Economic Aspects of the Regulatory Framework in the Area of Fertilizers

In-depth analysis for the IMCO Committee

2017
Economic Aspects of the Regulatory Framework in the Area of Fertilizers

IN-DEPTH ANALYSIS

Abstract
This study discusses economic implications of the proposed EU regulation on the market of CE marked fertilizers. Depending on the design of the regulation, the costs can be substantial. The expected additional costs of introducing mandatory or voluntary maximum threshold levels for cadmium in inorganic fertilizer are larger than the expected benefits. Measuring cadmium concentration in food in combination with food consumption information seems to be a more cost-effective strategy. Harmonizing the standards for new fertilizing products entering the EU market can increase their supply, support the development of the bioeconomy and hence should be enforced.

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Economic Aspects of the Regulatory Framework in the Area of Fertilizers

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LIST OF ABBREVIATIONS

Cd  Cadmium
CE  Circular Economy
CR3  Concentration ratio of 3 largest companies
CR5  Concentration ratio of 5 largest companies
EU  European Union
EU-15  15 EU Member States before the 2004 enlargement
EUN-13  13 EU Member States of the 2004, 2007, and 2013 enlargements
HHI  Herfindahl Hirschman Index
K  Potassium
MPB  Marginal Private Benefit
MPC  Marginal Private Cost
MSC  Marginal Social Cost
N  Nitrogen
P  Phosphorus
P₂O₅  Phosphorus pentoxide
PFCs  Perfluorinated compounds
SBS  Structural Business Statistics
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EXECUTIVE SUMMARY

Key Findings

Many environmental regulations at EU and Member State level exist that monitor and control possible contaminants, including the monitoring of heavy metals in food. They provide flexibility at Member State level to respond to environmental problems where necessary and internalize some environmental and health safety concerns. Hence, new regulatory policies have to pass the benefit-cost-analysis test using the current market situation as the reference and need to consider the existing internalization of external effects explicitly.

Further, regulations often include sunk costs that discriminate against smaller companies. The sunk costs are expected to be the case for the proposed regulation on CE marked fertilizing products affecting inorganic fertilizer and manure.

For the case of new fertilizing products entering the market harmonization of standards can have positive effects, stimulating investments by reducing regulatory costs. Fertilizer input (nitrogen and phosphorus) in the EU is declining for inorganic fertilizers as well as for nutrients from manure (Wesseler et al., 2015). Fertilizer input in the EU-15 is much higher than in the EUN-13 (i.e., the 13 Member States of the 2004, 2007, and 2013 enlargements). The impacts of the new regulation on fertilizing products at farm level will mainly affect farmers in the EU-15 and less so in the EUN-13. This conclusion applies to inorganic as well as organic fertilizer from manure and to nitrogen as well as phosphorus.

A stronger regulation that increases the costs of producing inorganic fertilizer will in particular harm small-scale fertilizer producing companies and can significantly contribute to an acceleration in market concentration as the market includes a high number of small and medium scale enterprises as indicated by low concentration within the sector.

The use of non-manure organic fertilizer is a niche market with small quantities being traded. A harmonization of non-manure organic fertilizer standards will, in particular, benefit SMEs in Italy and The Netherlands and to a lesser extent SMEs in Austria, France, Germany, and Spain.

There is substantial uncertainty with respect to the effects of cadmium in fertilizer on cadmium accumulations in humans. Cadmium concentration in soils in the EU is declining. The share of phosphorus fertilizer exceeding 60mg Cd per kg of P₂O₅ is relatively small. A limit of 60mg Cd per kg of P₂O₅ is expected to have only a small effect on fertilizer expenditures by farmers but an average large effect on fertilizer producing firms. Higher costs faced by inorganic fertilizer producers with respect to maximum levels of cadmium will be transmitted to farmers only partially. Maximum limits on cadmium, voluntary or mandatory, will increase cost without generating additional benefits. Further, an EU-wide threshold level on cadmium concentration in mineral phosphorus fertilizer may result in third-country effects reducing the expected impacts of the regulation. Similarly, imposing limits on heavy metals and organic pollutants for manure will increase marketing costs, reduce trade, and harm the environment. Nevertheless, a harmonization of standards with respect to possible contaminants in new fertilizing products can have a positive effect on increasing production and trade and support the development of the EU bioeconomy.

Recommendations

Additional voluntary maximum levels of cadmium and other heavy metals for inorganic fertilizer should not be introduced. The additional limits will only increase administrative costs
without generating substantial - if at all - additional benefits. Similarly, imposing limits on heavy metals and organic pollutants for manure will increase marketing costs, reduce trade, and harm the environment and should not be introduced. To protect the environment and human health, the monitoring of heavy metals and organic compounds should be enforced as a cost effective alternative to the proposed regulation of the markets for inorganic fertilizer and manure. Harmonization of standards with respect to possible contaminants in new fertilizing products can have a positive effect on increasing production and trade and support the development of an EU bioeconomy and should be introduced. Harmonization of standards should focus on the contaminants mentioned in the impacts assessment of the European Commission. Particular attention should be paid to PFCs.
1. THEORETICAL AND METHODOLOGICAL BACKGROUND

KEY FINDINGS

• Many environmental problems related to the use of fertilizing products are internalized by policies at EU level.

