Agriculture Committee

Nitrogen Fertiliser Management Strategies

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1. INTRODUCTION

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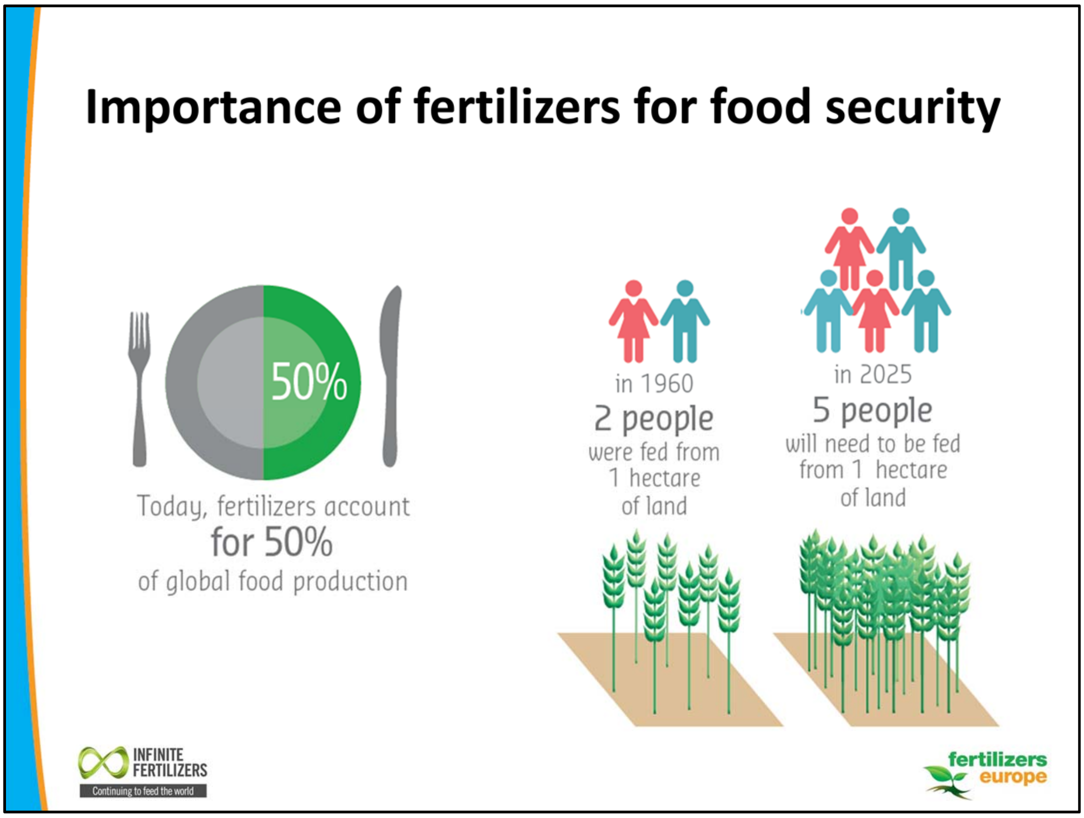
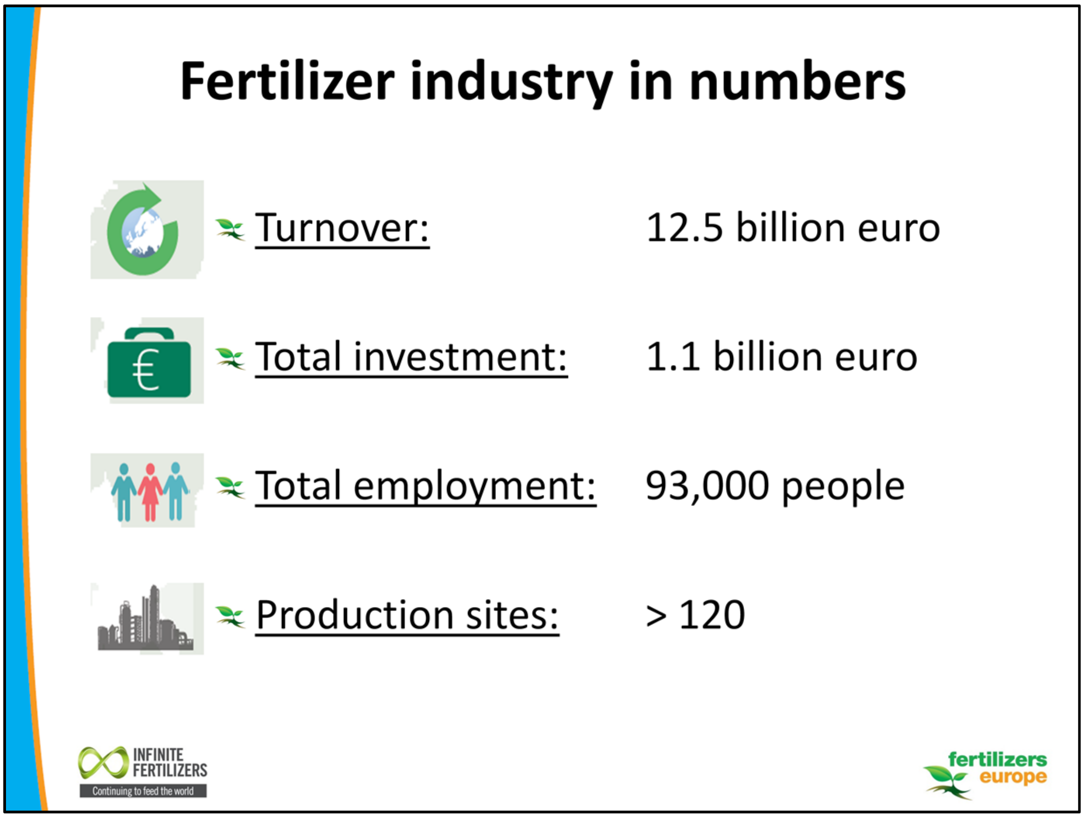


