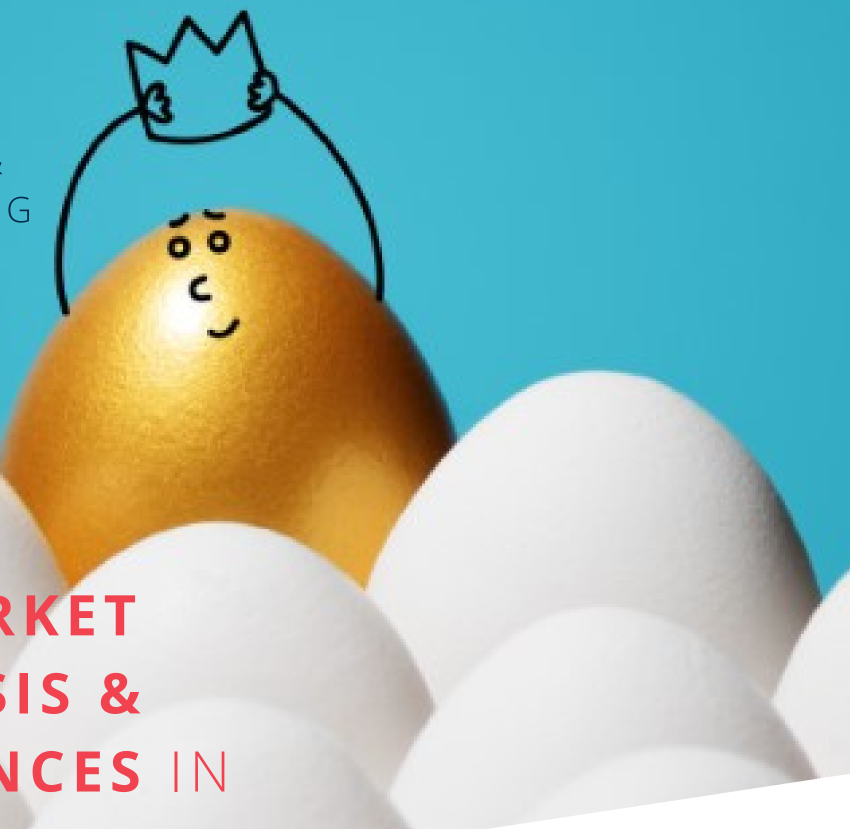
FERTIMANURE

Innovative nutrient recovery from secondary sources – Production of high-added value **FERTI**lisers from animal **MANURE**



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D1.2.
REPORT ON **THE MARKET LANDSCAPE ANALYSIS & END-USER PREFERENCES** IN THE PROJECT-PARTICIPATING **EU** STATES STATES.

FERTIMANURE

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D1.2 – Report on the market landscape analysis and end-user preferences in the project participating EU states

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List of Abbreviations

AN	Ammonium nitrate
AS	Ammonium sulphate
ASN	Ammonium sulphate nitrate
BBF	Bio – Based Fertilisers
CAN	Calcium ammonium nitrate
CELAC	Community of Latin American and Caribbean States
DAP	Diammonium phosphate
EC	European Commission
EU	European Union
EUR	euro
ESU	Economic Size Units
FSS	Farm Structure Survey
GVA	Gross Value Added
ha	Hectare
KN	Potassium nitrate
MAP	Monoammonium phosphate
MOP	Muriate of potash
MS	Member State
N	Nitrogen
NPK	Nitrogen phosphorus potassium
OM	organic matter
P	Phosphorus
PC	Project Coordinator
PMB	Project Management Board
PTC	Project Technical Committee
SO	Standard Output
SOP	Sulphate of potash
SSP	Single superphosphate
TMF	Tailor Made Fertilisers
TSP	Triple superphosphate
UAA	Utilized agricultural area
UAN	Urea ammonium nitrate
USD	US dollar
WP	Work Package

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1. Preface

This report is part of the Horizon 2020 project Fertimanure – “From Farm to Market: Upcycling manure to improved fertilising products”. The project is coordinated by BETA Technological Centre at the University of Vic in Catalonia, Spain, and includes together 20 partners from 7 EU countries, Argentina and Chile. It includes universities, research centres, cluster organisations, public bodies, SMEs and NGOs.

This report is part of Work Package 1: FERTIMANURE framework and as such constitutes the required deliverable D1.2 Report on the market landscape analysis and end-user preferences in the project participating EU states, Task 1.2. Market landscape analysis and end-users preferences.

The exact description of Task 1.2 is as follows:

First step in understanding market potential of the FERTIMANURE end-products (BBFs and TMFs) is to perform a market landscape analysis and detect the issues that could be of importance for the future sector development (e.g. advantages and shortcomings, legal or geographical limitations etc.). Special emphasis will be placed on the EU fertilizer market as well as on the already existing BBFs (where this is possible) in order to get a clear image on the size of the market, distribution of different fertilizers at the market and connection between fertilizer types and agricultural sectors. This will also be of great value for the transferability of data/findings from the project on-farm pilots. The second part of the task is an evaluation of end-users preferences in order to detect parameters that are important to relevant stakeholders when making decisions. One of the experienced bottlenecks of the BBFs market implementation is the farmers acceptance – understanding product´s short and long-term advantages, accessibility, application process etc. Exploration of different farmers needs and requirements and its continuous involvement in the research process will lead to the development of market suitable end products. Next to EUs fertilizer market, special emphasis will be placed on the CELAC market and notions of CELAC farmers regarding new fertilizers acceptance. This activity will be performed through different communication channels (via different questionnaires, workshops etc.) and will occur in all participating countries. The outputs of this WP will serve as a baseline for the subsequent tasks of the project. Furthermore, the task will be closely linked with the activities performed within WP6 and WP7.

This report updates members of the **FERTIMANURE** project on the present farming and agri-food production structure in Europe and CELAC region, explains how it has changed over the course of years and describes conditions that shaped those changes in the production paradigm. Furthermore, report´s aim is to inform about both past as well as to present agri-food status in Europe.

The review will focus on the most important aspects related to the fertiliser market, evolution of European agricultural production, effects of nutrient balances on agricultural sector and legislative framework related to fertilisers production and consumption.

The methodology employed is mainly based on desk research techniques via literature review, partners years of experience and targeted interviews/discussion with experts. Information on the CELAC region are based on the input and reports from the Argentinian partner.

2. Overview of the consortium´s state-of-the-art statistics in agriculture

2.1. Geographical overview

The FERTIMANURE project includes 19 partners from 7 EU countries and 1 partner from CELAC region. EU countries participating in the project include **France, Germany, Spain, Italy, Belgium, The Netherlands** and **Croatia** (Figure 1). CELAC region is represented by **Argentina and Chile**.

Project consortium is geographically well distributed across EU-27 with an intention to cover diverse range of agricultural and nutrient management practices and includes stakeholders with different knowledge background and fertiliser needs. CELAC region is represented by the largest CELAC member state – Argentina and Chile.

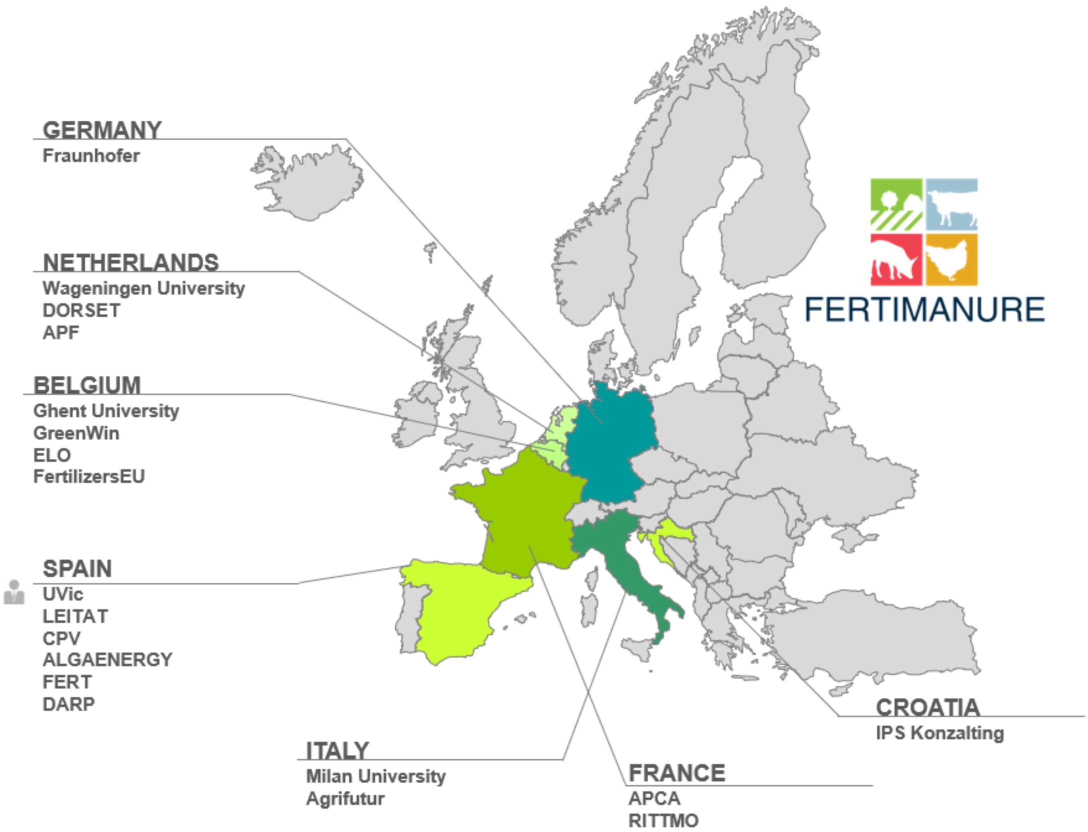


Figure 1 Map of FERTIMANURE consortium – EU

2.1.1. Europe geographical overview

Geographically, Europe can be divided into 4 major physical regions, running from north to south: Western Uplands, North European Plain, Central Uplands and Alpine Mountains (Table 1., Boudreau D et al, 2012).

Table 1 Overview of geographical regions in Europe

Region	Description of region
Western Uplands	The Western Uplands, also known as the Northern Highlands define the physical landscape of Scandinavia (Norway, Sweden, and Denmark), Finland, Iceland, Scotland, Ireland, the Brittany region of France, Spain, and Portugal. The Western Uplands is defined by hard, ancient rock that was shaped by glaciation.
North European Plain	The North European Plain extends from the southern United Kingdom east to Russia. It includes parts of France, Belgium, the Netherlands, Germany, Denmark, Poland, the Baltic states (Estonia, Latvia, and Lithuania), and Belarus. The climate supports a wide variety of seasonal crops. North European Plain remains the most densely populated region of Europe.
Central Uplands	The Central Uplands extend east-west across central Europe and include western France and Belgium, southern Germany, the Czech Republic, and parts of northern Switzerland and Austria. The Central Uplands are lower in altitude and less rugged than the Alpine region and are heavily wooded.
Alpine Mountains	The Alpine Mountains include ranges in the Italian and Balkan peninsulas, northern Spain, and southern France. The region includes the mountains of the Alps, Pyrenees, Apennines, Dinaric Alps, Balkans, and Carpathians.

The Nomenclature of Territorial Units for Statistics (NUTS) was drawn up by Eurostat decades ago to provide a breakdown of the economic territory of the European Union into territorial units. The current NUTS nomenclature, applicable from 1 January 2018, subdivides the economic territory of the European Union into 104 regions at NUTS 1 level, 281 regions at NUTS 2 level and 1 348 regions at NUTS 3 level (Figure 2, Regions in the European Union, 2018).

Figure 2 Map of European Union (europa.eu)

2.1.2. CELAC geographical overview

The Community of Latin American and Caribbean States (CELAC) is an intergovernmental mechanism that includes 33 countries in Latin America and the Caribbean (Figure 3).

The countries forming the CELAC are: **Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Ecuador, El Salvador, Granada, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Dominican Republic, St. Lucia, St. Kitts and Nevis, St. Vincent and Grenadines, Trinidad and Tobago. Uruguay and Venezuela.**

Representative of CELAC region in the project is **Argentina and Chile. –**Argentina is a bi-continental country in the southern part of South America. It is subdivided in 23 provinces and an autonomous city (the federal capital) which totalizes 2.780,400 km^2. Argentina is the second largest country in the South America after Brazil and eight worldwide. Argentina is the second most important economy of South America. It is one of the three Latin American sovereign states that are part of the G20 (Group of 20). Chile is situated along the western seaboard of the South America. Total area reaches 291,931 square miles. Chile is divided into 16 regions which are further organized into 57 provinces (Statoids, Regions of Chile, 2018).

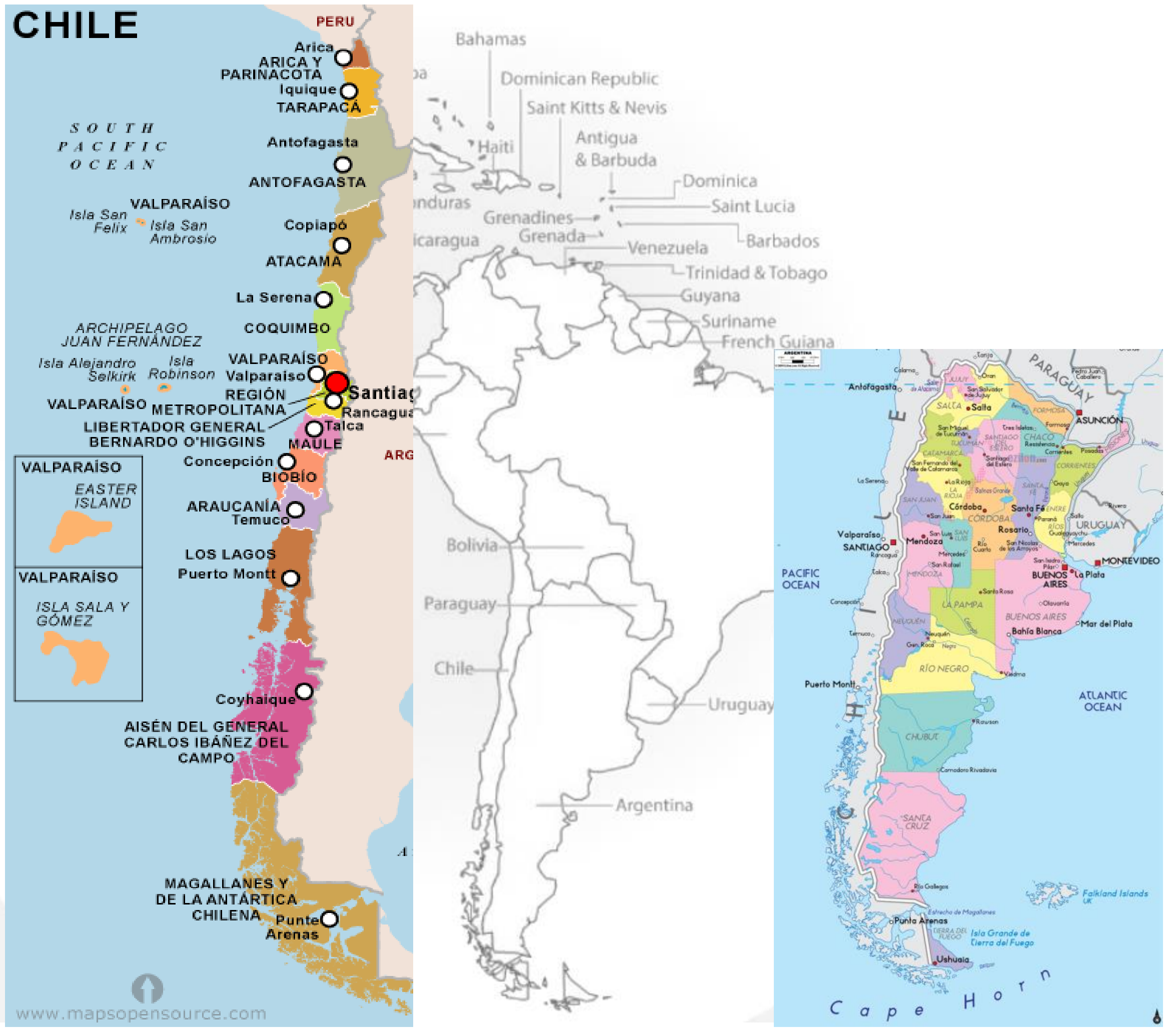


Figure 3 Map of Argentina (ezilon.com), Chile (mapsopensource.com) and CELAC region (telesurenglish.net)

3. Agricultural production in the EU and CELAC

3.1. Overview of agricultural production in the EU and CELAC

Agricultural statistic data presented here for the EU are based on different surveys and statistical overviews. Most of the agricultural data used in the report refer to either Farm Structure Survey (FSS) from 2016 or the last Statistical Book issued in 2019.

When analysing agricultural sector, it is crucial to say that there were 10,5 million agricultural holdings in the EU in 2016. The number of farms in the EU decreased by about one quarter in the relatively short period between 2005 and 2016, meaning that around 4,2 million of farms across the Member States have been lost.

The amount of land used in the EU for agricultural production has remained steady. The consolidation in the amount of agricultural land used in the EU reflects the growth in the number of the largest holdings and the land they use for agricultural purposes.

The vast majority of the EU farms are so called family farms (96 % in 2016). Furthermore, most farms are small in nature. Two thirds of the EU´s farms were less than 5 hectares (ha) in size in 2016. Although the average mean size of an agricultural holding in the EU was 16.6 ha in 2016, only about 15 % of farms were this size or larger (Cook E., 2019).

EU farms can be broadly characterised as following:

		Type of farms	Characterisation of farm type (2016)
	1	**semi-subsistence**	✓ 4 million farms are in terms of standard output (SO) below 2.000 EUR/year ✓ these farms are responsible for only 1 % of the EU´s total agricultural economic output ✓ around 30 % of such farms consume more than 50 % of their own production
	2	**small and medium-sized farms**	✓ 3 million farms are in terms of SO within the range of 2.000 – 8.000 EUR/year
	3	**large agricultural enterprises**	✓ 304.000 farms (2,9 % of the EU total) each produced an SO of 250.000 EUR/year or more ✓ these farms were responsible for a majority (55,6 %) of the EU´s total agricultural economic output

Table 2 Overview of farm size in the EU

Statistics indicated in Figure 4 show that Romania has the highest number of registered farms and on the other side, their SO is relatively small. However, project consortium member states are mostly located in the upper part of the figure and support the fact that these countries have a well-developed agricultural production with not only numerous agricultural holdings but also with a higher SO meaning that Consortium represents a significant number of agricultural holdings located across the EU.

The EU´s agricultural industry created (gross) value added of 181,7 billion EUR in 2018, meaning that agriculture contributed 1,1 % to the EU´s GDP in 2018 (Eurostat, 2018).

The agricultural sector in the EU invested an estimated 59,0 billion EU in 2018, accounting for 32,5 % of Gross Value Added (GVA). Almost ¾ of this investment was made in only 6 Member States: France (17,7 % of the EU total), Germany (15,7 %), Italy (14,8 %), the Netherlands (8,0 %), the United Kingdom (7,9 %) and Spain (7,7 %) (Eurostat, Agriculture, forestry and fishery statistics, 2019).

The level of investment in the EU agriculture in 2018 was an estimated 2,3 billion EUR more than in 2017 and 4,6 billion EUR more than in 2016 ([Eurostat, Agriculture, forestry and fishery statistics, 2019]()).

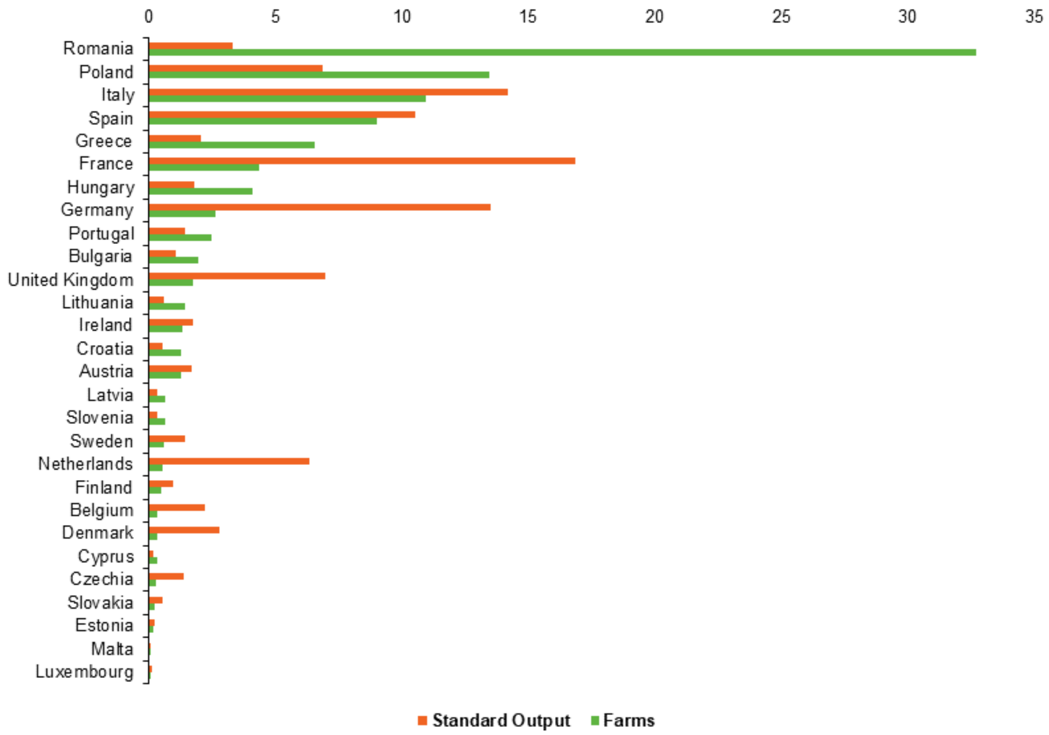


Figure 4 Farms and standard output (share of EU total, %) ([Eurostat, FSS, 2016]())

Figure 5 shows positioning of each EU Member State regarding an average size of family farms. Farms with the most hectares in the EU are in the United Kingdom, Luxembourg, Denmark, Germany, Finland and France. For example, an average farm size in the UK is around 68 ha, while in the Netherlands it is around 33 ha and in Croatia it is only 8 ha. When all data are analysed, the EU -28 average sums up to 12 ha per farm.

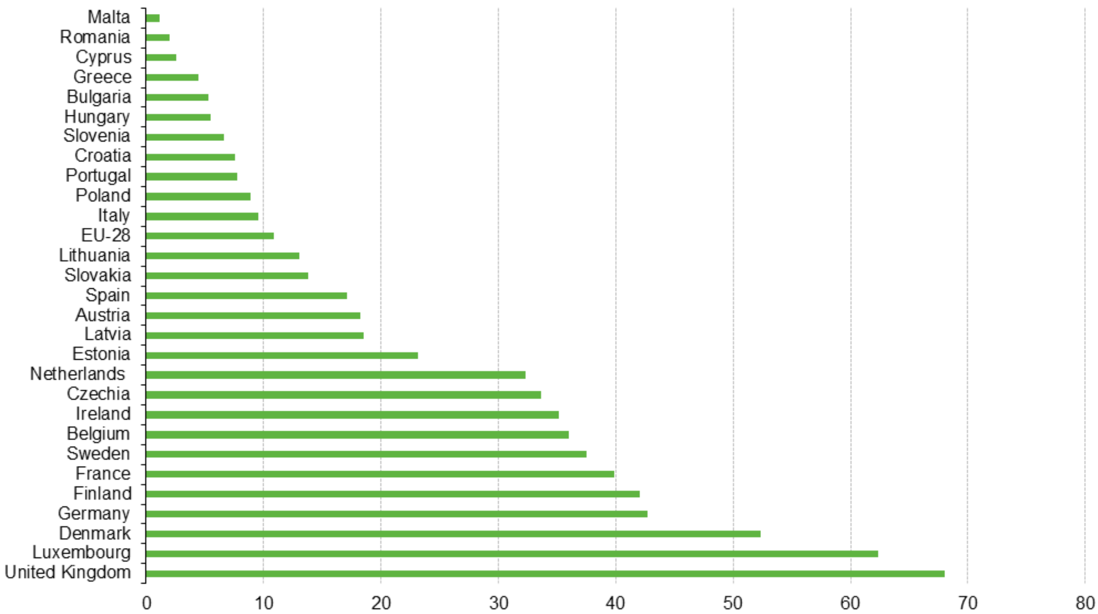
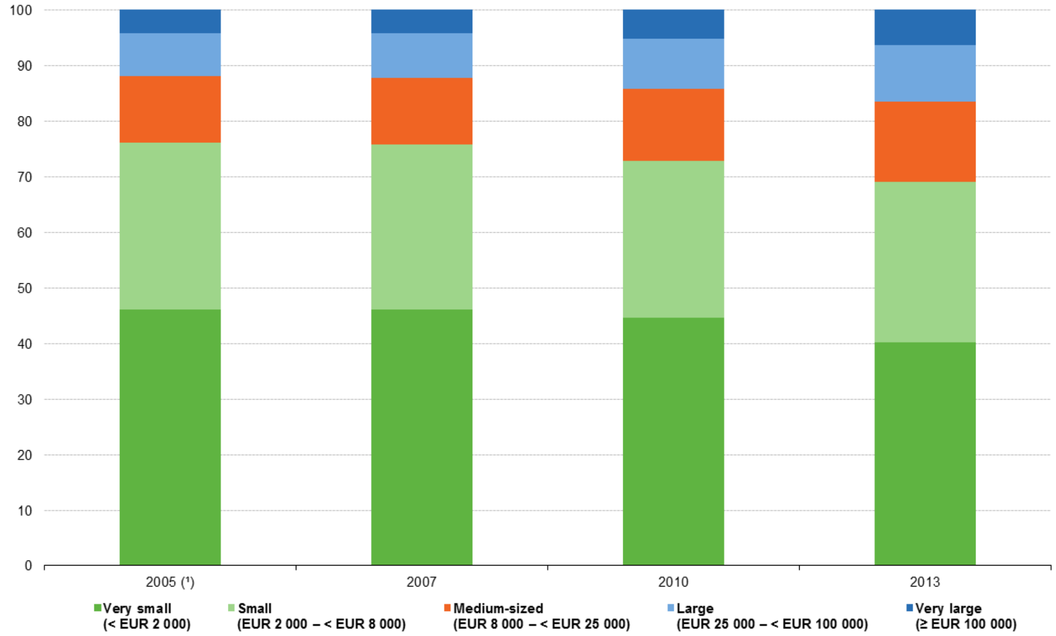


Figure 5 Average size of family farms, ha per farm ([Eurostat, FSS, 2016]())

When analysing agricultural sector and different agro-related markets, it is substantial do understand trends that happen over a course of time. With that said, share of total number of farm holdings by economic size in EU are more or less similar within period of 2005 to 2013 (Figure 6).



(¹) Excluding Croatia.

Figure 6 Share of the total number of farms, by economic size of farm, EU-28, 2005-2013 (% of total) ([Eurostat, 2016]())

There were 10,3 million people working as farm managers in the EU in 2016. The average age of farmers is very much at the older end of the age spectrum – 32 % of farm managers were older than 65 years, while only 11 % of farm managers were younger than 40.

Most farm managers in the EU have only practical experience – 68,3 % in 2016. Only 9,1 % of farm managers had full agricultural training and the rest (22,6 %) had basic agricultural training.

When it comes to farm labour, most farms in the EU (90 %) were farms with only family workers. Across all the farms in the EU-28, family farms used 81,4 % of the regular agricultural labour force (Figure 8).

Farms by type of farm labour, 2016
(thousands except for standard output (million))

	Total farms	Family farms	*Farms with only family workers*	*Farms where family workers make up 50% or more (not 100)*	Non-family farms	*Farms where family workers make up less than 50% (not 0)*	*Farms with no family labour force*
(thousands)							
Number of holdings	10 465	9 956	9 728	228	509	176	333
Utilised agricultural area (hectares)	173 453	107 959	92 402	15 558	65 494	18 231	47 263
Livestock (livestock units)	126 240	78 936	62 278	16 658	47 304	17 961	29 343
Regular labour force (annual work units)	8 259	6 727	6 272	455	1 532	583	949
Standard output (million euro)	352 189	209 722	169 132	40 590	142 466	51 070	91 396
(% of total)							
Number of holdings	100	95.2	93.0	2.2	4.9	1.7	3.2
Utilised agricultural area (hectares)	100	62.3	53.3	9.0	37.7	10.5	27.2
Livestock (livestock units)	100	62.5	49.3	13.2	37.4	14.2	23.2
Regular labour force (annual work units)	100	81.4	75.9	5.5	18.6	7.1	11.5
Standard output (million euro)	100	59.5	48.0	11.5	40.5	14.5	26.0

Figure 7 Farms by type of farm labour (Eurostat, FSS, 2016)

Figure 8 shows that the EU farms remain diverse in terms of what they grow or rear – 52,5 % of all farms in 2016 were categorized as crops specialist, 31,6 % of farms were specialized in field cropping, 18,9 % were specialised in permanent crops and only 1,8 % of farms were being classified as horticulture specialists.

On the other side, 25,1 % of EU´s farms were livestock farms, 6,2 % sheep/goats and other grazing livestock farms and 5,4 % were dairy farms. Mixed farms made up most of the rest (21,1 %). There were 87 million bovine animals, 148 million pigs, 98 million sheep and goats in 2018.

However, majority of livestock were held in just a few large Member States (Figure 9). Three quarters of the EU´s bovine population was kept in France (21,2 %), Germany (13,7 %) and the United Kingdom (11 %), Ireland (7,5 %), Spain (7,4 %), Italy (7,2 %) and Poland (7,1 %). Almost three quarters of the EU´s pigs were found in Spain (20,8 %), Germany (17,8 %), France (9,3 %), Denmark (8,5 %), the Netherlands (8,1 %) and Poland (7,4 %).

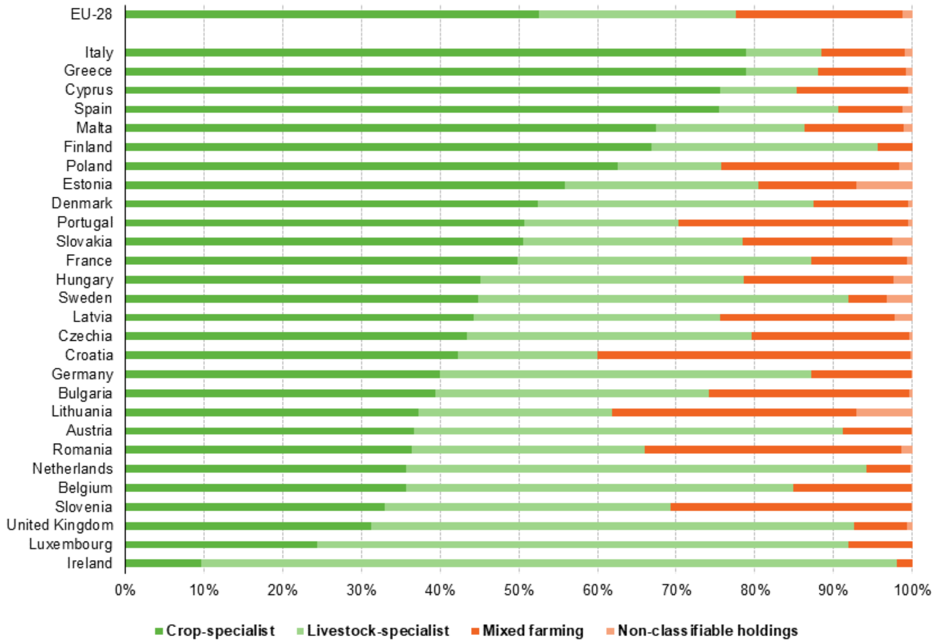


Figure 8 Specialization of agricultural holdings (% of total holdings) (Eurostat, FSS, 2016)

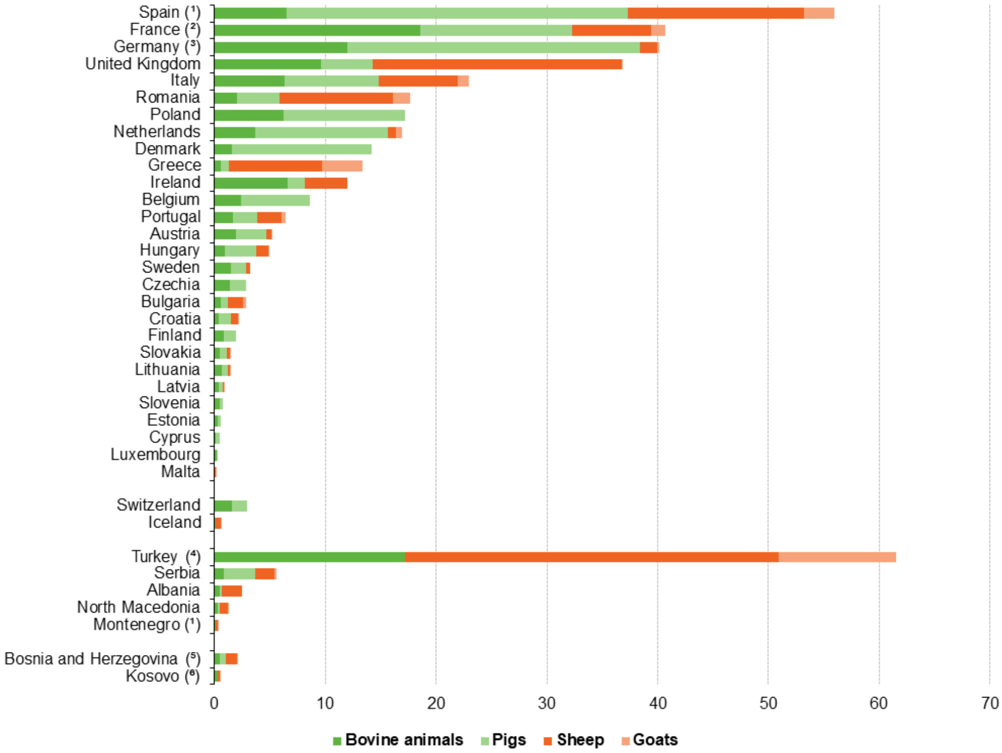


Figure 9 Livestock population in the EU-28 (million heads) ([Eurostat, 2018](#))

3.2. Overview of the agricultural sector in the EU

The value of the output produced by the EU´s agricultural industry was an estimated 432,6 billion EUR in 2017 (Figure 10, [Eurostat, Agriculture, forestry and fishery statistics, 2019](#)).

Out of the total output of the EU´s agricultural industry in 2017, 50,6 % came from crops, within which vegetables and horticultural plants and cereals were the most valuable. The most common cereals are wheat and spelt (46,0 %), grain maize and corn-cob mix (20,9 %) and barley (18,90 %). A further two-fifths (40,9 %) came from animals and animal products – mainly from milk, pigs, and cattle. Agricultural services and other non-agro activities contributed the remaining 8,5 %.

Contributions from Member States vary significantly. In 2018, 55 % of the total output value of the EU´s agricultural industry came from France (77,2 billion EUR), Italy (56,9 billion EUR), Germany (52,7 billion EUR) and Spain (52,2 billion EUR). About another one quarter (23,4 %) came from the combined output of the United Kingdom, the Netherlands, Poland, and Romania. At the end, 78,4 % of the total value of the EU´s agricultural industry in 2018 came from these 8 Member States.