• New policies have to pass the benefit-cost-analysis test using the current market situation as the reference.

• Regulations often include sunk costs that discriminate against smaller companies; this is expected to be the case for the proposed regulation on CE marked fertilizing products affecting inorganic fertilizer and manure.

• For new fertilizing products entering the market, harmonization of standards can have positive effects, stimulating investments by reducing regulatory costs.


The “Fertilisers Regulation” is expected to ease the access of innovative organic and waste-based fertilizers to the EU single market, bringing them on the playing field with conventional, non-organic fertilizers through granting them access to CE marking. To date, the access of non-organic fertilizers to the single market depends on mutual recognition between the Member States, and due to diverging national rules is often difficult. The Regulation will update the current requirements for inorganic CE marked fertilizers. The requirements will apply to the finalized CE marked fertilizing products, including those imported into the EU and sold in the single market.

This briefing note covers the following issues:

a) review of the current state of play of the market for fertilizing products with an indication on barriers for free movement of goods and economic potential of reducing these barriers;

b) critical assessment of the European Commission’s proposal in the light of available sources (including Commission’s impact assessment 1 and experts’ assessment);

c) policy recommendations addressing the current legislative and regulatory course and in particular the proposed regulation.

The proposed regulation on fertilizers addresses negative implications of fertilizer use on the environment and human health. From an economic point of view, the optimal level of fertilizer use (Figure 1) is where the marginal private benefits (MPB) of fertilizer use equal the marginal private costs (MPC) (point c). In the case where additional costs arise that the private sector does not consider when deciding about the use of fertilizer, those costs need to be added to the marginal private costs as the marginal private costs do not reflect the marginal social costs (MSC). (A similar situation applies to the private costs in case of social benefits of fertilizer use that are not considered by the private sector). To equalize the private optimal use of fertilizer with the social optimal use, the use of fertilizer can be taxed (Pigouvian tax). This is illustrated in Figure 1. In this case, the tax increases the costs of fertilizer use that in

the end the optimal level used by the private sector will be equal to the socially optimal level (point d).

The Pigouvian tax can be an efficient instrument in cases where there is no intervention by the government, full information among all participating agents exists, and markets are characterized by perfect competition. In reality, this situation does not exist. Many environmental implications of fertilizer use are already internalized via some rules and regulations, and a more realistic assumption is that the marginal private costs (MPC') are equal to the marginal social costs (MSC) (point d) as illustrated in Figure 2. In this case, a change in regulation has to pass the benefit-cost assessment, while different approaches for addressing the problem should be compared (Coase, 2006). The important message is that a reduction down to zero often cannot be justified. Only in the extreme case (where the marginal social costs are so high that they are always above the marginal private (social) benefits), would a complete ban be justifiable, but in that case, we would not observe a use of fertilizers anyhow as it would not be economical in the first place.

**Figure 1: Internalised external effects of agriculture production**

The second important message is that current market prices carry information about external effects to the extent that they have been internalized and should be the basis for a benefit-costs analysis (Wesseler and Drabik, 2016).

An additional issue that deserves attention is that additional regulations in many cases increase the fixed costs of companies and in that case delay market penetration and increase market concentration. This is illustrated in Figure 3. The horizontal axis shows the value of the investment (V) and the vertical axis the sunk investment costs (I), the value of the investment, as well as the value of the option of the investment (F(V)).

Considering market uncertainties and irreversibility effects of investments the optimal level of investment is at point V1, V2, or V3, depending on the specificities of the investment (prices, uncertainty, opportunity costs) and to the right of the intersection of the black line starting at I1 with the horizontal axis, where the costs equal the benefits. The important message is that per unit of investment more than one unit of benefits is needed. If the investment costs are increased from I1 to I2, the benefits needed for the investment to be profitable increase as well. Again, a higher amount will be needed, that is, for every additional unit of investment costs more than one unit of additional benefits will be needed. Hence, first, regulations can substantially reduce the profitability of investments and result in fewer investments being made and second, increase the concentration in the specific sector.
regulated as in many cases a larger amount of initial investment is needed that larger firms are easier able to shoulder than smaller ones.

**Figure 2:** Internalised external effects of agriculture production where $\text{MSC} = \text{MPC}'$

![Graph showing internalised external effects of agriculture production](image)

Linking this to the current regulation and the proposed reforms (EC 2016a) on the market of Circular Economy (CE) marked fertilizing products one can observe that the proposal, in general, is in line with the framework presented.

First, the proposal does not prevent fertilizers that are already in use and regulated by national law to be removed from the market nor does it require to change national regulations that have internalized potential externalities in their national regulations.

