0.2	1%	Norway	0.3	1%	Korea	0.4	1%
13	Bangladesh	0.4	1%	Uzbekistan	0.2	0%	United States	0.2	1%	Netherlands	0.4	1%
14	Colombia	0.4	1%	Korea	0.1	0%	United Kingdom	0.2	1%	Spain	0.3	1%
15	Belarus	0.4	1%	Türkiye	0.1	0%	Finland	0.1	1%	Colombia	0.3	1%
16	Germany	0.3	1%	Colombia	0.1	0%	Morocco	0.1	0%	Australia	0.3	1%
17	Spain	0.3	1%	United Kingdon	0.1	0%	Poland	0.1	0%	Japan	0.3	1%
18	Ukraine	0.3	1%	Philippines	0.1	0%	Uzbekistan	0.1	0%	Ukraine	0.3	1%
19	Australia	0.2	1%	Croatia	0.0	0%	Chinese Taipei	0.1	0%	United Kingdom	0.3	1%
20	United Kingdom	0.2	1%	Turkmenistan	0.0	0%	Viet Nam	0.1	0%	Bangladesh	0.3	1%
	Top 20	27.7	87%	Top 20	37.0	100%	Top 20	28.7	97%	Top 20	26.7	84%
	World	32.0	100%	World	37.0	100%	World	29.5	100%	World	31.9	100%

Blue indicates countries classified in the major 26 group and are included in Figure 2.12.
Orange indicates countries classified in the other 26 group and are included in Figure 2.13.
Source: FAO (2024[11]).

Table A A.4. Total household wastewater generated, collected and treated by country, 2021

Country	EU27	OECD	Additional countries covered by PSE	Total household wastewater million m^3 Generated	Collected	Safely treated	Proportion of total household wastewater generated Collected	Safely treated
China			Y	71,481	51,721	46,305	72%	65%
India			Y	34,533	10,335	9,171	30%	27%
Russia			Y	4,095	3,909	529	95%	13%
United States		Y		11,574	10,683	10,539	92%	91%
Canada		Y		1,312	1,173	1,011	89%	77%
Brazil			Y	8,443	4,903	2,788	58%	33%
Belarus				263	218	148	83%	56%
Indonesia			Y	6,903	-	-	n.a.	n.a.
Pakistan				5,899	-	-	n.a.	n.a.
Germany	Y	Y		5,122	5,084	5,084	99%	99%
Morocco				552	228	200	41%	36%
France	Y	Y		2,840	2,627	2,627	93%	93%
Poland	Y	Y		1,522	1,246	1,246	82%	82%
Viet Nam			Y	2,868	-	-	n.a.	n.a.
Netherlands	Y	Y		725	723	723	100%	100%
Türkiye		Y		4,342	3,628	2,750	84%	63%
Australia		Y		875	833	666	95%	76%
Israel		Y		303	296	282	98%	93%
Ukraine			Y	1,432	793	491	55%	34%
Mexico		Y		4,358	2,679	2,544	61%	58%
Belgium	Y	Y		418	383	383	92%	92%
Argentina			Y	1,551	965	566	62%	36%
Spain	Y	Y		2,425	2,126	2,086	88%	86%
United Kingdom		Y		2,379	2,350	2,350	99%	99%
Lithuania	Y	Y		159	149	149	93%	93%
Norway		Y		282	270	213	96%	76%
Colombia		Y		1,726	666	367	39%	21%
Philippines			Y	3,193	1,564	1,371	49%	43%
Italy	Y	Y		2,080	2,066	1,971	99%	95%
Chile		Y		769	721	696	94%	91%
South Africa			Y	1,700	1,121	1,042	66%	61%
Finland	Y	Y		302	279	279	92%	92%
Korea		Y		1,790	1,782	1,782	100%	100%
Japan		Y		12,023	11,761	11,761	98%	98%
New Zealand		Y		370	343	315	93%	85%
Ireland	Y	Y		169	144	141	85%	83%
Hungary	Y	Y		352	315	315	90%	90%
Czechia	Y	Y		369	332	332	90%	90%
Sweden	Y	Y		576	548	548	95%	95%
Slovakia	Y	Y		367	302	293	82%	80%
Denmark	Y	Y		231	222	222	96%	96%
Greece	Y	Y		365	338	338	93%	93%
Estonia	Y	Y		45	41	41	91%	91%
Kazakhstan			Y	536	222	191	41%	36%
Austria	Y	Y		713	703	703	99%	99%
Latvia	Y	Y		98	92	91	94%	93%
Portugal	Y	Y		483	382	356	79%	74%
Costa Rica		Y		170	68	40	40%	23%
Switzerland		Y		421	418	418	99%	99%
Slovenia	Y	Y		57	40	38	69%	67%
Luxembourg	Y	Y		22	21	21	98%	96%
Iceland		Y		12	12	9	97%	73%
Total OECD member countries				62,145	55,846	53,730	90%	86%
Total all 52 countries				205,594	131,825	116,533	64%	57%
Total of major 26 countries				176,653	107,322	92,852	61%	53%
Total of other 26 countries				28,941	24,504	23,681	85%	82%
World total				270,675	157,340	150,232	58%	56%

Note: Countries highlighted in blue are referenced as the "major 26" grouping of countries for the purpose of this report. The remaining are referenced as the "other 26" countries. Countries are listed in the same order as in Table 1.2.
Source: UN Habitat and WHO (2021[82]).

OECD FOOD, AGRICULTURE AND FISHERIES PAPERS

This report is published under the responsibility of the Joint Working Party on Agriculture and Trade.

Comments are welcome and can be sent to tad.contact@oecd.org.