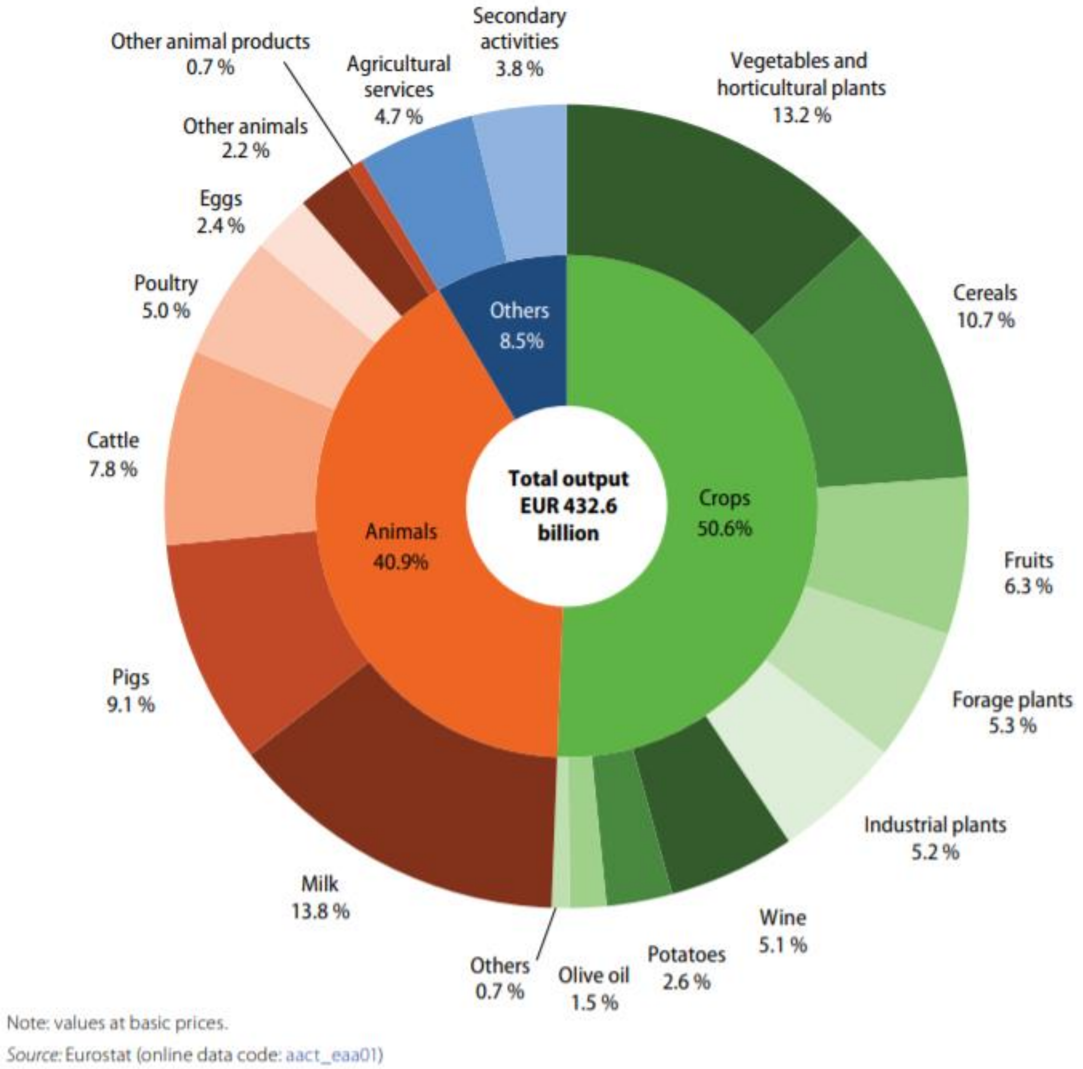
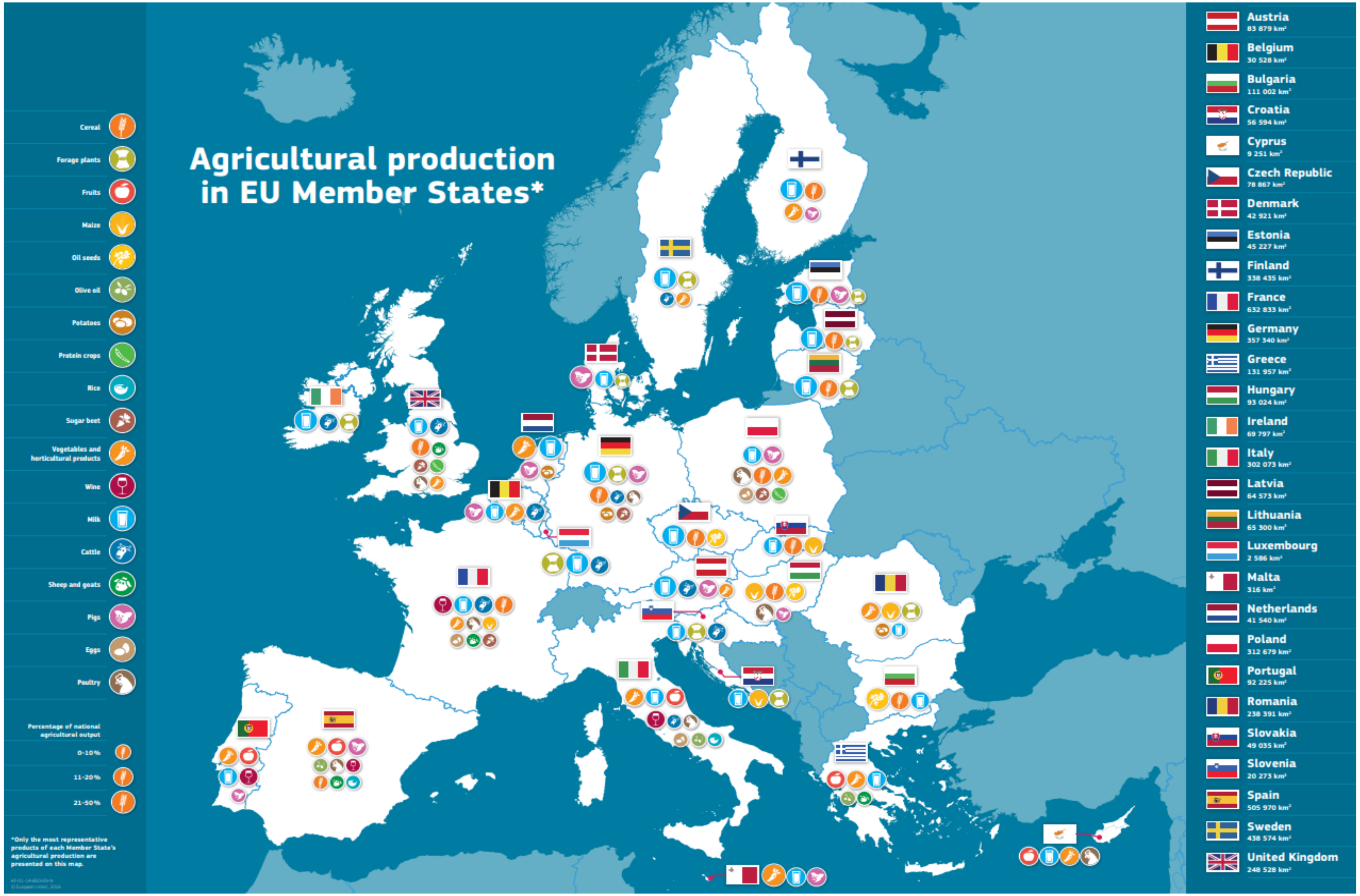


Figure 10 Output of the agricultural industry, EU – 28 (% of the total output) (Eurostat, 2017)

Overview of the most important agricultural production types per country and across the EU Members States is indicated in Figure 11.

Figure 11 Most representative agricultural products per EU Member States ([Agricultural production in EU Member States, 2016](#))



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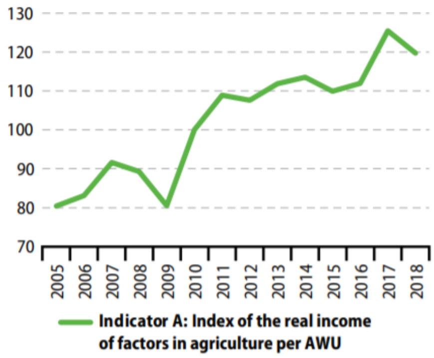
3.2.1. Agricultural statistics – key figures

EU-28

Key information:

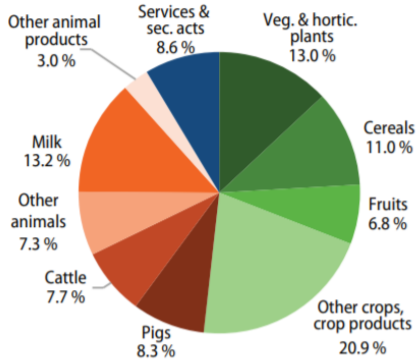
Total land area	**2016**	4 346 737	km²
Share of farmland in total land area	**2016**	*39.9 %*	share of total land area
Gross Domestic Product	**2018**	15 898.3	EUR billion
Population	**2018**	512.4	million

Figure 1: Agricultural factor income per annual work unit, 2005-2018
(index 2010=100)



Source: Eurostat (online data code: aact_eaa06)

Figure 2: Output of the agricultural industry, 2018
(% of total output value, at basic prices)



Source: Eurostat (online data code: aact_eaa01)

Farms and farmland			
Farmland (utilised agricultural area)	**2016**	*173 339*	thousand hectares
Farms (agricultural holdings)	**2016**	*10 467 760*	number
Very small farms (with < EUR 8 000 of standard output)	**2016**	*67.6 %*	share of all farms
Family farms (with > 50 % of regular labour from family members)	**2016**	96.0 %	share of all farms

Farmers			
Employment in agriculture	**2017**	*4.1 %*	share of total employment
Total labour force input in agriculture	**2018**	*9 256*	thousand annual work units
Young farmers (under 40 years old)	**2016**	*10.6 %*	share of all farm managers
Female farmers	**2016**	*28.4 %*	share of all farm managers
Farmers with full agricultural training	**2016**	9.1 %	share of all farm managers

Economic performance of agriculture			
Contribution of agriculture to Gross Domestic Product	**2018**	*1.1 %*	share of GDP
Gross value added (at basic prices)	**2018**	*181 738*	EUR million
Value of agricultural output (production value at basic prices)	**2018**	*434 291*	EUR million
Value of crop output	**2018**	*224 850*	EUR million
Value of animal output	**2018**	*172 000*	EUR million
Agricultural factor income per annual work unit (Indicator A)	**2018**	*-4.6 %*	change 2018/2017

Agricultural production			
Cereals	**2018**	295 113	thousand tonnes
Root crops	**2018**	*173 412*	thousand tonnes
Fresh vegetables	**2018**	62 297	thousand tonnes
Permanent crops	**2018**	80 644	thousand tonnes
Raw milk	**2018**	*172 200*	thousand tonnes
Bovine meat	**2018**	7 932	thousand tonnes
Pig meat	**2018**	23 846	thousand tonnes
Poultry meat	**2018**	*15 200*	thousand tonnes

Figure 12 Agricultural production in EU-28 – key statistical figures (Eurostat, 2018)

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3.2.2. Summary of agricultural production across FERTIMANURE consortium

The FERTIMANURE Consortium includes 7 EU Member States (MS) and CELAC region (Argentina). The following table provides some of the information (2016, 2018) relevant for the agricultural sector in the Consortium MS to get a better image on the size of the agro production and its relevance in terms of economy.

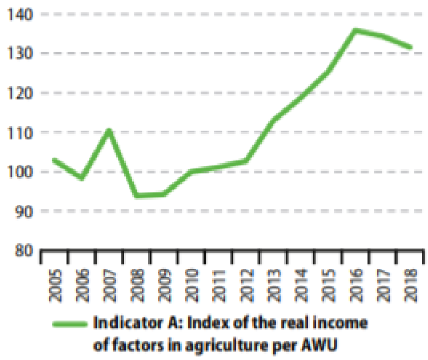
Spain	**With 13,4 % share of the total farmland and 9 % of farms in the EU, the value of the output of the agricultural industry amounted 52.2 billion EUR in 2018. The most important sectors for the output generation include fruits, vegetable, and crops production, as well as pig farming. Majority of farms are family farms (88,5 %) and 8,6 % are young farmers.**
France	With 16 % share of the total farmland and 4,4 % of farms in the EU, the output of the agricultural industry amounted 77,2 billion EUR in 2018 meaning that France has the highest output among MS. Key agricultural sectors include wine and milk production as well as cereals production and cattle farming. The value of crop output was significantly higher when compared to animal output (44,31 billion EUR in 2018). Majority of farms are family farms (72,3 %) and a significant number of farm managers have full agricultural training (34,9 %).
Belgium	With only 0,8 % share of the total farmland and only 0,4 % of farms in the EU, the value of the output of the agricultural industry amounted 8,2 billion EUR in 2018 and majority of it distributed over horticulture, pigs farming and milk production. Value of crop output amounts 3,6 billion EUR while value of animal output amounts 4,5 billion EUR. Majority of farms are family farms. Young farmers account for 10 % of the total farm managers and ¼ of all farm managers have full agricultural training.
Italy	With 7,3 % share of the total farmland and almost 11 % of farms in the EU, the value of the output from the agricultural industry amounted 56,9 billion in 2018 and majority of it distributed over wine, vegetables and cereals production. Services in agriculture amount for around 17 % of the total output. Around 50 % of farms in Italy are characterized as very small farms (50,6 %) and there is a significant number of female farmers (31,5 %).
Germany	With 9,6 % share of the total farmland and 2,6 % of farms in the EU, the value of output from the agricultural industry amounted 52,7 billion EUR in 2018. The economic output is almost evenly distributed between crop and animal production and most valuable sectors are milk, cereals and horticulture production and pig farming. Majority of farms are family farms (95 %). Young farmers account for 14,7 % of all farm managers.
Croatia	With only 0,9 % share of the total farmland and 1,3 % of farms in the EU, the value of output from the agricultural industry amounted 2,3 billion EUR in 2018. Agricultural output is based mainly on cereals, industrial crops, and horticulture production. Majority of farms in Croatia are family farms (96,8 %). Young farmers account for 10,5 % and there are only 2,4 % of farmers with full agricultural training.
The Netherlands	With 1 % share of the total farmland and 0,5 % of farms in the EU, the value of output from the agricultural industry amounted 28,2 billion in 2018. The most important sectors include vegetables and horticulture plants and milk production and pig farming. Services in agro sector are also significantly presented in the total output (12,4 %). Majority of farms are so called family farms (91,2 %) and young farmers account 8.7 % of the total farm managers. Around 9,4 % of the total farm managers are farmers with full agricultural training.
Argentina	A significant 55 % of the total land area in Argentina is reported as agricultural land. Agriculture in Argentina's economy accounted for 9 % of the GDP. Main crops include soybeans, cattle meat, sunflower seed, sugar cane and apples. Argentina is the world's third biggest soybean exporter (57,8 million tonnes in 2017). Majority of Argentina´s farms are family farms (75 %) that account for 18 % of the country´s agricultural land and produce 27 % of total agro output. Non-family farms account for 79 % of Argentina´s agricultural land (World Agriculture Watch – Argentina).
Chile	Mainland Chile has an area of 75.6 million hectares (ha), 51.7 million of which are suitable for mixed agriculture and 35.5 million of which are used for agricultural livestock raising or forestry. However, due to geographical and economic factors, the area under cultivation currently stands at just 2.12 million ha. This area is distributed among 1.303,210 ha of annual and permanent crops, 401,018 ha of sown fields and 419,714 ha of fallow land (Sustainable Agriculture and Healthy Food in Chile, Fuster R. and Mattar C., 2019). The agricultural sector has decreased its share in GDP from nearly 10 % to only 3 % explained by the significant increase in the services of the national economy. In monetary terms the agricultural GDP is growing from US $ 5.190 million in 2008 to US $ 5.938 million in 2010 and US $ 7.326 million in 2013 (FAO, Chile Case Study, 2016).

Table 3 Summary of agricultural information in the FERTIMANURE consortium (Eurostat, 2018; Factsheet – Agribusiness in Argentina, 2016)

3.2.3. Agricultural production in Spain

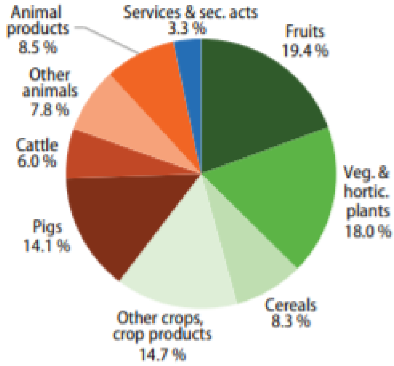
Key information:				Share of EU-28 total
Total land area	2016	502 654	km^2	11.6 %
Share of farmland in total land area	2016	46.2 %	share of total land area	-
Gross Domestic Product	2018	*1 202.2*	EUR billion	*7.6 %*
Population	2018	46.7	million	9.1 %

Figure 1: Agricultural factor income per annual work unit, 2005-2018
(index 2010=100)



Source: Eurostat (online data code: aact_eaa06)

Figure 2: Output of the agricultural industry, 2018
(% of total output value, at basic prices)



Source: Eurostat (online data code: aact_eaa01)

Table 9.10: Spain

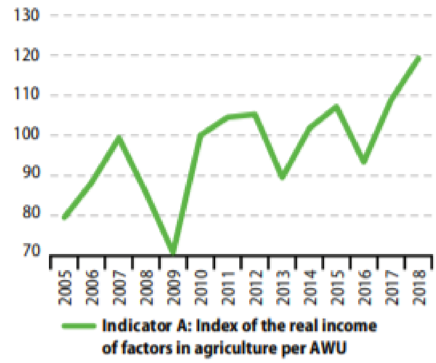
Farms and farmland				Share of EU-28 total
Farmland (utilised agricultural area)	2016	23 230	thousand hectares	13.4 %
Farms (agricultural holdings)	2016	945 020	number	9.0 %
Very small farms (with < EUR 8 000 of standard output)	2016	52.7 %	share of all farms	-
Family farms (with > 50 % of regular labour from family members)	2016	88.5 %	share of all farms	-
Farmers				**EU-28 average**
Employment in agriculture	2018	*3.7 %*	share of total employment	*4.1 %*
Total labour force input in agriculture	2018	865	thousand annual work units	-
Young farmers (under 40 years old)	2016	8.6 %	share of all farm managers	*10.6 %*
Female farmers	2016	22.5 %	share of all farm managers	*28.4 %*
Farmers with full agricultural training	2016	1.9 %	share of all farm managers	9.1 %
Economic performance of agriculture				**Share of EU-28 total**
Contribution of agriculture to Gross Domestic Product	2018	2.3 %	share of GDP	-
Gross value added (at basic prices)	2018	28 813	EUR million	15.9 %
Value of agricultural output (production value at basic prices)	2018	52 158	EUR million	12.0 %
Value of crop output	2018	31 483	EUR million	14.0 %
Value of animal output	2018	18 955	EUR million	11.0 %
Agricultural factor income per annual work unit (Indicator A)	2018	-2.1 %	change 2018/2017	-
Agricultural production				**Share of EU-28 total**
Cereals	2018	24 491	thousand tonnes	8.3 %
Root crops	2018	5 043	thousand tonnes	*2.9 %*
Fresh vegetables	2018	14 534	thousand tonnes	23.3 %
Permanent crops	2018	28 328	thousand tonnes	35.1 %
Raw milk	2018	*8 418*	thousand tonnes	*4.9 %*
Bovine meat	2018	669	thousand tonnes	8.4 %
Pig meat	2018	4 530	thousand tonnes	19.0 %
Poultry meat	2018	1 637	thousand tonnes	*10.8 %*

Figure 13 Key information on agricultural production in Spain ([Eurostat, 2018](#))

3.2.4. Agricultural production in France

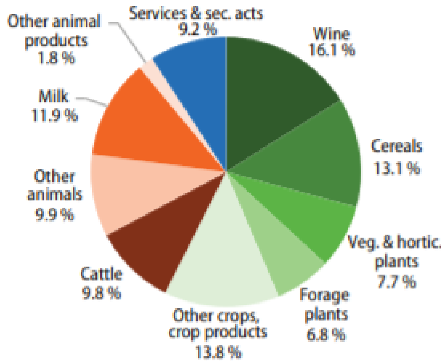
Key information:				Share of EU-28 total
Total land area	2016	633 886	km²	14.6 %
Share of farmland in total land area	2016	43.9 %	share of total land area	-
Gross Domestic Product	2018	*2 353.1*	EUR billion	*14.8 %*
Population	2018	66.9	million	13.1 %

Figure 1: Agricultural factor income per annual work unit, 2005-2018
(index 2010=100)



Source: Eurostat (online data code: aact_eaa06)

Figure 2: Output of the agricultural industry, 2018
(% of total output value, at basic prices)



Source: Eurostat (online data code: aact_eaa01)

Table 9.11: France

Farms and farmland				Share of EU-28 total
Farmland (utilised agricultural area)	2016	27 814	thousand hectares	16.0 %
Farms (agricultural holdings)	2016	456 520	number	4.4 %
Very small farms (with < EUR 8 000 of standard output)	2016	18.9 %	share of all farms	-
Family farms (with > 50 % of regular labour from family members)	2016	72.3 %	share of all farms	-

Farmers				EU-28 average
Employment in agriculture	2017	*2.5 %*	share of total employment	*4.1 %*
Total labour force input in agriculture	2018	744	thousand annual work units	-
Young farmers (under 40 years old)	2016	15.6 %	share of all farm managers	*10.6 %*
Female farmers	2016	21.3 %	share of all farm managers	*28.4 %*
Farmers with full agricultural training	2016	34.9 %	share of all farm managers	9.1 %

Economic performance of agriculture				Share of EU-28 total
Contribution of agriculture to Gross Domestic Product	2018	1.4 %	share of GDP	-
Gross value added (at basic prices)	2018	32 989	EUR million	18.2 %
Value of agricultural output (production value at basic prices)	2018	77 186	EUR million	17.8 %
Value of crop output	2018	44 315	EUR million	19.7 %
Value of animal output	2018	25 790	EUR million	15.0 %
Agricultural factor income per annual work unit (Indicator A)	2018	9.6 %	change 2018/2017	-

Agricultural production				Share of EU-28 total
Cereals	2018	62 568	thousand tonnes	21.2 %
Root crops	2018	48 478	thousand tonnes	*28.0 %*
Fresh vegetables	2018	5 654	thousand tonnes	9.1 %
Permanent crops	2018	9 129	thousand tonnes	11.3 %
Raw milk	2018	26 012	thousand tonnes	15.1 %
Bovine meat	2018	*1 460*	thousand tonnes	*18.4 %*
Pig meat	2018	*2 182*	thousand tonnes	*9.1 %*
Poultry meat	2018	*1 732*	thousand tonnes	*11.4 %*

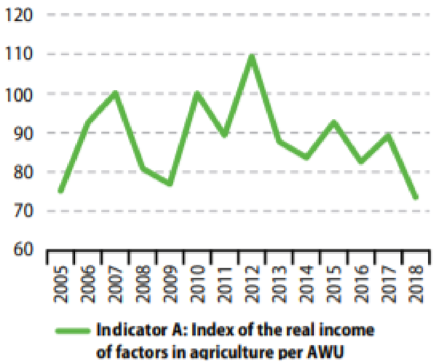
Figure 14 Key information on agricultural production in France (Eurostat, 2018)

3.2.5. Agricultural production in Belgium

Belgium

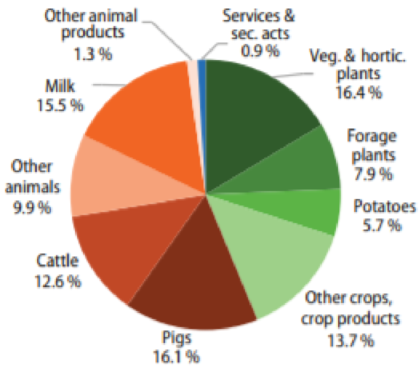
Key information:				Share of EU-28 total
Total land area	2016	30 451	km²	0.7 %
Share of farmland in total land area	2016	44.5 %	share of total land area	-
Gross Domestic Product	2018	459.8	EUR billion	2.9 %
Population	2018	11.4	million	2.2 %

Figure 1: Agricultural factor income per annual work unit, 2005-2018
(index 2010=100)



Source: Eurostat (online data code: aact_eaa06)

Figure 2: Output of the agricultural industry, 2018
(% of total output value, at basic prices)



Source: Eurostat (online data code: aact_eaa01)

Table 9.2: Belgium

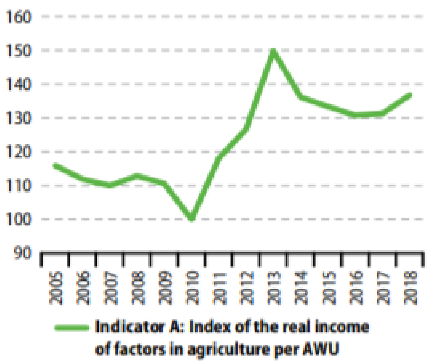
Farms and farmland				Share of EU-28 total
Farmland (utilised agricultural area)	2016	1 354	thousand hectares	0.8 %
Farms (agricultural holdings)	2016	36 890	number	0.4 %
Very small farms (with < EUR 8 000 of standard output)	2016	6.2 %	share of all farms	-
Family farms (with > 50 % of regular labour from family members)	2016	83.8 %	share of all farms	-
Farmers				**EU-28 average**
Employment in agriculture	2017	1.2 %	share of total employment	4.1 %
Total labour force input in agriculture	2018	56	thousand annual work units	-
Young farmers (under 40 years old)	2016	10.2 %	share of all farm managers	10.6 %
Female farmers	2016	14.5 %	share of all farm managers	28.4 %
Farmers with full agricultural training	2016	21.3 %	share of all farm managers	9.1 %
Economic performance of agriculture				**Share of EU-28 total**
Contribution of agriculture to Gross Domestic Product	2018	0.4 %	share of GDP	-
Gross value added (at basic prices)	2018	1 959	EUR million	1.1 %
Value of agricultural output (production value at basic prices)	2018	8 190	EUR million	1.9 %
Value of crop output	2018	3 582	EUR million	1.6 %
Value of animal output	2018	4 531	EUR million	2.6 %
Agricultural factor income per annual work unit (Indicator A)	2018	-17.5 %	change 2018/2017	-
Agricultural production				**Share of EU-28 total**
Cereals	2018	2 483	thousand tonnes	0.8 %
Root crops	2018	8 578	thousand tonnes	4.9 %
Fresh vegetables	2018	2 041	thousand tonnes	3.3 %
Permanent crops	2018	610	thousand tonnes	0.8 %
Raw milk	2018	4 219	thousand tonnes	2.5 %
Bovine meat	2018	277	thousand tonnes	3.5 %
Pig meat	2018	1 073	thousand tonnes	4.5 %
Poultry meat	2018	470	thousand tonnes	3.1 %

Figure 15 Key information on agricultural production in Belgium ([Eurostat, 2018](#))

3.2.6. Agricultural production in Italy

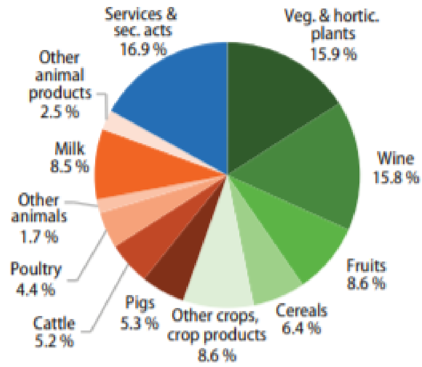
Key information:				**Share of EU-28 total**
Total land area	**2016**	297 734	km²	6.8 %
Share of farmland in total land area	**2016**	42.3 %	share of total land area	-
Gross Domestic Product	**2018**	1 765.4	EUR billion	11.1 %
Population	**2018**	60.5	million	11.8 %

Figure 1: Agricultural factor income per annual work unit, 2005-2018
(index 2010=100)



Source: Eurostat (online data code: aact_eaa06)

Figure 2: Output of the agricultural industry, 2018
(% of total output value, at basic prices)



Source: Eurostat (online data code: aact_eaa01)

Table 9.13: Italy

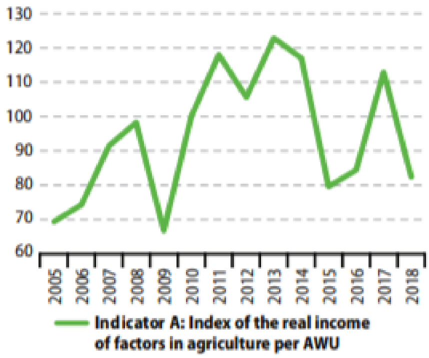
Farms and farmland				**Share of EU-28 total**
Farmland (utilised agricultural area)	**2016**	12 598	thousand hectares	7.3 %
Farms (agricultural holdings)	**2016**	1 145 710	number	10.9 %
Very small farms (with < EUR 8 000 of standard output)	**2016**	50.6 %	share of all farms	-
Family farms (with > 50 % of regular labour from family members)	**2016**	:	share of all farms	-
Farmers				**EU-28 average**
Employment in agriculture	**2017**	3.4 %	share of total employment	4.1 %
Total labour force input in agriculture	**2018**	1 127	thousand annual work units	-
Young farmers (under 40 years old)	**2016**	7.9 %	share of all farm managers	10.6 %
Female farmers	**2016**	31.5 %	share of all farm managers	28.4 %
Farmers with full agricultural training	**2016**	6.1 %	share of all farm managers	9.1 %
Economic performance of agriculture				**Share of EU-28 total**
Contribution of agriculture to Gross Domestic Product	**2018**	1.8 %	share of GDP	-
Gross value added (at basic prices)	**2018**	32 544	EUR million	17.9 %
Value of agricultural output (production value at basic prices)	**2018**	56 906	EUR million	13.1 %
Value of crop output	**2018**	31 533	EUR million	14.0 %
Value of animal output	**2018**	15 733	EUR million	9.1 %
Agricultural factor income per annual work unit (Indicator A)	**2018**	4.2 %	change 2018/2017	-
Agricultural production				**Share of EU-28 total**
Cereals	**2018**	16 541	thousand tonnes	5.6 %
Root crops	**2018**	3 249	thousand tonnes	1.9 %
Fresh vegetables	**2018**	12 160	thousand tonnes	19.5 %
Permanent crops	**2018**	18 628	thousand tonnes	23.1 %
Raw milk	**2018**	13 132	thousand tonnes	7.6 %
Bovine meat	**2018**	809	thousand tonnes	10.2 %
Pig meat	**2018**	1 471	thousand tonnes	6.2 %
Poultry meat	**2018**	1 285	thousand tonnes	8.5 %

Figure 16 Key information on agricultural production in Italy ([Eurostat, 2018](#))

3.2.7. Agricultural production in Germany

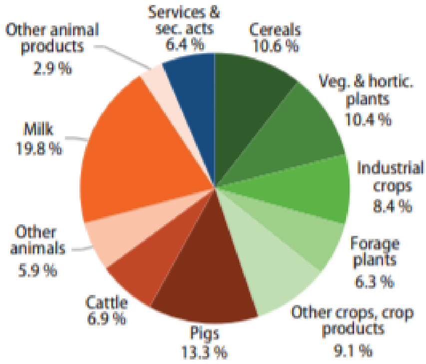
Key information:				Share of EU-28 total
Total land area	2016	353 296	km²	8.1 %
Share of farmland in total land area	2016	47.3 %	share of total land area	-
Gross Domestic Product	2018	3 344.4	EUR billion	21.0 %
Population	2018	82.8	million	16.2 %

Figure 1: Agricultural factor income per annual work unit, 2005-2018 (index 2010=100)



Source: Eurostat (online data code: aact_eaa06)

Figure 2: Output of the agricultural industry, 2018 (% of total output value, at basic prices)



Source: Eurostat (online data code: aact_eaa01)

Table 9.6: Germany

Farms and farmland				Share of EU-28 total
Farmland (utilised agricultural area)	2016	16 715	thousand hectares	9.6 %
Farms (agricultural holdings)	2016	276 120	number	2.6 %
Very small farms (with < EUR 8 000 of standard output)	2016	10.5 %	share of all farms	-
Family farms (with > 50 % of regular labour from family members)	2016	94.4 %	share of all farms	-

Farmers				EU-28 average
Employment in agriculture	2017	1.3 %	share of total employment	4.1 %
Total labour force input in agriculture	2018	474	thousand annual work units	-
Young farmers (under 40 years old)	2016	14.7 %	share of all farm managers	10.6 %
Female farmers	2016	9.6 %	share of all farm managers	28.4 %
Farmers with full agricultural training	2016	17.0 %	share of all farm managers	9.1 %

Economic performance of agriculture				Share of EU-28 total
Contribution of agriculture to Gross Domestic Product	2018	0.5 %	share of GDP	-
Gross value added (at basic prices)	2018	16 476	EUR million	9.1 %
Value of agricultural output (production value at basic prices)	2018	52 731	EUR million	12.1 %
Value of crop output	2018	23 613	EUR million	10.5 %
Value of animal output	2018	25 732	EUR million	15.0 %
Agricultural factor income per annual work unit (Indicator A)	2018	-26.9 %	change 2018/2017	-

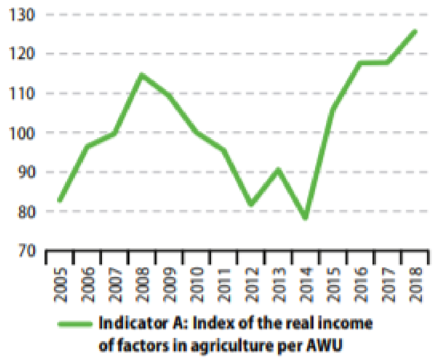
Agricultural production				Share of EU-28 total
Cereals	2018	37 975	thousand tonnes	12.9 %
Root crops	2018	35 422	thousand tonnes	20.4 %
Fresh vegetables	2017	3 450	thousand tonnes	5.5 %
Permanent crops	2017	1 728	thousand tonnes	2.5 %
Raw milk	2018	33 110	thousand tonnes	19.2 %
Bovine meat	2018	1 102	thousand tonnes	13.9 %
Pig meat	2018	5 343	thousand tonnes	22.4 %
Poultry meat	2018	1 572	thousand tonnes	10.3 %

Figure 17 Key information on agricultural production in Germany ([Eurostat, 2018](#))

3.2.8. Agricultural production in Croatia

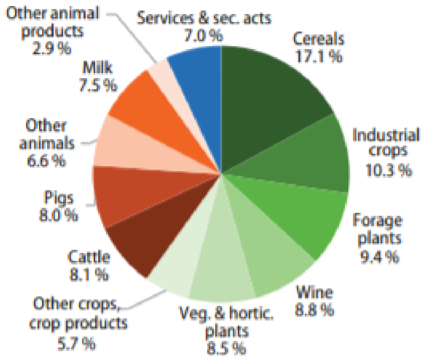
Key information:				Share of EU-28 total
Total land area	2016	55 896	km²	1.3 %
Share of farmland in total land area	2016	28.0 %	share of total land area	-
Gross Domestic Product	2018	51.6	EUR billion	0.3 %
Population	2018	4.1	million	0.8 %

Figure 1: Agricultural factor income per annual work unit, 2005-2018
(index 2010=100)



Source: Eurostat (online data code: aact_eaa06)

Figure 2: Output of the agricultural industry, 2018
(% of total output value, at basic prices)



Source: Eurostat (online data code: aact_eaa01)

Table 9.12: Croatia

Farms and farmland				Share of EU-28 total
Farmland (utilised agricultural area)	2016	1 563	thousand hectares	0.9 %
Farms (agricultural holdings)	2016	134 460	number	1.3 %
Very small farms (with < EUR 8 000 of standard output)	2016	68.9 %	share of all farms	-
Family farms (with > 50 % of regular labour from family members)	2016	96.8 %	share of all farms	-
Farmers				**EU-28 average**
Employment in agriculture	2018	5.3 %	share of total employment	4.1 %
Total labour force input in agriculture	2018	175	thousand annual work units	-
Young farmers (under 40 years old)	2016	10.5 %	share of all farm managers	10.6 %
Female farmers	2016	26.0 %	share of all farm managers	28.4 %
Farmers with full agricultural training	2016	2.4 %	share of all farm managers	9.1 %
Economic performance of agriculture				**Share of EU-28 total**
Contribution of agriculture to Gross Domestic Product	2018	1.9 %	share of GDP	-
Gross value added (at basic prices)	2018	1 083	EUR million	0.6 %
Value of agricultural output (production value at basic prices)	2018	2 333	EUR million	0.5 %
Value of crop output	2018	1 398	EUR million	0.6 %
Value of animal output	2018	772	EUR million	0.4 %
Agricultural factor income per annual work unit (Indicator A)	2018	6.6 %	change 2018/2017	-
Agricultural production				**Share of EU-28 total**
Cereals	2018	3 231	thousand tonnes	1.1 %
Root crops	2018	964	thousand tonnes	0.6 %
Fresh vegetables	2018	185	thousand tonnes	0.3 %
Permanent crops	2018	346	thousand tonnes	0.4 %
Raw milk	2018	634	thousand tonnes	0.4 %
Bovine meat	2018	44	thousand tonnes	0.6 %
Pig meat	2018	75	thousand tonnes	0.3 %
Poultry meat	2018	66	thousand tonnes	0.4 %

Figure 18 Key information on agricultural production in Croatia (Eurostat, 2018)

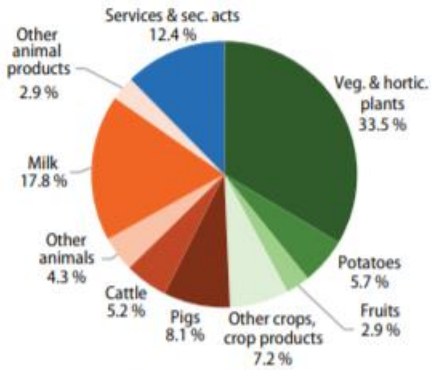
3.2.9. Agricultural production in the Netherlands

Key information:				Share of EU-28 total
Total land area	2016	34 188	km²	0.8 %
Share of farmland in total land area	2016	52.5 %	share of total land area	-
Gross Domestic Product	2018	*774.0*	EUR billion	*4.9 %*
Population	2018	17.2	million	3.4 %

Figure 1: Agricultural factor income per annual work unit, 2005-2018 (index 2010=100)

Source: Eurostat (online data code: aact_eaa06)

Figure 2: Output of the agricultural industry, 2018 (% of total output value, at basic prices)



Source: Eurostat (online data code: aact_eaa01)

Table 9.20: Netherlands

Farms and farmland				Share of EU-28 total
Farmland (utilised agricultural area)	2016	1 796	thousand hectares	1.0 %
Farms (agricultural holdings)	2016	55 680	number	0.5 %
Very small farms (with < EUR 8 000 of standard output)	2016	4.2 %	share of all farms	-
Family farms (with > 50 % of regular labour from family members)	2016	91.2 %	share of all farms	-

Farmers				EU-28 average
Employment in agriculture	2018	*2.1 %*	share of total employment	*4.1 %*
Total labour force input in agriculture	2018	154	thousand annual work units	-
Young farmers (under 40 years old)	2016	8.7 %	share of all farm managers	*10.6 %*
Female farmers	2016	5.2 %	share of all farm managers	*28.4 %*
Farmers with full agricultural training	2016	9.4 %	share of all farm managers	9.1 %

Economic performance of agriculture				Share of EU-28 total
Contribution of agriculture to Gross Domestic Product	2018	1.4 %	share of GDP	-
Gross value added (at basic prices)	2018	10 682	EUR million	5.9 %
Value of agricultural output (production value at basic prices)	2018	28 153	EUR million	6.5 %
Value of crop output	2018	13 883	EUR million	6.2 %
Value of animal output	2018	10 785	EUR million	6.3 %
Agricultural factor income per annual work unit (Indicator A)	2018	-17.0 %	change 2018/2017	-

Agricultural production				Share of EU-28 total
Cereals	2018	1 335	thousand tonnes	0.5 %
Root crops	2018	*12 538*	thousand tonnes	*7.2 %*
Fresh vegetables	2018	4 596	thousand tonnes	7.4 %
Permanent crops	2018	*713*	thousand tonnes	*0.9 %*
Raw milk	2018	14 426	thousand tonnes	8.4 %
Bovine meat	2018	*459*	thousand tonnes	*5.8 %*
Pig meat	2018	*1 536*	thousand tonnes	*6.4 %*
Poultry meat	2018	:	thousand tonnes	-

Figure 19 Key information on agricultural production in the Netherlands ([Eurostat, 2018](#))

3.3. Agricultural production in Argentina

Over the past decades, Argentina experienced a massive agricultural transformation. Statistics show that Argentina yields are among the highest in the world. It is crucial to mention that important transformations in the agro sector occurred in the period of 1996 to 2007. Momentous changes in organizational practices, as well as in production techniques brought about an upsurge in the quantities produced.