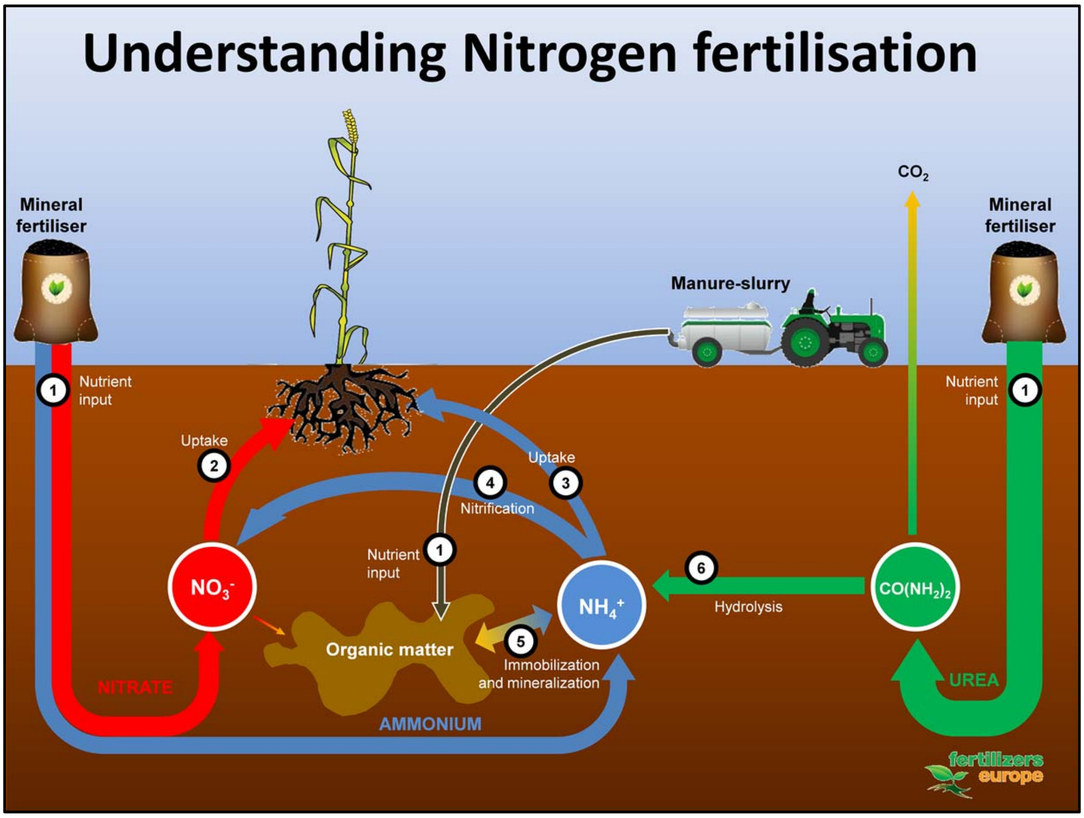
Why we need mineral fertilizers?
Today, fertilizers account for 50% of food global production.
Considering the world population growth, in 2025, 1 ha of land will have to feed 2.5 more people than in 1960.
The more sustainable option is to make better use of land currently used for agriculture. This faces challenges of its own, however, in the form of increasing urbanization, soil erosion and nutrient exhaustion, as well as increasing water scarcity. Since the “green revolution” of the 1960s and 1970s, growth in agricultural productivity has started to slow down in many regions and recent climate change studies predict that this slowdown will continue.
Global food security rests on reversing this trend through better agricultural efficiency, including more effective crop nutrition.

Fertilizers Europe represents the majority of European fertilizer true producers, not the importers, not the retailers, in Europe and is therefore recognized as the dedicated industry source of information on mineral fertilizers.



To conclude this introduction, some key figures about our members.

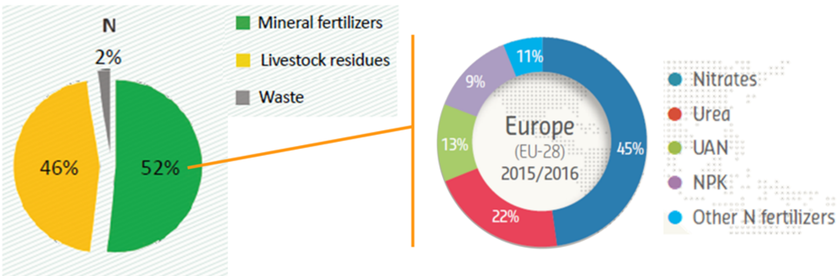
2. NITROGEN FERTILIZATION



1. Nitrogen can be **applied** to the soil in the form of ammonium, nitrate, urea or a mix of these, as well as by organic fertilizers and manures containing complex organic nitrogen compounds who will go to the organic pool of the soil.
2. **Uptake of nitrate** is rapid due to its high mobility in the soil. Most cropss prefer nitrate over ammonium.
3. **Ammonium** is bound to clay particles in the soil and plant roots have to reach it to take it up. Most ammonium is therefore nitrified before it is taken up.
4. This process is called **Nitrification.** It is done by soil bacterias and takes few days to several weeks depending from the soil temperature
5. Ammonium can also be realized into the soil via the **Mineralization** of soil organic matter (and manure). On the other hand, **Immobilization** fixes mineral nitrogen in soil organic matter. Activity of soil microbes is mainly stimulated by ammonium. Immobilized nitrogen it is not immediately available for plant uptake, but needs to be again mineralized.
6. **Urea** is hydrolyzed by soil enzymes, called urease, and converted into ammonium and carbon dioxide. Depending from the temperature, the process is more or less rapid (one day to one week).

So, differences between N sources

	Mineral fertilisers			Manure
	Nitrate	Ammonium	Urea	
Availability for plant uptake	+++	++	+	Need to be mineralized first
Price	20% of the total input costs			Recycling of farm nutrients



Sources: Mineral fertilizers from Fertilizers Europe Forecast; livestock manures calculated from estimation on the basis of animal numbers from Fertilizers Europe Forecast; waste sources from Eurostat.

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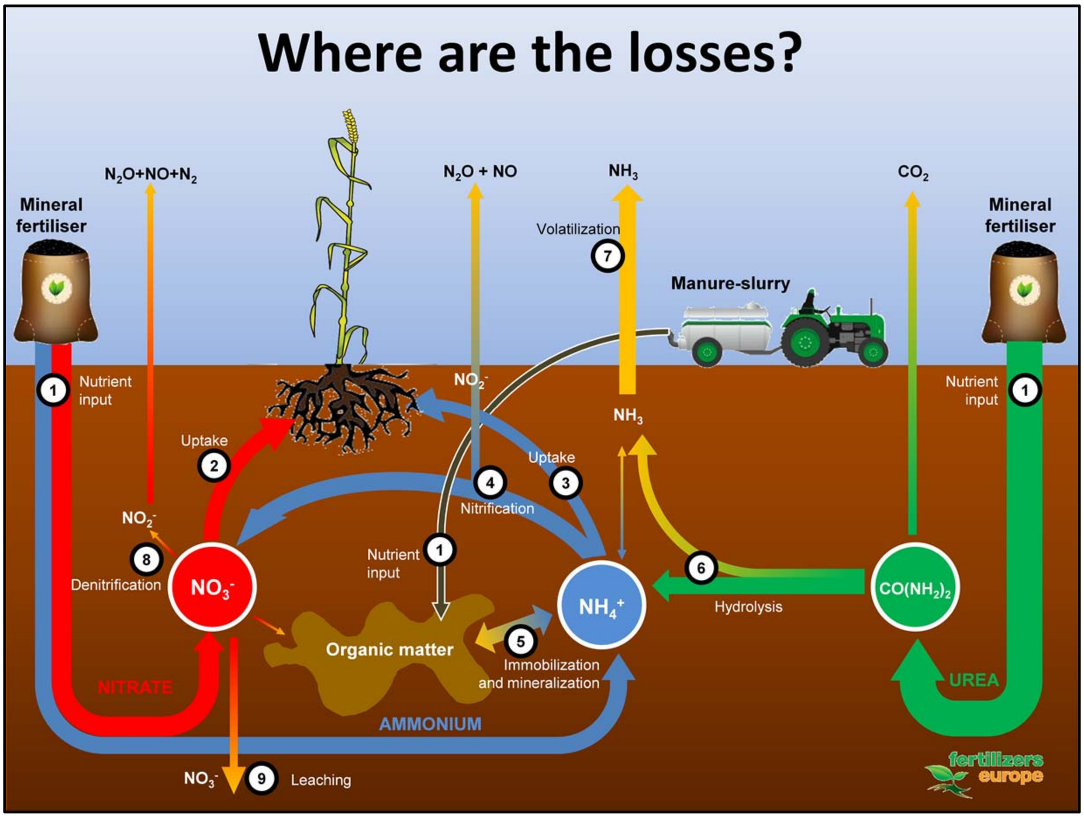
So if we quickly compare the different source of nitrogen,
Nitrates are directly available for the plant.
Ammonium have to be transformed in nitrate what takes few days to several week depending from temperature
Urea have to be hydrolized to ammonium what takes 1 day to 1 week, then to nitrate.
Organic Nitrogen coming from manure has to be mineralized to ammonium first (10 to 20% of manure is mineralized over the year) and then transform to nitrates.
Mineral fertilizers are accounting for 20% of the input costs for the farmers but are extremely efficient. For 1€ invested in fertilizers, the farmers get 3,5€ from the consequent yield increase.
So 52% of the Nitrogen is coming from mineral fertilizers and mainly in nitrate form.