Second, the new proposal includes new fertilizing compounds that are expected to enter the market, mainly as by-products of biorefineries or other means of processing biological resources, including biowaste. A harmonization in this area can increase the potential market and reduce the certification costs of companies interested as well as the uncertainty related to market access. In this case, this will reduce the trigger value in Figure 3 and should make it easier for companies in general to enter the market as well as easier for smaller companies.
Figure 3: The value of opportunities

Third, contaminants in CE marked fertilizing products, and in particular, the cadmium content has received special attention. The proposal addresses the environmental and human health externalities related to the use of cadmium. The impact assessment (EC 2016b,c) recognises that current regulations internalise some of the externalities (Directive 86/278/EEC of 12 June 1986), while a stronger regulation in this area for phosphate, where already well-established markets exist, will increase the regulatory hurdle and discriminate against smaller inorganic fertilizer trading and processing (fertilizer blenders) firms.

These aspects will be discussed in more detail in the next section.
2. **FERTILIZER USE IN THE EU**

**KEY FINDINGS**

- Fertilizer input (nitrogen and phosphorus) in the EU is declining for inorganic as well as from manure.

- Fertilizer input in the EU-15 is much higher than in the EUN-13.

- The new regulation on fertilizing products at farm level will mainly affect farmers in the EU-15 and less in the EUN-13. This applies to inorganic as well as organic fertilizer from manure and to nitrogen as well as phosphorus.

- Additional regulations addressing inorganic fertilizer will affect a large number of SMEs as the inorganic fertilizer market is not highly concentrated.

- A stronger regulation that increases the costs of producing inorganic fertilizer will harm in particular small scale companies and can significantly contribute to an acceleration in market concentration.

- The use of organic non-manure fertilizer is a niche market with small quantities being traded.

- A harmonization of organic fertilizer standards excluding manure will in particular benefit SMEs in Italy and The Netherlands and to a lesser extend SMEs in Austria, France, Germany, and Spain.

- Cadmium concentration in soils in the EU is declining according to two studies.

- The share of phosphorus fertilizer exceeding a 60mg Cd per kg of P2O5 is relatively small.

- A limit of 60mg Cd per kg of P2O5 is expected
  - to have only a small effect on fertilizer expenditures by farmers;
  - an average large effect on fertilizer producing firms.

- There is substantial uncertainty with respect to the effects of Cd in fertilizer on Cd accumulations in humans.

- The effect on fertilizer costs at farm level of an introduction of maximum threshold levels for cadmium in phosphorus fertilizer will be minimal.

Two issues related to fertilizers are currently discussed in the European Union. First, a high amount of organic waste is generated, and this waste contains valuable nutrients (N, P, K) that could be used as fertilizer. In addition to recycling nutrients, using organic matter improves soil quality and fertility. There is a trade-off between the benefits and costs in the form of transportation of bulky organic fertilizers, local availability of biomass, and the price of organic fertilizers. The second issue concerns ways of reducing the quantity of contaminants in fertilizing compounds and cadmium in particular especially via using less phosphate because the amount of cadmium is closely linked to the use of phosphate rock.
2.1. **Nitrogen and Phosphorus Use by Member State**

Figure 4 presents the consumption of nitrogen and phosphorus per hectare in the EU Member States in 2013. The values correspond to the total amount of a nutrient from all sources, that is, mineral and organic fertilizers and manure. The countries are ordered by the use of nitrogen. The Netherlands, Belgium, and Malta lead the list with 338, 310, and 270 kg of nitrogen per hectare, respectively. The smallest amounts of nitrogen are used in Bulgaria, Estonia, and Romania, with 81, 71, and 68 kg per hectare, respectively.

The use of phosphorus per hectare is significantly lower than the use of nitrogen in all Member States—on average the use of phosphorus amounts to 12.5% of the use of nitrogen. There are two reasons for that. First, physiologically plants need less phosphorus; second, phosphorus is more expensive compared to nitrogen.
Figure 4: Nitrogen and phosphorus use in the EU Member States in 2013 (kg/ha)

Source: Eurostat (2016).
Figure 4 also shows that the order of countries changes somewhat when the use of phosphorus is considered. That said, on the high end are still Malta, Cyprus, and The Netherlands with 52, 39, and 33 kg per hectare, respectively, while farmers in Estonia, Romania, and Bulgaria use only 9, 8, and 5 kg of phosphorus per hectare, respectively.

Figure 5 decomposes the total use of nitrogen in the EU Member States by its source: mineral fertilizers, manure, and organic fertilizers (excluding manure). Whereas the comparison of the total use of nitrogen has little meaning as it is strongly determined by the area of utilized agricultural area in a given Member State, the composition of the total use is more informative. Figure 5 shows that the lion’s share of nitrogen comes from only two sources: mineral fertilizers and manure. The share of organic fertilizers is negligible.2 Similar conclusions can be drawn for phosphorus from Figure 6.

A closer look at the use of phosphorus fertilizer reveals that the quantity of phosphorus fertilizer input over the past 15 years on average has decreased, while the input from organic fertilizer decreased at a higher rate than the input from organic phosphorus fertilizer. Hence, while the overall input of phosphorus fertilizer declined at the same point in time a substitution effect of inorganic fertilizer with organic fertilizer was observed (see Wesseler et al. 2015 for the details). The same has happened in the case of nitrogen fertilizer. Overall, these trends were more pronounced among the EU-15 than the EUN-13 (i.e., the 13 Member States of the 2004, 2007, and 2013 enlargements), which is not surprising considering the on average much lower level of fertilizer input in the EUN-13 in comparison to the EU-15. What is surprising is still the large difference in absolute fertilizer input between the EU-15 and the EUN-13, but this not only applies to the fertilizer market but also for other input markets as well as output markets (Ihle et al. 2016, Wesseler et al. 2015).