The three main crops (wheat, corn, and soybeans) jumped from 31,8 Mtn to 111,5 Mtn (2015/2016 season) with an average annual sector growth of 5,3 % (Buenos Aires Cereal Exchange, 2019). At the same time, the agro sector also produced 2,6 Mtn of citrus, 13,4 million hectolitres of wine, about 3 Mtn of beef, 2 Mtn of poultry, 441 thousand tons of pork, and 11 billion litres of bovine milk (INTA, 2017; Data from the Ministry of Agroindustry). However, there is great heterogeneity in performance between producers in different regions.

Figure 20 shows an expansion of cereals and oilseed cultivated land in Argentina during the last 120 years (expressed in millions of hectares – Mha; Rosario cereal exchange market). The 2018-2019 campaign amounted to 37,5 Mha planted and reached a record value of 133 Mtn of harvested area.

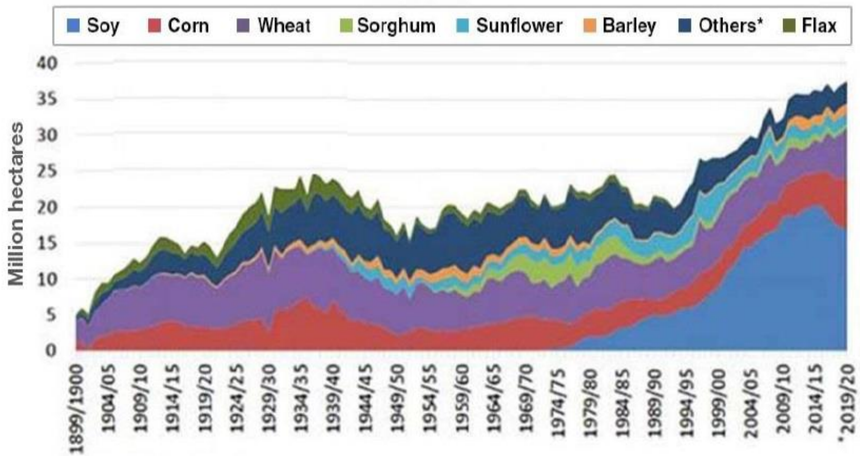


Figure 20 Sown area expansion by crop in Argentina (1899 – 2020; source BCR) (INTA FERTIMANURE report, 2020)

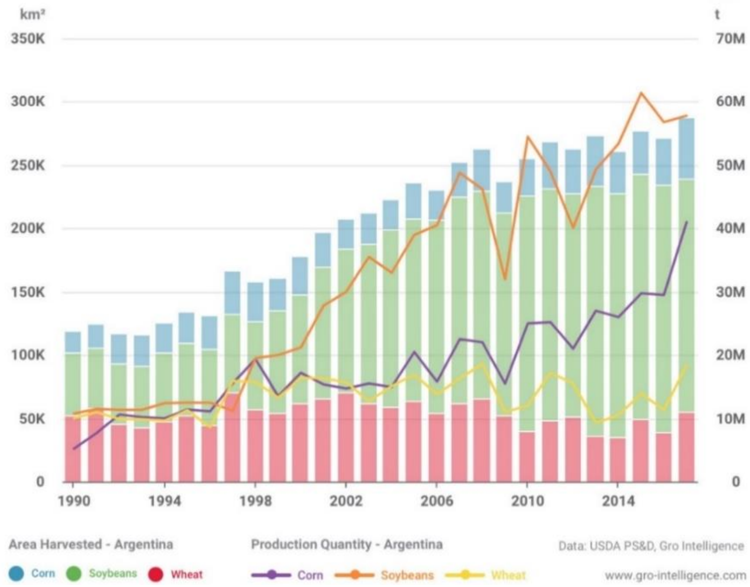


Figure 21 Overview of agricultural crops production in Argentina, 1990 – 2017 ([Gro Intelligence, 2017](#))

The beef and cattle industry are an important part of Argentina's agricultural sector; the beef sector generates 22 % of the agricultural sector gross domestic production. With almost 52 million head of cattle (Figure 22), the cattle sector in Argentina consists of more than 200,000 farms (SIGSA and SENASA, 2014). Majority of farms (88 %) have fewer than 500 animals, but these account for only 40 % of the total cattle population. As it is the case in many other states, few farms in Argentina (12 %) hold 53 % of the cattle population, with a range of 501 to 5,000 animals per farm (FAO, Low – emissions development of the beef cattle sector in Argentina, 2017). Geographical distribution of cattle population in the Argentina is shown in Figure 23.

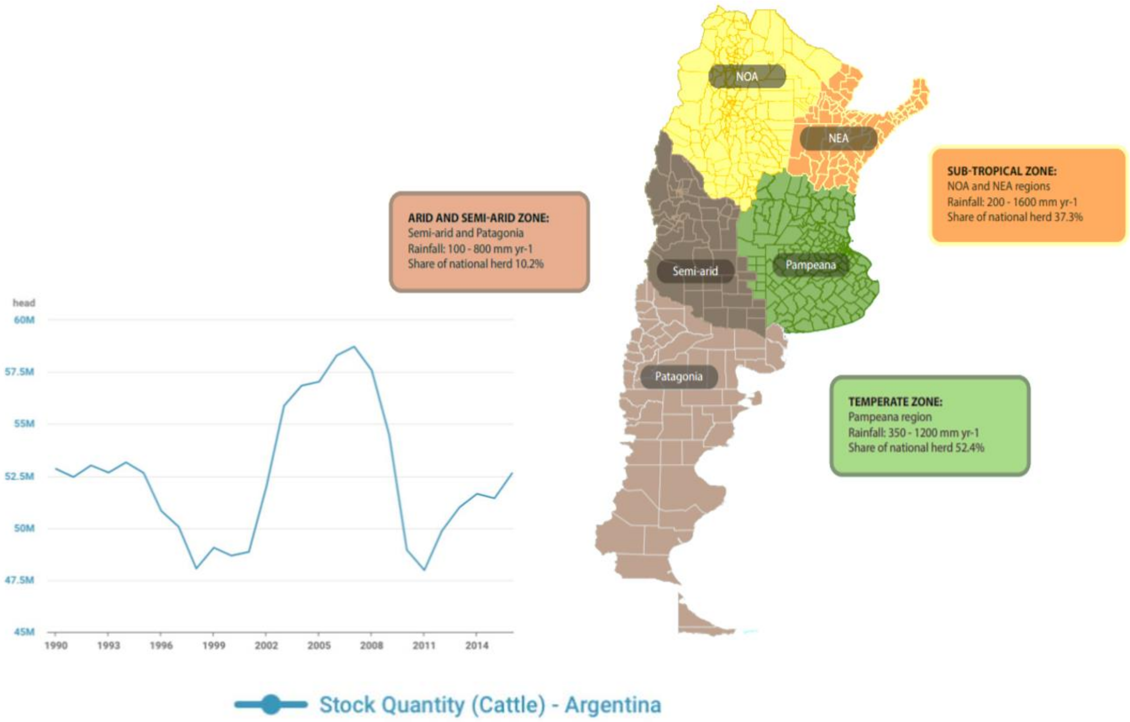


Figure 22 Overview of cattle production in Argentina, 1990-2017 (Gro Intelligence, 2017) and geo-climatic zones of Argentina and distribution of beef cattle herd in Argentina by region (Low-emissions development of the beef cattle sector in Argentina, FAO, 2017)

Other CELAC countries underwent an analogous agricultural process than the one that took place in Argentina.

Table 4 shows the evolution of the area sown and the volume of harvested soybeans in two different periods in the five main South America countries, which together hold 50 % of the world´s soybean production. The data clearly show that e.g. Brazil increased its soyabean production over the period of 10 years for a significant 84 %, while Paraguay and Uruguay had even higher production rates. In case of Argentina, production was increased for around 45 %.

Country	Hectares in 2006	Hectares in 2016	Tons in 2006	Tons in 2016	Increased production
Brasil	22,04	33,15	52,46	96,29	83,54%
Argentina	15,13	19,50	40,53	58,79	45,05%
Paraguay	2,20	3,37	3,80	9,16	141,05%
Bolivia	0,95	1,33	1,61	3,20	98,75%
Uruguay	0,30	1,14	0,67	2,20	228,35%
World	95,93	121,53	221,55	334,89	51,15%

* Quantity in millions of hectares and millions of tons - Source: FAO

Table 4 Evolution of soyabean production in CELAC region in period 2006 - 2016 (INTA, FERTIMANURE report, 2020)

3.4. Agricultural production in Chile

According to the latest report, published in 2015 (ODEPA, 2015), mainland Chile has an area of 75.6 million hectares (ha), 51.7 million of which are suitable for mixed agriculture and 35.5 million of which are used for agricultural livestock raising or forestry. However, due to geographical and economic factors, the area under cultivation currently stands at just 2.12 million ha. This area is distributed among 1.303,210 ha of annual and permanent crops, 401,018 ha of sown fields and 419,714 ha of fallow land. Of the 1.3 million ha with annual and permanent crops, 704,575 ha are used for annual crops, 296,587 ha for fruit trees, 137,593 ha for wine-grape vines and 78,072 ha for vegetables *(Sustainable Agriculture and Healthy Food in Chile, Fuster R. and Mattar C., 2019)*.

Category	Area (ha)	Main species	Area (ha)
Annual Crops	704.575	Wheat	263.000
		Corn	125.200
		Oats	90.449
		Potato	50.524
		Raps	49.448
Fruit	296.587	Table Vines	48.500
		Apple trees	36.205
		Avocado trees	29.000
		Walnut trees	27.941
		Cherry trees	20.591
Wine vines	137.593	Red wine varieties	101.752
		White Wine Varieties	35.841
		Pisco Varieties	8.202
Vegetables	78.072	Maize for human consumption	9.727
		Lettuce	6.673
		Tomato	5.038
		Onion	4.454
		Marrow	3.989

Source: ODEPA.

Table 5 Area occupied by the 5 main species of the relevant categories of agricultural crops in Chile (Sustainable Agriculture and Healthy Food in Chile, Fuster R. and Mattar C., 2019)

FERTIMANURE

Sector	Jan-Dec 2016	Share (%)
Exports by sector		
Total crop livestock	15.037.317	
Agricultural	9.090.265	60,5
Livestock	1.237.317	8,2
Forestry	4.709.735	31,3
Imports by sector		
Total crop livestock	5.137.768	
Agricultural	3.320.246	64,6
Livestock	1.562.740	30,4
Forestry	254.782	5,0
Trade Balance for products		
Total crop livestock	9.899.549	
Agricultural	5.770.019	58,3
Livestock	-325.423	-3,3
Forestry	4.454.953	45,0

Source: prepared by ODEPA with information from the National Customs Service. Figures subject to review by value variation reports (IVV).

Table 6 Trade balance of crop-livestock products by sector: Chile and the world, (thousands of USD) (Sustainable Agriculture and Healthy Food in Chile, Fuster R. and Mattar C., 2019)

Latin America is in third place, with 155,270 t and 18.2 % of the total exported in fruit corresponds to Chile. The main exported products are apples (82,163 t), avocados (13,372 t) and pears (11,486 t). Chile is one of the largest agricultural producers in Latin America and an important player in the global agri-food markets. The country has several advantages for agricultural production. In the first place, it is favoured by the counter-season with respect to the large consumer markets of the northern hemisphere. On the other hand, it is in one of the five macro zones with a Mediterranean climate in the world, so it offers excellent conditions for the fruit and vegetable industry. Finally, Chile is a practically pest-free country due to its geographic isolation and the natural barriers that protect it and transform it into a phytosanitary and zoo sanitary island: the Atacama desert to the north, the Andes mountain range to the east, the Pacific Ocean to the west and the ice and glaciers to the south. Chile's foreign trade in agricultural and forestry products, that is, the sum of exports and imports reached a value of 20.23 million USD in 2016, of which 15.095 corresponded to the export and 5.237 to the import *(Chile, Fertimanure report, 2020).*

Between 2010 and 2016, the agricultural sector, on average, has decreased the total number of employed persons by 0,9 %. The participation of agricultural employment in the period in question has decreased from 9,8 % in 2010 to 8,6 % in 2016. However, agricultural activity continues to be one of the most important economic activities with respect to the generation of employment, being even more relevant in rural areas (PASO, 2017; *Chile, Fertimanure report, 2020).*

3.5. EU agricultual sector – conclusions

3.5.1. Strenghts of EU agriculture

Thanks to its varied climate, fertile soil, the technical skills of its farmers and the quality of its products, the EU is one of the world's leading producers and exporters of agricultural products. The EU production and farming structures are highly diversified, allowing the sector to respond to different market and consumer demands.

Predominantly rural area cover for about 44,6 % of the total EU territory and 20,5 % of population lives there. Based on the Farm Structure Survey from 2016, majority of farms utilize less than 5 ha of arable land (66,6 %) (EU statistical factsheet, EC, 2020).

The EU´s agricultural industry created (gross) value added of 181,7 billion EUR in 2018, meaning that agriculture contributed 1,1 % to the EU´s GDP in 2018 (Eurostat, 2018). Furthermore, the agricultural sector in the EU invested an estimated 59,0 billion EU in 2018, accounting for 32,5 % of Gross Value Added (GVA).

Around 25% of the EU's trade surplus is generated by exporting agricultural products. Agriculture and food related industries and services provide over 44 million jobs in the EU, including regular work for 20 million people within the agricultural sector itself (Agriculture - CAP, EU, 2017).

In terms of new market and technological challenges in agriculture, the EU plays a constructive role in devising innovative and forward-looking common rules for global trade as well as state-of-the-art technology solutions. EU food chains are diverse and adaptive, enabling them to meet the various consumers' expectations, helping some producers increase value added. The level of investment in EU agriculture in 2018 was an estimated 2,3 billion EUR more than in 2017 and 4,6 billion EUR more than in 2016 (Eurostat, Agriculture, forestry and fishery statistics, 2019).

New opportunities are arising related to the increased consumer interest in local food and short supply chains. On average, about 15 % of EU farms sell more than half of their production directly to consumers. However, these are mainly small farms (between 1 and 8 Economic Size Units - ESU), with only 3 % of the farms above 100 ESU selling more than half of their production directly to consumers.

Agriculture contributes 25 million tonnes of oil equivalent (12.3 %) to renewable energy production (2015), which is an increase of 15 % from 2013 to 2015 (DG AGRI, 2017).

3.5.2. Weaknesses of EU agriculture

The EC public consultation on family farming identified the main challenges to family farms such as social challenge (ageing and succession), economic challenge and an administrative burden. Other challenges included competition with large-scale corporate farms, the cost of inputs, access to finance and to markets, working/living conditions, public policies, and access to land and natural resources (Family farming in Europe: challenges and prospects, EU, 2014).

Furthermore, new technologies, such as genetically modified crops and livestock, may favour large-scale or non-family farming. Increased price fluctuations and occasional food scares are testing the resilience of different types of farming. A distinction must be drawn between challenges facing individual family farms and those facing the farming system as a whole.

The EU's farm population is also ageing as new entrants find it difficult to access capital and land, while prospects for reversing this trend are not promising given the overall demographic trends in the EU. There are also important structural constraints, with many small farms, limited land availability, and diverse land market, taxation and inheritance legislation within MS. Compared to most producers in third countries, EU farmers face higher costs for compliance with legislation compared to competitors in the fields of the environment, animal welfare and food safety. Big challenges confronting agriculture in Europe are climate change and land take, i.e. the conversion of land to, for example, settlements and infrastructure. Climate change requires the adaptation of crop varieties and causes extreme weather events and thus it demands profound risk management. Farming also must be more environmentally aware these days. Land take leads to a reduction in agricultural land in many regions (EEA, 2017).

Income in the farming sector is generally low and below what can be achieved in other sectors in the economy (on average only 40 % of average wages in the EU-28 economy). Within the farming sector there are huge differences in income level between different regions, size classes and sectors. Income is also quite volatile, with up to 20% of farmers experiencing income drops above 30% each year (Modernising and simplifying the CAP, EC, 2017).

3.6. CELAC agro sector – conclusions

3.6.1. Strenghts of CELAC agriculture

The Latin American region is an important net exporter of food and agricultural commodities, accounting for 16 % of total global food and agriculture exports and 4 % of total food and agriculture imports. The region is one of the few parts of the world with significant resources of unexploited agricultural land (concentrated in Brazil and Argentina), suggesting the region will continue to play a pivotal role in global food production and exports in the future (Economics, Rabobank, 2015).

The country is a leading food producer, with large-scale agricultural and livestock industries that have greatly benefitted from the commodity price boom of the past decade. The country has a solid comparative advantage in agriculture due to its exceptionally fertile lands, especially for cereal and livestock production. It is one of the world's leading producers of sunflower seed oil, soybeans, honey, lemons and beef (FAO, 2017).

The agricultural sector experimented a major boost between 2001 and 2007, due in part by inputs use increase (land, work, capital, fertilisers, machinery, genetically improved seed), and was the highest growth value of the 50 years analyzed (1,18 % annually). As well, greatest technological changes occurred (genetically modified seeds, direct sowing, precision agriculture, etc.).

According to the FADA report, agri-food chain generates 1 out of 6 private jobs (direct and indirect), as well as 10 % of Gross Domestic Product. What is more important, 7 out of every 10 dollars of country's total exports come from agri-food sector. As of 2016, Argentina had a gross domestic product (GDP) of more than 550 billion USD, making it one of the largest economies in the region.

Chile’s central regions possess millions of hectares of prime agricultural land. The central valley, which runs through the 6th, 7th, and northern 8th region, is great for growing grapes, cherries, blueberries, raspberries, kiwi, apples, corn, etc., many of which are exported during the harvest season in March, April, and May. The southern regions also produce significant amount of food but are generally better suited for ranching (Chile: Advantages and Disadvantages, 2018).

Agriculture is Chile’s second largest source of exports. Therefore, an efficient agro-food industry is a top priority in Chile. Today, the food industry represents 25 % of Chile’s economy and employs more than 1 million people. It is expected that in 2030, the food processing industry will account for one third of the country’s economy. The fruit, wine, poultry, beef, pork, and dairy industries offer large export potential. Rising attention to animal welfare, traceability, productivity, and control are clear trends in the agro-food industry. Natural advantages, government strategies of increasing the production of value-added food products, expanding international trade networks, and rising domestic food consumption are key elements driving growth in the Chilean food processing industry (Fact Sheet – Agro industry & Food Technology in Chile, 2012).

Latin America is in the third place, with 155,270 t and 18.2 % of the total exported in fruit corresponds to Chile. The main exported products are apples (82,163 t), avocados (13,372 t) and pears (11,486 t). Chile is one of the largest agricultural producers in Latin America and an important player in the global agri-food markets. The country has several advantages for agricultural production. In the first place, it is favoured by the counter-season with respect to the large consumer markets of the northern hemisphere. On the other hand, it is in one of the five macro zones with a Mediterranean climate in the world, so it offers excellent conditions for the fruit and vegetable industry. Finally, Chile is a practically pest-free country due to its geographic isolation and the natural barriers that protect it and transform it into a phytosanitary and zoo sanitary island: the Atacama desert to the north, the Andes mountain range to the east, the Pacific Ocean to the west and the ice and glaciers to the south (Chile, Fertimanure report, 2020).

3.6.2. Weaknesses of CELAC agriculture

Argentina is highly vulnerable to climate change, given its geographic position and socio-economic characteristics. Since the early 2000s, the country has been developing a set of sectoral plans and measures for increasing adaptation and mitigation to climate change.

Policies on food loss and waste The Argentine Government has recently officially recognized the socio-economic impacts of food loss and waste along the food value chain, with negative effects on the sustainability of food systems, the use of natural resources, producers' incomes and consumer prices.

Agricultural policy in Argentina has resulted, when compared to many other countries, in few programs aimed at subsidizing input prices or affecting land allocation decisions via direct payments. Environmental issues, such as deforestation, wetland preservation, or ag-chemical use are just recently starting to be considered in the policy agenda (Agricultural Policy Reports, 2018).

Although there are substantial reserves of unexploited agricultural land in the region, these are not evenly distributed among countries, meaning that raising productivity will be essential in many parts of the region in order to meet domestic needs and to capitalise on export opportunities.

Chile has suffered from drought periodically for many years. A combination of climate change, population growth and man-made problems have exacerbated a drought that has dragged on for the last four years, costing the country millions of dollars in damage to Chile's second largest industry – agriculture (mining is its largest).

Agriculture, especially the type that Chile specializes in – water-needy fruits including citrus, grapes and avocados – is a thirsty business and uses an average 78% of the country's total freshwater annually: a figure that dwarfs Chile's mining industry needs which in comparison uses a measly 6 %, according to figures from the Agriculture Ministry (Facing Chile's Agricultural Emergency, 2012).

4. Fertilisers market

The chapter will provide an overview of fertiliser types currently present in Europe and CELAC countries. Statistic data related to the production of the main fertiliser types will also be depicted. Furthermore, the chapter will provide information on the size of the fertiliser market worldwide, in the EU and in CELAC countries.

It will also cover the use of fertilisers and agricultural sectors in EU and CELAC. This is important section which will provide a clear insight on the size of the fertilisers market, distribution of different fertilisers at the market and connection between fertiliser types and agricultural sectors, because one of the main objective of FERTIMANURE project is to develop, integrate, test and validate nutrient management strategies to efficiently recover mineral nutrients and other relevant products with agronomic value (organic amendments and biostimulants) from animal manure, to finally obtain reliable and safe fertilisers that can compete in the European fertilisers market.

4.1. Fertiliser types in the EU and CELAC

The production of **nitrogen mineral fertilisers** is based on a technology called Haber-Bosch process. The process refers to fixing nitrogen from air with hydrogen to produce liquid ammonia. Globally, 3 – 5 % of the global annual natural gas consumption is used by the industry to produce nitrogen fertiliser. The cost for natural gas represents 60 – 80 % of the variable input costs for production of nitrogen fertiliser.

Phosphorous based fertilisers exclusively origin from mined ore. The process to convert the ore into a fertiliser product is done via a chemical extraction with an acid, into a water-soluble salt.

Potash based fertiliser is based on mined rock. The production method is mainly based on a purification process of the potassium rock (Fertilisers in the EU, EC, 2019).

Overview of the main fertiliser production routes is indicated in Figure 23.

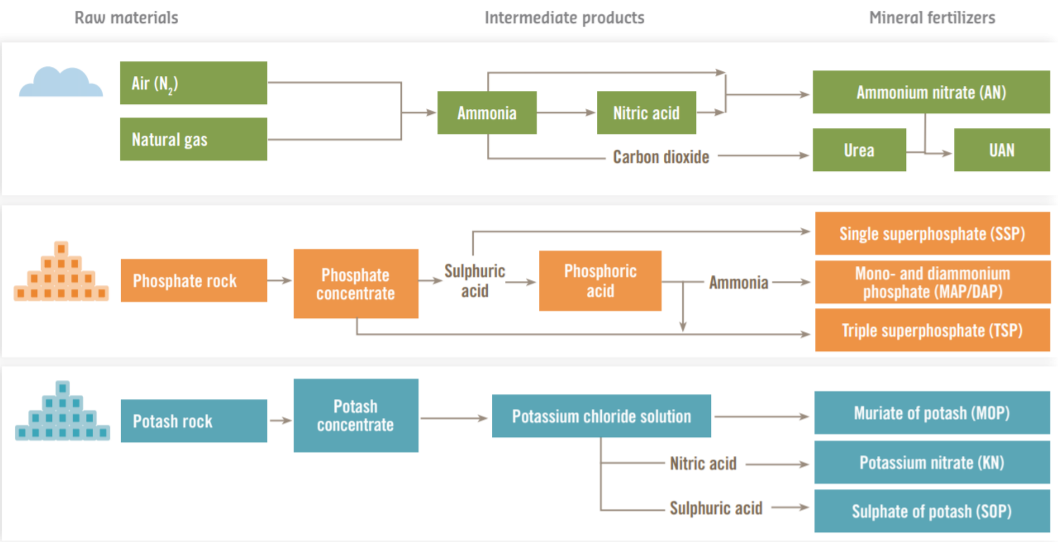


Figure 23 Production of main fertiliser products – overview per nutrient (Fertilisers Europe)

European agriculture is highly dependent on mineral fertilisers which are based on chemical industry capacities, as well as the economic situation and input (natural gas, phosphate rock, potash rock) prices in the EU and worldwide. Therefore, EIP-Agri emphasises that current dependency of the EU agriculture on fossil-based mineral fertilisers must be regarded as a very serious threat to future food security.

Table 7 provides an extract of the list of critical materials in the EU related to the agro sector – phosphorus and phosphate rock.

Raw materials	Main global producers (average 2010-2014)	Main importers to the EU (average 2010-2014)	Sources of EU supply (average 2010-2014)	Import reliance rate*	Substitution indexes EI/SR**	End-of-life recycling input rate***
Phosphate rock	China (44%) Morocco (13%) United States (13%)	Morocco (31%) Russia (18%) Syria (12%) Algeria (12%)	Morocco (28%) Russia (16%) Syria (11%) Algeria (10%) EU – Finland (12%)	88%	1.0 / 1.0	17%
Phosphorus	China (58%) Vietnam (19%) Kazakhstan (13%) United States (11%)	Kazakhstan (77%) China (14%) Vietnam (8%)	Kazakhstan (77%) China (14%) Vietnam (8%)	100%	0.91 / 0.91	0%

Table 7 List of critical materials for the EU (EU, 2017)

4.1.1. Size of the fertilisers market

4.1.1.1.Size of the mineral fertilisers market worldwide and in the EU

The total volume of fertilisers produced globally, measured as nutrient weight, was 181 million tons in 2016. Of the total volume, nitrogen represented 108 million tons (60 %), whereof urea 60 million tons, phosphorus 41 million tons (23 %) and potassium 32 million tons (17 %). According to the Fertilisers Europe, the EU production of fertilisers is relatively small measured as share of the global production: 9 % of the nitrogen, 3 % of the phosphate and 8 % of the potash is produced within the EU (Fertilisers in the EU, EC, 2019).

The world inorganic nitrogen fertiliser production is concentrated in Russia (20 %), the United States (19 %) and Canada (6 %). Despite relative abundance, resources of phosphate rocks are unevenly distributed around the world – Morocco, China and the US hold 2/3 of the world´s capacities. Canada, Russia, Belarus and Israel represent more than 2/3 of the world´s potassium production, while 8 companies control about 80 % of the potassium production. The most important potassium producing Member States are Germany, Spain and the UK (Fertilisers Study, 2012).

The use of fertilisers at global level is increasing on an annual basis by around 2 % for phosphorus and potassium. The growth rate for nitrogen-based fertiliser is higher (Fertilisers in the EU, EC, 2019).

The FAO fertilisers report indicate several important information for the previous few years as well as trends for the period to 2022 (Table 6; World fertiliser trends and outlook to 2022, FAO, 2019). Within these data one should fully understand the methodology: (i) capacity – nameplate (theoretical) capacity; (ii) supply – effective capacity, representing the maximum achievable production and (iii) demand – can be divided into fertiliser use and other uses; “demand for fertiliser use” means the use of fertilisers at a given point in time, while “demand for other uses” refers to consumption for non-fertiliser use, losses and unallocated demand.

World capacity for the most important nutrients is foreseen to increase to the total of 318.652 thousand tons in 2022 and almost 60 % of the amount refers to ammonia. Nevertheless, world supply (effective capacity) is indicated at much lower rate than the capacity itself. For example, supply of ammonia is only at 163.219 thousand tons (cca 27 thousand tons lower), while the difference for the phosphoric acid and potash is lower (around 11 thousand tons each).

When it comes to the world demand for nutrients in sense of fertilisers production, total demand estimated in 2022 is around 200.000 thousand tons and the total demand for other uses is around 54.000 thousand tons.

World capacity for producing ammonia, phosphoric acid and potash, 2016-2022 (thousand tonnes)

Year	2016	2017	2018	2019	2020	2021	2022
Ammonia, as N	180 496	184 558	186 974	189 523	187 354	188 908	190 397
Phosphoric acid, as P_2O_5	57 295	60 224	61 464	62 357	62 612	63 552	63 702
Potash, as K_2O	54 638	58 455	61 951	62 055	63 467	63 513	64 553
Total ($N+P_2O_5+K_2O$)	292 429	303 237	310 389	313 935	313 433	315 973	318 652

World supply of ammonia, phosphoric acid and potash, 2016-2022 (thousand tonnes)

Year	2016	2017	2018	2019	2020	2021	2022
Ammonia, as N	153 646	155 253	157 819	161 504	160 492	161 572	163 219
Phosphoric acid, as P_2O_5	46 308	47 564	48 620	49 510	50 520	51 520	52 066
Potash, as K_2O	44 177	46 284	49 422	51 373	52 752	53 664	54 197
Total ($N+P_2O_5+K_2O$)	**244 131**	**249 101**	**255 861**	**262 387**	**263 764**	**266 756**	**269 482**

World demand for nitrogen, phosphorus and potassium for fertilizer use, 2016-2022 (thousand tonnes)

Year	2016	2017	2018	2019	2020	2021	2022
Nitrogen, N	105 148	105 050	105 893	107 424	108 744	110 193	111 591
Phosphorus, as P_2O_5	44 481	45 152	45 902	46 587	47 402	48 264	49 096
Potassium, as K_2O	35 434	36 349	37 171	37 971	38 711	39 473	40 232
Total ($N+P_2O_5+K_2O$)	**185 063**	**186 551**	**188 966**	**191 981**	**194 857**	**197 930**	**200 919**

World demand for nitrogen, phosphorus (phosphoric acid based) and potassium for other uses, 2016-2022 (thousand tonnes)

Year	2015	2016	2016	2017	2018	2019	2020
Nitrogen, N	36 930	37 663	38 320	38 965	39 569	40 127	40 660
Phosphorus (phos. acid based), as P_2O_5	6 444	6 677	7 036	7 170	7 291	7 482	7 734
Potassium, as K_2O	5 572	5 752	5 876	5 993	6 112	6 237	6 363
Total ($N+P_2O_5+K_2O$)	**48 946**	**50 092**	**51 232**	**52 128**	**52 972**	**53 846**	**54 757**

Table 8 FAO world fertiliser trends and outlook to 2022 (World fertiliser trends and outlook to 2022, FAO, 2019)

The IFA report shows that the total employment by nutrients amounts 964 thousand people (Figure 24) while indirect employment from the supply side (i.e. transportation and retail) is estimated at 2.2 million persons. This figure still doesn´t include indirect employment generated at farm level.

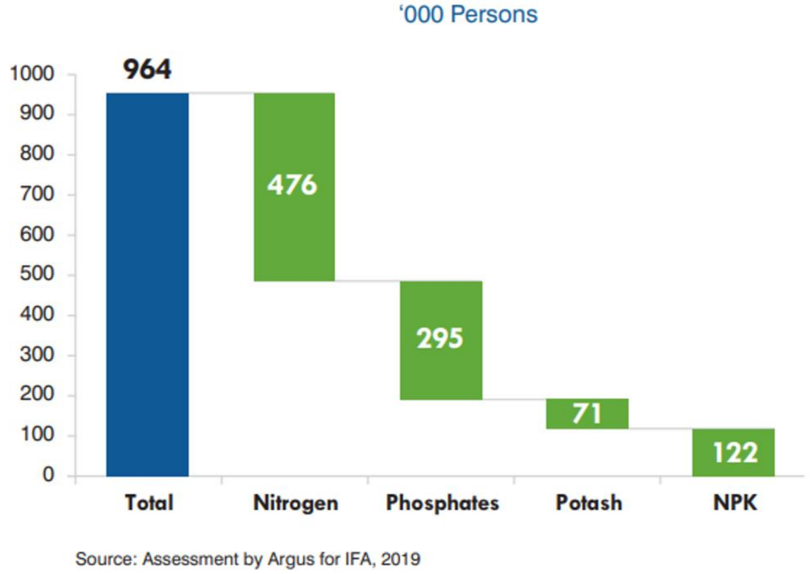


Figure 24 Employment by nutrients (Global sustainability report, IFA, 2019)

According to the EC estimates, the fertilising products sector has an annual turnover ranging from 20 – 25 billion EUR and accounts for about 100.000 jobs (expressed as Full Time Equivalent). In the inorganic fertilisers, large companies represent 75 % of the total market value, whereas for the other groups of products, SMEs represent approximately 98 %. At the end, 90 % of companies active in the fertilisers production are considered to be SMEs (Fertilisers Study, 2012).

As can be seen on Figure 25, nitrogen is the nutrient with highest consumption – projected annual growth rate of 1,1 %. The International Fertiliser Association (IFA) forecasts nitrogen fertiliser demand growth at 1,1 % per year through 2021. A growth rate of 1,6 % a year is estimated for phosphate and 2,2 % rate for potassium. A higher growth rate is forecast for urea.