3. Environmental challenges linked to nitrogen fertilization



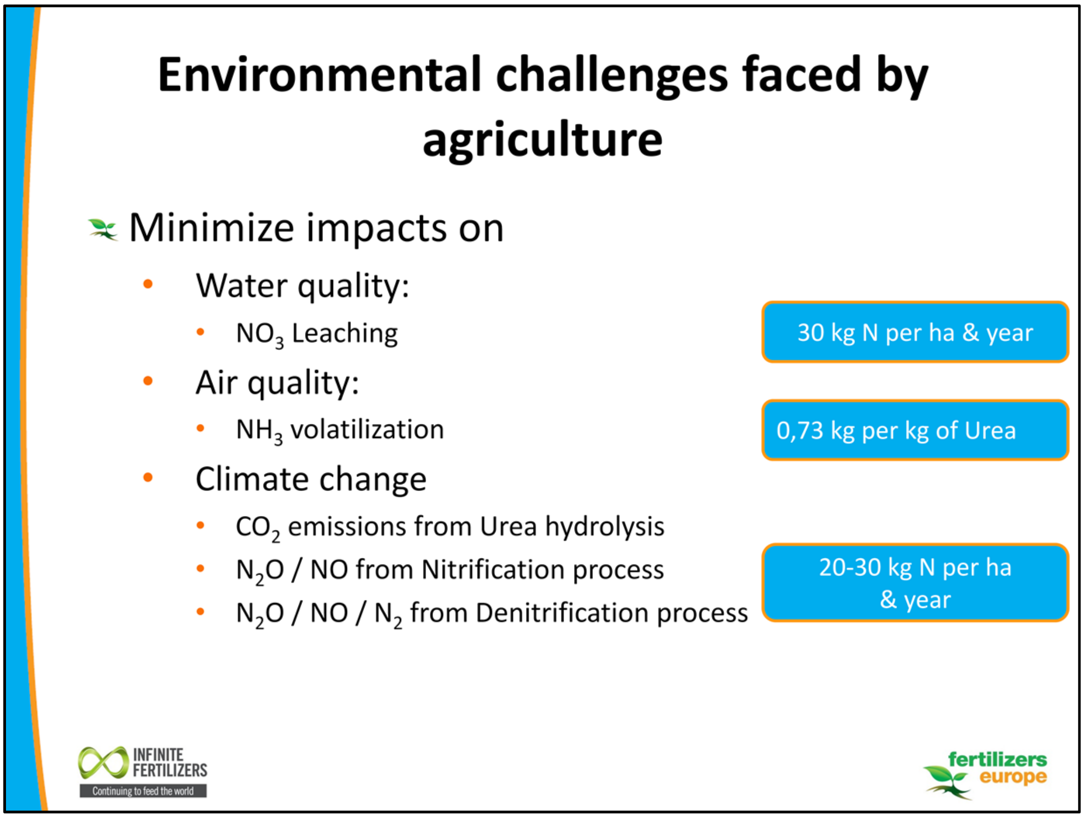
As mentionned previously, **Urea** is hydrolyzed into ammonium and carbon dioxide, which is already a first loss to the air.

7. **Ammonia volatilization** occurs when ammonium is converted to ammonia gas, which is lost to the atmosphere. Factors such as high soil pH, high temperature and wind, favour this conversion. If products containing urea are applied at the soil surface without incorporation, losses are highest. As, the pH around the urea granulate increases strongly during this process and the ammoniacal volatilization is amplified when urea is used.

During **Nitrification** process, Nitrous oxide and nitric oxide gases are lost to the atmosphere.

8. When the soil micro-organisms lack oxygen (e.g. in waterlogged or compacted soils), **denitrification** occurs. During this process, the soil bacteria convert nitrate and nitrite into nitrous oxide, nitric oxide and nitrogen which are also lost to the atmosphere.

9. **Leaching of nitrate** occurs mainly during winter when rainfall washes residual and mineralized nitrate away from the root zone. Accurate fertilization reduces leaching during and after the plant growth period.



The environmental challenges faced by agriculture is therefore to minimize impacts on
- Water quality by minimizing the leaching of nitrates
- Air quality by minimizing Ammonia emissions
- Climate changes by minimizing nitrous oxide, nitric oxide and nitrogen emissions coming from nitrification and denitrification processes.

For each type, you have an average of the quality of N lost to the environment.

European Regulatory Framework

- Nitrates Directive (91/676/EEC)
  - Reduce water pollution caused by nitrates from agricultural sources
- Water Framework Directive (2000/60/EC)
  - Preserve the aquatic ecosystems, as well as drinking water resources and bathing waters
- Air quality package (2013)
  - Reduction of national emissions of certain atmospheric pollutants

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Europe has developed a set of directive, such as:
The Nitrates Directive (91/676/EEC) aims at reducing water pollution caused or induced by nitrates from agricultural sources and preventing further such pollution
The Water Framework Directive (2000/60/EC) aims at preserving the aquatic ecosystems and the unique and valuable habitats, as well as drinking water resources and bathing waters
The air quality package will focus on air quality but also on climate change (greenhouse gas emissions).