The differences in the use of phosphorus fertilizer also indicate that a regulation on fertilizer will more strongly affect farmers within the EU-15 than in the EUN-13. In the EU-15 in particular farmers in France, Germany and Spain will be affected, and among the EUN-13, in particular, Poland follows by Romania and Hungary, but to a much smaller extent.

A further important issue to note is the relatively high share of nitrogen and phosphorus use from manure. The low trade in organic fertilizers indicates that most of the manure is used on-farm (above 90%), which is also supported by the Farm Accounting Data Network (FADN) data as described in more detail in Wesseler et al. (2015).

### 2.2. **Trade in Inorganic and Organic Fertilizers**

The main objective of the proposed regulation on the CE marked fertilizing products is to harmonize various standards for inorganic and organic fertilizers and new fertilizing compounds. This harmonization is expected to ease intra-EU trade in fertilizers and thus potentially reduce their prices. Table 1 presents the values of imports and exports of both mineral and organic fertilizers of individual EU Member States in 2012 (the latest data we were able to find).

A first thing to notice is that both imports and exports of mineral fertilizers are considerably greater than the corresponding trade in organic fertilizers. This is due to two reasons: (1) there are greater barriers in the internal market for organic fertilizers (e.g., differing standards), and (2) organic fertilizers (e.g., compost, manure) are bulkier compared to mineral fertilizers, which significantly increases the transportation costs. Second, most Member States are net importers of mineral fertilizers (the trade does not necessarily take place only within the European Union). Third, the net trade in organic fertilizers exhibits a more mixed pattern than the trade in mineral fertilizers. For example, Italy and The

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2 Data for nitrogen coming from organic fertilizers are not available for all EU Member States.
Netherlands are net exporters of organic fertilizers, but France and Bulgaria are net importers. Interestingly, most of the members of the European Consortium of the Organic-Based Fertilizer Industry (ECOFI) come from Italy and The Netherlands. This suggests that there are many producers of organic fertilizers in Italy and The Netherlands, thus (partially) explaining why the two countries export comparatively more organic fertilizers than the rest of the EU Member States. Nevertheless, Austria, France, Germany, and Spain also export a considerable amount of organic fertilizers.

A change in regulation will, in particular, affect those countries that are already relatively strong in trading organic fertilizer. A harmonization in the field organic fertilizer excluding manure will support the industry in those countries and can contribute to stimulating the growth of the industry in those countries. Among the EUN-13 countries, Hungary and Estonia are the countries who could benefit most as measured by their exports of organic fertilizers in monetary value.
Figure 5: Nitrogen use by source in the EU Member States in 2013 (thousand tons)

Note: Data for nitrogen coming from organic sources not available for all EU Member States.
Source: Eurostat (2016).
Figure 6: Phosphorus use by source in the EU Member States in 2013 (thousand tons)

Note: Data for phosphorus coming from organic sources only available for France, Spain, Poland, Germany, UK, Ireland, Hungary, Czech Republic, Portugal, Austria, Croatia, Denmark, Sweden, Finland, Slovakia, Belgium, and The Netherlands. Countries ordered by the use of mineral phosphorus. Source: Eurostat (2016).
Figure 7: Average fertilizers cost shares in the EU Member States

2.3. Concentration in the Fertilizer Industry

Figure 7 (adopted from Wesseler et al. 2015) depicts the average cost shares of fertilizers by Member State, for the periods 1989–2009 and 2004–2012. The values show fertilizers reaching an incidence on farming costs as high as 20% in Ireland and as low as 3.6% in Malta. In spite of the data not showing any clear patterns across Member States, for the majority of EU-15 Member States (with the exception of France and Germany), the cost shares of fertilizers appear declining, with a decrease as large as 44% for The Netherlands (from 4.9% to 3.4%) and 34.4% for Denmark (from 7.1% to 5.3%). The opposite emerges for the EUN-13 (with the exception of Cyprus, Slovenia, Romania, and Lithuania) showing an increasing cost share of fertilizers, the largest (in relative terms) that of Latvia (+13.1%, from 10.8% to 12.5%) and Estonia (+18.2%, from 10.8% to 13.3%).

Table 1: Trade in fertilizers in 2012 (million dollars)

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Looking at the supply side of the market, data from Fertilizers Europe indicate that the supply of all the nutrients are expected to maintain relatively steady in Central and Western Europe,
while Eastern Europe and Central Asia are expected to contribute to the growth in the global supply of nutrients by about 7% for N, 8% P, and 33% K.