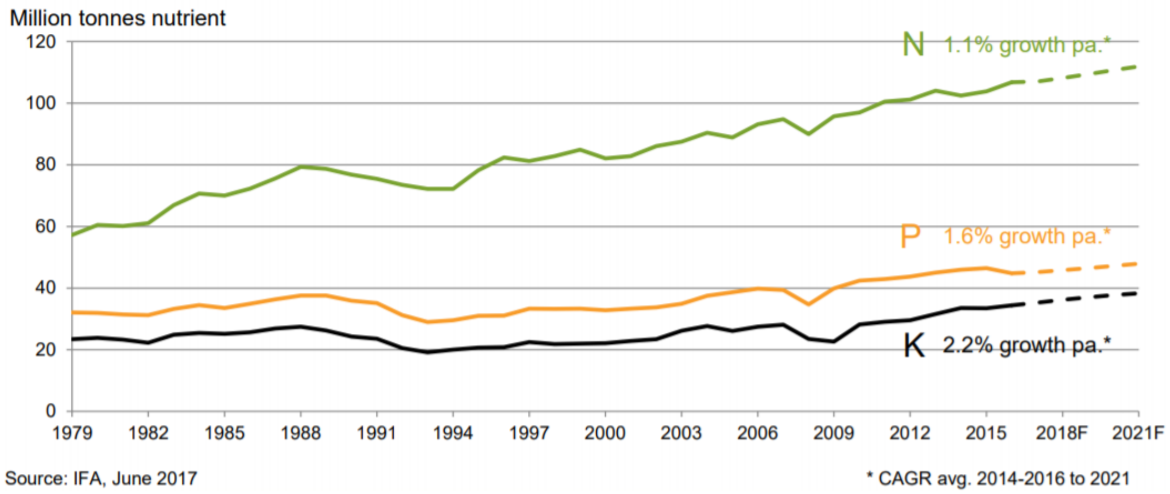


Figure 25 Fertiliser consumption in the EU (1979 – 2017, forecast to 2021) (Fertiliser industry handbook 2018, Yara, 2018)

When analysing fertiliser products on a global level, 4 key products have a large market share and more importantly are traded around the world (Figure 26):

- **urea** (46 % N)
- **diammonium phosphate** (DAP – 46 % P_2O_5 + 18 % N) and **monoammonium phosphate** (MAP – 46 % phosphate + 11 % N)
- **potassium chloride** (MOP – 60 % K_2O)

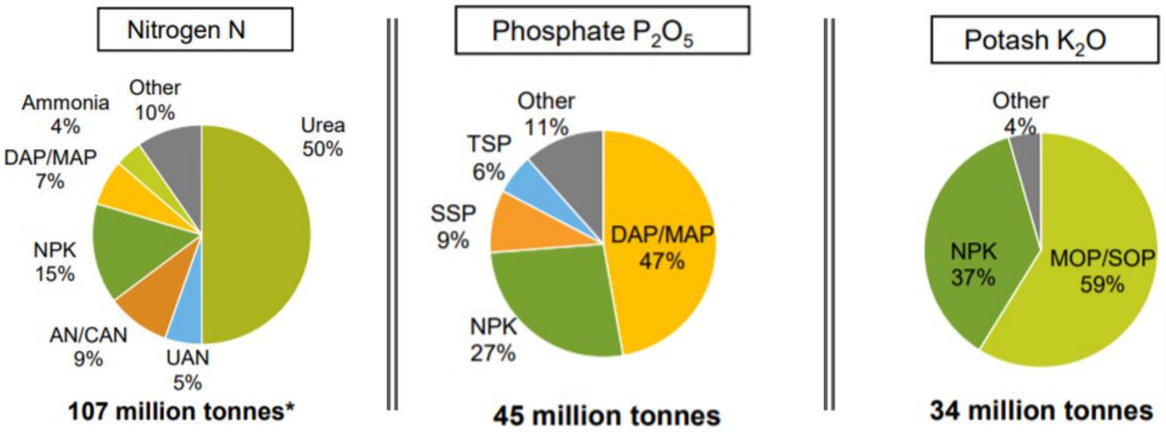


Figure 26 Key global fertiliser products – source IFA 2016 and 2015 ([Fertiliser industry handbook 2018, Yara, 2018]())

When regions worldwide are observed, one can see that fertilisers demand is largely influenced by the evolution of the planted area, yields, crops (type, rotation, prices), fertiliser subsidy regimes as well as nutrient recycling practices. Around 60 % of the total fertilisers consumption refers to nitrogen (N), namely urea. This is also in direct correlation to the regular fertiliser practice – nitrogen must be applied annually while phosphorus and potassium might not be applied so regularly. On the other hand, the map indicates that the region of Brazil has reverse ratios of N to P and K application (Figure 27). This is because Brazil has large soyabean production (30 % of the global production, 2016) which requires larger amounts of phosphorous and potassium (Fertiliser industry handbook 2018, Yara, 2018).

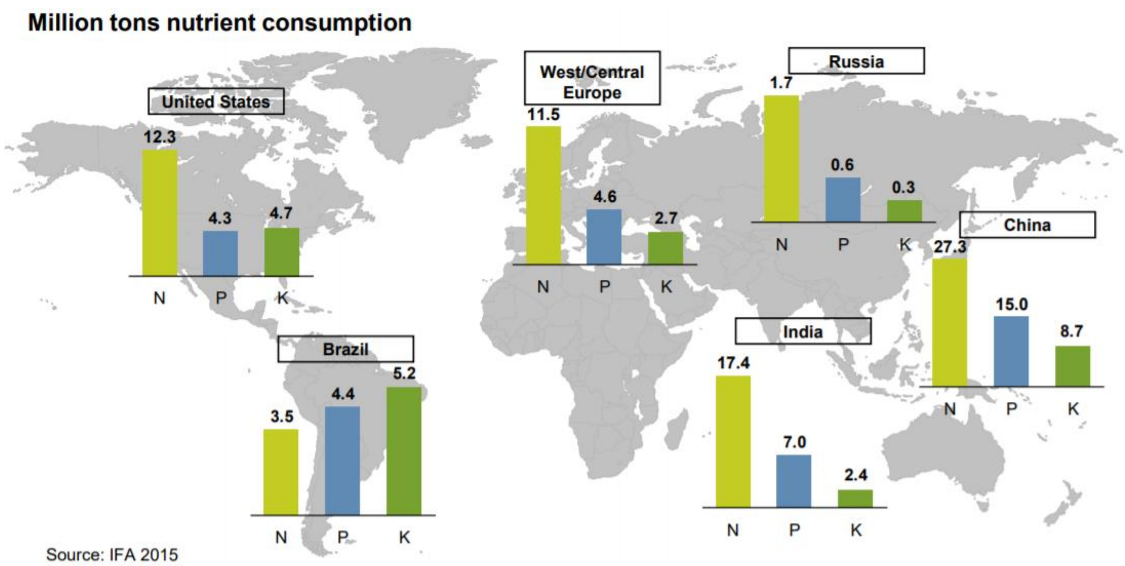


Figure 27 Key markets for fertiliser consumption worldwide–source IFA 2015 (Fertiliser industry handbook 2018, Yara, 2018)

Analysis of the fertiliser industry indicates differences between different nutrients, namely nitrogen industry is fragmented while phosphorous and potassium industry are more concentrated. According to the IFA statistics, top 3 producers of nitrogen account for only around 15 % of the total world capacity. On the other hand, top 3 producers of phosphate hold for about 24 % of the capacity and with potassium industry is even more concentrated and top 3 producers account for 49 % of capacity (Fertiliser industry handbook 2018, Yara, 2018).

Furthermore, IFA reports from 2015 indicate once again that urea is one of the most widely used fertilisers (Figure 28). In the EU-28, Russia and India, nitrogen fertilisers are mostly used for wheat production, while in the USA and Brazil the dominant sector is maize. It is interesting that nitrogen application in China mostly refers to fruits and vegetables sector and maize (Figure 30, Fertiliser industry handbook 2018, Yara, 2018).

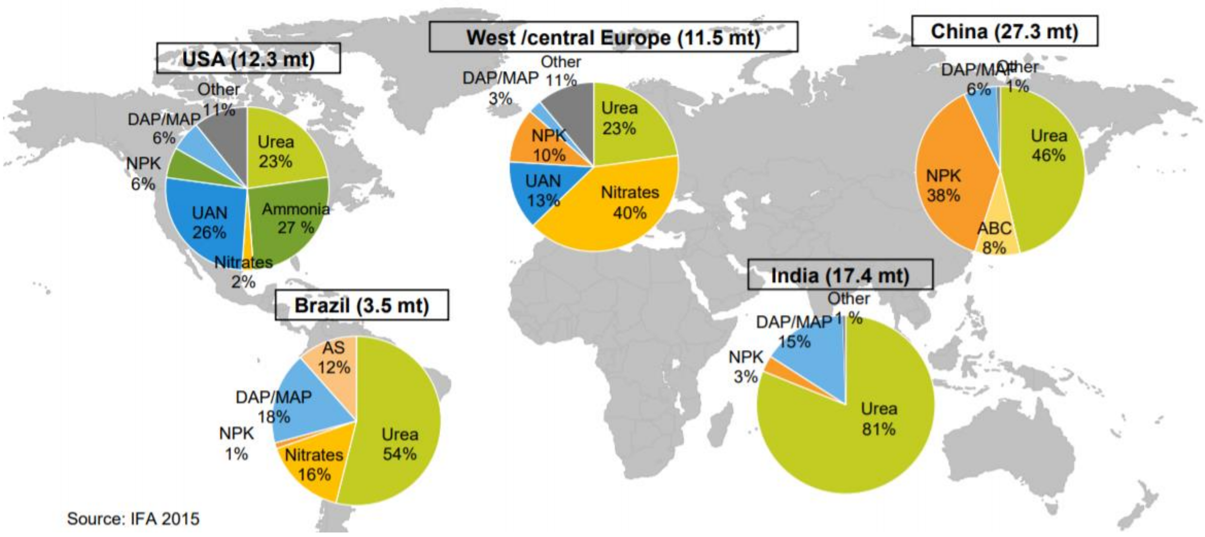


Figure 28 Nitrogen fertiliser application by region and product (Fertiliser industry handbook 2018, Yara, 2018)

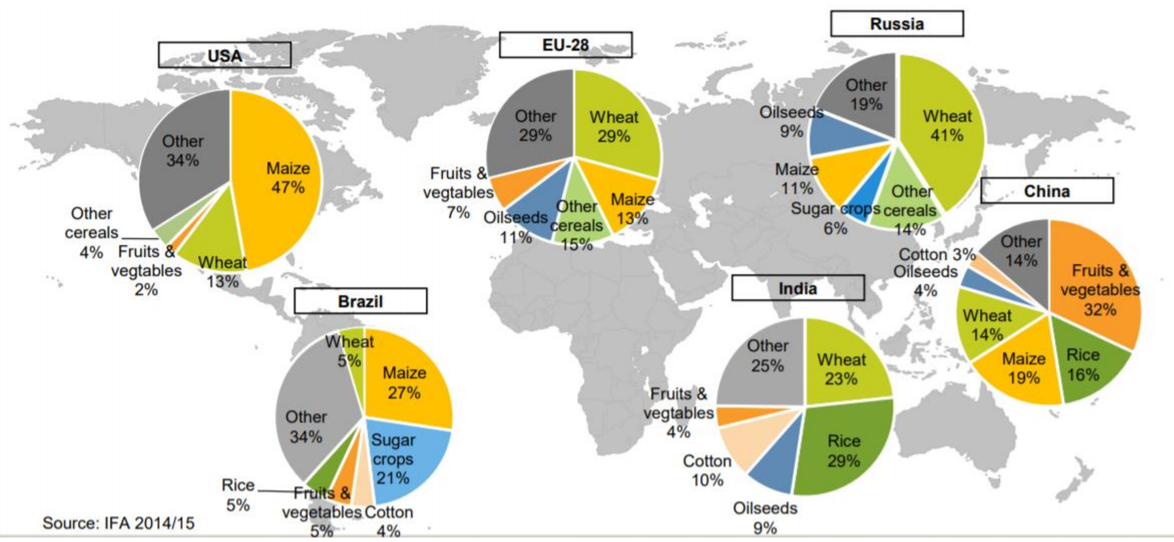
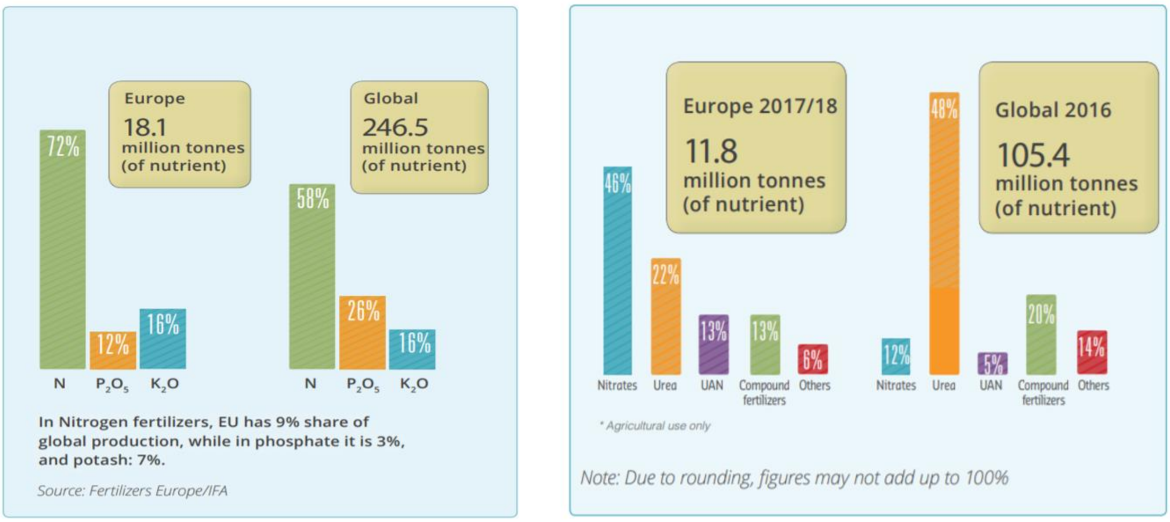


Figure 29 Nitrogen fertiliser application by region and crop (Fertiliser industry handbook 2018, Yara, 2018)

The EU is largely dependent on imports for the most of mineral fertilisers. In 2017, the value of the fertiliser market reached 17 billion EUR. France, Germany, and the UK represent 40 % of the market. The volume of fertilisers used in the EU represents 10 % of the total use at global level (Fertilisers in the EU, EC, 2019).

The EU key partners in fertiliser trade involve import and export countries - partners. According to the Eurostat and Fertilisers Europe annual report, biggest imports from the EU refer to Brazil (375 million EUR), Ukraine (202 million EUR), China (195 million EUR) and United States (136 million EUR). On the other hand, the biggest exports to the EU have been done by Russia (1.367 million EUR), Morocco (410 million EUR), Egypt (476 million EUR) AND Belarus (429 million EUR) (Industry facts and figures – 2019, Fertilisers Europe, 2019).

Figure 30 indicates fertiliser production by nutrient whereas the EU has 9 % share of the global production. Right side of the figure one can check nitrogen fertiliser consumption by product according to which EU agricultural sector mostly uses nitrates (46 %) and urea (22 %), while on a global level the most used nitrogen form is urea (48 %) (Industry facts and figures – 2019, Fertilisers Europe, 2019).



fertiliser production by nutrient (2017)

nitrogen fertiliser consumption by nutrient

Figure 30 Fertiliser production by nutrient and N fertiliser consumption by product in the EU and global (Industry facts and figures – 2019, Fertilisers Europe, 2019)

4.1.1.2. Size of the organic fertilisers market in the EU

The EU mineral business represents more than 80 % of the estimated total value of the fertilising materials market (Figure 31).

The organic fertilising sector is estimated at around 5 % which doesn´t include applications performed directly by farmers (e.g. manure). It is important to mention that in the aforementioned overview of the market, raw manure was not included since in the vast majority of cases manure is used by farmers directly on their own or neighbouring fields, generally without commercial transactions. Together, the sector of soil improvers (5 %), growing media (5 %) and bio-stimulants materials (2 %) are estimated at about 12 %. Based on these data, the new Fertilising Product Regulation will affect approximately 20 % of the total market value of all fertilising products.

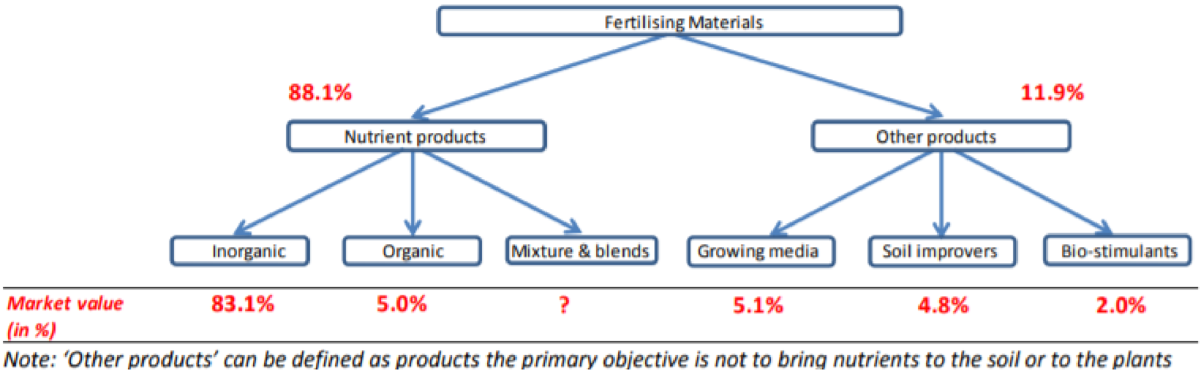


Figure 31 Market value distribution per category of fertilising products (Fertilisers Study, 2012)

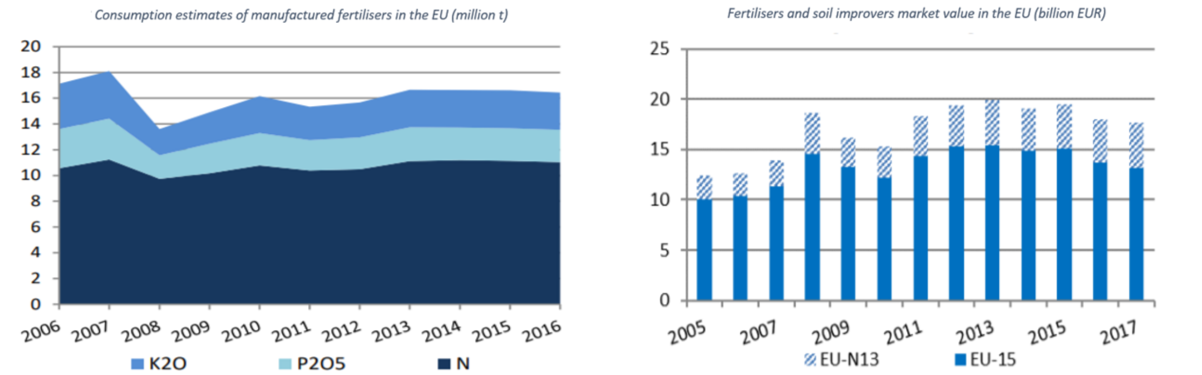


Figure 32 Consumption estimates (million t) and market value of fertilisers in the EU (billion EUR) (Fertilisers in the EU, EC, 2019)

Over the season, fertilisers containing an average of 11,5 million tons of nitrogen, 2,7 million tons of phosphate and 3,1 million tons of potash were applied to 133,8 million hectares of farmland (Forecast of food, farming and fertiliser use in the European Union, Fertilisers Europe, 2019).

Figure 33 provides information on sources of nitrogen in the EU agriculture. Majority of nitrogen comes from mineral fertilisers and manure.

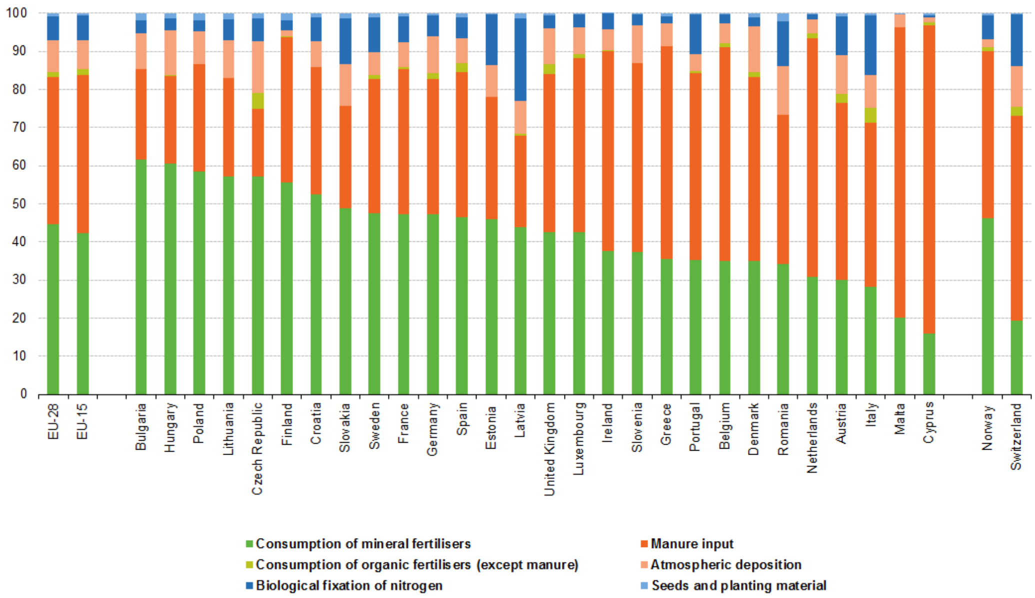


Figure 33 Sources of nitrogen inputs in the EU agriculture (Fertilisers Study, 2012)

Sub-sector	Market value	Market volume	Employment	Companies	SME ratio	Level of innovation	Other/Additional information
Mineral (Inorganic) fertilisers	17 billion € turnover (2010) mature market	GLOBAL - 170 Mio metric tonnes (2008/2009) (60 % N) EU MARKET - 16 Mio tons nutrients (consumption/yr) - 10.3 million tons N - 2.5 million tons P_2O_5 - 2.7 million tons K_2O	56 000 56 400	N: few huge gas industries P_2O_5 and K_2O: few companies in the mining industry +/- 100 producers and about 30 importers (large market players have +/- 90 % market share) more than 1000 SME's trading and blending inorganic fertilisers 1056 companies (source: ESTAT)	N: low K: low P: low blenders: high	low to moderate	market with different actors for each nutrient developed distribution networks low risk of substitution through organic fertilisers
Organic fertilisers (excluding manure, compost and digestate, industrial by-products only)	6 % of 17 billion € (1.02 billion € - estimated by the study team) moderate market value increase	EU MARKET - 332,800 tonnes N (2.9%) - 540 000 tonnes P (15.2%) - On average 6 % of the total inorganic fertiliser market	2 600	mostly SMEs, well organised 95 companies	very high (98 %)	high for all sectors including industrial by-products and manure	some also active in bio-stimulant and soil improver sectors market developed mainly in the Mediterranean countries
Organo-mineral fertilisers	475 million € high market value increase potential	Producing Member States: IT, FR, ES, DE, BE, NL	1 650	75 companies	very high		main markets in IT, ES, FR, DE, NL, BE, HR + RS high exports to non-EU MS market potential in other MS
Soil improvers Liming materials industry	2.5 billion € (added value, not turnover) maximum 20% concern use in agricultural sector mature market	EU MARKET - 5.6 million tonnes - 28.4 million tonnes	2 200 11 000 people in 23 countries	30 companies active in the agro sector blending by distributors 100 companies (200 production plants) – 4 or 5 at EU level	very low for producers very high for distributors	low to average	part of a larger business sector in which agriculture market segment is low (about 20 %)
Organic soil improvers sector (mainly products from waste, recycling activities, compost and digestate)	1.045 billion € (estimated turnover) (hobby representing 20% of total) high market value increase potential	EU MARKET - 23.6 million tonnes of biowaste (collected separately out of 80.1 million tonnes collectable, i.e. 29%) - growth potential - 124 million tonnes in EU-27 - 13.3 million tonnes of compost (2008) from the 23,6 million tonnes collected - green waste compost: 5.7 million tonnes	20 000 for the whole sector	at least 3 000 companies, including very large waste processors and many SMEs, some of which are rather old (>100 year old) and were involved with fertilisers before mineral fertilisers were marketed around 8 000 companies, including very large waste processors and a majority of SMEs active in the production of compost and digestate from source segregated waste	high	high	the turnover of 1.045 billion € comes from 2 sources: - the price paid by waste producers to deliver waste to the compost producing plants (largest part) - the price paid by the users of compost (minor part) the second part might be considered as being part of the fertilising materials/products market

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		- bio-waste compost: 4.8 million tonnes - sewage compost: 1.5 million tonnes - mixed waste compost: 1.4 million tonnes - agricultural use + growing media products = 70 % of the consumption					- estimation of the second part - 500 million € maximum
Growing media sector (mainly peat)	1.262 million € 1.038 million € (estimated total turnover for the fertiliser market) mature market	EU MARKET - 74 % of the EU production by FI, IE and DE - FI and IE use most peat for energy purposes - intense intra-EU trade flows (25% of global EU market) compared to other organic product markets - 37 million m^3 equivalent to circa 11 million tonnes according to EPAGMA	13 000	500 companies (EE, FI, DE, IE, LV, LT, NL, PL, SE,UK) mostly SMEs only 14 large companies	high/very high	average	
Bio-stimulants	low market value 400 million € (estimated turnover) high market value increase potential	mainly intra-EU trade	no statistics available	high level of fragmentation mainly SMEs in ES, IT, FR and DE with national or regional scope no statistics on number of companies	high	highly innovative large number of innovative products	limited product flows across MS speciality crops and high price high margins for producers often associated to liquid fertilisers
Fertilising additives	640 million € high market value increase potential	EU MARKET - markets in ES, FR, IT, DE, BE, DK, HU, PL, UK, NL, PT, CZ	3 300	200 companies	very high		

Figure 34 Summary figures per fertilising materials market segment (Fertilisers Study, 2012)

4.1.2. Size of the fertiliser market in CELAC – import, export

The supply of fertilisers in Argentina is made up of both imported and national production. The last 10-years market evolution shows that imported fertilisers represent the highest percentage of the supply (Figure 35). On average, 60 % of fertilisers are imported while remaining 40 % refer to national production.

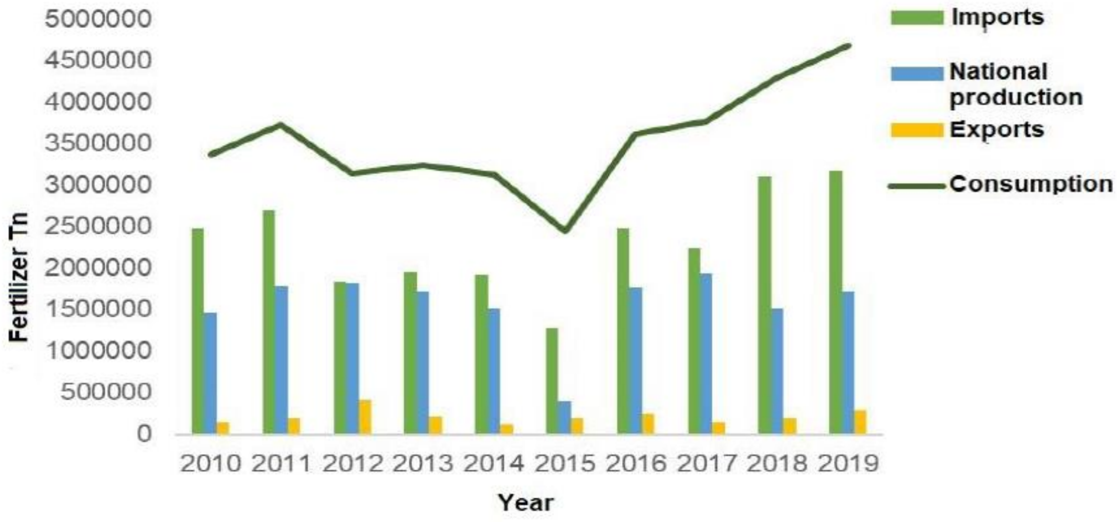

Figure 35 Fertilisers balance during the last 10 years in Argentina (CIAFA, 2020; INTA report, 2020)

During the last 4 years both, the fertilisers import and consumption, increased. The highest fertiliser imports were registered in 2019 amounting 3.18 Mtn. On the other hand, the highest national fertilisers production was registered in 2017 amounting 1.9 Mtn, which represents 47 % of the total fertiliser supply. On average 13 % of national manufactured fertilisers are exported. The highest 10-year record was registered in 2012 with 22 % of national production exported (401,000 tons).

When imported fertilisers are being analysed, the phosphate group of fertilisers are on the top of the list, reaching maximum values of 60 % (2015) and an average of 54 % of total imports (2010-2020). In 2016, nitrogen fertilisers begin to take the lead, even surpassing phosphates (Figure 36).

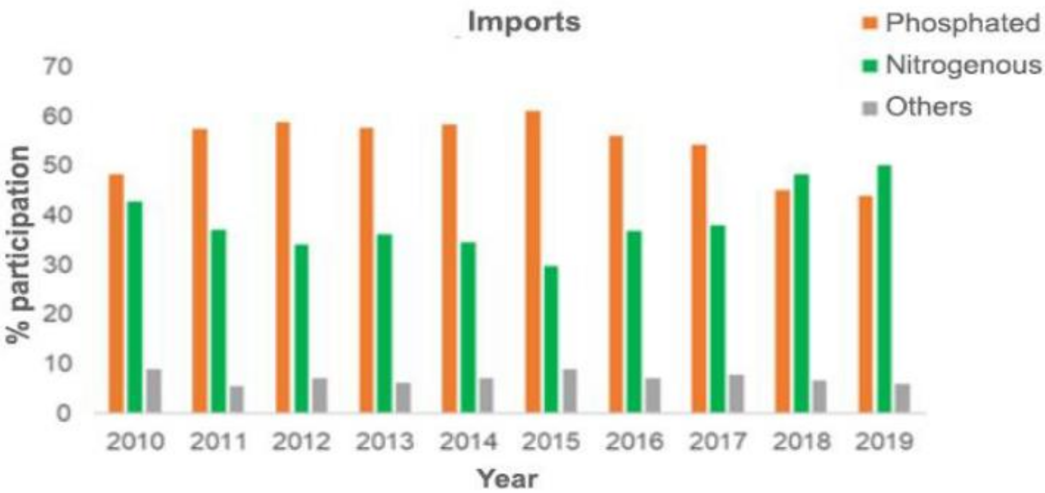

Figure 36 Group of fertiliser imports over the last 10 years (source: CIAFA, 2020; INTA, 2020)

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Argentina imports nitrogen fertilisers from US (26 %), Russia (19 %) and the Netherlands (14 %), while phosphate fertilisers are imported from Mexico (45 %), China (29 %) and Egypt (14 %) (Figure 37).

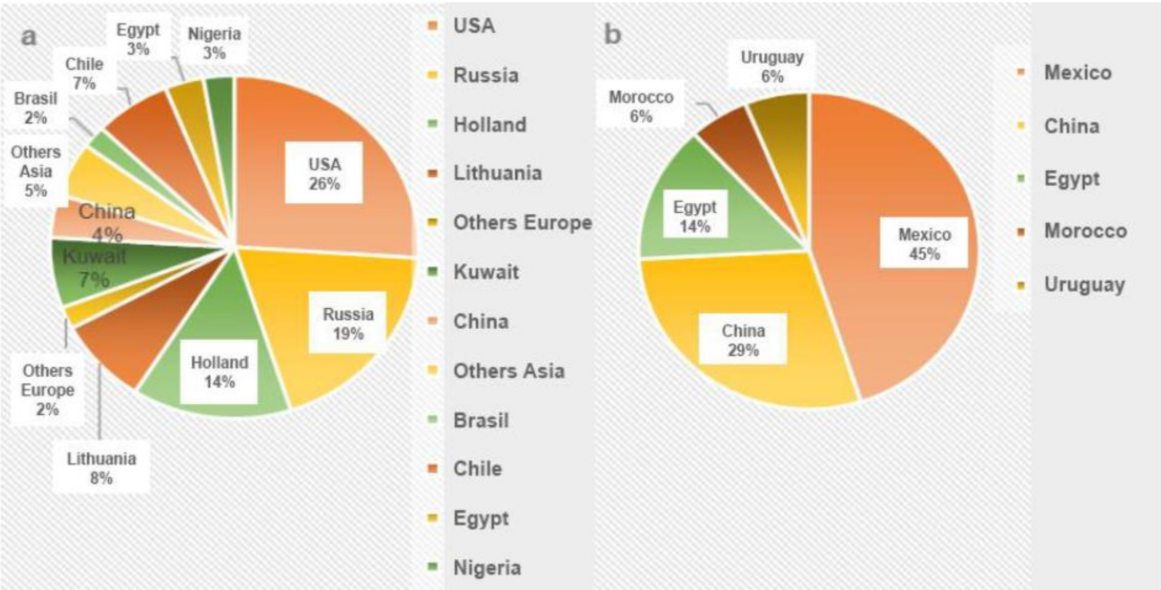


Figure 37 Origin of fertilisers imported to Argentina (2017) – A) nitrogen fertilisers; B) phosphate fertilisers (source: OEC, 2017, INTA, 2020)

The national production of fertilisers in Argentina over the last 10 years was concentrated on the nitrogen fertilisers, representing 70 % of the overall production (Figure 38). On the other side, phosphates participate in a production with only 22 % on average (2010-2020).

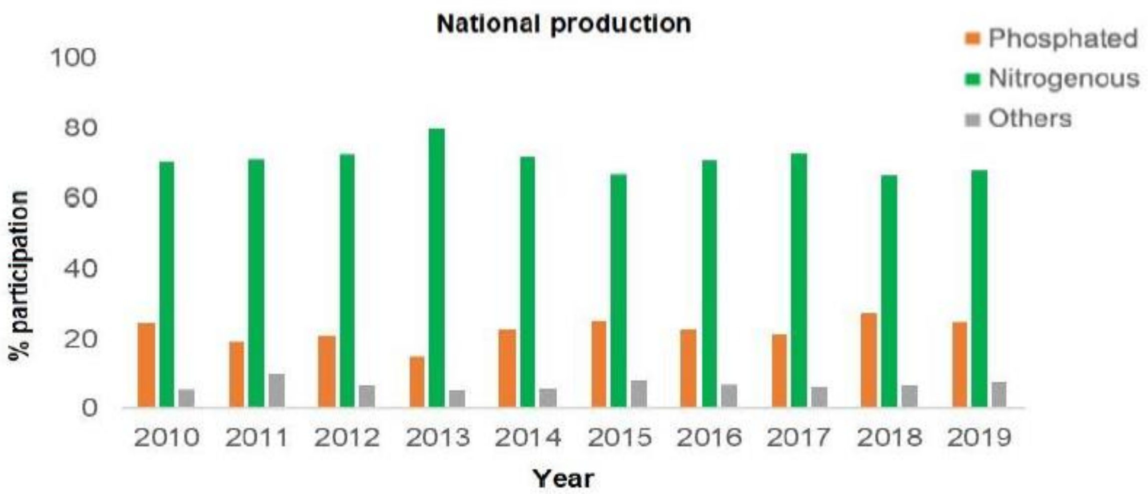


Figure 38 Argentina national fertilisers production (source: CIAFA, 2020; INTA, 2020)

Nearly 70 % of the nitrogen fertilisers comes from a plant located in Bahía Blanca (Buenos Aires) with a potential production capacity of 1.1 Mtn /year. The rest of the local production is supplied by a plant located in Campana (Buenos Aires), with an annual production capacity of 500,000 Tn/year.

Regarding the phosphate fertilisers, national production is distributed over two plants: one located in the city of Ramallo (Buenos Aires) with a capacity of 180,000 Tn/year and the other one located in Puerto San Martín (Santa Fe) with a capacity of 240,000 tons/year (MAGyP, 2016).

Between 2010 and 2013, the nitrogen fertilisers made up the 93 % of the overall fertilisers export, while phosphate fertilisers were exported by 38 %. During the 2019 campaign, the percentage of export participation of nitrogen and phosphate fertilisers were 52 % and 45 % respectively (Figure 39).