Limitation on N input

- Nitrates Directive (91/676/EEC)
  - Programs for Nitrate-Vulnerable Zones – NVZ (= areas subject to nitrate leaching or run-off) or throughout the whole national territory (11 MS)
  - Application of nitrogen from livestock manure is limited to 170 kg nitrogen per ha per year
  - Possibility of derogation if justified → 230 to 250 kg of nitrogen from animal manure per ha

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What are the limits introduced by these directive:
Pursuant to the Nitrates Directive, all EU Member States have drawn up action programs for areas which are subject to nitrate leaching or run-off (areas known as Nitrate-Vulnerable Zones – NVZ) or throughout their whole national territory.
11 MS decided to protect their whole territory (Austria, Denmark, Finland, Germany, Ireland, Lithuania, Luxembourg, Malta, Netherlands, Romania, Slovenia), as well as Flanders and Northern Ireland. The other Member States designated parts of their territory as NVZ. In all those areas, the application of nitrogen from livestock manure is limited to 170 kg nitrogen per ha per year.
In certain cases, Member States can benefit from a derogation allowing application of a higher limit. This derogation must be justified on the basis of objective criteria, for example long growing seasons, crops with high nitrogen uptake, high net precipitation in the vulnerable zone and soils with exceptionally high denitrification capacity. At the end of 2014, six countries had a derogation, namely Belgium (Flanders), Ireland, Denmark, the Netherlands, the United Kingdom and Italy. Farms with derogation may use from 230 to 250 kg of nitrogen from animal manure per ha.
Water framework directive “just” ask to implement correctly the nitrate directive.
The Air quality package is not yet implemented.

4. IMPACT ON FERTILIZERS CONSUMPTION

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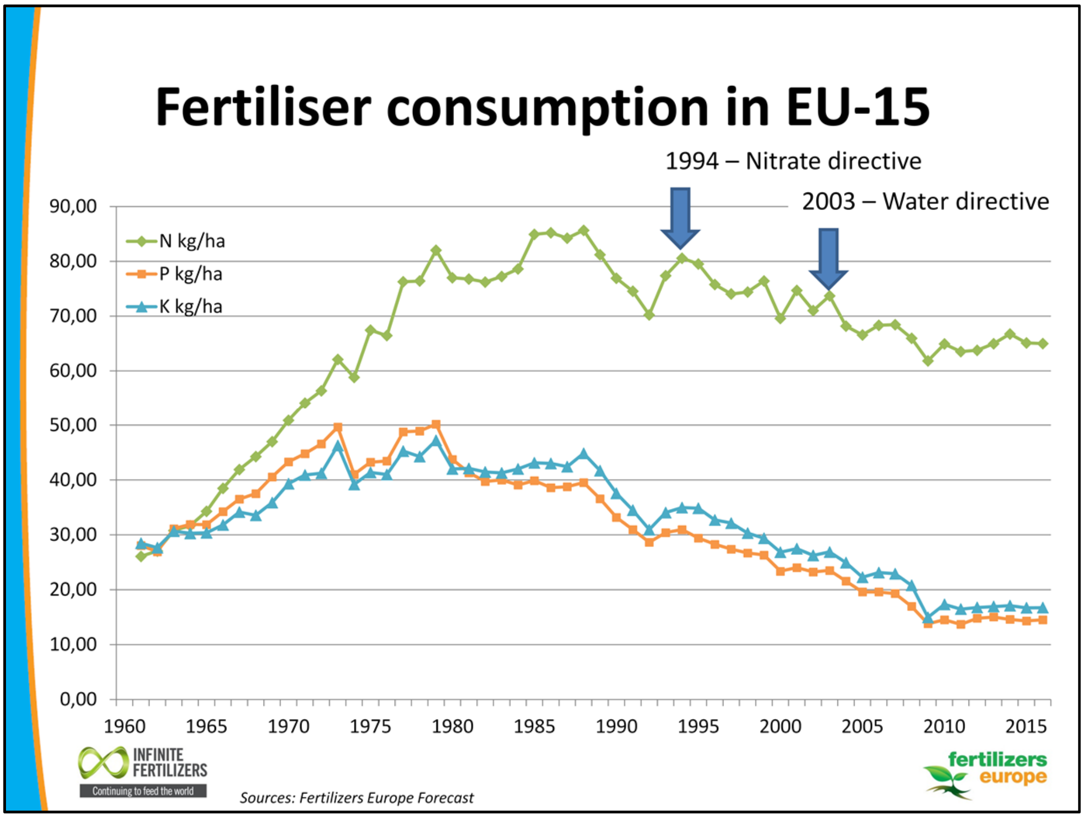
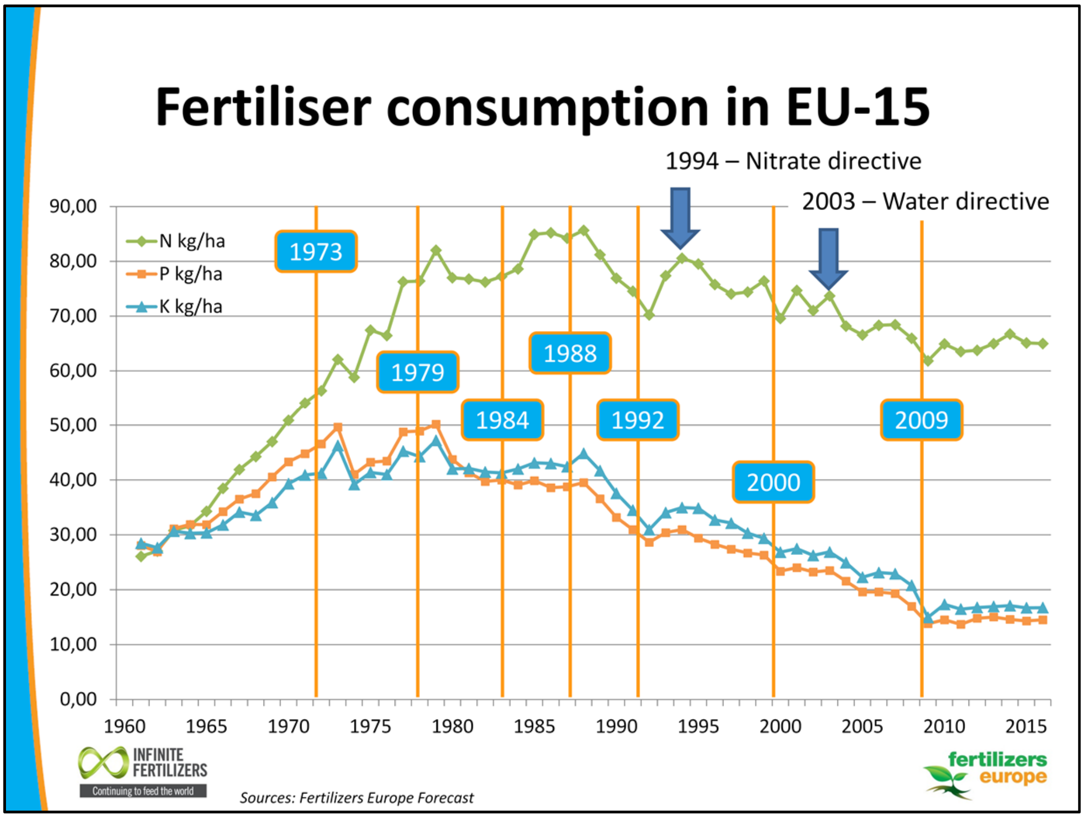
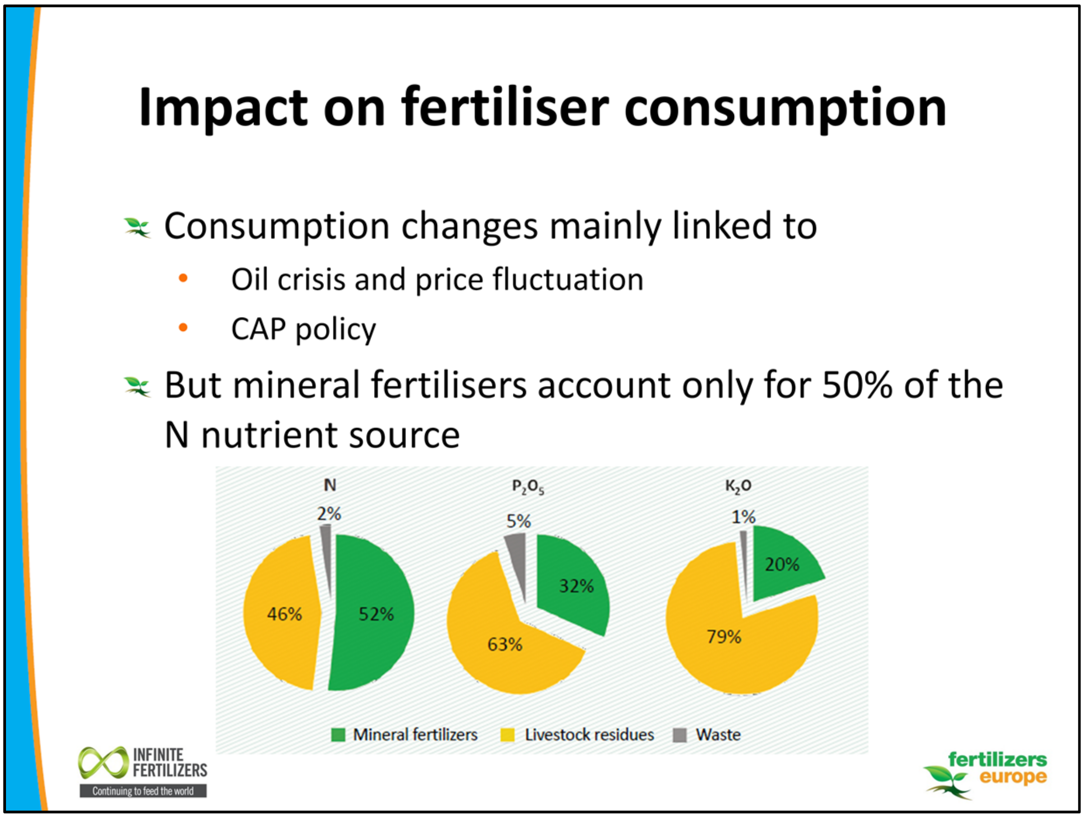