The production and sales of the different types of fertilizers appear concentrated in a few countries. Figures collected from the Structural Business Statistics (SBS) database of Eurostat for NACE C20.1.5 Manufacturers of fertilizers and nitrogen compounds presented in Table 2 (Wesseler et al. 2015) include turnover (in million euros) for the Top 10 producing Member States for the period 2003–2012. Regarding turnover, the EU-27 fertilizer sector was considerably hit in 2009 due to the economic recession that saw a decline in sales values departing from an otherwise growing trend. Overall, in the 10-year period considered, the EU-27 sales for this industry have nearly doubled from €13.8 billion in 2003 to €26.3 billion in 2012 (note that the 2012 levels refer to the EU-28), in stark contrast to the decline in quantity used, suggesting an increase in unitary value of the products in the market. Companies in the Top 10 producing Member States sold between 74.8% and 84% of the total sales in the EU market. Such an increase in the unitary value of fertilizers may be due to the high and increasing oil prices that have overall (excluding the plunge of the mid-2008 to early 2009) driven up prices of many other commodities (Gnutzmann and Spiewanowski 2014).

For the period considered, Germany is the EU Member State with the highest sales of fertilizers; its market share ranges from 17.3% to 19.8%, followed by Poland, France, the UK, and The Netherlands (according to 2012 rankings). It should be noted that despite the growing turnovers, the relative importance of the Top 5 producers regarding sales has been dwindling, in favor of other Member States, in particular, Belgium and Lithuania.

Despite the slump in sales in the year 2009, the number of enterprises producing fertilizers has been increasing over the period 2003–2012, from 1027 to 1244, and the average economic size of each enterprise had been growing from €13.39 million in 2003 to €21.17 million in 2012. While fertilizer enterprises among the Top 10 countries appear growing, regarding their average size, Germany seems to be following the opposite trend. In particular, the average size of enterprises in Poland and the UK has doubled in the last decade, to reach values above the EU-27 average, but while the number of enterprises has grown in the former from 86 to 94, for the latter there has been a decline, suggesting intensification of operation of the existing companies. The two countries that show the highest number of enterprises are Spain and Italy, jointly encompassing more than 39% (404 enterprises; 214 in Spain and 190 in Italy) of the total number of enterprises in 2003 and 36% (446 enterprises; 264 in Spain and 182 in Italy) in 2012. Both countries show, among the Top 10 producing ones, the smallest average size in terms of sales per unit, well below the EU-27 average, indicating that those countries present a highly fragmented fertilizer industry (Wesseler et al. 2015).

<p>| Table 2: Top 10 EU Member States by total fertilizer sales in 2012 (million euros) |</p>
<table>
<thead>
<tr>
<th>Sales</th>
<th>% (EU-27)</th>
<th>Output</th>
<th>% (EU-27)</th>
<th>Output</th>
<th>% (EU-27)</th>
<th>Output</th>
<th>% (EU-28)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>2382</td>
<td>17.3</td>
<td>3076</td>
<td>17.9</td>
<td>3228</td>
<td>19.8</td>
<td>4711</td>
</tr>
<tr>
<td>France</td>
<td>2391</td>
<td>17.4</td>
<td>2747</td>
<td>16.00</td>
<td>2591</td>
<td>15.9</td>
<td>2815</td>
</tr>
<tr>
<td>Poland</td>
<td>1098</td>
<td>8.00</td>
<td>1184</td>
<td>6.9</td>
<td>1040</td>
<td>6.4</td>
<td>2402</td>
</tr>
<tr>
<td>UK</td>
<td>1410</td>
<td>10.3</td>
<td>1887</td>
<td>11.0</td>
<td>N/A</td>
<td>-</td>
<td>2179</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1192</td>
<td>8.7</td>
<td>1739</td>
<td>10.1</td>
<td>1348</td>
<td>8.3</td>
<td>2068</td>
</tr>
<tr>
<td>Spain</td>
<td>905</td>
<td>6.6</td>
<td>1051</td>
<td>6.1</td>
<td>1109</td>
<td>6.8</td>
<td>2026</td>
</tr>
<tr>
<td>Italy</td>
<td>944</td>
<td>6.9</td>
<td>1360</td>
<td>7.9</td>
<td>1295</td>
<td>8.0</td>
<td>1838</td>
</tr>
<tr>
<td>Belgium</td>
<td>401</td>
<td>2.9</td>
<td>461</td>
<td>2.7</td>
<td>400</td>
<td>2.5</td>
<td>1572</td>
</tr>
<tr>
<td>Lithuania</td>
<td>312</td>
<td>2.3</td>
<td>487</td>
<td>2.8</td>
<td>585</td>
<td>3.6</td>
<td>1167</td>
</tr>
</tbody>
</table>
Concentration in the fertilizer market represents a worldwide concern. In the case of fertilizers (but also in other industries), some well-known European-based agrochemical producers, (e.g., Bayer, BASF, Isagro, Yara) appear prominently also among the leaders in this industry.