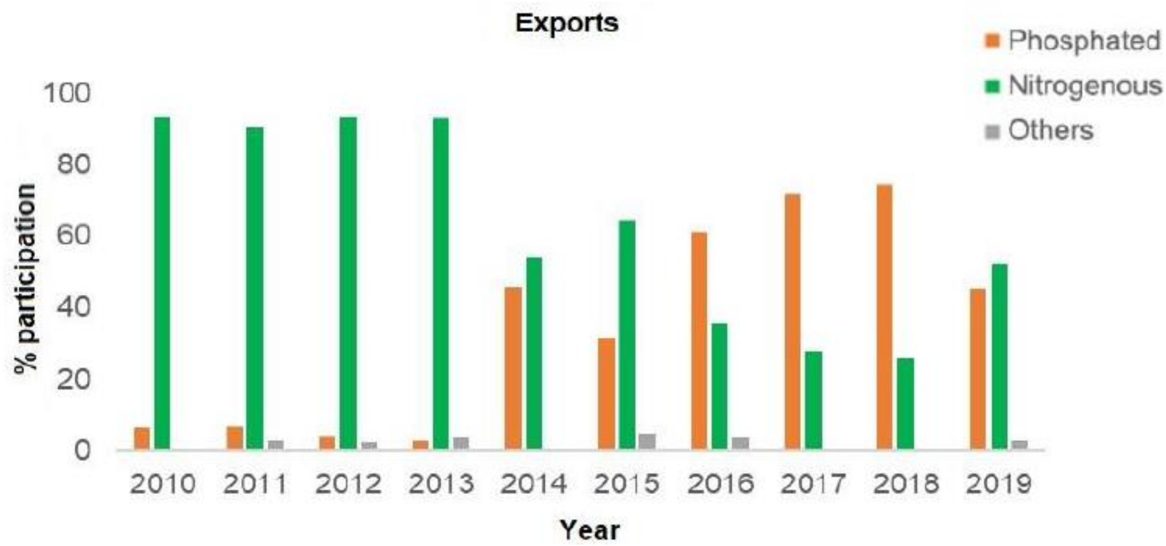


Figure 39 Export of fertilisers from Argentina (source: CIAFA, 2020; INTA, 2020)

Figure 40 indicates that nitrogen fertilisers are almost entirely exported to Mexico (98 %) while phosphate fertilisers are exported to Paraguay (78 %) and Brazil (16 %).

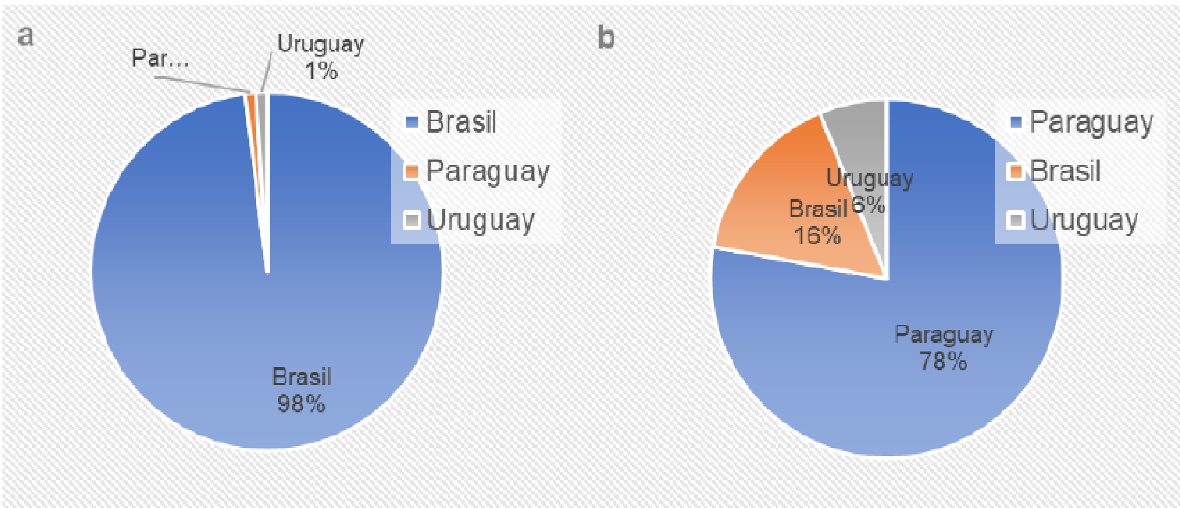


Figure 40 Export of fertilisers from Argentina – A) nitrogen fertilisers export; B – phosphate fertilisers export (source: OEC, 2017, INTA, 2020)

Using SENASA records for 2018, CABIO4 reported 88 companies producing inoculants/biological fertilisers with 653 trademarks and 15 bio-controllers manufacturing companies offering 27 types of products.

In 2014 Rhizobia inoculants sales was a $ 176.5 million worth market in Argentina with a national share of 94 % (645 products) plus 43 imported products available (Bisang and Regunaga, 2016). Majority of these products (51 %; 354 products) are being used in soybean production, while 9.6 % (66 products) and 9.3 % (64 products) are being used in wheat and corn production, respectively.

Chile is a net exporter of fertilisers. According to the FAO study, the demand for fertilisers increases by about 2 % on a yearly basis (2014-2018). These data are directly related to the increase in agricultural production to meet the needs of the world population.

The domestic fertiliser market is characterized by an oligopolistic structure with only few companies producing it. Fertilisers of conventional use are also few, including diammonium phosphate (DAP), triple superphosphate (TSP), urea and potassium sulphate.

Fertilisers are of great importance for agricultural production in Chile, accounting for even up to 60 % of the production cost for some crops. As it is the case worldwide, nitrogen, phosphate and potassium products are mostly used.

Type	**2013**	**2014**	**2015**	**2016**	**2017**
3101. Animal or vegetable fertilizers	4.991.123	5.835.824	6.210.351	8.234.623	9.534.098
3102. Mineral or nitrogen chemical fertilizers	285.772.012	241.463.110	260.983.480	164.594.533	173.707.998
3103. Mineral or phosphate chemical fertilizers	53.049.484	52.905.983	51.585.096	34.722.348	29.127.131
3104. Mineral or potassium chemical fertilizers	37.450.383	27.913.635	44.604.252	24.203.990	29.750.223
3105. Mineral or chemical fertilizers with 2 or 3 fertilizers	139.341.991	133.536.848	157.597.711	96.866.293	118.149.086
Total	**520.607.005,9**	**461.657.414,3**	**520.982.905,4**	**328.623.802,5**	**360.270.553,4**

Table 9 Imports of fertilisers in Chile over the period 2013 – 2017 (expressed in USD, source: Legal Publishing, Chile - Fertimanure report, 2020)

Product	2013	2014	2015	2016	2017
31021000. Urea	1.998	62.974	13.372	102.233	529.578
31023000. Ammonium nitrate	116.945.216	120.015.971	95.225.369	62.374.118	53.915.562
31031030. Triple superphosphate	-	-	15,39	61,87	-
31042000. Potassium chloride	501.419.139	425.547.004	372.465.441	301.220.924	258.250.979
31043000. Potassium sulfate	19.414.476	56.415.417	56.050.814	64.658.524	39.560.965
31053000. Diamonic phosphate	8.365	4.187	462	2.423	27.615
31054000. Monoamonic phosphate	-	2.997	-	-	3.793

FOB (*Free on Board*) is an incoterm – an international trade clause – that is used for buying and selling operations in which the transport of the goods is carried out by ship, whether maritime or river

Table 10 Main fertilisation export products in Chile over the period 2013 – 2017 (value in FOB, USD, source: Legal Publishing, Chile - Fertimanure report, 2020)

There are 5 main strong fertiliser importing companies: Soquimich, Anagra S.A., Iansagro S.A., Agrogestión Vitra Ltda. And Mosaic de Chile Fertilizantes Ltda. The companies mentioned above account for more than 60 % of total fertiliser imports. Besides being importers, these companies also play a role as fertilisers distributors *(Chile, Fertimanure report, 2020).*

Company	2013	2014	2015	2016	2017	Total general
ANAGRA S.A.	112.938.326	124.370.470	136.441.027	74.672.852	68.359.653	**516.782.328**
Agrogestion Vitra Ltda.	111.144.269	114.557.163	117.947.386	66.836.473	68.817.201	**479.302.491**
Soquimich S.A	90.382.796	86.365.633	68.799.845	50.337.733	32.527.230	**328.413.236**
Mosaic d/Chile Fertilizantes Ltda	79.967.413	32.378.207	-	-	-	**112.345.620**
Iansagro S.A	5.585.186	10.348.451	58.753.076	12.406.979	13.653.606	**100.747.298**
CNA Chile Spa	-	-	10.233.227	20.651.983	62.317.271	**93.202.481**
Compañía Agropecuaria Copeval	-	-	48.699.413	18.546.941	20.868.555	**88.114.909**
Orica Chile S.A.	20.382.245	19.109.669	15.929.139	3.344.230	-	**58.765.283**
ADM Chile Comercial Ltda.	30.977.506	18.639.986	-	-	-	**49.617.492**
Famesa Explosivos Chile S.A	9.392.237	3.283.474	3.060.023	-	5.150.230	**20.885.963**
Iinversiones Ramaja Ltda.	-	-	-	10.013.022	4.594.582	**14.607.604**

Ranking of top import companies in 2017

N°	Description	Volume	% of Total	Cif en US$	% Total
1	AGROGESTION VITRA LTDA.	231.033.411,00	21,54	68.817.200,68	19,1
2	ANAGRA S.A.	245.785.309,00	22,91	68.359.653,03	18,97
3	CNA CHILE SPA	211.507.163,00	19,72	62.317.270,60	17,3
4	SOQUIMICH COMERCIAL S.A.	104.511.362,33	9,74	32.527.230	9,03
5	COMPANIA AGROPECUARIA COPEVAL	67.157.333,00	6,26	20.868.555	5,79
6	IANSAGRO S.A.	43.602.895,00	4,06	13.653.606	3,79
7	MAXAM CHILE S.A.	25.080.500,00	2,34	7.766.073	2,16
8	FAMESA EXPLOSIVOS CHILE S.A.	17.216.400,00	1,61	5.150.230	1,43
9	INVERSIONES RAMAJA LTDA.	18.816.160,00	1,75	4.594.582	1,28
10	YARA CHILE FERTILIZANTES LTDA	15.139.753,90	1,41	4.143.801	1,15

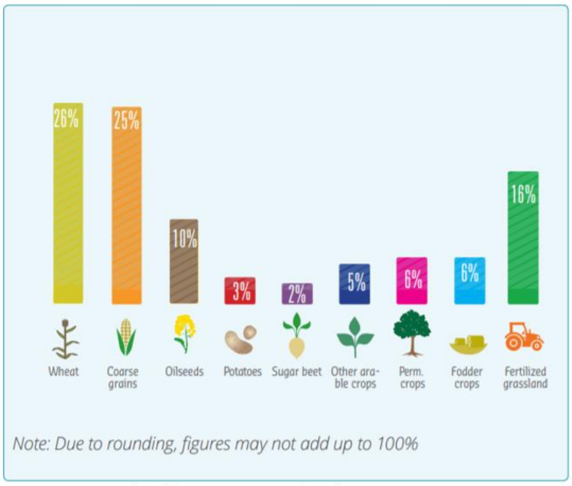
Table 11 Ranking of top fertilisers import companies in Chile (2013 – 2017; CIF values, USD; source: Legal Publishing, Chile - Fertimanure report, 2020)

4.2. Fertilisers use & agricultural sectors

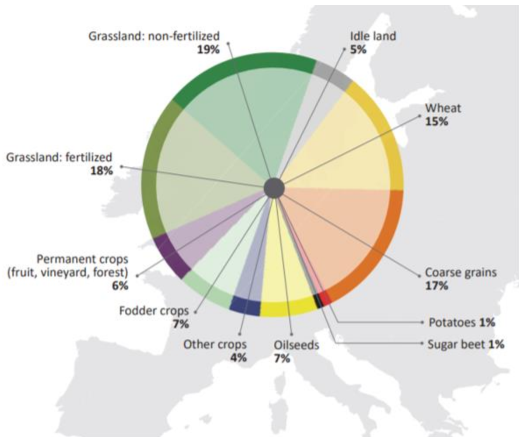
4.2.1. Fertilisers use in agricultural sectors in EU

Europe is one the world´s largest and most productive suppliers of food. The productivity of European agriculture is generally high, in particular in western Europe. One of the reasons is certainly a sufficient fertilisation and selection of highly productive plant species. Fertiliser application is determined by the crop type, soil characteristics, climate and so on. Numerous reports indicate that majority of fertilisers used refer to either mineral fertilisers or manure application.

Fertilisers Europe state that most of fertilisers are used for production of wheat, coarse grains, and oilseeds. A significant 16% of the total fertiliser consumption also refers to fertilisation of grassland (Figure 41). If an analysis of agricultural land use in the EU is made, the aforementioned crops are also the one most common one (e.g. coarse grains cover 17 % of the total agricultural land in the EU).



fertiliser consumption by crop



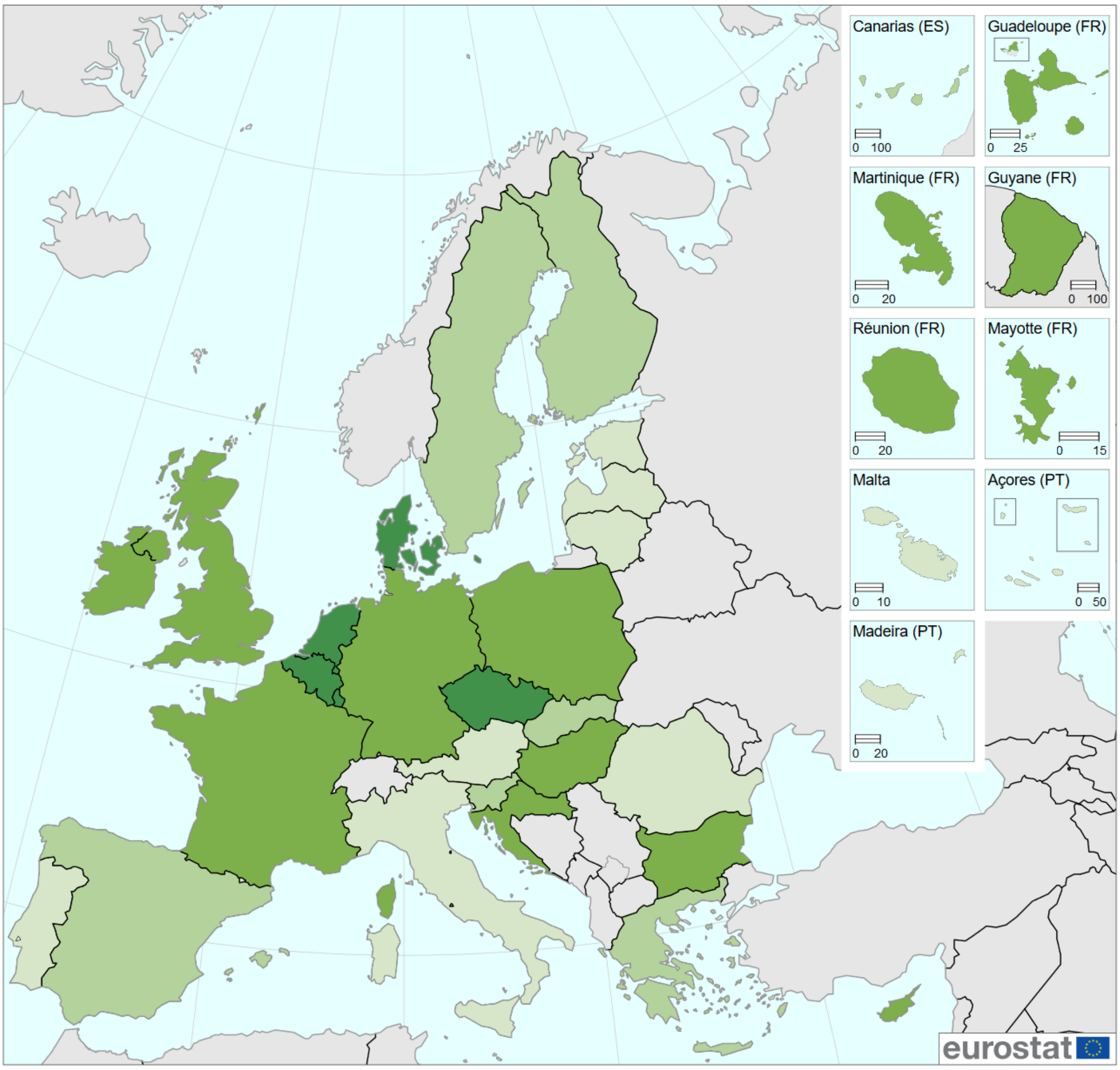
agricultural land use in the EU

Figure 41 Filter consumption by crop and agricultural land use in the EU ([Industry facts and figures, Fertilisers Europe, 2019](#))

On a European average, the nitrogen fertiliser consumption per hectare of fertilised UAA amounts to 77,2 kg N/ha in 2018 (Figure 42). The highest N consumption is detected in central Europe, with the Benelux countries, Czechia and Denmark accounting for more than 100 kg

N/ha. The lowest values were reported in the Baltic countries, Italy, Malta, Austria, Portugal and Romania and in these countries it was less than 60 kg N/ha (Eurostat, 2018).

On the other hand, the amount of phosphorus used per hecater of fertilised UAA averaged 8,6 kg/ha in 2018. Several countries in southern and eastern Europe are well above the EU average. The highest value of more than 12 kg P/ha can be observed for Cyprus, Croatia and Hungary, while the lowest values are obtained in the Benelux countries, Estonia, Malta and Germany (less than 6 kg P/ha) (Eurostat, 2018).



Administrative boundaries: © EuroGeographics © UN–FAO © Turkstat
Cartography: Eurostat – IMAGE, 05/2020

Kilogram nitrogen per hectare:

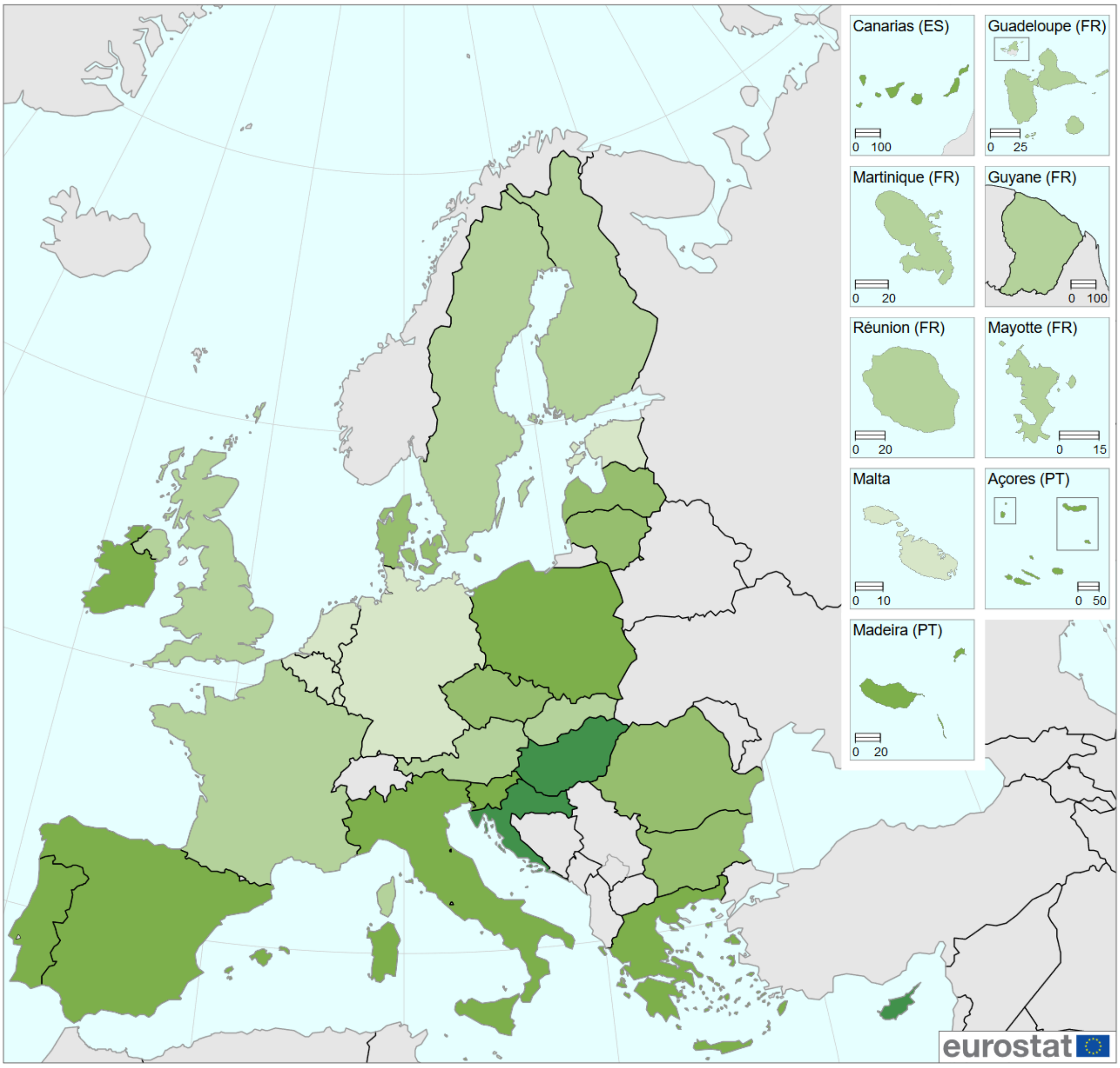
- **< 60 (minimum value: 40.3)**
- **60 – < 80**
- **80 – < 100**
- **>= 100 (maximum value: 120)**
- **Data not available**

0 200 400 600 800 km

Note: For the nitrogen fertiliser consumption, values from 2017 were taken as a reference for 2018 for the following countries, because no data are available for 2018: Belgium, Denmark, Cyprus, Malta. Fertilised UAA is calculated by excluding from UAA the hectares occupied by fallow land, rough grazing and organic arable land. As there are no data available for 2018 yet, 2016 was chosen as reference year for UAA, fallow land and rough grazing.

Source: Eurostat (online data codes: aei_fm_usefert, ef_m_farmleg, ef_lac_greenfal, ef_lus_pegrass, org_cropar)

Figure 42 Nitrogen fertiliser consumption per hectare of fertilised UAA, EU -27 and UK, 2018 (kg N/ha) (Eurostat, 2018)



Administrative boundaries: © EuroGeographics © UN–FAO © Turkstat
Cartography: Eurostat – IMAGE, 05/2020

0 200 400 600 800 km

Kilogram phosphorus per hectare:

- **< 6 (minimum value: 3.1)**
- **6 – < 7**
- **7 – < 9**
- **9 – < 12**
- **>= 12 (maximum value: 24.1)**
- **Data not available**

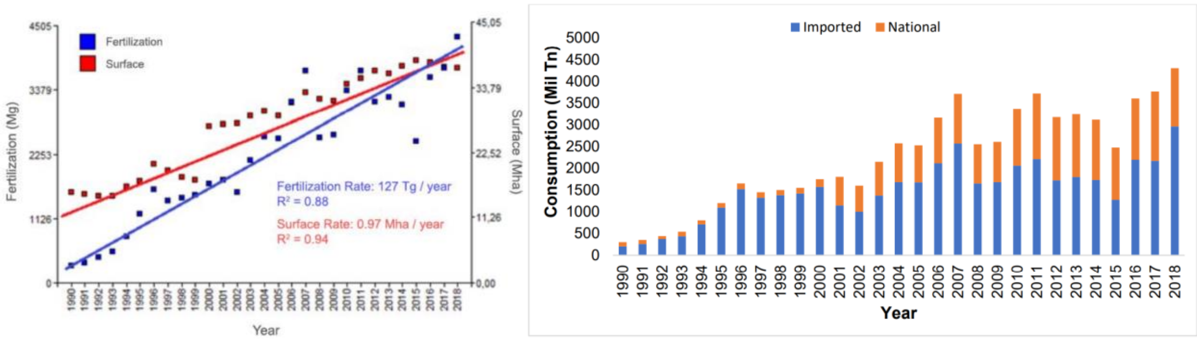
Note: For the phosphorus fertiliser consumption, values from 2017 were taken as a reference for 2018 for the following countries, because no data are available for 2018: Belgium, Denmark, Cyprus, Malta. Fertilised UAA is calculated by excluding from UAA the hectares occupied by fallow land, rough grazing and organic arable land. As there are no data available for 2018 yet, 2016 was chosen as reference year for UAA, fallow land and rough grazing.

Source: Eurostat (online data codes: aei_fm_usefert, ef_m_farmleg, ef_lac_greenfal, ef_lus_pegrass, org_cropar)

Figure 43 Phosphorous fertiliser consumption per hectare of fertilised UAA, EU -27 and UK, 2018 (kg N/ha) (Eurostat, 2018)

4.2.2. Fertilisers use in agricultural sectors in CELAC

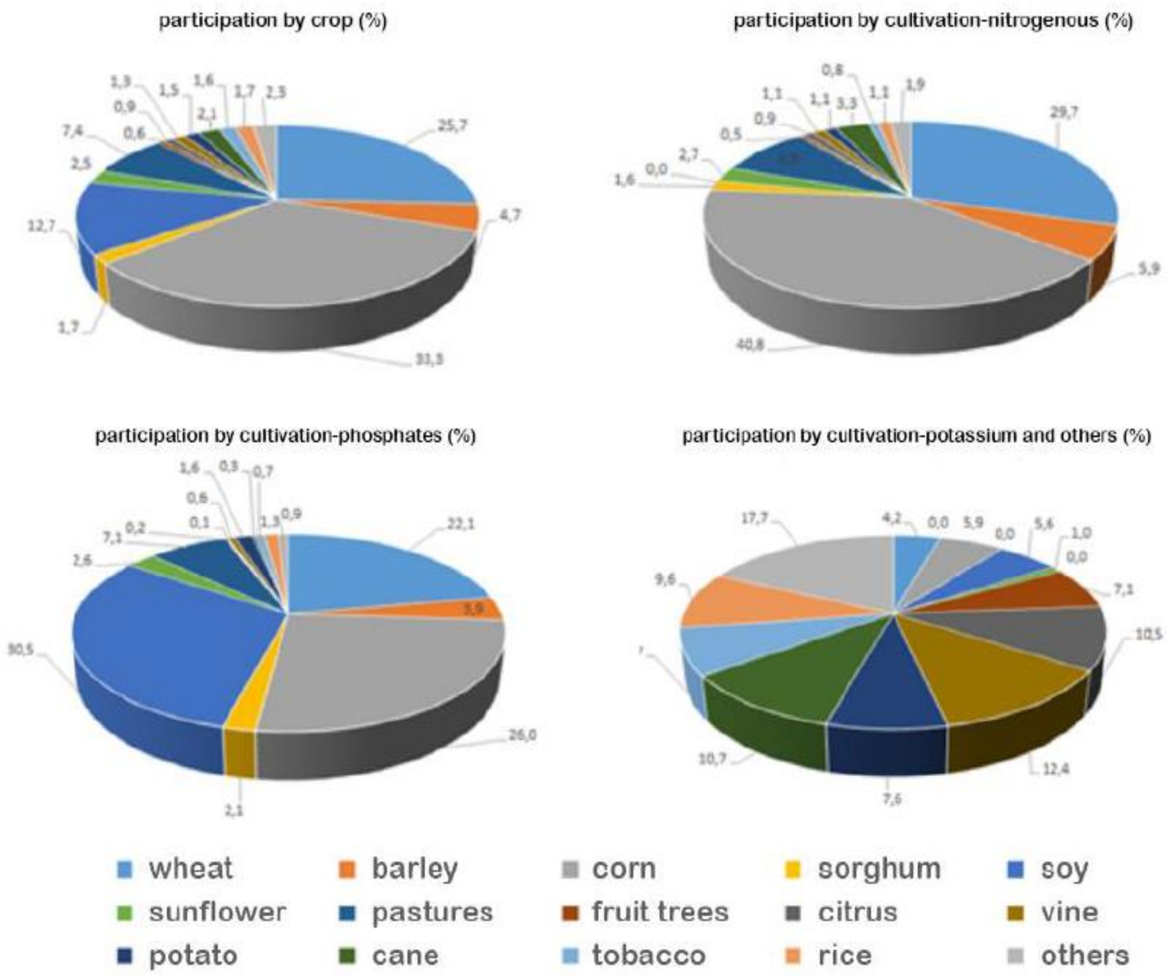
Inorganic fertilisers, primarily nitrogen and phosphorous are the most widely used in Argentina, both in extensive and intensive crop production. The third most important nutrient is sulphur (4 % of the total fertilisers consumption). A large part of the nutrient comes from simple superphosphate and represents over 10 % of the market share. Common agriculture practice in Argentina means sulphur is always applied together with phosphor or nitrogen. Potassium usage is very limited, and it is being used only with regional crops and rice production.
Regarding the micronutrients market, fruit crops have the highest demand for zinc and boron, although recently micronutrients have started to be applied in extensive crops as well (e.g. corn, sunflower and soybeans) (Grasso et al., 2018; INTA, FERTIMANURE report, 2020).
According to the Civil Association Fertilizar, an estimated fertilisers consumption in 2018 was 4,305,443 tons (Graph 1). Majority of fertilisers applied refer to nitrogen fertilisers (2,415,171 tons) and phosphor fertilisers (1,559,427 tons), followed by sulphur fertilisers (177,263 tons). These three elements hold up 92 % of the total fertilisers market share.



Graph 1 Cultivated area and fertilisers consumption (1990 – 2018) (source: Fertilizar, 2020); Consumption of fertilisers based on origin – national or import (1990 – 2018) (CIAFA, 2020, FERTIMANURE report, INTA, 2020)

Total consumption of fertilisers increased by 21 % during 2018/2019 campaign, compared to the 2017/2018 campaign. Reasons behind this increase are associated with an expansion of the area planted with grasses (barley, wheat and corn increased their area by 10.5 %, 11 % and 8.8 % respectively) that resulted with high demand for nitrogen fertilisers and fertilisation doses in these crops were higher than usual. What is beneficial is that during this campaign a higher percentage of farmers did soil analyses prior to fertilisation.

Wheat, barley, corn, soy, sorghum, sunflower and pasture crops sum up to 88 % of total inorganic fertiliser consumption (2017/2018). Wheat and corn are the most demanding crops for fertiliser application (corn - 40.8 %; wheat - 29.7 %). The category "other crops" refers to fruit trees (1 %), citrus (1 %), vine + grape (1 %), potato (1 %), sugar cane (2 %), tobacco (2 %), rice (2 %) and "various crops" (horticultural, cotton, yerba mate, olive, forest and ornamental (2 %).
Phosphorus fertilisers sum up to 93 % of the total fertilisers applied in soybean production (nitrogen fertilisers are substituted by inoculants), 33 % in wheat and 30 % in corn (Graph 2).



Graph 2 Fertilisers consumption: A) Total fertilisers consumption per crop; B) N fertilisers total consumption per crop; C) P fertilisers total consumption per crop; D) K and other fertilisers consumption per crop (source: Fertilizar, 2020; FERTIMANURE report, INTA, 2020)

Full overview of commercially available and farmers used inorganic fertilisers is presented in the Table 7. As mentioned earlier, the highest is the consumption of nitrogen fertilisers (urea, UAN).

Commercial product	Consumption	(Tn)
	2018	2019
Urea	1.630.596	1.826.695
UAN	552.535	616.734
Limestone Ammonium Nitrate	128.830	108.947
Other Nitrogenates	103.210	65.838
MAPS and other MAPS	829.033	941.154
Simple Superphosphate	306.238	316.622
DAP and other NP	271.150	290.916
Triple Superphosphate	110.566	97.384
Other phosphates	42.440	78.653
Potassium Chloride	27.614	25.732
Potassium Nitrate	5.384	5.771
Potassium Sulfate	7.831	5.839
Potassium Thyosulphate	3.057	2.258
Other Potassium Derivates	25.426	26.492
NPK Blends	84.271	78.655
Ammonium Thosulfate	91.113	110.349
Gypsum	42.539	43.596
Ammonium Sulphate	37.774	42.192
Other Sulfurs	5.837	2.741
TOTAL	4.305.444	4.686.567

Table 12 Commercial products (inorganic fertilisers) consumption (2018 – 2019) (source: Fertilizar AC-CIAFA; INTA)

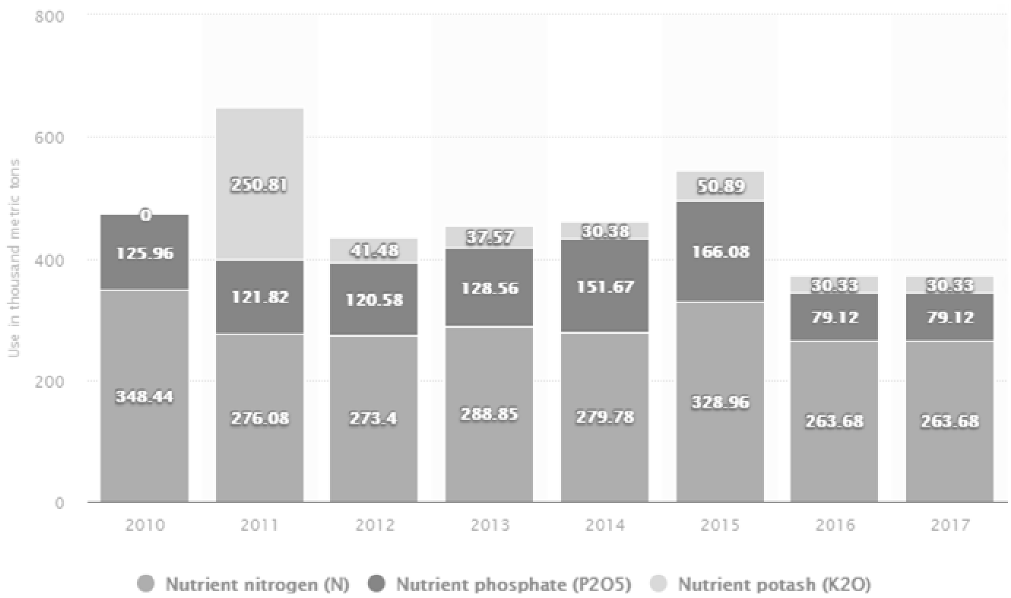
The domestic market is characterized by having an oligopolistic structure, with few companies dominating the national supply. Some natural fertilisers are produced internally, among which are sodium nitrate, potassium, and potassium chloride, which are destined for internal marketing and export. For this reason, most of the fertilisers sold in the national market, approximately 85 %, originate from imports from different countries and the rest, approximately 15 %, are produced in the country. This import is characterized by being seasonal and is mainly concentrated between April and September. For the country, the intensification of agriculture has brought with its significant increases in yield, placing this sector among the most productive in the region.

According to the World Bank, the consumption of fertilisers between 2011 and 2015 in Chile was 579 kilograms per hectare of arable land. The Chilean regions of greatest importance due to the potential demand for fertilisers are La Araucanía, Biobío, and Los Lagos. The national market is mainly supplied by imports. The main imported fertilisers are urea and superphosphates.

The current trend in the use of commercial fertilisers in the fruit and vegetable sector consists of an efficient and responsible use, which does not cause damage to the environment, through the implementation of good agricultural practices, the use of precision agriculture and the calculation of the proportion of nutrients needed according to the crop and type of soil and the right way and time for its application. In general, a cultural change is taking place with a trend more towards organic, which is also affecting the agricultural sector, although not at such accelerated steps as those in markets such as Europe (Chile, Fertimanure report, 2020).

The domestic fertiliser market in Chile is characterized by having an oligopolistic structure, with very few companies offering it. Fertilisers of conventional use are also few: diammonium phosphate (DAP, by its name in English), triple superphosphate (TSP), urea and potassium sulphate. The predominant format corresponds to the solid, granulated, and bulk product. Fertilisers are of great importance in Chile, accounting for up to 60 % of the production cost for some crop types. In the country prevails the use of nitrogenous, phosphate and potassium products, whose properties are responsible for the initial development of a crop, its protection against diseases and its growth, in that order (Chile, Fertimanure report, 2020).