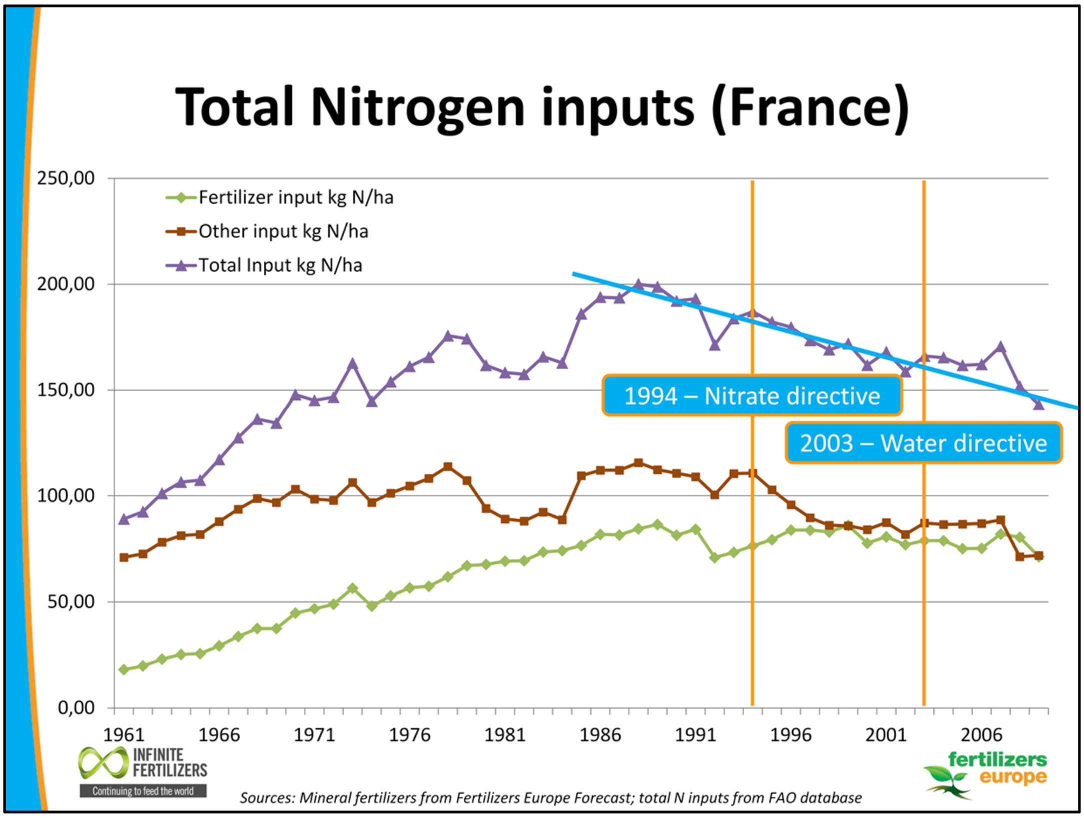
If we look at the consumption of mineral fertilizers in EU-15, it is difficult to see a clear impact from the different directives.



But if we look at « financial » crisis, the impact is much more obvious
1973: first oil crisis
1979: second oil crisis
The 1980s was the decade that saw the first true reforms of the CAP, foreshadowing further development from 1992 onwards. Due to huge overproduction the CAP was becoming expensive, therefore in 1984 quota on dairy production were introduced as well as in 1988, a ceiling on EU expenditure to farmers.
After 2 years of low wheat price (1991 and 1992), the MacSharry reforms of the CAP was launched in 1992 to limit rising production, while at the same time adjusting to the trend toward a more free agricultural market. The reforms reduced levels of support by 29% for cereals and 15% for beef. They also created 'set-aside' payments to withdraw land from production, payments to limit stocking levels, and introduced measures to encourage retirement and afforestation.
Since the MacSharry reforms, cereal prices have been closer to the equilibrium level, there is greater transparency in costs of agricultural support and the 'decoupling' of income support from production support has begun. However, some price drop on the cereal market have still affected the consumption, in 2000: second year of low wheat price
And in 2009, where wheat price fall from 280€/t in 2008 to 120€/t in 2009.