The values of the Herfindahl-Hirschman Index (HHI) are 205, 249, 302, and 286 for the years 2009 to 2012, respectively, which suggest that the European fertilizer market does not represent a concentrated industry.\(^4\)

The values reported in Table 3 indicate that the European fertilizer market presents only a limited to the moderate level of concentration. The concentration ratio for the four largest companies (CR4) exceeds slightly one-fourth of the market in the years 2011 and 2012, while the combined estimated shares of the Top 10 companies reach a maximum of 37.65% in 2011. Yara International ASA shows a larger presence in Europe than it does in the global arena (6.4%) with estimated shares approaching or exceeding 10% in most of the years considered, for values as high as 12.36% in 2008 and 12.18% in 2011. K+S Group is the second largest in, although with shares that do not exceed 6% (Wesseler et al. 2015). None of the other companies listed in Table 3 shows a market share of 5%, except Eurochem in 2012, whose values approaches it (4.91%).

**Table 3: Estimated market shares and concentration ratios for the Top 10 companies operating in the EU-27 fertilizer market**

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yara International ASA</td>
<td>9.45</td>
<td>9.18</td>
<td>8.91</td>
<td>12.36</td>
<td>10.50</td>
<td>10.81</td>
<td>12.18</td>
<td>11.39</td>
</tr>
<tr>
<td>K+S Group</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4.22</td>
<td>5.82</td>
<td>5.58</td>
<td>5.07</td>
</tr>
<tr>
<td>Eurochem</td>
<td>1.69</td>
<td>2.82</td>
<td>3.34</td>
<td>2.92</td>
<td>2.38</td>
<td>2.56</td>
<td>2.11</td>
<td>4.91</td>
</tr>
<tr>
<td>Israel Chemicals Ltd</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3.79</td>
<td>2.58</td>
<td>3.78</td>
<td>3.75</td>
<td>3.93</td>
</tr>
<tr>
<td>Fertiliberia S.A.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.72</td>
<td>2.34</td>
<td>2.47</td>
<td>3.40</td>
<td>3.02</td>
</tr>
<tr>
<td>Agrium Inc.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.83</td>
<td>0.79</td>
<td>0.88</td>
<td>0.79</td>
<td>2.31</td>
</tr>
<tr>
<td>Grupa Azoty S.A. Group</td>
<td>-</td>
<td>1.05</td>
<td>1.08</td>
<td>1.29</td>
<td>1.21</td>
<td>1.20</td>
<td>1.23</td>
<td>1.67</td>
</tr>
<tr>
<td>ANWIL S.A.</td>
<td>0.96</td>
<td>0.83</td>
<td>0.79</td>
<td>1.29</td>
<td>1.21</td>
<td>1.20</td>
<td>1.23</td>
<td>1.87</td>
</tr>
<tr>
<td>Uralkali Group</td>
<td>-</td>
<td>-</td>
<td>0.44</td>
<td>0.68</td>
<td>1.14</td>
<td>1.57</td>
<td>1.13</td>
<td></td>
</tr>
<tr>
<td>Acron Group</td>
<td>0.73</td>
<td>0.69</td>
<td>0.78</td>
<td>1.06</td>
<td>0.95</td>
<td>1.05</td>
<td>0.99</td>
<td>0.94</td>
</tr>
<tr>
<td>TOTAL mkt. share Top 10</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>28.30</td>
<td>33.38</td>
<td>37.65</td>
<td>37.40</td>
<td></td>
</tr>
<tr>
<td>CR3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>17.10</td>
<td>19.19</td>
<td>19.87</td>
<td>21.37</td>
<td></td>
</tr>
<tr>
<td>CR5</td>
<td>22.23</td>
<td>26.75</td>
<td>28.14</td>
<td>29.48</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\text{HHI}_{\text{max}})</td>
<td>205</td>
<td>249</td>
<td>302</td>
<td>286</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Wesseler et al. (2015).

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3 Turnover and production value aggregates in 2012 are only available for EU-28.

4 The maximum value of the index is 10 000.
2.4. Evaluating Policy Options to Reduce the Presence of Cadmium in Phosphate Fertilizers and Soils

The impact assessment of limits for cadmium in phosphate fertilizers of the European Commission does a good job of qualitatively assessing some proposed policy options. However, the qualitative assessment has its limits and does not provide sufficient information for policymakers. For example, at its best, the qualitative assessment can order individual policy options according to pre-defined criteria, but it is not able to determine how much better option A is relative to option B. The situation gets even more complicated when a policymaker is interested in welfare distributional effects of individual policies.

Based on our analysis of the proposed legislation and our earlier work on the concentration in the EU fertilizers market, we now outline a more detailed assessment following section 1 that can be used to assess most of the suggested policy options aimed at reducing the presence of cadmium in the EU soils.

The size of the problem

The use of mineral phosphorus has decreased since the early 2000s in European agriculture. While cadmium concentration in the soil may accumulate, there is also a reduction due to uptake by plants and leaching (Smulders, 2016). Data for the European Union indicate that the soil cadmium input from agriculture has decreased. This observation is in line with the reduction in mineral phosphorus use.

The reduction in cadmium input does not necessarily imply that the uptake of cadmium by plants has decreased as cadmium might accumulate in soils. A study from Sweden for wheat shows that from the 1980s onwards the cadmium concentration has decreased (Smulders, 2016). Future scenarios indicate that cadmium concentration in soils will continue to decrease as long as the cadmium concentration in mineral phosphate is not about 80mg per kg or more (Smulders, 2016).