Between 2011 and 2017, nitrogen fertiliser was the most consumed in Chile for agricultural use. In 2017, consumption of nitrogen fertiliser in the Andean country was estimated at 263.7 thousand metric tons. Meanwhile, phosphate fertiliser consumption amounted to around 79 thousand tons that year, followed by potash, with 30 thousand tons (Statista, Total fertilizer use for agriculture in Chile from 2010 to 2017, by nutrient, 2020).



Graph 3 Total fertilizer use for agriculture in Chile from 2010 to 2017, by nutrient (source: Statista, 2020)

5. Bio-based fertilisers

5.1. Bio-based fertilisers definition

The basis of the FERTIMANURE project is to demonstrate and validate at farm-level the performance of innovative technologies or innovative integrated treatment schemes to recover mineral nutrients, bio stimulants and organic matter from animal manure. The project will put special emphasis on 5 different and complementary on-farm experimental pilots to recover bio-based fertilisers (BBFs) with a high agronomic value.

With that said, it is crucial to understand what bio-based fertilisers are in its basis. Existing definitions state that **bio-based fertilisers are fertiliser products derived from renewable biomass-related resources** (e.g. digestate)**.**

With this in line, the FERTIMANURE Consortium concluded that **FERTIMANURE bio-based fertilisers are fertiliser products or resources for the production of (Tailor-Made) Fertiliser that is derived from renewable biomass-related resources. The BBFs of**

FERTIMANURE are "obtained through a physical, chemical, and/or biological process step for the treatment of manure that result into a change in composition of nutrients compared to the input material(s) in order to ger better marketable products and/or transportable products.

Within the FERTIMANURE project, an emphasis is also placed on **Tailor-Made Fertilisers (TMF) that are characterized as produced fertilisers with a specific (by the end-user) defined composition, and by using bio-based fertilisers and mineral fertilisers as main resources in order to meet with different crop requirements, soil fertility status and/or the fertilisation management plan.**

The new Fertiliser Products Regulation makes a difference between organic fertilisers, organo – mineral fertilisers and mineral fertilisers (Table 8).

	Organic Fertilizers	Organo-mineral fertilizers	Mineral fertilizers
Carbon	≥15% (solid) ≥5% (liquid)	≥7.5% (solid) ≥3% (liquid)	<1%
Nutrient forms	Organic nutrients	Organic and mineral forms in every pellet, granule or other	Only inorganic forms of nutrients
Nutrient release	Slow nutrients converted to plant-available form by natural (soil) processes	Some immediate (mineral), some slow (organic) + controlled-release effect of organic material coating mineral forms	Immediately available to plants unless they contain a controlled-release technology (CRF)

Table 13 Distinction between different types of fertilisers according to FPR (Building a credible European organic fertiliser industry, ECOFI, 2019)

It is crucial to mention that the bio-based fertiliser sector is research-based, knowledge-intensive and innovation-driven. Lately, the industry has found increasingly efficient and effective ways to extract nutrients from different sources of bio-based by-products and re-formulate them into safe, high-quality and effective fertilisers and soil improvers with consistent nutrient release rates (Building a credible European organic fertiliser industry, ECOFI, 2019).

Increased environmental concerns have paved the way for the use of the bio-based fertilisers. Therefore, this type of fertilisers will have an increasingly important role in future food production. Furthermore, BBFs will reduce European dependency on imported fertilisers as well as to create new employment opportunities in rural areas.

The basis of bio-based fertilisers is livestock manure, sewage sludge and food chain waste. From these, manure is, by far, the largest waste stream, representing more than 70 % of the nutrients in these three waste streams.

Input for bio-based fertilisers

Eurostat report from 2014 states that the total livestock population in the EU-27 is estimated at 147 million pigs, 88 million cattle (cca 25 % of dairy cattle), 1.3 billion poultry, 83 million sheep and 10 million goats. The majority of livestock are kept in just few Member States (Eurostat, 2014).

Statistical data regarding the total livestock population over the FERTIMANURE consortium / Member States indicate that Members States presented cover around 73 % of the total EU pigs population, as well as 63 % of the total EU cattle population and 71 % of the total EU poultry population (Figure 44).

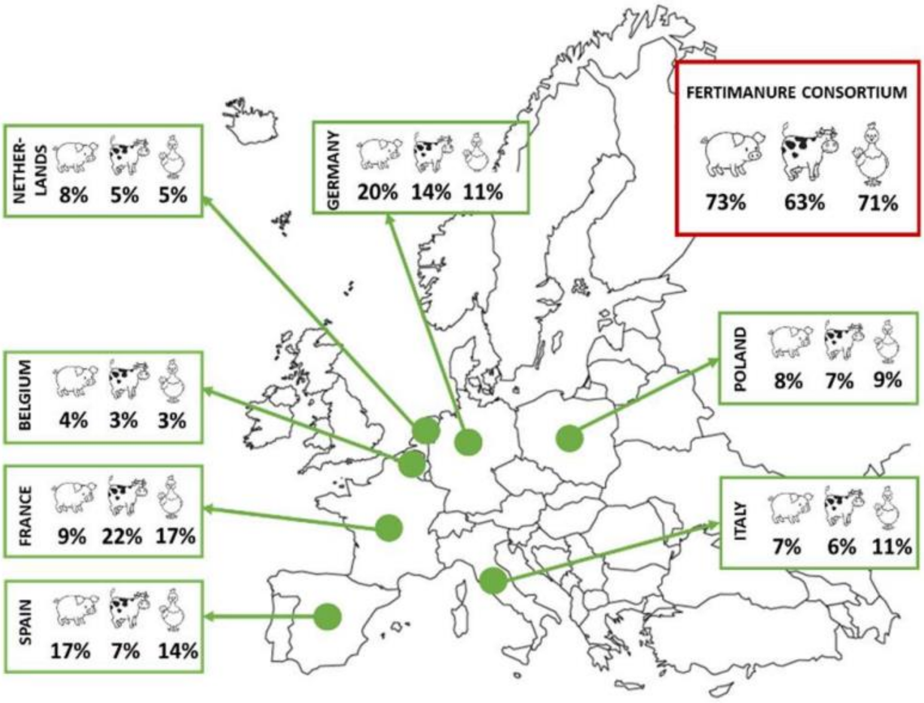


Figure 44 Livestock population covered by the FERTIMANURE consortium (7 EU Member States)

Analysis indicate that livestock population excrete around 1.400 Mt of liquid and solid manure annually. Of this, 600 Mt are in the form of liquid manure from cattle and pigs and about 300 Mt represent solid cattle manure. Main disposal route is land application. More than 90 % of manure produced in the EU-27 is being returned to agricultural land either through the spreading of collected manure or directly by grazing. This represents about 53 % of the P and 33 % of the N applied annually to organic soils (Nutrient Recover and Reuse in European agriculture, RISE, 2016 - original authors –Sutton et al, 2011; van Dijk et al 2016).

Total N and P excreted by livestock in the EU-27 are estimated at 7 – 9 Mt N/year and 1,8 Mt P/year (Nutrient Recover and Reuse in European agriculture, RISE, 2016 - original authors – Leip et al, 2014; Sutton et al, 2011; van Dijk et l 2016; Velthof et al 2015). Such an enormous amount of manure is also a subject to nutrients losses. Besides manure storage and an effective application processes, nutrient losses can be to further process manure to concentrate nutrients and produce organic fertilisers that are stable for application, easily handled and more effectively transported.

However, from all the available technologies, only a limited number is fully used at farm scale. Indeed, the amount of manure processed in the EU represent less than 8 % of the total amount produced (Mini paper EIP AGRI, original author - Foged et al, 2011). The most common treatment for the remaining 8 % of manure (108 Mt) is an initial liquid/solid separation (through filtration, sieving or centrifuging) or anaerobic digestion. The solid fraction can be dried before pelletising or following incineration, or alternatively, biothermal drying is used to produce compost. The liquid fraction can be concentrated through evaporation or filtration methods to produce a mineral concentrate ([Nutrient Recover and Reuse in European agriculture, RISE, 2016 - original authors – Foged et al 2011]).

The RISE report provides an overview of the main routes for nutrient recovery and reuse from livestock manure. These routes include primarily liquid/solid separation and anaerobic digestion process. The full overview is depicted on Figure 45 ([Nutrient Recovery and Reuse in European agriculture, RISE, 2016]).

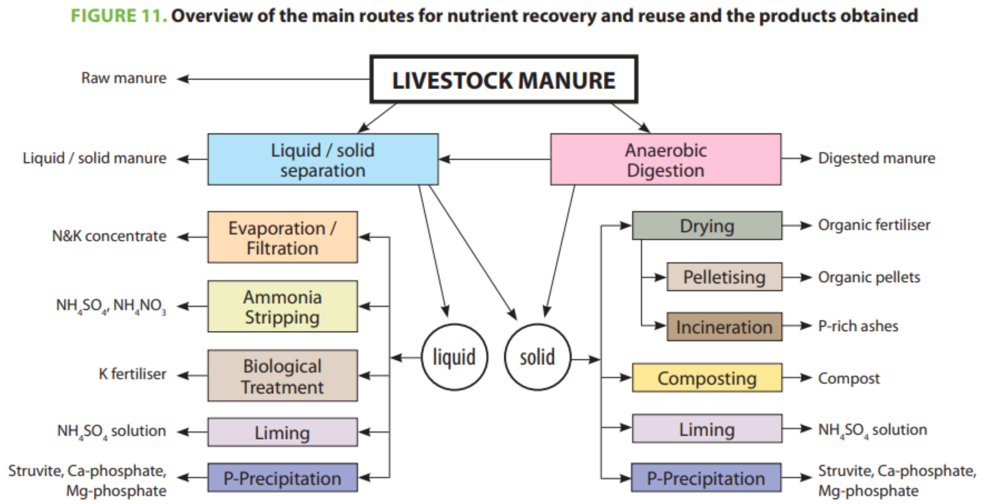


Figure 45 Overview of the main routes for nutrient recovery and reuse and the products obtained ([Nutrient Recovery and Reuse in European Agriculture, RISE, 2016])

In the FERTIMANURE project, 16 different technologies will be applied to obtain 11 BBFs and 20 different TMFs. An overview of the technologies implemented is listed in the Table 9.

BBF Type	Targeted BBF	Technologies	Amount produced (per tone of manure)	Delivery and Nutrient Content
Mineral	$(NH_4)(NO_3)$, $(NH_4)_2SO_4$	Membrane contactors	13 Kg $(NH_4)_2SO_4$ 23 Kg $(NH_4)(NO_3)$	Liquid, 20-25% concentration
		Acid scrubber + N-stripping	5-20 Kg*	Liquid 40% concentration, <1% impurities
	H_3PO_4	Thermal treatment + acid extraction	1.7 Kg	Liquid, 15% concentration
	$(NH_4)_3PO_4$	P-leaching + ion exchange	20-30 Kg	Solid, purity > 95%
	NH_4OH	Vacuum drier + condenser	15-20 Kg	Liquid 40% concentration, <1% impurities
Organo-mineral	Nutrient rich concentrate	Freeze concentration	50 L	Liquid, Concentrations: 23 g N/L, 5 g P/L, 4 g K/L.
	P-rich organic product (P_2O_5)	Precipitation	0.35 kg	Solid, 50-80% OM, P 1% per kg OM
Organic Amendments	Biochar	Thermo-Catalytic Reforming	50-60 Kg	>90% m/m carbon, < 3% m/m oxygen, < 1% m/m hydrogen, >100m^2 specific surface area
		Pyrolysis	200 Kg	>90% m/m carbon, < 3% m/m oxygen, < 1% m/m hydrogen
	Compost	Composting	85 Kg	Solid (50% moisture), Concentrations: 10 g P/Kg, 12 g N/Kg, 3 g K/Kg
	Biodried manure	Biodrying	60 Kg	Solid (20-30% moisture), Concentrations: 10 g P/Kg, 12 g N/Kg, 3 g K/Kg.
Biostimulants	Microalgae hydrolysate biostimulants	Microalgae reactor & enzymatic hydrolysis	80-90 L	Small molecular peptides under 20 kDa and high content of free amino acids 5-8%

* As this is included in different on-farm pilots, the values included represents the range for the different pilots.

Table 14 Main characteristics of the BBFs obtained in the FERTIMANURE on-farm pilots (FERTIMANURE proposal, 2019)

5.1.1. Bio-based fertilisers trends

The intense use of chemical fertilisers causes water contamination, loss of nutrients, and deterioration of soil. It is estimated that 30–50% of fertiliser nutrients are either leached to groundwater or volatilizes to air. The number of chemical fertilisers can be reduced their composition is tailored to the type of soil, their controlled release rate, and crops rotation (Wang et al., 2018).

The EU expects that bio-waste will replace up to 30 % of the inorganic fertilisers currently used (Hansen, 2018). The transition from a fossil-based to a bio-based economy requires the recovery of nutrients from waste streams. The substitution of mineral fertilisers with bio-based alternatives is an important direction in materials and energy recovery (Christel et al., 2014).

Technological progress in fertiliser industry bases mainly on process, not product innovations, in particular on increasing efficiency of existing technologies (higher yields, lower use of raw materials, lower energy consumption, higher profitability of the process). This is related with low expectations of farmers that are final customers of fertiliser products. Due to the constant demand for fertilisers, demand still exceeds supply (Bio-based fertilisers: A practical approach towards circular economy, Chojnacka, 2020).

The concept of a circular economy is based on reuse, valorisation, recycling, and exploitation of natural cycles. Although this concept is widely discussed scientifically and politically, it has only been fragmentarily applied in practice. In elaboration of bio-based fertiliser technologies, the following aspects are important: environmental impact should be minimized, resources should be used in a regenerative way with the consideration of resource scarcity issue, technologies should assure profitability and economic benefits to industrial enterprises. Limitations of natural resources and environmental protection should be a priority, but with sustaining business requirements for economic benefits. The global bio fertilisers market size is projected to reach USD 2.7 billion by 2027, expanding at a CAGR of 12.8 % (Global Biofertilisers Market, BW, 2020).

There are several technologies available for the production of inorganic/organic liquid/solid fertilisers from manure. The final products include NH_4SO_4, NH_4NO_3, as well as N and K concentrate (Klop et al., 2012), K fertiliser, struvite, Ca/Mg-phosphate, P-rich ashes. They can be manufactured by liquid/solid separation followed by evaporation/filtration, ammonia stripping, liming, biological treatment, phosphorus precipitation or by anaerobic digestion followed by drying, pelletizing, incineration, composting, liming, and P-precipitation. Currently several membrane processes (nanofiltration, reverse osmosis, membrane distillation) are applied for ammonium fertiliser recovery from manure (Zarebska et al., 2015). However, there are still challenges related to the production of more concentrated and marketable products, storage, and handling as well as diminishing losses of nutrients (Ippersiel et al., 2012).

New fertiliser products regulation as well as continuous investment in R&D are nowadays resulting in the development of new bio-based and tailor-made fertilisers. Furthermore, scarcity of some nutrients and EU´s growing demand to increase self-reliance in agro sector supports development of new business models and technologies. The same growing trend is expected in the near future as well.

5.1.2. Types of bio-based fertilisers in the FERTIMANURE project

The bio-based fertilisers to be obtained within the FERTIMANURE project include:

Mineral	**$(NH_4)(NO_3)$**	**ammonium nitrate (AN)** AN is most frequently produced by neutralisation of nitric acid with ammonia and is mainly processes into high quality fertilisers. As a straight fertiliser, in 2005 it accounted for 7 % of world consumption of nitrogen fertilisers (including urea)	Orica, Incitec Pivot Limited, Neochim PLC, URALCHEM Holding P.L.C., San Corporation, CF Industries Holdings, Inc., EuroChem Group AG, Austin Powder Company, Vijay Gas Industry P Ltd, and OSTCHEM Holding
	$(NH_4)_2SO_4$	**ammonium sulphate (AS)** AS is a valuable fertiliser since sulphur is in a sulphate sulphur form which is readily soluble in water. AS also releases nitrogen to the soil directly as ammonium.	Amresco Inc., BASF SE, Domo Chemicals, Martin Midstream, General Chemical, GFS Chemicals Inc., Honeywell and Royal DSM
	H_3PO_4	**phosphoric acid** About 90 % of the phosphoric acid produced is used to make fertilisers – 3 forms: triple superphosphate (TSP), diammonium hydrogenphosphate (DAP) and monoammonium dihydrogenphosphate (MAP).	The Mosaic Company, OCP S.A., Yara International, Prayon Group, Nutrien, PJSC PhosAgro, Aditya Birla Group, and Israel Chemicals Limited.
	$(NH_4)_3PO_4$	**diammonium hydrogen phosphate** An inorganic phosphate and an ammonium salt broadly used as a fertiliser.	Bunge, PhosAgro AG, SABIC, Mosaic Co., China Blue Chemicals Ltd., Sichuan Chuanxi Xingda Chemical Co., JR Simplot, Gujarat Narmada Valley
	NH_4OH	**ammonium hydroxide** This represents a solution of ammonia in water and is very commonly used in a production of mineral fertilisers.	Yara, CF, DOW, Malanadu Ammonia, KMG Chemicals, Lonza, FCI, Thatcher Group, Weifang Haoyuan
Organo – mineral	nutrient rich concentrate	**liquid NPK** Liquid fraction of the concentrate will be composed of N, P and K in a ratio 23:5:4 g/L.	Agrium Inc., Yara International ASA, Israel Chemical Ltd., Kugler Company, Haifa Chemicals Ltd., Agroliquid, Plant Food Company, Compo Expert
	P-rich organic product (P_2O_5)	**P product** Solid fraction of a minimum of 1 % of P per kg OM and with 50 – 80 % of OM.	
Organic amendments	biochar	**biochar** Biochar is charcoal produced by pyrolysis of biomass in the absence of oxygen. It is stable solid rich in carbon.	BSEI, Airex Energy Inc., Diacarbon Energy
	compost	**compost** Compost is solid fraction of an organic matter that has been decomposed in an aerobic process	Harvest Power, Cocoa Corporation, Dirt Hugger, Worm Power, MyNoke, Nutrisoil, SAOSIS, Kaharim Farms, Dit Dynasty
	bio dried manure	**bio-dried manure** Solid fraction with the composition of N:P:K ratio 12:10:3	
Bio stimulants	microalgae hydrolysate bio stimulants	**microalgae hydrolysate bio stimulants** Small molecular peptides under 20 kDa and with a high content of free amino acids (5 – 8 %)	BASF SE, Isagro Group, Sapec Group, Biolchim S.P.A, Italpollina SAP, Valagro Group, Koppert B.V.

5.1.3. Ammonium nitrate $(NH_4)(NO_3)$

The global ammonium nitrate market size was estimated at 4.67 billion USD in 2016. The chemical compound is mainly used in fertilisers industry (78 %) and as a basis for explosives (22 %) (Chemical Economics Handbook, IHS Markit, 2019). In terms of revenue, fertiliser was the largest application segment accounting for 2,79 billion USD in 2016. The demand for this type of a fertiliser product is expected to grow at a CAGR of 3,5 % from 2016 to 2025 (Ammonium nitrate market, GVR, 2016).

The demand for ammonium nitrate in the EU was valued at 2,03 billion USD in 2016. However, high penetration of urea in fertiliser applications to substitute the product in Spain and Portugal has hampered the product demand over the past few years and this trend is expected to continue over the next eight years impacting the industry growth in the region. Europe dominated the ammonium nitrate market with a share of 43,2 % in 2019. This is due to the rising production of crops including wheat and potatoes (Ammonium nitrate market, GVR, 2016).

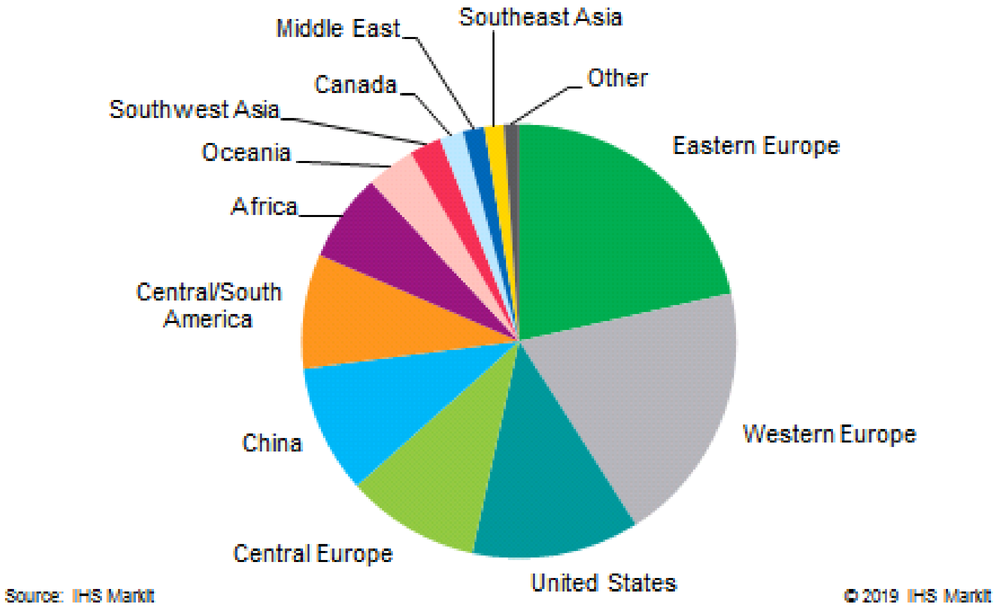


Figure 46 World consumption of ammonium nitrates (AN and CAN) in 2019 (IHS Markit, Chemical Economics Handbook, 2019)

Eastern Europe, Western Europe, and the United States are the leading consumers of ammonium nitrates (AN + CAN). In 2019, these three regions together accounted for about 53 % of total world consumption (Figure 46).

Growth in consumption will be driven by Eastern Europe, China, and Central and South America (Ammonium nitrate - Chemical Economics Handbook, IHS Markit, 2019).

5.1.4. Ammonium sulphate $(NH_4)_2(SO_4)$

The global ammonium sulphate market size was valued at 3,1 billion USD in 2019 and is anticipated to register a CAGR of 4,7% from 2020 to 2027. The growing consumption of nitrogen-based fertilisers to increase crop yield on account of the rising demand for food is likely to drive the product demand. The product is well used in Southeast Asia, Central/South America, Western Europe, China, and the United States (Figure 47).

The key factor driving the global market is the consumption of the product as a soil fertiliser as the chemical contains nitrogen and sulphur. It is mainly used for reducing the acidity in alkaline soils as they have a high pH level. The product is also largely preferred for flooded soils used in rice cultivation as nitrate-based fertilisers are a poor choice as they could lead to denitrification and leaching *(Ammonium Sulphate Market, GVR, 2019).*

In 2018, ammonium sulphate was used mainly (95 % of world consumption) as a nitrogen fertiliser material and accounted for about 4,8 % of the world nitrogen fertiliser market. Industrial use of ammonium sulphate accounts for only about 5 % of world consumption (Ammonium sulphate - Chemical Economics Handbook, IHS Markit, 2019).

It is highly preferred for crops such as potatoes, citrus fruits, rapeseed, soybean, and rice. Thus, the demand for ammonium sulphate is high in developing countries such as Brazil, Indonesia, India, and Vietnam owing to the high cultivation of the aforementioned crops.

The global ammonium sulphate market has been segmented into liquid and solid fraction. The solid fraction accounted for the largest market share (80,2 %) in 2019 owing to its water-soluble properties which makes it suitable for various applications. The liquid fraction is mainly used in the fertilisers production and water treatment industries. Ammonium sulphate market is expected to grow at a CAGR of 4,9 % from 2020 to 2027.

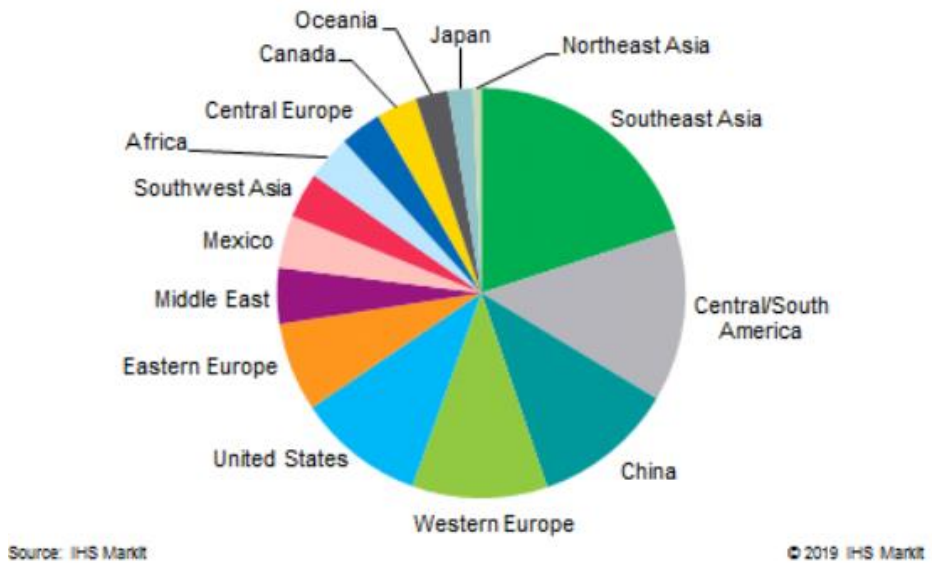


Figure 47 World consumption of ammonium sulphate in 2018 (IHS Markit, Chemical Economics Handbook, 2019)

Companies such as Domo Chemicals, BASF, SABIC, and Honeywell International have established themselves as a key manufacturer and focus lots of research on the novel uses of ammonium sulphate. Some other major manufacturers include Novus International, Sumitomo Chemical, and Helm AG.

5.1.5. Phosphoric acid (H_3PO_4)

The global phosphoric acid market size was valued at 45,85 billion USD in 2019 and is expected to register a compound annual growth rate (CAGR) of 3,7% from 2020 to 2027.

High usage of phosphoric acid for production of phosphate fertilisers, such as Mono-Ammonium Phosphate (MAP) and Diammonium Phosphate (DAP), is expected to drive the market over the forecast period.

Globally, phosphoric acid is the second-largest consumed inorganic acid after sulfuric acid.

Figure 48 indicates that Asia Pacific was the largest market in 2019 and accounted for a global share of over 48 % (Phosphoric acid market, GVR, 2019). The region is estimated to retain its dominant position throughout the forecast years owing to high phosphate rock reserves in China, which is also a major producer of phosphoric acid.

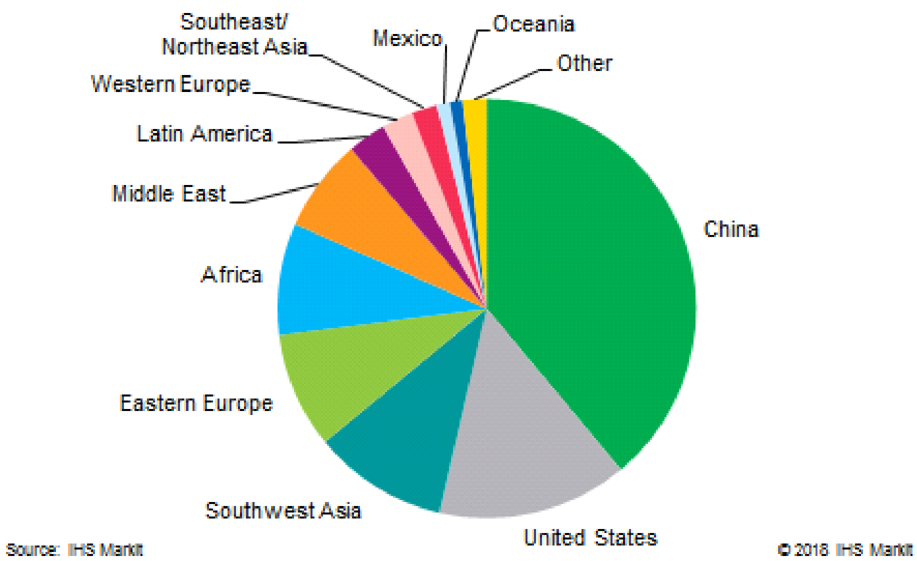


Figure 48 World consumption of phosphoric acid (Phosphoric acid - Chemical Economics Handbook, Phosphoric Acid, 2018)

5.1.6. Diammonium hydrogen phosphate $(NH_4)_3(PO_4)$

The global market of diammonium hydrogen phosphate has reached 892 million USD in 2018. By 2025, it is expected to amount to 2.367 million USD *(Fertiliser Update: Diammonium Hydrogen Phosphate Market Expects Strong Grows, 2019).* An annual growth rate (CAGR) of slightly above 12 % is expected from 2019–2025. *(World Fertiliser Magazine, Global diammonium hydrogen phosphate market is expected to reach US$2367 million by 2025, 2019)*

Diammonium hydrogen phosphate (DAP) is one of the commonly used phosphorus fertiliser. The Europe Market for DAP is segmented on the basis of application, end user industry and region. Diammonium hydrogen phosphate fertiliser is mostly used for peanut, broomcorn, cotton, paddy, and vegetable crops; hence, the demand is dependent on the production of these crops. The next major application is seen in the wine industry and yeast industry. The Europe market has been geographically segmented into Germany, the United Kingdom, France, Spain, and Italy.

Bunge, PhosAgro AG, SABIC, Mosaic Co., China Blue Chemicals Ltd., Sichuan Chuanxi Xingda Chemical Co., JR Simplot and Gujarat Narmada Valley are the leaders in the Europe

Diammonium hydrogen phosphate market (Europe Diammonium Hydrogen Phosphate Market, MDF, 2020).

Asia-Pacific region dominated the diammonium hydrogen phosphate market across the globe with the largest consumption from countries such as China and India. *(Diammonium Hydrogen Phosphate (DAP) Market - Growth, Trends, and Forecast (2020 - 2025), 2020)*

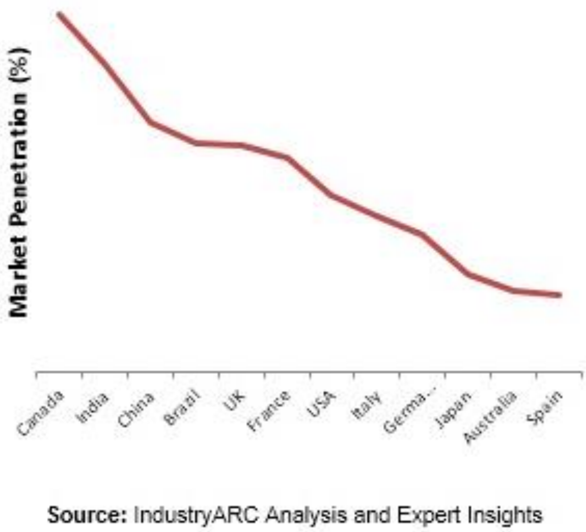


Figure 49 Diammonium hydrogen phosphate market penetration, 2021 forecast (%) (Diammonium Hydrogen Phosphate Market – Forecast (2020-2025), 2016)

5.1.7. Ammonium hydroxide (NH4OH)

The global ammonia hydroxide market was valued at 550 million USD in 2020 and is expected to reach 610 million USD by 2024, at a CAGR of 1,6 % during the forecast period *(Aqua Ammonia Market 2020, MW, 2020).*

The Asia-Pacific market held the largest market share of the global ammonium hydroxide market *(Ammonium Hydroxide Market, SR, 2020)*. Across the agriculture industry there was a growth of around 3 % in 2017, which is further expected to grow in the upcoming years. *(Ammonium Hydroxide Market, SR, 2020)*

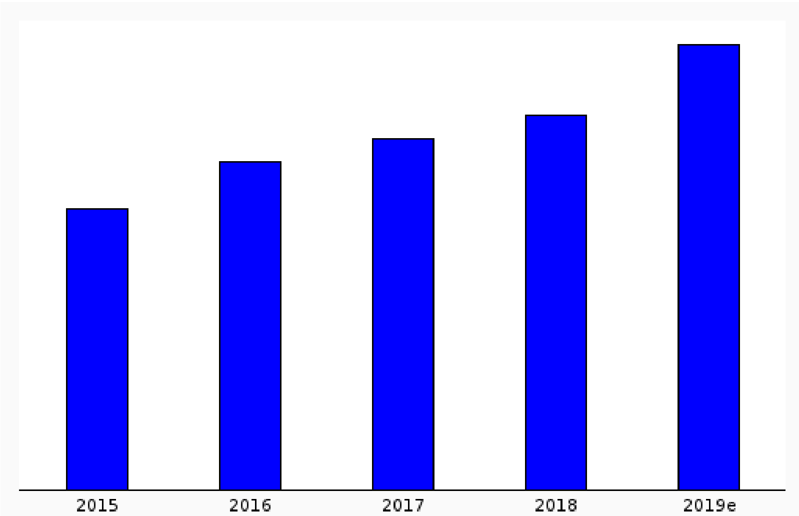


Figure 50 Global ammonia hydroxide market (millions USD) (Aqua ammonia (ammonium hydroxide) Market Report, 2020)

5.1.8. Nutrient rich concentrate

Global liquid fertiliser market was valued at 11,108 million USD in 2016 and is expected to reach 13,530 million USD by 2023, registering a CAGR of 2,8% from 2017 to 2023. Liquid fertiliser proves to be beneficial as it exhibits quicker and broad range of effects on crops and acts as catalyst, thereby increasing the plant nutrient intake *(Liquid Fertilisers Market by Type AMR, 2017).*

In 2016, Asia-Pacific accounted for more than half of the total liquid fertilisers market, and is expected to continue this trend, owing to surge in crop cultivation land and the growth in need to boost crop production, which rapidly motivates farmers to use liquid fertilisers, specifically in U.S., China, India, Brazil, and the other developing countries. France occupied nearly one-fifth of the total Europe liquid fertilisers market in 2016 *(Global Liquid Fertilisers Market, AMR, 2018)*.

The major companies include Agrium Inc., Yara International ASA, Israel Chemical Ltd. (ICL), K+S Aktiengesellschaft, Kugler Company, Haifa Chemicals Ltd., Agroliquid, Plant Food Company, Inc., Compo Expert GmbH, and Rural Liquid Fertilisers *(Global Liquid Fertilisers Market, AMR, 2018).*

Figure 51 Liquid fertilisers market – growth rate by region, 2018 (Liquid Fertilisers Market – Industry Growth, Trends, and Forecasts (2020-2025), 2019)

5.1.9. Biochar

Biochar is charcoal derived by controlled heating of waste materials, such as agricultural waste, wood waste, forest waste, and animal manure. Among all the end uses, it is widely used in a soil amendment to reduce pollutants and toxic elements and to prevent reducing moisture level, soil leaching, and fertiliser runoff. Environmental awareness, cheaper cost of raw material, and cohesive government policies for waste management are anticipated to result in market expansion.

The global biochar market is expected to grow from 1,385.94 million USD in 2019 to 3,457.61 million USD by the end of 2025 at a CAGR of 16,45 % *(Intrado GlobeNewswire, 2020).*

In 2018, the agriculture application segment accounted for 71,1% of the total biochar demand.

In rural areas of countries such as China, Japan, Brazil, and Mexico, a large amount of biochar is produced in collaboration with research groups and institutions. The number of organized players in the industry manufacturing high-quality products is expected to increase with the growing demand for organic food.

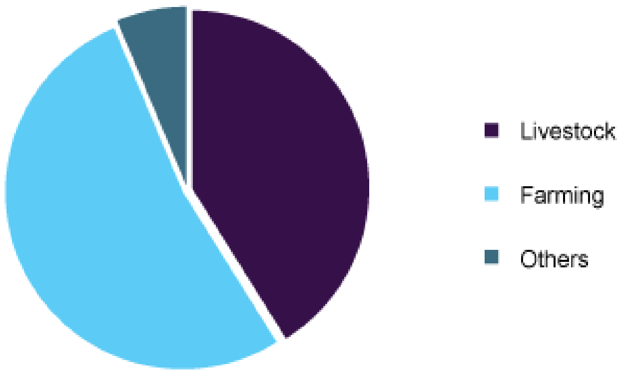


Figure 52 Figure 53 Global biochar volume share, for agriculture application, 2017 (%) (Biochar Market Size, GVR, 2019)

Key players involved in the manufacturing of Biochar are BSEI, Airex Energy Inc., and Diacarbon Energy. More than 80 % of medium and large-scale manufacturers are concentrated in North America while the Asia Pacific and Europe comprise lesser concentration.