So we can affirm that considering the price of mineral fertilizers, the choices of the farmers in terms of fertilisation management are mainly driven by costs-control than by environmental constraints and is therefore much more affected by economical crisis and CAP policy reforms (affecting the level of subsidies they are receiving).
Considering these situation, in order to see the impact of the environmental constraints on the fertilisation practices of the farmers, we need to consider the whole N inputs, it means also consider the livestock residues.



If we take the example of France as representative of the EU-15, the nitrate directive was set in place at a time where a decrease in the quantity of Nitrogen applied per ha was already seen.
The Nitrate directives set a limit for the application of nitrogen from livestock manure to 170 kg nitrogen per ha per year what is shown by the brown curve. At the same time and in order to cover the Nitrogen need of the plants, there was an increase of the input coming from mineral fertilizers.

5. Differences between EU-15 and EU-13: forecast in term of Nitrogen consumption

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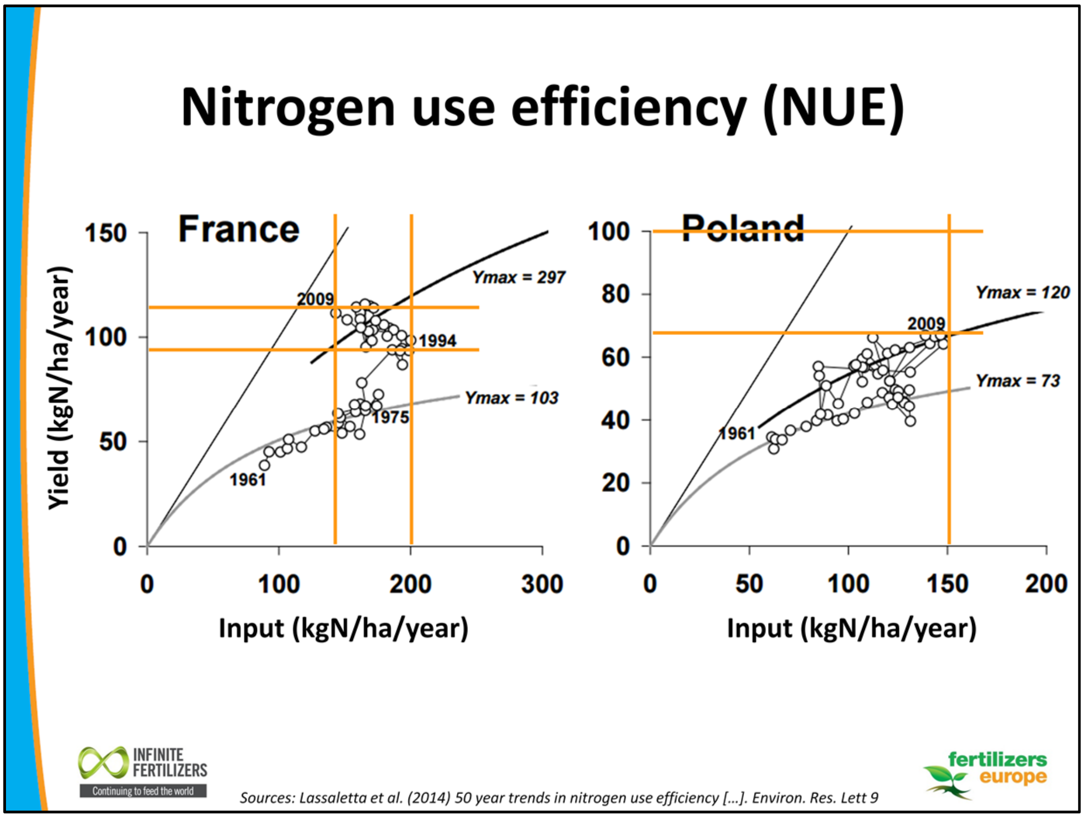
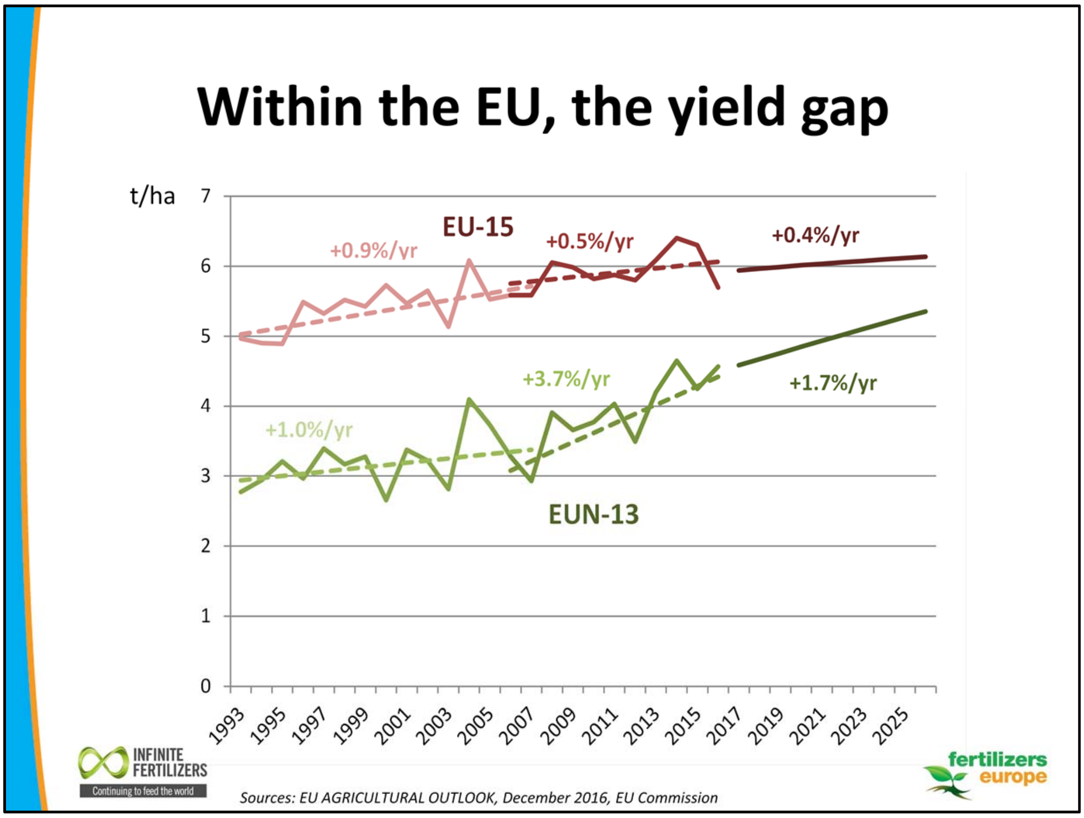
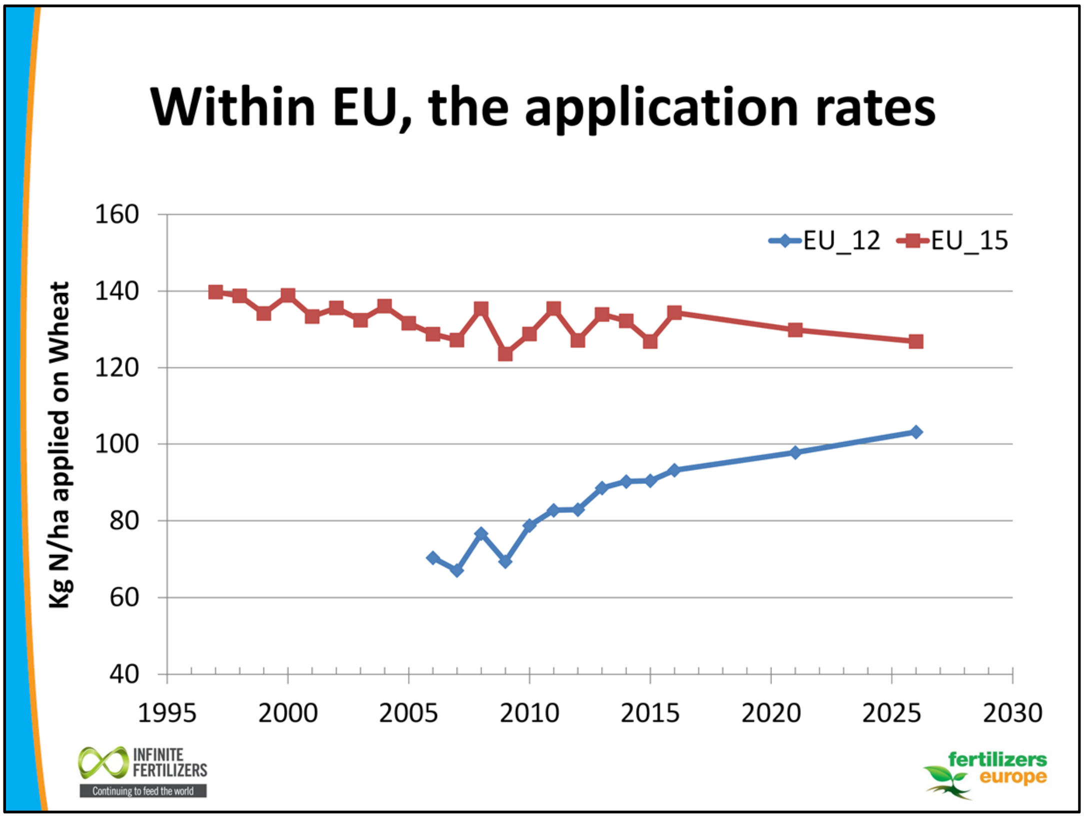