In summary, the reduction in mineral phosphorus use, the measures of cadmium concentration in soils, as well as the uptake by plants all indicate that the problem has decreased over time.

The limits on the cadmium content are to be imposed on fertilizer (phosphate) producers. Recognizing limited global deposits of phosphate rock, their uneven geographical distribution, as well as differing quality with respect to the content of cadmium in the rock, a fertilizer producer can choose phosphate rock from two sources: a high-cadmium and a low-cadmium source. The assumption of only two phosphate rock sources does not affect the qualitative results and is consistent with the empirical observation that the EU phosphate producers can either import the rock from Russia (a low cadmium content) or African countries (typically higher cadmium content). In summary, blenders can mix different sources of phosphate to reduce the average content of cadmium. The incentives to do so will be high considering the strong competition in the market as indicated by the low HHI (Table 3). Further, the percentage of cadmium concentration in samples of mineral fertilizers exceeding 60 mg Cd/kg of P2O5 has been in the order of 8% and 21% (Smolders, 2016).

The economic effect of a change in regulation at farm level can be considered to be small. The use of mineral phosphate ranges between about 1.99 kg/ha of utilized agricultural area (UAA) in The Netherlands and 12.10 kg per hectare UAA in Poland. This is equivalent to costs on average between 1.00 and 13.00 euro per hectare. Considering that about 20 percent of the mineral phosphate could potentially be an issue and would need to be replaced, this amounts to costs of between 0.20 and 0.50 euro per hectare on average. The regional effects can be different, but it is hard to imagine that the change in regulation at farm level will become an important issue from a cost perspective.
The situation looks different at an aggregate or industry level. The total use of mineral phosphorus as a fertilizer has been about 1,185,646 metric tons as of 2013 in the European Union with a market value of about 930 million euros. If about 20% of mineral phosphorus were affected, this would result in about 200 million euros of market value or about 150,000 euros on average per fertilizer producing firm. Depending on the details of regulating cadmium content in fertilizer, the cost will differ, but the regulation will most likely affect the whole industry if certification is needed. As such kind of regulations almost always include sunk costs they will harm smaller fertilizer producing firms more than larger ones, thus contributing to a concentration in the industry.
3. **EVALUATION OF THE PROPOSED REGULATION**

**KEY FINDINGS**

- Higher costs faced by inorganic fertilizer producers will be transmitted to farmers only partially.
- Maximum limits on cadmium, voluntary or mandatory, will increase cost without generating substantial - if at all - additional benefits.
- Imposing limits of heavy metals and organic pollutants for manure will increase marketing costs, reduce trade, and harm the environment.
- A harmonization of standards with respect to possible contaminants in new fertilizing products can have a positive effect on increasing production and trade and support the development of EU bioeconomy.
- Many environmental regulations at EU and Member State level exist that monitor and control possible contaminants including the monitoring of heavy metal in food. They provide flexibility at Member State level to respond to environmental problems where necessary.

In this section, we provide some specific comments on the proposed legislation on CE marked fertilizing products and cadmium contents of these products. We differentiate between mineral and organic fertilizing compounds as they are two different product groups with different market players.

There are three players in the EU phosphate fertilizer supply chain that may be affected by the proposed regulation setting EU-wide limits on cadmium content in fertilizers: suppliers of phosphate rock, fertilizer producers, and farmers.

The European Union depends on the imports of phosphate rock. The main suppliers of the European Union are Russia and African countries, mainly Morocco. The extent to which these suppliers will be affected by the proposed regulation depends on the share of exports of the rock to the European Union in total sales, as well as on the purity of the rock (Russia tends to have relatively Cd cleaner rock). The extent to which the prices of phosphate rock will increase also depends on the market power of the suppliers. This area needs more research attention in the future.

With respect to the impacts for fertilizer producers, our earlier study has shown that the EU fertilizer industry exhibits a limited to the moderate level of concentration. This suggests that possible price increases due to the proposed regulation will be hampered by competition among fertilizer producers. It can thus be expected that the higher costs faced by fertilizers producers will be transmitted to farmers only partially.

At this moment, we are not in a position to quantify the likely cost incidence of the regulation for the EU fertilizer producers industry. However, observing that the many EU Member States already set upper limits on cadmium content of 60mg/kg of P₂O₅, which is one of the proposed EU-wide thresholds, it is reasonable to assume that the impacts at farm level will not be significant. The impacts at industry level may differ, depending on the details of the regulation.

Regarding farmers, we note that the share of expenditures on fertilizers in the total costs of EU farmers ranges between 4% (Malta) and 20% (Ireland), and in most Member States is less than 14%. This suggests that prices of fertilizers would have to increase significantly to
have a marked effect on the costs of EU farmers. However, the cost to farmers due to the proposed regulation could be significant if farmers were responsible for checking and documenting the cadmium content in fertilizers (instead of fertilizer producers).

It should also be noticed that cadmium is bound to phosphate; however, the use of phosphorus fertilizer per hectare in the EU exhibit a decreasing trend, among other things, because of more efficient applications. This suggests that the soil contamination via phosphate fertilizers will become less of a concern over time as already indicated by studies (Smolders, 2016).