Aberystwyth University, Massey University, Federal Rural University of the Amazon, and the University of East Anglia are among the few of the research institutions engaged in the production and R&D activities of biochar *(Biochar Market Size, GVR, 2019).*

5.1.10. Compost

The global compost market is expected to reach an estimated 9,2 billion USD by 2024 with a CAGR of 6,8 % from 2019 to 2024. Emerging trends, which have a direct impact on the dynamics of the industry, include the development of bio dynamic compost and the use of biochar in composting. Harvest Power, Pacific, Worm Power, Dirt Hugger, Agrilife, MyNoke, Nutrisoil, Davo's Worm Farm, Dirty Dynasty, and Kahariam Farms are among the major suppliers of composts *(Global Compost Market Report 2019, 2019).*

The current annual EU production of compost amounts to 17.3 million tonnes per year as a central estimate (with a possible range of 13-18 million tonnes). The vast majority of this (ca 14 million tonnes) is derived from green waste and separately collected biowaste, while some 800,000 tonnes are produced from sewage sludge. Some sources suggest that compost is (or at least has been) produced from mechanical biological treatment (MBT) of mixed MSW in some smaller countries, but a current EU-wide figure could not be derived. It is estimated that the majority (ca. 85 %) of compost is used as a fertiliser or soil improver in agriculture, gardening, horticulture and landscaping *(Digestate and compost as fertilisers: Risk assessment and risk management options, 2019).*

Around 180 million tonnes of digestate are produced in the EU-28 per year, almost half of this in Germany. With 120 million tonnes, the majority of digestate produced in the EU is agricultural digestate (typically a mix of manure and plants, particularly energy crops). About 46 million tonnes are produced from the organic fraction of mixed MSW (mechanical biological treatment – MBT), at least 7 million tonnes from source separated biowaste and smaller quantities (ca. 1,7 million tonnes each) from sewage sludge and agro/food industry by-products. The vast majority of digestate is used directly as a fertiliser *(Digestate and compost as fertilisers: Risk assessment and risk management options, 2019).*

The largest compost producer in the EU is Germany with 4.3 million tonnes, followed by the UK (ca 2,8 million tonnes), France (2,5 million tonnes) and Italy (ca 2,2 million tonnes) *(Digestate and compost as fertilisers: Risk assessment and risk management options, 2019).*

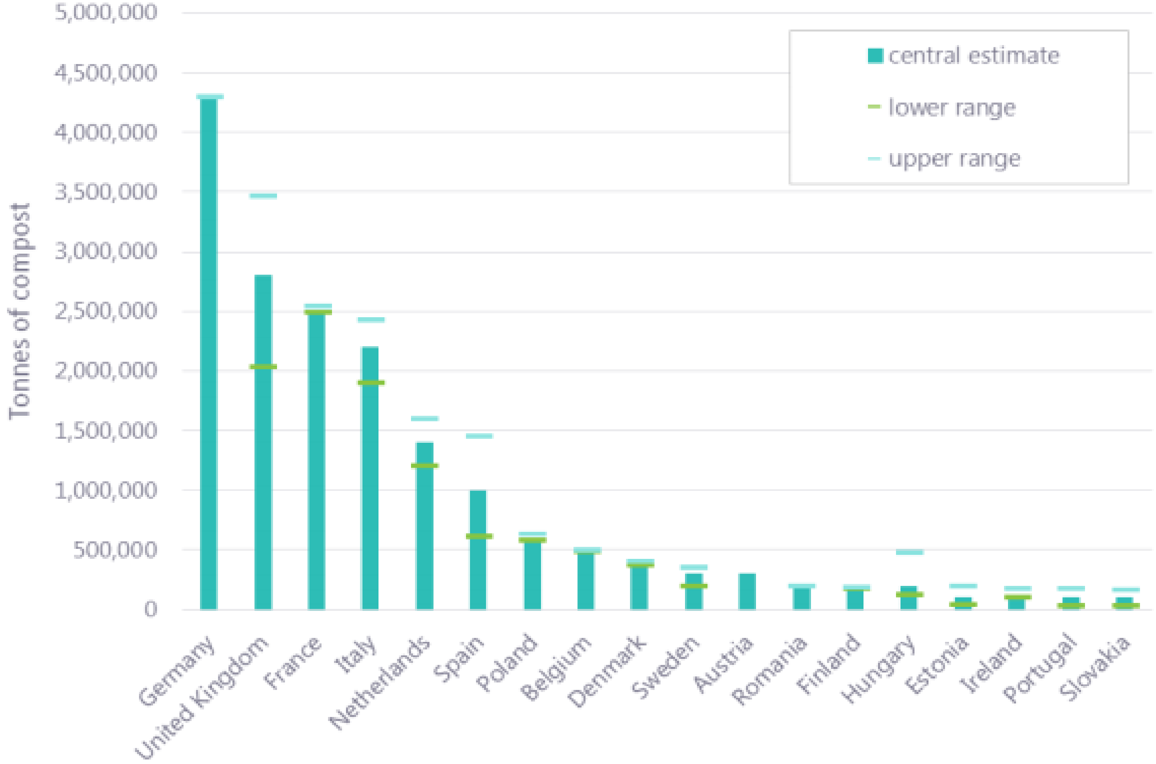
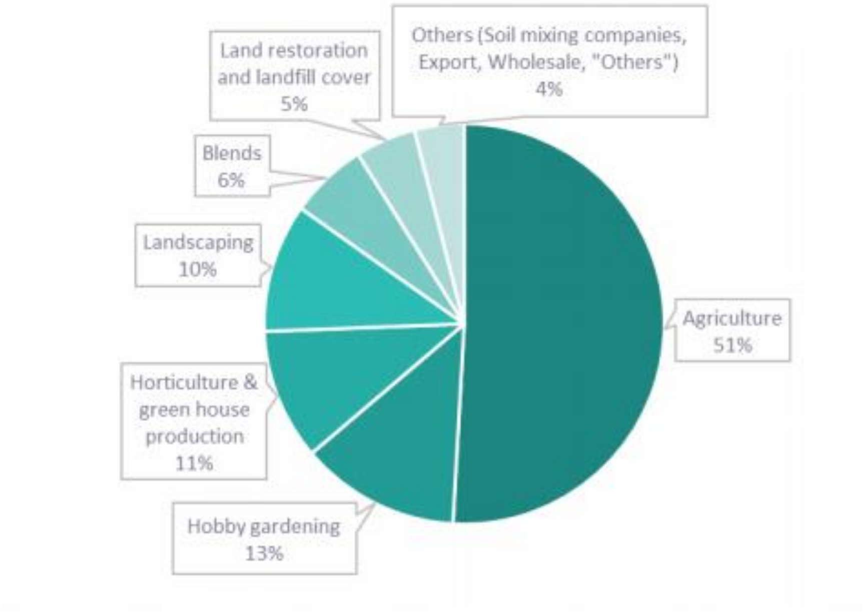


Figure 54 Estimated quantity of compost per country, in tons [(Digestate and compost as fertilisers: Risk assessment and risk management options, 2019)]

Compost type	Production quantity (t)	Feedstocks type	Feedstocks quantity (t)
Green waste compost	8,000,000 (7,000,000-9,000,000)	Source separated garden and park waste.	16,500,000
Vegetable, fruit and garden waste compost (VFG compost)	100,000 (100,000-150,000)	Only separately collected biodegradable materials according to the specific input list of ECN 20144 (ECN-QAS Part CII, Annex CII 2) and the input materials listed in Table 14 of JRC 2014. [1)]	300,000
Bio-waste compost	6,000,000 (5,000,000-7,000,000)	Only separately collected biodegradable materials according to the specific input list of ECN 20144 (ECN-QAS Part CII, Annex CII 2) and the input materials listed in Table 14 of JRC 2014. [1)]	12,500,000
Sewage sludge compost	Ca. 800,000[1)]	Sewage sludge; sometimes mixed with green waste.	Ca. 1,700,000

Figure 55 Estimated quantity of compost in the EU-28 by feedstock used, in tons [(Digestate and compost as fertilisers: Risk assessment and risk management options, 2019)]



Source: Based on DG JRC: Technical proposals on end-of-waste criteria for biodegradable waste subjected to biological treatment, 2014.

Figure 56 Compost use distribution (%)[(Digestate and compost as fertilisers: Risk assessment and risk management options, 2019)]

5.1.11. Microalgae hydrolysate bio stimulants

The global bio stimulants market size was estimated at 1,74 billion USD in 2016, projected to expand at a CAGR of 10,2% from 2017 to 2025. Rising focus on enhancing productivity, coupled with rapid soil degradation, is likely to drive the market over the forecast period *(Biostimulants Market Size, GVR, 2018).*

Table 5: Global biostimulant market value in millions of euro's, by active ingrediënt, [12, adapted].

Active ingredient	Market value 2016 (Million EUR)	Percentage of total (%)	Projection 2022 (Million EUR)	Percentage of total projection (%/y)	CAGR (%/y)
Seaweed extracts	483	33,3	894	33,6	10,5
Humic substances	450	31,1	827	31,1	10,4
Vitamins and amino acids	148	10,2	269	10,1	10,3
Microbials amendments	141	9,7	262	9,9	10,6
Trace Minerals	140	9,6	256	9,6	10,4
Others	87	6,0	150	5,6	10,1
Total	**1449**	**100,0**	**2658**	**100,0**	**10,4**

Figure 57 Global biostimulant market value in millions of EUR, by active ingredient (Bio4safe project report)

More than 40 % of the total global biostimulant market value is represented by the biostimulants used for row crops, also the CAGR is the highest for row crops *(Bio4safe project report).*

Europe accounts for approximately 40 % of the global market for biostimulants and as such represents a total value of 580 million EUR. As such, Europe appears to be the largest market for biostimulants.

Table 7: global market in millions of euro's , by Region, [12].

Region	Market value 2016 (mln EUR)	Percentage of total (%)	Projection market value 2022 (mln EUR)	Percentage of total projection (%/y)	CAGR (%/y)
Europe	580	40,0	1090	41,0	10,9
Asia Pacific	396	27,3	769	28,9	11,5
North America	210	14,5	340	12,8	8,2
South America	203	14	354	13,3	9,5
Rest of the world	60	4,2	104	3,9	9,4
Total	**1448**	**100,0**	**2658**	**100,0**	**10,4**

Figure 58 Global biostimulant market value in millions of EUR, by region (Bio4safe project report)

Key participants in the global market for biostimulants include BASF SE, Isagro Group, Sapec Group, Biolchim S.P.A, Novozymes A/S, Platform Specialty Products Corporation, Valagro Group, Koppert B.V., Italpollina SAP, and Biostadt India Limited.

Worldwide the most produced microalgae species are: *Arthrospira spp.*, *Chlorella spp.*, *Dunaliella spp.*, *Nostoc spp*. and *Aphanizomenon spp.* *(Microalgal Biostimulants and Biofertilisers in Crop Productions, 2019).*

6. Legislative framework on bio-based fertilisers

6.1. EU approach to nutrient management

The following lines provide an overview of the legislative framework over the course of time, but primarily the focus is on the new regulatory development.

One of the core documents for fertilisers in EU was and still is **Regulation (EC) 2003/2003** of the European Parliament and of the Council relating to fertilisers brings into one piece of legislation all the EU rules that apply to fertilisers. Regulation (EC) No 2003/2003 is a recast of 18 earlier Directives governing mineral fertilisers that had been introduced since 1976. According to the Regulation, fertilisers are characterized as chemical compounds that provide nutrients to plants. Furthermore, the Regulation (EC) 2003/2003 ensures that these highly technical requirements are implemented uniformly throughout the EU Member States and therefore so called “EC fertilisers” can circulate freely within the EU single market. EC label also guarantee farmers a minimum nutrient content and overall safety. What is crucial to say is that this Regulation only applies to mineral fertilisers consisting of one or more plant nutrients. All other fertilisers were covered by EU´s countries national legislation. The current EU regulation does not cover ‘national fertilisers’. These are fertiliser products that are marketed by Member States in accordance with their own national legislation. The level of this legislation across Member States varies.

The new **Regulation (EU) 2019/1009** will apply as of 16 July 2022 (Briefing EU fertilising products, 2019). The **Proposal for a regulation of the European Parliament and of the Council laying down rules on the making available on the market of CE marked fertilising products and amending Regulations (EC) No 1069/2009 and (EC) No 1107/2009** – the main elements of new regulation will include:

- ✓ **opening the single market for more fertilising products**
  common rules on safety, quality and labelling requirements for all fertilising products traded across the EU

- ✓ **introducing limit values for toxic contaminants in fertilising products**
  for the first time regulation will introduce limits for toxic contaminants to ensure soil protection and reduce health and environmental risks

- ✓ **maintaining optional harmonisation** manufacturer of fertilising products will be given an option to either apply the new regulation and CE-marking the product or complying with national rules and sell the product to other EU countries based on the mutual recognition rules

According to the Commission, the Proposal has two objectives:

- ✓ to incentivise large scale fertiliser production from domestic sources, **transforming waste into nutrients for crops**
- ✓ to **introduce harmonised cadmium limits for phosphate fertilisers**.

Furthermore, the Proposal defines **recovery rules for bio-waste** transformed into compost and digestate (so called "end-of-waste" criteria). It amends the 2009 **Animal by-products Regulation** to enable derived products no longer posing significant risks to animal health to move freely on the EU market as fertilising products. It also amends the 2009 **Regulation on plant protection products** to exclude plant bio-stimulants covered by the proposal from its scope. Regulation (EU) 2019/1009 will replace Regulation (EC) No 2003/2003 which does not include fertilisers produced from recovered or organic materials.

According to the EU, fertilising products are used to improve plant growth, mainly in agriculture. Fertilisers can be grouped into 2 broad groups: fertilisers – which provide nutrients to plants and other products – whose primary objective is to promote plant growth through other means.

Based on EC elaborate market research, inorganic fertilisers account for 80 % of the market value and are economically most valuable. On the other side, organic and organo – mineral fertiliser together account for 6,5 % while plant bio-stimulants and agronomic additives account for only about 3 % of the market. The last category mentioned has been identified as the one with a strong market potential (Briefing EU fertilising products, 2019).

The new **Regulation (EU) 2019/1009** covers 7 categories of fertilising products, definition of which can be found in Figure 59.

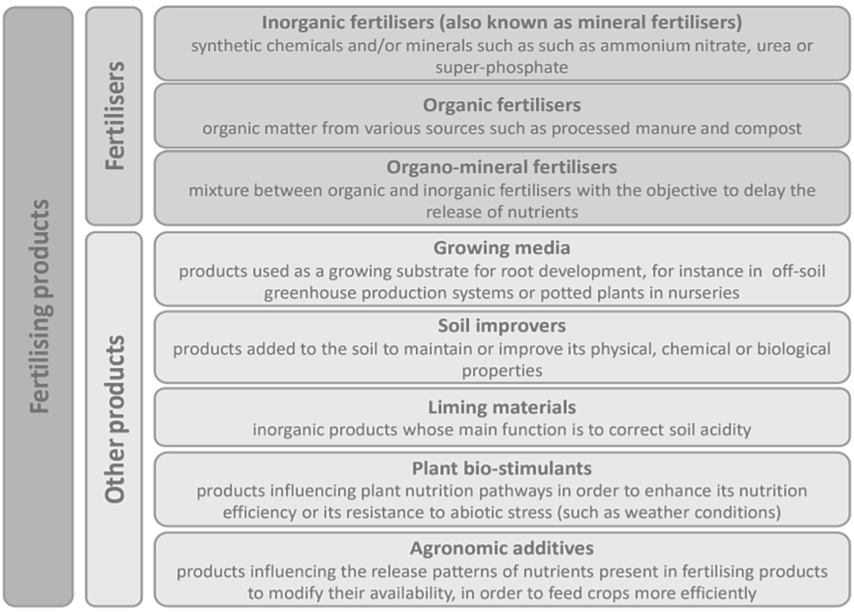


Figure 59 Categories of fertilising products with definitions (Briefing EU fertilising products, 2019)

Detailed overview of the categorization of different fertilizing products in the EU according to the new Regulation 2019/1009 is depicted in the Figure 60. The new EU Fertilising Products

Regulation was approved by the European Parliament and the Council of the European Union on 5 June 2019.

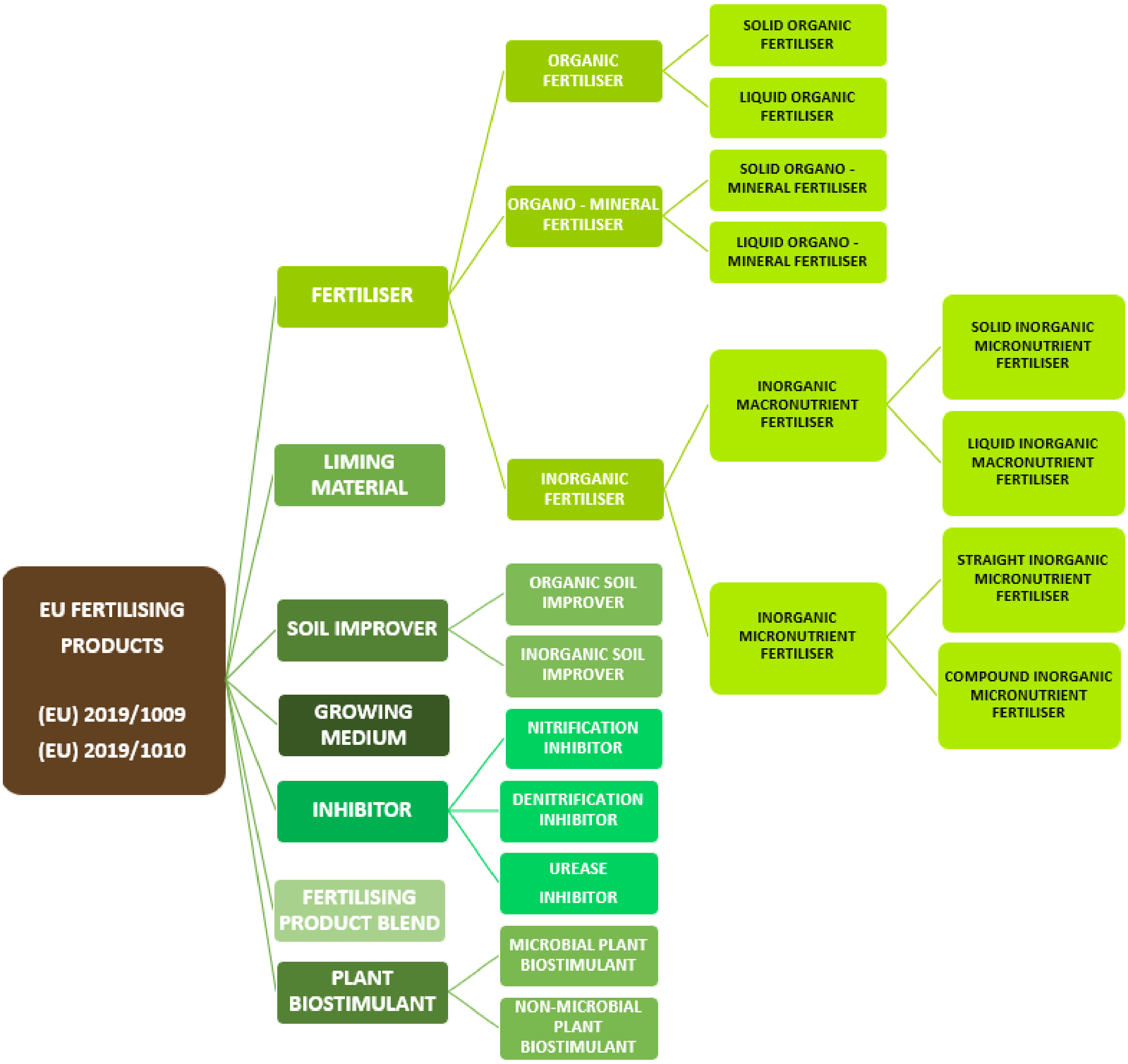


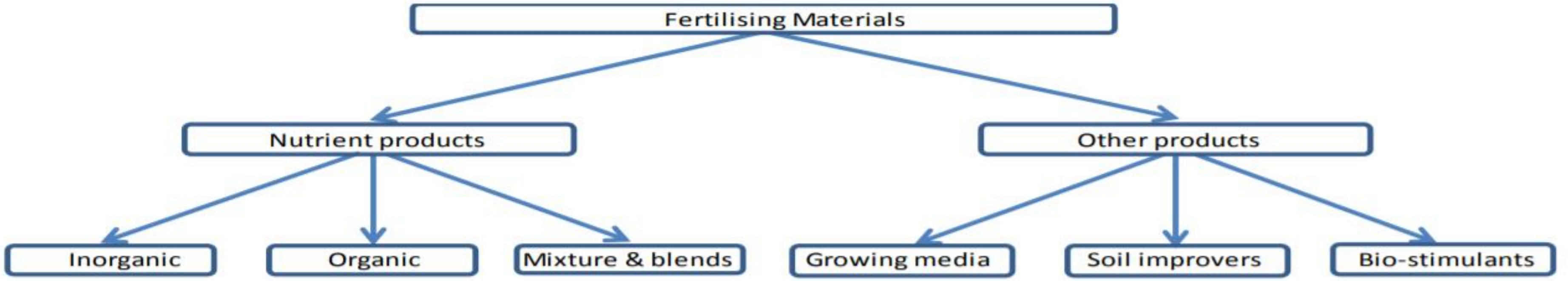
Figure 60 Official Journal of the EU, vol. 62/2019, Regulations (EU) 2019/1009 and (EU) 2019/1010 (link)

List of the most important EU legislative documents that deal with different scopes of fertilising products is depicted in Table 15 (Nutrient Recovery and Reuse in European agriculture, RISE, 2016).

Category	Main EU legislation and guidance	Date
Fertiliser Manufacture & trade	**Critical raw materials list** (CRM). List of 20 raw materials for which "supply security is at risk and economic importance is high". Phosphate rock was added to the list in 2014.	2014
	Fertiliser regulation EC (2003/2003) (under revision) – The current version defines and lists inorganic fertilisers and micro-nutrients and regulates their market placement.	2003
Nutrient use and management in crop and livestock production	**CAP**: DP (indirectly through greening), RD (indirectly through agri-env-climate measures and directly through WFD measure), and Cross Compliance (area "environment, climate change, good agricultural condition of land)	2013
	Nitrates Directive (91/676/EEC) – limit of 170 kg N/ha/yr from livestock manure in NVZ ,	1991
	Sludge Directive (86/278/ EEC) – regulates the use of sewage sludge in agriculture	1986
Biodiversity	**Habitats Directive** (92/43/EEC)	1992
	Birds Directive (79/404/EEC)	
Treatment of animal manure and organic wastes	Animal by-product regulation (1069/2009/EU) implemented by the 142/2011/EU regulation – regulates the disposal of animal-by-products.	2009
Containment of water pollution	**Nitrates Directive** (91/676/EEC) – limits nitrates in water to 50 mg/l	1991
	Water framework Directive (2000/60/EC) – establishes a framework for the protection of surface and groundwater in the EU	2000
	Urban Waste Water Directive (91/271/EEC) – requires the collection of waste water and the implementation of secondary treatment for agglomerations with more than 2000 person equivalents. More advanced treatments for populations > 10000 person equivalents	1991
	Groundwater Directive (2006/118/EC) – sets a quality standard of 50 mg/l of nitrates	2006
	Surface Water Directive (75/440/EEC)	
	Drinking Water Directive (98/83/EC) – maximum allowed concentration of nitrates in water of 50 mg/l and guide level of 25 mg/l	1998
	Bathing Water Directive 76/160/EEC amended by 2006/7/EC	2006
	Directive on Dangerous Substances 76/464/EEC = 2006/11/EC	2006
	Marine Strategy Framework Directive 2008/56/EC	2008
	Air Quality Directive (2008/50/EC)	2008
Containment of air pollution	**Industrial Emissions Directive** (2010/75/EU) - (replaces IPPC Directive 96/61/EC) best available practices for intensive rearing of poultry and pigs	2010
	EU National Emissions Ceilings Directive (2001/81/EC) (under revision) – sets emissions ceilings for several air pollutants including NH_3 and NO_x	2001
Waste and food waste	**Hazardous waste directive** (91/689/EEC)	1991
	Waste Framework Directive (2008/98/EC)	2008
	Landfill Directive (1999//31/EC)	1999
	Waste Shipment regulation (96/61/EC)	1996
Non-regulatory nutrient management	EMAS – Eco-management and Audit Scheme (voluntary)	
	Stockholm convention on persistent organic pollutants	2004
	Eco-labels	
	Best Environmental Management Practices	
General Initiatives	Bioeconomy communication	2012
	Circular Economy Package	2015

Table 15 Overview of the EUs most important regulations related to fertilisers

The study prepared back in 2012 and as a basis for the new Regulation made a preliminary list of raw materials used as ingredients or additives in fertilising materials (Table 16). Materials are categorized based on the type of product – inorganic, organic, mixture and blends, growing media, soil improvers and bio stimulants. The list provides an excellent overview of products currently present at the market as well as a glimpse on products with a high market potential in future.



1H- 1,2,4-triazole 2-aminoethanol 3-methylpyrazole Algal limestones Alkaline calcium phosphate Aluminium-Calciumphosphate Ammonium dihydrogenorthophosphate (MAP) Ammonium molybdate Ammonium Nitrate Ammonium sulfate Ammonium sulphate nitrate Basic Slag Boric acid Boron "Boron ethanol amine" "boron, cobalt, copper, iron, manganese, molybdenum and zinc (micro nutrients)" Calcined Phosphate	Algae Animal by-products Bark composted Bewerage industry residues Biogas manure and other animal by-products (e.g.digestive tract content, compost, digestion residues) Brewer grains, distiller's wash, draff, laitance, malt residus Bristles By-products from dairies, breweries (wine lees) and oil mills Castor meal (after heating and in permanent dust binding shape)	All raw materials as listed in organic and mineral fertilisers Animal by-products Clay Forestry residues Plant residues Residues from bakery Residues from bewerage industry Residues from food, paper and textile industry Residues from fruits, cereals, tabacco Residues from milk products Residues from restaurants Rock flour and	Acidic peat Algae Algal limestone Ammonium dihydrogenorthophosphate (MAP) Ammonium molybdate Ammonium nitrate Ammonium sulfate Ammonium sulphate nitrate Aquatic plant biomass Artificial Manure Aspiration residues out of cereal processing Bark (composted or aged) Biogas manure and other animal by-products(e.g. digestive tract content, compost, digestion residues) Biostimulant Boric acid Boron "Boron ethanol	Algal limestone Ammonium dihydrogenorthophosphate (MAP) Animal manure and by-products Bark Boron Calcium borate Calcium dihydroxid Calcium oxide Carbolime generated in the sugar industry Ca-Salts and Mg-Salts (Chlorides, Sulfates, Sulfites, Carbonates, Oxides) Chaff Chalk Champignon compost Cobalt Cocoa product waste Coffee waste Colemanite Colloids	Fulvic acids Humic acids Plant extracts with low nutrient content, as well as other homeopathic preparations Rhizobium for inoculation of fabaceae (Leguminous plants) Same raw materials used for organic and mineral fertiliser, but with low nutrient content Sea-weeds Synthetised amino-acids

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Calcium salts Calcium Ammonium Nitrate Calcium borate Calcium carbonate Calcium chloride Calcium Cyanamide Calcium dihydroxid Calcium Magnesium Nitrate Calcium oxide Calcium silicate Calciumsilicophosphate Carbolime generated by the sugar industry Ca-Salts and Mg-Salts (Chlorides, Sulfates, Sulfites, Carbonates, Oxides) Chelating agents Chemical nitrogen Chile Nitrate Cobalt Cobalt chelate Cobalt salt Colemanite Concentrated Superphosphate Copper Copper chelate Copper hydroxide Copper oxide Crotonylidene diurea Cyanoguanidine Diammonium hydrogenorthophosphate (DAP Dicalcium phosphate Dimethylpyrazol sulfate (DMPP) Enriched kainit salt Iron chelate	Coconut shell Coir Decomposed or overstored seeds Filtration residues from beer and fruit Fish meal Forestry residues Green compost Guano Hair flour Hoof and horn meal and powder Hydrolysed proteins from animal by- products Manure Molasses Organic Fertilisers plus Alkaline peat Organic Fertilisers plus Green composted improver Organic Fertilisers plus Humified peat Organic Fertilisers plus Lignite Organic Fertilisers plus Uncomposted straight plant improver Overstored animal feed and animal feed residues Peat peeling plants residues	powder Sludge	amine" Brewer grains Bristles By-products from dairies, breweries (wine lees) and oil mills Calcium borate Calcium carbonate Calcium chloride Calcium cyanamide Calcium dihydroxid Calcium hydroxide Calcium nitrate Calcium oxide Calcium sulfate Carbolime generated in the sugarindustry Ca-Salts and Mg-Salts (Chlorides, Sulfates, Sulfites, Carbonates, Oxides) Castor meal (after heating and in permanent dustbinding shape) Chalk Clay Cobalt chelate Cobalt salt "Coconut fiber, Coconut coir" Coconut shell Colemanite Compost (green compost) Composted pine bark Copper chelate Copper hydroxide Copper oxide Crotonylidene diurea Cyanoguanidine	Compost from pine bark, pine needles Copper Crop residues Crushed volcanic rock Diammonium hydrogenorthophosphate (DAP) Dicyanamide Dimethylpyrazol phosphate Dolomite Dried organic seaweeds Food and green waste Fossile rocks (lime) Iron Lime from calcium cyanamide generation Lime stone Magnesite Magnesium carbonate Magnesium hydroxide Magnesium nitrate Magnesium oxide Magnesium sulfate Manganese Manure Molybdenum Monopotassium phosphate Natural phosphate rendered fully soluble Natural textiles from sewage and sludge olive pulp Organic fraction of RSUs from different collections Peat Peel Plant origin substances, as long as they	

Iron -II-salts Isobutylenediurea Kainit Kieserite Lime Lime from calcium cyanamide generation Limestone Magnesite Magnesium Ammonium Nitrate Magnesium carbonate Magnesium hydroxide Magnesium nitrate Magnesium oxide Magnesium phosphate Magnesium salts Magnesium sulfate Magnesium Sulpho-Nitrate Manganese Manganese chelate manganese oxide Manganese-II-salts Molybdenum Monocalcium phosphate Monopotassium phosphate Muriate of Potash Natural phosphate rendered fully soluble Natural phosphates Nitrogen Nitrogenous Calcium Cyanamide Normal Superphosphate Orthophosphoric acid Oxamide Partially Solubilised Rock Phosphate	Plant origin material from agricultural processing Plant residues Pomace Pomace Potato starch (potato nitrogen concentrate) Press- and extraction residues from oil seeds (soy, rape, mustard, sunflower, pumpkin) Residues from bakery Residues from food, paper and textile industry Residues from fruits, cereals, tabacco Residues from milk products Residues from restaurants Residues out of cereal processing Rice husks Roasted coffee residues Sewage sludge Sugar beet residues Tricalcium phosphate vermicompost Vinasse and Distillery slops Wood fibres Wool		Decomposed or overstored seeds Diammonium hydrogenorthophosphate (DAP Dicalcium phosphate of animal origin Dimethylpyrazol sulfate (DMPP) Distiller's wash, draff, laitance, malt residus Distillery slops Dolomite Extruded wood fiber Fermented substrate from farm fertiliser Filtration residues from beer and fruit Fish meal Forest litter Guano Hair flour horn and hoof meal and powder Humidified peat Hydrolysed proteins from animal by-products Iron chelate Iron -II-salts Isobutylenediurea Jute-, hemp-, flax-fibres Kieserite Lapillus Lava Lignite (young brown coal, xylite) Lime from calcium cyanamide generation lime stone Magnesite Magnesium carbonate Magnesium hydroxide Magnesium nitrate	are not classified as fertiliser because of low nutrient content (especially wood fibres, peat, bark and barkproducts) Potassium carbonate Potassium chloride Potassium nitrate potassium sulfate Poultry manure lime (3,0 CaO 1,0 MgO1) Residues obtained from the pressing of grapes Rock flour Saw dust Silicates of calcium and magnesium Slag lime Sludge Sludge from water treatment Straw Sulfur Tobacco refuse Urea formaldehyde resin Vegetal residues and by-products Vermicompost Waste cocoa Waste from agro-industrial activities Waste from the processing of untreated wood Waste kept from ornamental plants Waste of animal origin, including zootechnical sewage Zinc	

perhydroimidazo[4,5-d]imidazole-2,5-dione Phosphate rock Phosphorus Potash/ crude potassium Potassium Potassium carbonate Potassium chloride Potassium Chloride containing Magnesium Salt Potassium nitrate Potassium sulfate Poultry manure lime (3,0 CaO 1,0 MgO1) Rock flour Secondary nutrients and micro nutrients Silicates of calcium and magnesium Slag lime Slags, steelmaking, converter Sodium borate Sodium molybdate Sodium Nitrate (Nitrate of Soda) Soft Ground Rock Phosphate Sulphate of Ammonia Sulphate of Potash Sulphate of Potash containing Magnesium Salt Sulphuric acid Thomas Phosphates Tricalcium phosphate Triple Superphosphate Urea Urea formaldehyde Zinc chelate Zinc oxide Zinc salts			Magnesium oxide Magnesium salts Manganese chelate Manure Molasses Molybdenum Monopotassium phosphate mushroom compost Natural phosphate rendered fully soluble Needle and leaf mold Needle litter Overstored animal feed and animal feed residues Oxamide Peat Peat (sedge peat) Peat (sphagnum peat) Peat moss Peeling vegetable residues Perlite Phosphates Plant residues from agriculture Polyurethane foams Pomace Pomace Potash/ crude potassium Potassium carbonate Potassium chloride Potassium nitrate Potassium sulfate Potato nitrogen concentrate Poultry manure lime Press- and extraction residues from oil seeds (castor, soy, rape, mustard,		

			sunflower, pumpkin) Progressed animal manure Pumice (volcanic rock) Rice hulls, rice husks Roasted coffee residues Rock flour Sand Saw dust Silicates of calcium and magnesium Silt Simple non-composted vegetal soil conditioner Slag lime Sodium borate sodium molybdate Sodium nitrate Soil spent mushroom compost Sphagnum split birck Straw Sugar beet residues trass or pozzolana Tufa (limestone) Urea, Urea formaldehyde Vermicompost Vermiculite Vinasse Wood chips and fibre Wool Zeolite Zinc chelate Zinc oxide Zinc salts		

Table 16 Preliminary list of raw materials used as ingredients or additives in fertilising materials (Briefing EU fertilising products, 2019)

6.1.1. Legislative framework overview at a glance

The following chapter provides general information on the fertiliser products legislative framework and national specifications currently active in the Member States of the Fertimanure Consortium. The information present overview of data collected within the D 1.3.

Detailed information on the current legislation as well as the anticipated supplementary MS Regulations and Requirements (in addition to the new Fertiliser Product Regulation) in each of the Consortium countries can be found in the D 1.3 Report on the BBF Regulatory Framework in the EU and CELAC countries.

6.1.2. Spain

The current regulation in Spain specifies rules for fertiliser products based on or incorporating humic acids, amino acids, alginic acid, etc. The European Biostimulants Industry Council (EBIC) states that “most fertilisers must be registered prior to marketing, with clear dossier requirements. It also mentions a group of products called "other means of plant defence".
Legislation ORDEN APA/1470/2007 covers the regulation on these products. If a product is in line with provisions in this ORDEN, no registration is necessary prior to marketing (European Biostimulants Industry Council, 2019).
In the case of products with organic components, the manufacturer must ensure that the composition, richness and other guaranteed characteristics of the final product are maintained and that the product continues to meet the conditions specified in the regulations referred to in Annex V of Regulation (EC) No 2019/1009, by means of control analyses at least quarterly in such cases.

6.1.3. France

In 2015 the concept of a circular economy took off due to the legislation around “Energy Transition for Green Growth”. This led to the expansion of a number of national legislative texts and working groups looking to clarify the conditions and modalities for returning various organic fertiliser to the soil. The waste prevention measures outlined in the Waste Framework Directive includes an increase in the role of the producer responsibility with regard to waste.
Currently, waste status can be awarded to any sewage sludge, effluents or organic by-products by providing a spreading plan for the product as raw matter. Alternatively, the product can be transformed in order to comply with standards. France is the 2nd largest producer of compost in Europe with nearly 2.5 metric tonnes (Mt) of compost produced annually. An online report on the waste management in France by Knight, 2016 states that “anaerobic digestion and composting contribute significantly to the achievement of recycling targets at French and European levels. In France, recovery methods concern different types of waste from manure to organic fractions from municipal waste”. The report goes on to mention that France was also one of the first countries to introduce a product status (later becoming “end-of-waste” status) through the Rural Code and the French compulsory standards NFU 44-051 and NFU 44-095 .
In terms of waste, France is following both European legislation and the demands of the Environment Grenelle. This dual pressure is leading to the implementation of innovative policies and high performance regulatory, financial and organisational instruments (Knight, 2016).