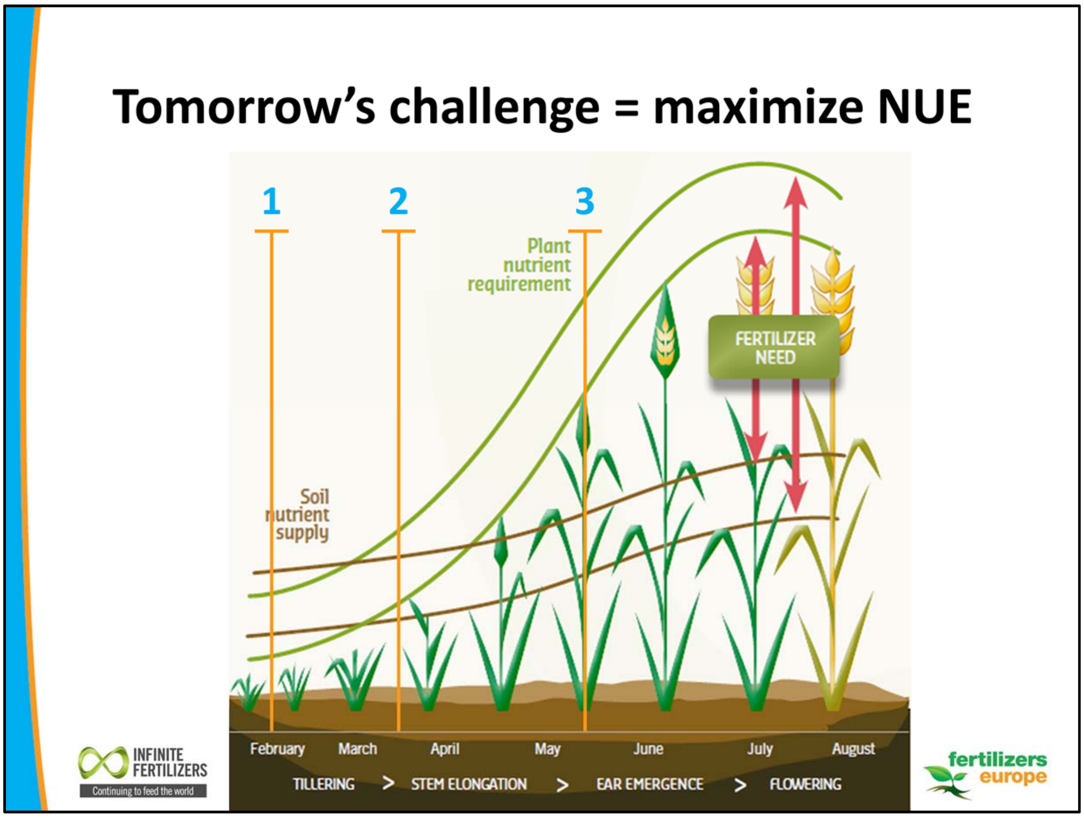
As shown in the previous graph, a changes in the N input per ha per year occurred in France in the 1990's. At that time the input level reached his maximum with 200 kgN/ha/year and a yield of a little bit less than 100 kgN/ha/year.
In 2009, France reached a higher production of a little bit more than 110kgN/ha/year with an input of 143 kgN/ha/year, so a 13% increase of the yield with almost 30% less total input, thanks to a better nutrient use efficiency
If we take Poland, as representative of the EU-13, the max input is 150 kgN/ha/year for a production of 70 kgN/ha/year, both values being the maximum level achieved in 2009.
The target for EU-13 is now to continue to increase the yield without increasing the total nitrogen input by choosing strategies that maximize the nutrient use efficiency.