The current regulation with respect to cadmium content mainly covers mineral fertilizers. Introducing a mandatory maximum level of cadmium in mineral fertilizers considering the developments of rock phosphate use, the cadmium levels in soils, plants, and humans, is not supported by these developments. A maximum level that is not binding will not affect cadmium levels. A voluntary maximum level as proposed will also not strongly if at all, affect the cadmium level in mineral fertilizers as long as this results in additional costs within the fertilizer industry. Introducing such a policy will most likely only increase administrative costs without generating additional benefits.

Most of the organic fertilizer is used in the form of manure in European agriculture. Further, most of the manure is used on-farm and is not traded. The combined use of mineral and organic fertilizer on farms has, in general, worked well over the past decade. In some cases, nitrogen emissions in the environment have been observed beyond levels established within the European Union. Requiring stakeholders to document the nutrient content in manure traded between farms will increase the costs and most likely reduce the trade. This can be counter-productive to balancing the origin of manure in animal intensive production regions with an oversupply of manure and regions, where the supply of manure is below the level that can be applied. In the end, this may result in higher environmental pollution.

The phosphorus content in manure, which has substituted the use of mineral phosphate partially, has not indicated an increase in soil cadmium levels so far. Based on the observed trends, we do not expect this to happen in the future either. The same applies to other heavy metals.

Further, the directive on sewage sludge (Directive 86/278/EEC of 12 June 1986), the Commission Regulation (EC) No 1881/2006 on foodstuffs regulates maximum limits for certain contaminants in food including some heavy metals. Similarly, the Water Framework Directive and the Directive on Environmental Quality Standards (Directive 2008/105/EC, recently amended by Directive 2013/39/EU) regulate the use of heavy metals and organic compounds (for a more detailed discussion see EC, 2016b) including monitoring activities. Here specific attention needs to paid to PFCs, as a failure in monitoring the content can generate substantial costs a case from Germany shows (Waiblinger Kreiszeitung, 2016). Many of the monitoring activities are end-of-pipe observations and provide useful early warning information that will allow the Member States to respond at the local level where needed and provides the flexibility necessary.

Nevertheless, the impact assessment of the EU Commission does not consider the possibility that the EU might get cadmium back through the backdoor in the form of imports of agricultural products from countries that do not have such strict cadmium standards, even so, maximum levels for food products have been established. A higher standard on cadmium

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5 Consider, for example, an African phosphate rock producer (where the content of cadmium is generally higher) who cannot export as much rock to the European Union as he used to. He could, therefore, lower the price and sell more in the domestic market. It is well possible that the final agricultural products from these markets could later be destined to Europe. The magnitude of this effect will depend on how much the EU regulation will affect the world prices of phosphate rock.
level and other heavy metals in inorganic fertilizer may result in trade diversion reducing the competitiveness of EU agriculture and in particular in the EU-15.

Currently, the market for non-manure based organic fertilizer in the EU is tiny. The market for such new fertilizing products is expected to increase in the future with the expected increase in the importance of the bioeconomy. Supporting the development of this market will also support the development of the bioeconomy. Harmonizing the product standards among the EU Member States can support the development of markets for those products. The standards should focus on those ingredients that are of utmost concern. These include heavy metals and organic pollutants (EC 2016b). As these are products entering the market setting the standards up-front can be expected to cause limited market disruptions and support those that are already in the market by expanding their market opportunities.


4. RECOMMENDATIONS

We do not observe that the change in regulation will have an impact on the health and environmental concerns related to cadmium exposure to humans and the environment. Imposing voluntary minimum standards for cadmium in inorganic fertilizer will increase costs at fertilizer industry as well as administrative level among the EU Member States without generating additional benefits. Such kind of policy should not be followed.

Cadmium concentration in the environment and food in the European Union shows a declining trend. A mandatory binding maximum level of cadmium in inorganic fertilizer is also expected not to result in additional benefits justifying the additional costs.

Considering that in the end the impacts on human health are the most important implications of cadmium in the environment, considering the high scientific uncertainty establishing cause and effect between phosphorus fertilizer use and cadmium accumulations in humans, and considering the decline in mineral phosphor fertilizer application, considering negative effects on the fertilizer industry, alternative strategies should be considered.

One such kind of alternative strategy could be strengthening the monitoring of cadmium content in food products and providing consumers with information about avoiding high cadmium levels in food consumption. Considering the current situation and trends, a regulation of the fertilizer industry in this regard might not generate benefits and only increase costs. Monitoring cadmium content more closely in food can be a cost-effective alternative.

The use of manure at farm level as well as the trade in manure should not be further regulated. The current regulations with respect to the use of fertilizer in agriculture in combination with several environmental regulations at EU and national level cover potential negative effects on the environment and provide instruments to reduce the use of manure where necessary. Enforcing existing regulations should receive priority. Adding an administrative burden to farmers, will not generate additional environmental benefits and may even result in the opposite.

New fertilizing products entering the European market can benefit from the harmonization of standards by reducing the cost of marketing the products. The standards should concentrate on the most important contaminants as mentioned in EC (2016c).
REFERENCES


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