6.1.4. Belgium

In all Member States, the Nitrates Directive is perceived as a successful legislative tool to reduce the loss of nutrients and to allow for the application of recycled nutrients over

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unprocessed manure or chemical fertilisers. In Belgium, the implementation of the Directive into national legislation is moving towards stricter monitoring and higher fines.

In Flanders, manure use and management is strictly regulated by the manure decree and the manure action plans. All famers with a production of at least 300 kg P_2O_5 have to submit a manure declaration. The whole region of Flanders is designated as a nitrate vulnerable zone, which means that the maximum application standard for manure is 170 kg N per ha, in line with the Nitrate Directive.

The implementation of the Nitrates Directive via the Flemish Manure decree since 1991 is rated as having a neutral effect. Digestate products resulting from co-fermented animal manure with plant-based input streams are considered as 'animal manure' and are therefore limited in Nitrate Vulnerable Zones (NVZ) to 170 kg N/ha/y.

6.1.5. The Netherlands

In the Netherlands the whole country is designated as a Nitrate Vulnerable Zone. The current legislation is defined in the Six Action Plan Nitrates Directives (2018-2021). The maximum application standard for manure and digestate is 170 kg N per ha which is in line with the value mentioned in the Nitrates Directive. The amount that can be applied is based on the total nitrogen content of manure or digestate or other organic product. The Netherlands has a derogation for dairy farms with more than 80% grassland. They are allowed to apply higher manure/digestate application rates on grassland: 230 kg N as manure per ha on sandy soils and 250 kg N as manure per ha on clay soils.

Furthermore, total nitrogen application standards (manure/digestate/organic plus mineral fertilisers) for different crop-soil combinations have been set as a maximum of nitrogen application. For this calculation on the effectiveness of the nitrogen must be taken into account. The effectiveness is defined for different types of products in terms of Nitrogen Fertiliser Replacement Value (NFRV).

Besides the N application standards for manure and for N total (manure + fertiliser) also application standards are defined for phosphate. The phosphate application standards depend on the soil phosphorus status and crop type. In principle, the phosphorus status of all soils are assumed to be high. If the farmer can prove (by a certified sampling and laboratory tests) that the status is lower than high then he is allowed to apply more phosphate at that field. If the soil phosphorus status is neutral, the phosphate application rate is 95 kg P_2O_5 per ha for grassland and 70 kg P_2O_5/ha for arable land.

There is strict legislation regarding the periods when manure and fertilisers can be applied (Rijksdienst voor Ondernemend Nederland). This legislation identifies what type of fertiliser can be applied during a set period. These periods not only depend on the amount of fertiliser being applied but also the type of soil they are being applied to.

6.1.6. Italy

Fertilisers, including products generally called "biostimulants" are regulated by Legislative Decree 75/2010, without calling them by their name. This decree provides that fertilising products as set in Annex 1, 2, 5, 6 and 13 can be placed on the market, provided they comply with any relevant legislation (EC regulation No 1774/2002) (Art. 4 of Legislative Decree 75/2010). Biostimulant products ("Corroboranti") can be marketed without authorisation (as outlined in annex 6 of Legislative Decree 75/2010) only if they are placed on the market using names strictly related to the component and they are not a mixture; proper use has no harmful

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effect on the environment and human health and they have been included in Annex I of Ministerial Decree No 18534/2009 (EBIC)

With the national regulations, the Register of Fertilisers Manufacturers has been instituted at the Ministry for Alimentary, Agricultural and Forester Policies (MIPAAF). Such Register assigns a registration number to all the “Manufacturers of fertilisers” that operate in Italy. Moreover a Register of Fertilisers (national) has been introduced and divided into two sections: The “Register of Fertilisers” for conventional fertilisers and the “Register of Fertilisers” for the ones allowed in the organic farming, where the manufacturers enter the products they’re introducing into the market (Assofertilizzanti federchimica)

There are different regulations for the use of waste products and of the by-products of animal origin. The last are ruled, also for their use in the preparation of fertilisers and organic amendments, according to Reg. EC 1069/2009 and to Reg. EU 142/2011.

Organic Farming is an integral part of a sustainable farming system. Since the introduction of the European (Reg. EEC 2029/91 later substituted by two regulations Reg. EC 834/2007 and Reg. EC 889/2008) and national Regulations, organic farming has become not only an officially recognized activity, but also an activity that is supported through public funds and ruled by precise directives that govern its different aspects, safeguarding consumers and environment; such directives refer also to the use of fertilisers in the organic farming. They are now regulated by the new Legislative Decree 75/2010, where the annex 13 contains a list of the types of fertilisers present in the national directive allowed in organic farming (Assofertilizzanti federchimica).

6.1.7. Germany

The German legal regulation with regard to the application of fertilisers consists of the Fertiliser Law (Düngemittelgesetz (DüMG)). The purpose of the law is to regulate the nutrient supply to plants, maintain or improve the soil fertility, avoid any risks to human’s or animal’s health, ensure a sustainable and resource efficient use of nutrients and implement regulations from the EU with regard to the aforementioned issues. In order to enforce the Fertilising Law, two ordinances are applied i) Fertilisation Ordinance (Düngeverordnung (DüV)) and ii) Fertiliser Ordinance (Düngemittelverordnung (DüMV)).

The Fertilisation Ordinances regulate the application of fertilisers. The objective is to balance the nutrient supply by the farmer and nutrient demand by the crops. For the application of manure, for example, thresholds for nitrogen are applied. The load of nitrogen on arable land must not exceed 170 kg N/Hectares (ha). In addition, the time for the application is restricted. After the harvest of the main crop until January 31st it is prohibited to spread out the manure to the fields. For phosphorus, no general threshold exists. To determine the right amount for supply the phosphorus content in soil has to be analyzed and both balanced with the demand by the crops.

The legal basis for the production, buying and selling, and use of fertilisers, soil improvers, plant aid agents (Pflanzenhilfsmittel) and growth media is the Fertiliser Law (Düngegesetz - DüG) and the respective Fertiliser Regulation (Düngemittelverordnung (DüMV)). The Fertiliser Regulation establishes the requirements for commercialising a fertiliser. Fertiliser must only be used according to good agricultural practice (GAP) and must be adapted to the plant's needs in terms of type, amount and required time of presence of a certain nutrient. When using fertilisers, the nutrients present in the soil must be considered (European Biostimulants Industry Council, 2019). Plant strengtheners are considered substances and mixes including

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microorganisms that are intended to maintain plant health in general and are not considered plant protection products. Soil improvers are substances without any significant nutrient or microorganism content that aims to influence the biological, chemical or physical properties of the soil in order to improve growth conditions for the crops or promote a symbiotic assimilation of nitrogen. Plant aid agents are also substances without significant nutrient content however they are intended to act chemically or biologically on plants to achieve a plant-structural, production-technical or use-technical benefit. Manure itself is a raw material for the production of organic and organo-mineral fertiliser. Both, the solid and the liquid phase of the manure can be used for this purpose. The resulting products are fertilisers with a combination of N, P and K or only with one macronutrient.

6.1.8. Croatia

The Croatian agricultural policy is conjoined in 2001 under The Agriculture Act (Off. Gaz. 66/01), while the manure policy is elaborated within the Law on **fertiliser**s and soil improvers (Off. Gaz. 163/03). Namely, Law brought significant changes in comparison to the old legislation (the use of **fertiliser**s according to the Good Agriculture Practice, quality and control parameters for **fertiliser**s and soil improvers, **fertiliser** labelling etc.). Although the then-current regulations limited the application of agricultural inputs, specifically **fertiliser**s, their imprecise nature led to their liberal interpretation. Perceivable changes in national legislations were evident since October 2005 when European Union formally opened negotiations with Croatia. After 1st of July and Croatia's entry into the EU, more than 63 different legislations concerning agriculture, environment, and water and soil quality were modified and transformed into new regulations harmonized with the European "acquis communautaire".

As manure application creates important part of the Nitrate Directive, Croatia adopted legislation (Off. Gaz. 07/2013) which stresses out that manure should be applied in an environmentally friendly way. Maximum annual application of N in the form of animal manure at farm scale must not exceed 210 kg per ha in the first four years, leading it to 170 kg per ha.

Furthermore, the Law (*Off. Gaz. 07/2013*) prescribes that farms with 1 or less livestock unit (LSU) per ha have a transition period of 4 years (starting from July, 1st 2013) to build up manure and slurry containers while larger farms have transition period of 2 years.

Due to the poor economic situation and instilled agricultural management, Croatian leading agricultural institutions devoted a lot of effort in farmer's education concerning appropriate nutrient management. What is more, in past few years, Croatian farmers experienced influences from other EU member countries (Austria, Slovenia, Germany) and made some improvements regarding rising awareness of manure and its value.

Though EU member states have a uniform statistic approach to data collection and interpretation, Croatia used different methodologies (e.g. CORINE Land Cover – abbr. CLC) and therefore some data on the agricultural production couldn´t be brought to comparison so easily. In addition, some data have been collected indirectly (e.g. *fertiliser*s consumption statistics are based on the amount of *fertiliser* sold by *fertiliser* companies) and therefore needs to be taken with caution. For example, some statistics indicate that the use of mineral fertiliser has increased by 40% from 2001 to 2008 (Znaor, 2011).

The ratio of organic and mineral fertilisers is in favour of mineral ones. The reason behind this action is due to the unevenly distributed animal production (manure) and instilled farmer´s practice (well- known nutrient´s content). However, over the last few years, Croatian farmers faced difficulties with mineral fertilisers application. Primarily, it is because of the significant

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increase in prices. On the other side, organic fertilisers production in Croatia is very small and it is mostly made for Croatian market. All the fertilisers that are placed on the market needs to be analysed and with "*EZ certificate*" certificate which states the amount of nutrients in fertiliser.

6.2. CELAC approach to nutrient management

6.2.1. Argentina

All administration and jurisdiction in environmental matters is provincial, but legislation is primarily federal and subsidiarity local. As for national legislation, Argentina has ten minimum standards for environmental protection. Without detriment to the amount of general regulations enunciated above, the closest to the subject of excreta are Laws 25675, or General Environmental Law, Law 25688 Environmental Water Management Regime, and Law 25831 Regime of Free Access to Public Environmental Information.

The Argentine legislation has been adopting issues that not only ensure the maintenance of the environment, but has incorporated the idea of sustainability as an element of standards or care to sustain over time the environment and the economic operations that are made in the territory, so as to ensure not only environmental quality, but predictability in the development of farms. The objective of the laws is to order the processes that promote, regulate, and establish guidelines to correctly implement the handling, treatment and reuse of excreta and other contaminating elements resulting from the intensive agro-industrial production process.

6.2.2. Chile

In Chile, there is a Decree Law No. 3,557 / 1981 that establishes provisions on agricultural protection of the Ministry of Agriculture in Title III paragraph II on fertilisers states: Article 38.- The fertilisers that are sold packaged must indicate on the container or on a special label, in indelibly, the centesimal composition of the product they contain. In the case of solid products that are sold in bulk, the centesimal composition of the same must be indicated in the corresponding tickets, invoices, or dispatch guides.

From November 2019, the Committee on Agriculture of the Chamber of Deputies began discussion of the law No. 20.089 establishing rules on the composition, labelling and marketing of fertilisers in Chile. The so-called fertiliser labelling law is currently in the second legislative process, in the hands of the Senate.

7. End-users preferences

7.1. End-users preferences regarding the bio-based fertilisers use - literature overview

To increase the adoption of tailor-made and bio-based fertilisers, a good understanding of the fertiliser market and the end-users preferences is crucial. In this case, farmers are the primary end-users of the fertiliser products, and it is important to understand their preferences as well as decision-making processes underlying the use of different fertiliser types. However, it is also relevant to consider which other stakeholders may have an interest in the increased use of tailor-made and bio-based fertilisers, and what perceptions and preferences they may have.

By definition, **bio-based fertiliser** (BBF) is a fertilising product or resource for the production of (Tailor-Made) Fertiliser that is derived from renewable biomass-related resources (e.g. digestate), and Tailor-Made Fertiliser (TMF) is a produced fertiliser with a specific (by end-user) defined composition, and by using BBFs and mineral fertilisers as main resources in

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order to meet with the crop requirements, the soil fertility status and/or the fertilisation management plan.

The following lines provide general overview of research performed in the EU over the last few years and related to the end-users preferences when it comes to the fertilisers selection and application on field (Table 17.).

Table 17 Overview of research projects consulted for the design of the FERTIMANURE end-users preferences questionnaire

Research project	Research team/institution	Research year
Danish farmers preferences for bio-based fertilisers – a choice experiment, 2017 (EU project INEMAD - Improved Nutrient and Energy Management through Anaerobic Digestion	Jacobsen B.H., Bonnichsen O., Tur-Cardona J.	2017
Farmer perceptions and use of organic waste profucts ad fertilisers – a survey study of potential benefits and barriers	Case SDC, Oelofse M., Hou Y, Oenema O., Jensen LS	2017
Farmers' reasons to accept bio-based fertilizers – A choice experiment in 8 European countries	Tur Cardona J., Speelman S., Verpecht A., Buysse J.	2015
Biogas digestate marketing: Qualitative insights into the supply side	Dahlin J, Herbes C, Nelles M.	2015
Phosphorus supply to organic agriculture. What does the organic sector think about different phosphorus fertilisers? (CORE Organic-project IMPROVE-P)	Løes A.K.	2016
Green marketing strategies in the dairy sector: consumer stated preferences for carbon footprint labels	Canavari M., Coderoni S.	2018

The research performed in Denmark by Jacobsen et al. (2017) was focused on how much farmers are willing to pay for bio-based fertilisers and what characteristics of bio-based fertilisers are the most important for them to start using bio-based fertilisers. Within this research, bio-based fertiliser refered to different types of fertilisers based on organic manure and can therefore be products from different types of separation, digestate from biogas plants or products which are processed further (e.g. struvite or concentrate N). The researchers have collected in total 202 responses from Danish farmers.

The purpose of this research was to extract knowledge about Danish farmers's willingness to pay for bio-based products, differentiated according to properties such as form, volume, certainty in N-content as well as the presence of organic carbon and hygenisation. A percentage reduction in the bio-based product price compared to the respondents' present chemical fertiliser price was used as the level of payment that the farmer is willing to pay. The attributes and their levels were identified firstly by experts, then at stakeholder meetings and interviews with farmers (Danish farmers preferences for bio-based fertilisers – a choice experiment, 2017).

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Attributes	Attribute levels
Price	Same as artificial fertiliser
	20% cheaper
	40% cheaper
	60% cheaper
Form	Liquid
	Granulate
	Semi-solid
	Combination of liquid and solid
Advised volume of bio-based fertiliser needed compared to artificial fertiliser	Same as current artificial fertiliser
	×2 volume
	×4 volume
	×6 volume
Uncertainty about the N-content	Certainty about N-content
	Possibly 25% variation in N-content
	Possibly 50% variation in N-content
	Possibly 75% variation in N-content
Organic carbon	No organic carbon
	As much organic carbon as in straw-containing stable manure
Pests and diseases	Not made hygienic
	Made hygienic
Rate of nutrient release	Slow
	Fast

Figure 61 Attributes and attribute levels (source: Danish farmers preferences for bio-based fertilisers – a choice experiment, 2017)

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	Bio-based fertiliser A	Bio-based fertiliser B
Price	Same price as artificial fertiliser	40% cheaper
Form	A combination of liquid and solid forms	Liquid
Advised volume of bio-based fertiliser needed compared to artificial fertiliser	2x volume	Same volume as current artificial fertiliser
Uncertainty about the N-content	Possibly 50% variation on N-content	Certainty about N-content
Organic carbon	No organic carbon	No organic carbon
Pests and diseases	Not made hygienic	Made hygienic
Speed of nutrient release	Slow	Slow

Please indicate the fertiliser that you prefer:

- ❍ Bio-based fertiliser A
- ❍ Bio-based fertiliser B
- ❍ Current artificial fertiliser (ASC)

Figure 62 Example of a choice set (source: Danish farmers preferences for bio-based fertilisers – a choice experiment, 2017)

The collection of data was carried out through both online and postal questionnaires. The online questionnaire was sent to 5,000 farmers and the postal questionnaire was sent to another 2,000 farmers. A total of 202 responses were received from Danish farmers. Of these, 110 (54%) of responses were received through the online survey, while the rest (92) were collected with a postal survey.

The data was collected as part of the EU project INEMAD (Improved Nutrient and Energy Management through Anaerobic Digestion) which aims to reconnect livestock and crop production so the Danish results can be compared with the European results.

Results indicated that the farmers reveal preferences for a higher certainty in the N-content, low volume, organic carbon and hygienisation. The ideal product, which is like mineral fertiliser which includes organic material, typically can be sold for up to 50 % of the mineral fertiliser price.

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The analysis showed that some farmers are unlikely to accept bio-based fertilisers unless the products has completely the same properties as mineral fertilisers (Danish farmers preferences for bio-based fertilisers – a choice experiment, 2017).

Similar project was performed by Case et al. (2016) when 452 Danish farmers provided a better insight in their current and future use of raw and processed manure and other bio-based fertiliser products. Results indicated that only respondents were mostly livestock farmers (35 %).

Within the research, 72 % of farmers indicated using at least one form of organic fertiliser, mostly manures received from neighbouring farms, but also processed manure (19 %) and urban waste-derived products (9 %). The vast majority, 79 %, indicated that three years from now they expect to use the same amount of organic fertiliser as today, but 15 % expected to be using more.

Nearly half (47 %) indicated that they would be interested to use a form of organic fertiliser not currently available to them (e.g. processed manure (42 %), unprocessed manure, and lastly sewage sludge or municipal bio-wastes).

The farmers were also asked to prioritise their motivations or perceived barriers to organic fertiliser use. The most important element for farmers seemed to be odour nuisance, uncertainty of nutrient content, difficulty in planning for application (supply and nutrient availability), and cost of specific equipment needed for handling (Mini-paper – End-user requirements for recycled and bio-based fertiliser products, 2016).

A. Barriers to use of organic fertilisers Farm / farmer characteristic		Number of respondents	Odour nuisance	Unreliable nutrient content	Difficult to plan	Expensive machinery	No quality certification	Other	Difficult to handle	High costs	Restrictions on application	Unsuitable nutrient content	Difficult to get permit	Lack of subsidies	More pollution risk	Not easily available	Lack of expert advice
ALL		**107**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**10**	**12**	**13**	**14**	**15**
Farm activity	**Arable/horticulture**	**57**	1	2	3	4	5	8	6	7	11	8	11	10	13	13	15
	Mixed	**36**	1	3	5	8	4	1	7	14	6	12	8	10	10	13	15
	Livestock	**8**	7	1	7	1	11	4	5	1	5	11	7	11	10	11	11
Farming system	**Conventional**	**95**	2	1	3	4	4	7	6	8	11	9	10	12	13	14	15
	Organic	**11**	2	7	5	2	6	2	11	14	1	14	8	8	8	11	13
Farm size (Ha)	**10-19.9**	**20**	4	1	8	5	5	9	3	7	2	10	10	10	14	13	15
	20-29.9	**13**	5	6	3	2	1	14	3	8	8	7	10	10	12	12	14
	30-49.9	**16**	2	2	2	6	1	7	5	10	13	10	12	7	9	13	13
	50-99.9	**23**	3	5	1	1	6	4	9	7	7	11	10	11	11	14	15
	> 100	**30**	1	3	4	7	5	2	9	9	14	7	5	9	13	9	15
Age	**18 - 49**	**31**	1	5	6	3	2	4	10	14	8	7	11	8	11	11	15
	50 - 64	**55**	4	1	2	3	8	7	6	5	10	12	9	11	12	14	15
	65 +	**18**	1	3	5	6	2	10	4	9	6	6	10	14	10	10	15

Figure 63 Barriers to use organic fertilisers (source: Mini-paper – End-user requirements for recycled and bio-based fertiliser products, 2016)

A similar study by Tur Cardona et al. (2015) surveyed farmers (705) in 8 EU countries for their preferences in accepting bio-based fertiliser products to replace their current mineral fertiliser counterparts. Using a choice-experiment survey design, based on 7 fertiliser attributes (price, form, volume, certainty of N content, rate of nutrient release, organic carbon content, hygiene)

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they were able to identify that across all countries low price, high certainty of N content and low volume/high concentration was highly significant criteria, however, also hygienisation and high organic carbon was found of significant importance in more than half of the countries.

Dahlin et al. (2015) assessed biogas digestate marketing, based on a survey of digestate marketing information online and thanks to in-depth interviews with companies marketing digestate. The research was performed in Germany, Switzerland, Austria, Netherlands and France. The authors note that farmers often understand the importance of digestate in sense of bringing organic carbon to the soil and also calculate the economy in substitution of mineral fertiliser costs related to digestate nutrient content. However, local excesses of digestate availability enable farmers to negotiate down prices, and the digestate price also depends strongly on whether it is sold in bulk or in small-scale retail-type “on the shelf”, as well as on the degree of processing. Farmers are noted to be sceptical concerning digestate containing household wastes as input materials, although this can also be a price bargaining strategy.

Løes et al. (2016) collected 213 responses at stakeholder workshops held in seven countries to discuss the use of secondary P sources in organic farming. The respondents were generally reserved about acceptability of conventional manure in organic farming, with comments showing concerns about residues of pesticides, hormones and pharmaceuticals. Results varied in different countries, but often <50 % of respondents considered conventional manure acceptable. Ruminant and horse manure was generally preferred to manure from poultry or pigs (both cca 55 % acceptability) or fur animals. Appropriately treated park and recreation green waste achieved the highest acceptance (> 90 %) along with source-separated municipal food waste (85 %) and (non-animal) food industry residues (77 %) and catering food waste (71 %). More than 60 % of respondents also considered acceptable the use of human urine and human sewage in organic farming, with a general order of preference precipitates (69 %) > urine > sewage sludge > sewage sludge incineration ash (56 %). Meat and bone meal ash was also acceptable to over 70 % of respondents, but with comments that this often comes from non-organic / intensive production or should be applied under specific safety conditions (e.g. injected into the soil). Phosphate rock was considered acceptable to only 50 % of respondents, with concerns expressed concerning the country of origin.

The workshops as part of the CORE Organic-project IMPROVE-P were held in 6 EU countries, to explore the opinions among organic agriculture stakeholders on recycled fertilizer products. Phosphorus (P) will be depleted over time in soil via export of farm products, and needs replacement to maintain soil fertility. Green waste was the most popular fertilizer product, accepted by more than 90 % of respondents. Least popular was conventional manure from fur animals, but even for this material, more than 30 % of respondents were willing to accept its use in organic agriculture. There is a large interest among organic stakeholders in fertilizer products derived from human excreta, provided these can be controlled to be safe with respect to food safety issues (pathogens, pharmaceuticals, heavy metals and other pollutants). More than 60 % of the respondents accepted the use of human urine and sewage sludge. The results of this study indicate that organic stakeholders are ready to accept more recycled P fertilizers into organic agriculture, as long as means are taken to ensure sufficient purity, safety and environmental efficiency of such products. This calls for adaptations in the regulations for authorization of fertilizers and soil amendments to certified organic production (Phosphorus supply to organic agriculture: What does the organic sector think about different phosphorus fertilizers?, 2016).

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Manure from small ruminants (sheep and goats), cattle and horses was accepted by a majority of stakeholders, except from the German respondents who were generally very critical towards all use of conventional manure in organic agriculture. Conventional manure from poultry and pigs was also accepted by more than 40 % of the stakeholders, except from in Germany. Even manure from fur animals was considered acceptable by 40 % of Danish stakeholders. In general, Danish stakeholders were more positive towards the use of conventional animal manure than any other group. Stakeholders from Great Britain were also generally positive, whereas Austrian stakeholders were more negative, although not as negative as the German. Stakeholders from Norway were especially positive towards manure from ruminants. Except from manure from fur animals, Swiss stakeholders were generally positive towards conventional manure. Personal comments showed that residues of pesticides, hormones and pharmaceuticals, e.g. antibiotics and medicines against parasites, and also GMO feed, were major reasons for concern about utilizing conventional manure in organic agriculture (Phosphorus supply to organic agriculture: What does the organic sector think about different phosphorus fertilizers?, 2016).

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Table 18 Literature overview of previously conducted surveys regarding the end-users preferences within the EU R&D projects

No.	Project title	Project info	Questionnaire/Survey title	Link
1.	**NUTRIMAN** – Nutrient Management and Nutrient Recovery Thematic Network	NUTRIMAN is a Nitrogen and Phosphorus Thematic network compiling knowledge of „ready-for-practice" recovered bio-based fertiliser technologies, products, applications and practices for the interest and benefit of agricultural practitioners. The project focuses on connecting market competitive and commercially „ready for practice" innovative results drawn from high research maturity applied scientific programmes and common industrial practices.	Farmer consultation and identification of incentives and bottlenecks for using recovered products and recuperation technologies	https://nutriman.net/survey
2.	**LEX4BIO** – Optimising bio-based fertilisers in agriculture *(Providing a knowledge basis for new policies)*	The overall objective of the LEX4BIO project is to realise bio-based fertilisers potential to transform the agricultural industry by minimising the environmental impact of existing fertilisers and improving sustainability through recycling of nutrient-rich side-streams. LEX4BIO will focus on the most promising technologies for BBF production and evaluate their fertilisation potential and other properties against national and EU fertilisation requirements.	Questionnaire on bio-based fertilizers	https://surveynuts.com/surveys/take?id=185827&c=6425897677DVTT
3.	**Water2Return** – resource-oriented solutions for wastewater treatment based on a circular economy approach	The Water2Return project objective is to implement an integrated solution for slaughterhouse wastewater treatment, as well as for the recovery of nutrients with high market value in the agricultural sector. Water2REturn commercial outcomes will be: - An integrated system to treat wastewater while recovering nutrients, customisable according to the needs of the end user. - 3 raw materials: nitrate and phosphate concentrate, hydrolysed sludge and algal biomass, the basis for further manufacturing agronomic products. - 3 agronomic products: 1 organic fertiliser and 2 biostimulants, ready to be commercialised.	Questionnaire for Farmers Questionnaire for Slaughtering industry Questionnaire for the Fertilizer industry Questionnaire for the Wastewater Treatment industry Questionnaire for Consumers and NGOs	https://water2return.eu/questionnaire/
4.	**REFERTIL** – Reducing mineral fertilisers & chemicals use in agriculture by recycling treated organic waste as compost and bio-char products	The key objectives of the REFERTIL project are to improve current compost treatment systems and develop zero emission biochar technologies at the industrial scale for safe and economic nutrient recovery processes. Beyond the technological development the REFERTIL project also provides a strong policy support in the revision of the Fertiliser Regulation (Reg. EC No. 2003/2003) and possible inclusion of biochar – as organic fertiliser and soil aditive. The REFERTIL project will also define the improved compost and biochar quality and safety criteria and standards in the EU28 for safer, better, less costly and more environmental friendly utilization of the EU28 generated 150 M t/y plant/animal biomass waste streams.	Survey Questionnaire: biochar and compost consumer (farmer) acceptance evaluation	http://www.refertil.info/survey-questionnaire-biochar-and-compost-consumer-farmer-acceptance-evaluation
5.	**AGRIMAX** – Agri and food waste valorisation co-ops based on flexible multi-feedstocks biorefinery processing technologies for new high added value applications	The AGRIMAX project is designed to establish the technical and economic viability using bio-refining process on waste from crops and food processing to deliver new bio-compounds for the chemical, bio-plastic, food, fertilisers, packaging and agriculture sectors. The project will combine affordable and flexible processing technologies, including ultrasound assisted and solvent extraction, filtration, thermal and enzymatic treatments for the valorising side streams from horticultural and food processing industries that can be used in a cooperative approach by local stakeholders.	AGRIMAX survey: Perception of bio-based products for food and packaging	https://docs.google.com/forms/d/e/1FAIpQLSdCoX6Kx324jWHg6hCcViyBWOilpCZ7_dSNu-XEe4akhuK3BA/viewform
6.	**LIFE ALGAECAN** – Adding sustainability to the fruit and vegetable	The main objectives of the LIFE ALGAECAN project are to demonstrate the technical and economic feasibility of an innovative concept for fruit and vegetables processing industry wastewater treatment based on heterotrophic microalgae culture to substitute, in the long term,	Treatment and processing of animal and/or vegetable materials Questionnaire	https://www.lifealgaecan.eu/en/communication/encuestas/

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	processing industry through solar-powered algal wastewater treatment	the traditional aerobic digestion as preferred method for the treatment of these streams since instead of waste sludge and nutrients losses, added-value microalgae are produced.	Fertilizers survey Animal feeding survey	
7.	**CIRC4Life** – A circular economy approach for lifecycles of products and services	The CIRC4Life project envisages the following objectives: develop the three new circular economy business to underpin new services with novel features, develop a vendor-neutral and open source-based information logistical infrastructure, demonstrate the economic and environmental feasibility of the new circular economy business models, support the end-users, produce cross-cutting policy recommendations on circular economy. The project aims to develop three business models along the product value chain: co-creation of products/services, sustainable consumption, and collaborative recycling and reuse.	Surveys uncovering ways to engage consumers in the circular economy	https://www.circ4life.eu/surveys
8.	**RELACS** – Improving inputs for organic farming	RELACS seeks to promote the development and adoption of environmentally safe and economically viable tools and technologies to reduce the use of external inputs in organic farming systems, namely: copper and mineral oil for plant protection, recycled fertilizers and conventionalmanure in plant production, antibiotics and anti-worm drugs (anthelmintics) in animal production, synthetic vitamins in animal production. The project covers all major sectors of organic farming, including horticulture, arable cropping as well as cattle, sheep, pig and chicken production. The diverse needs in the different European countries and regions are considered. A multi-actor approach will be the core of the project, as RELACS was developed by involving actors and stakeholders from research and industry, organic farmers and advisors from the start.	International Inspecto survey on Anthelmintics and Antimicrobials	https://www.surveymonkey.co.uk/r/DMRSV59
9.	**SABANA** – Sustainable algae biorefinery for agriculture and aquaculture	SABANA aims at developing a large-scale integrated microalgae-based biorefinery for the production of biostimulants, biopesticides and feed additives, in addition to biofertilizers and aquafeed, using only marine water and nutrients from wastewater (sewage, centrate and pig manure). The objective is to achieve a zero-waste process at a demonstration scales up to 5 ha sustainable both environmentally and economically.	The suvey on the Social Impact Assessment (SIA)	https://www.sabanasurvey.eu/?lang=en
10.	**SOIACE** – Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use	The goal of SOIACE is to help European agriculture face major challenges, notably increased rainfall variability and reduced use of N and P fertilizers for both economic and ecological purposes. SOIACE will design solutions, strategies and tools that combine novel crop genotypes and agroecosystem management innovations to improve water and nutrient use efficiency. It will look at a range of agricultural contexts across pedo-climatic regions and farming systems in Europe.	Increasing uptake of more efficient agricultural practices	https://docs.google.com/forms/d/e/1FAIpQLSfK5mBSPTwS_1kADvS2IQyDxr-3MVhBzTFe1sNSeLFHv6jDWA/viewform

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7.2. Methodology behind designing the FERTIMANURE survey on end-users acceptance of bio-based fertilisers

Based on the literature overview, a FERTIMANURE survey has been prepared in order to assess end-users preferences and willingness to purchase bio-based and tailor-made fertilisers.

The FERTIMANURE project has carefully designed a **survey on end-users preferences** to check which parameters are of importance to stakeholders and more importantgly, to understand market preferences before developing business plans and policy proposals.

The following Table 18 provides the most important information regarding the survey development and how it will executed.

Table 19 Overview of the FERTIMANURE survey set-up and execution

	GENERAL TECHNICAL INFO	Questionnaire has been prepared in the **SurveySparrow app** and in total 9 variations of the questionnaire have been prepared: 8 questionnaires for the EU (2 questionnaires for Spain) and 1 questionnaire for CELAC (Argentina).
	PURPOSE OF THE SURVEY	Purpose of the survey is to gather information from end-users regarding the: - current use of fertilisers - whether they have already used BBFs/TMFs - are they willing to try using BBFs/TMFs - what is their attitude about using BBFs and TMFs
	DEDICATED FERTIMANURE PARTNERS	**Dedicated FERTIMANURE partners** that are responsible for the distribution of the questionnaire are: - SPAIN: LEITAT, CPV, DARP - FRANCE: APPCA, RITTMO - BELGIUM: ELO - THE NETHERLANDS: WENR, APF - ITALY – UMil - GERMANY: FHR - ARGENTINA: INTA - CROATIA: IPS - CHILE: LEITAT CHILE Next to the dedicated partners, IPS will forward email with the questionnaire links to **all FERTIMANURE partners** in case they also have contacts within the selected focus group/stakeholders.
	DEADLINE	Distribution of the questionnaire and responses collecting from **02/01/2021 – 30/04/2021** The results of the questionnaire will be included in the D6.2. in M18
	PREFERABLE STAKEHOLDERS	- **LIVESTOCK FARMERS** - **CROP GROWERS** - **HORTICULTURE GROWERS (open-field, greenhouse)** - **AGRO-SME´S** - **AGRO – COOPERATIVES (FARMERS ORGANIZATIONS)** - **AGRO AND NUTRIENT RECOVERY RELATED CLUSTERS**

All version of the survey will be attached at the bottom of this file. The survey is also available via the surveysparrow links as indicated below.

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FERTIMANURE

SURVEY LINKS

	English version	https://ips-konzalting.surveysparrow.com/s/fertimanure-project---end-users-preferences/tt-e72584
	Spain	https://ips-konzalting.surveysparrow.com/s/fertimanure-project---end-users-preferences-spain/tt-621443
	Catalonia	https://ips-konzalting.surveysparrow.com/s/fertimanure-project---end-users-preferences-catalonia/tt-3113d3
	France	https://ips-konzalting.surveysparrow.com/s/fertimanure-project---end-users-preferences---france/tt-4687a0
	Italy	https://ips-konzalting.surveysparrow.com/s/fertimanure-project---end-users-preferences-italy/tt-178765
	Germany	https://ips-konzalting.surveysparrow.com/s/fertimanure-project---end-users-preferences-germany/tt-7cb865
	Croatia	https://ips-konzalting.surveysparrow.com/s/fertimanure-project---end-users-preferences-croatia/tt-b56d05e19d
	The Netherlands	https://ips-konzalting.surveysparrow.com/s/fertimanure-project---end-users-preferences-nl/tt-7b0ae7
	Argentina / Chile	https://ips-konzalting.surveysparrow.com/s/fertimanure-project---end-users-preferences-argentina/tt-84aeb8

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Annex I FERTIMANURE survey – all available versions

Purpose of the questionnaire is to gather information from end-users regarding the current use of fertilisers as their preferences on the use of BBF/TMFs. The questionnaire will primarily be distributed by 12 dedicated FERTIMANURE partners in Spain, France, Belgium, the Netherlands, Italy, Germany, Argentina and Croatia.

SURVEY LINKS

English version	https://ips-konzalting.surveysparrow.com/s/fertimanure-project---end-users-preferences/tt-e72584
Spain	https://ips-konzalting.surveysparrow.com/s/fertimanure-project---end-users-preferences-spain/tt-621443
Catalonia	https://ips-konzalting.surveysparrow.com/s/fertimanure-project---end-users-preferences-catalonia/tt-3113d3
France	https://ips-konzalting.surveysparrow.com/s/fertimanure-project---end-users-preferences---france/tt-4687a0
Italy	https://ips-konzalting.surveysparrow.com/s/fertimanure-project---end-users-preferences-italy/tt-178765
Germany	https://ips-konzalting.surveysparrow.com/s/fertimanure-project---end-users-preferences-germany/tt-7cb865
Croatia	https://ips-konzalting.surveysparrow.com/s/fertimanure-project---end-users-preferences-croatia/tt-b56d05e19d
The Netherlands	https://ips-konzalting.surveysparrow.com/s/fertimanure-project---end-users-preferences-nl/tt-7b0ae7
Argentina / Chile	https://ips-konzalting.surveysparrow.com/s/fertimanure-project---end-users-preferences-argentina/tt-84aeb8

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