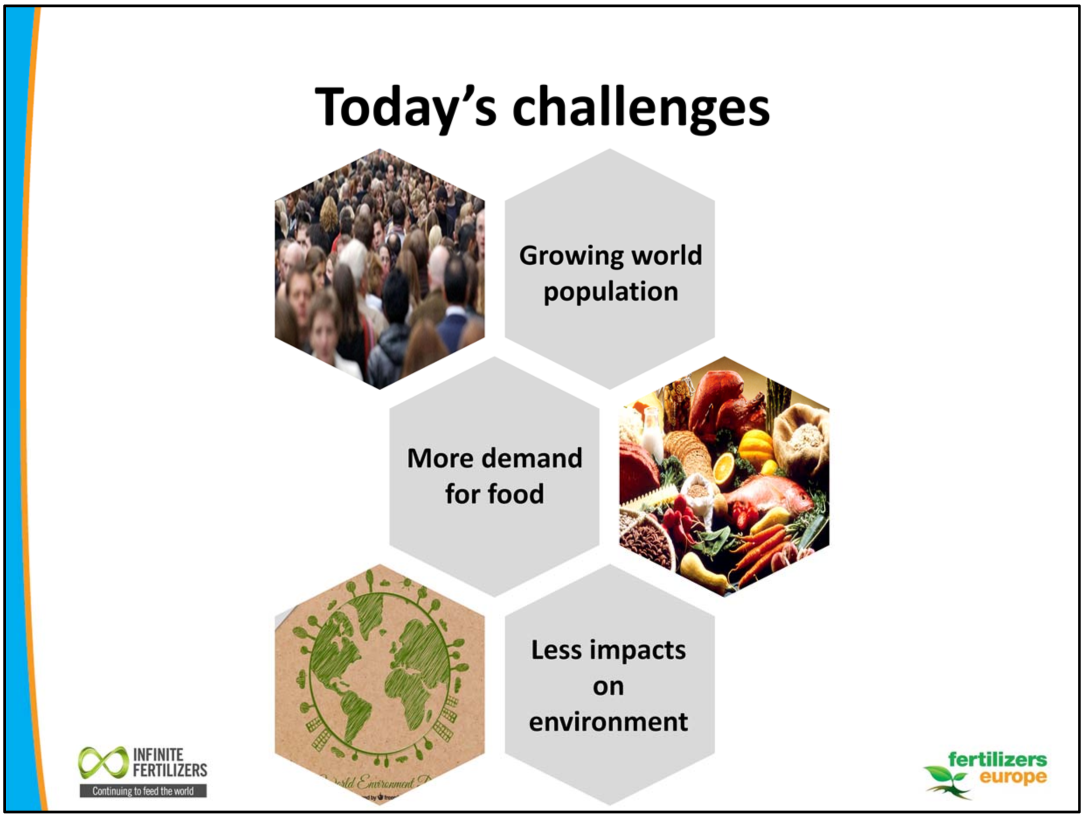
So the difference between EU-15 and EU-13 comes from the difference in the yield. But within the EU, the yield gap is forecasted to slowly close.



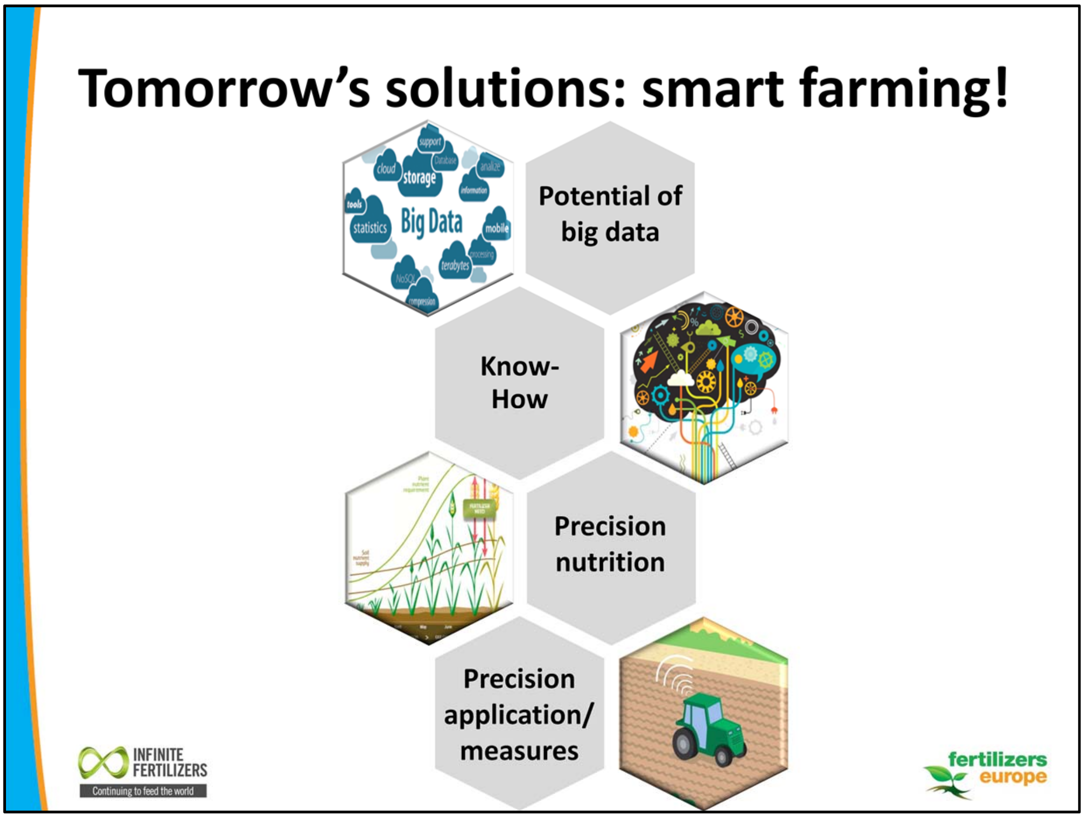
To achieve the closure of the gap, if we consider EU-12 (Croatia is not followed in Fertilizers Europe forecast), the application rates of mineral nitrogen fertilizers already increased by 33% in the last 10 years and is forecasted to continue to increase by a further 11% by 2026.
At the same time, the nitrogen application rate in EU-15 where the fertilizer market is considered to be mature is forecasted to stabilize.
So the gap between EU-15 and EU-12 will slowly get close.



In both part of Europe, the challenge will be to maximize Nitrogen Use efficiency.
For that, farmers have to be encouraged to follow good agricultural practices in order to optimize their inputs. Balanced application of fertilizers requires careful consideration of the plant nutrients requirement (depending from the crops, the growing conditions,…) to know the amounts of nutrients, including those from manures and organic material within the soil, needed to achieve optimal crop yield while keeping environmental impact to a minimum.
For example, split application of N fertilizers on winter wheat is now commonly used in Europe to divide total dosage into a number of smaller applications that closely match crop demand at specific stages in its growth. Mineral fertilizers have a more predictable release profiles as manure, in particular nitrate-based nitrogen fertilizers, it is why they are best suited to split application and it is also why highly efficient mineral fertilizers combined with data-based farming will be the key to maximize the nitrogen



To conclude, we all know what are the challenges faced by the agriculture today, Produce more food for the growing population while minimizing the impacts on the environment, what means on air, water and soil quality and health as well as preserving the biodiversity, include the biodiversity in farm species.



The more sustainable option is to make better use of land currently used for agriculture by increasing the agriculture efficiency. This will be helped by the potential of the data generated by the farming operation. Combined with a good knowledge of the plant needs and thanks to products designed to cover the exact needs of the plants and the improvement in the measurement and the application techniques, farmers will meet this challenge!

For more information

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