Knowledge grows

Fertilizers and Climate Change

Joachim Lammel
VP R&D Global Initiatives, Yara

Principle of crop nutrition

Mineral nutrients are essential building blocks of crop material and help the cop to grow and to produce yield

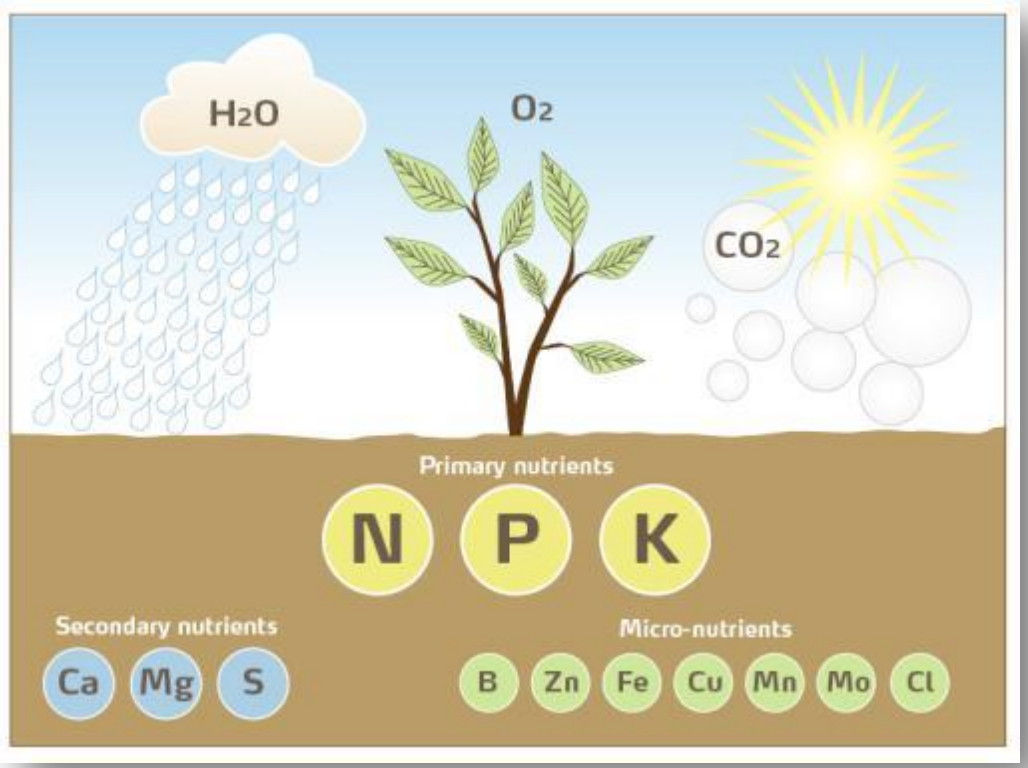
The carbon in crops originates from CO_2 absorbed by leaves.

From soil crops take water and inorganic ions - the plant nutrients.

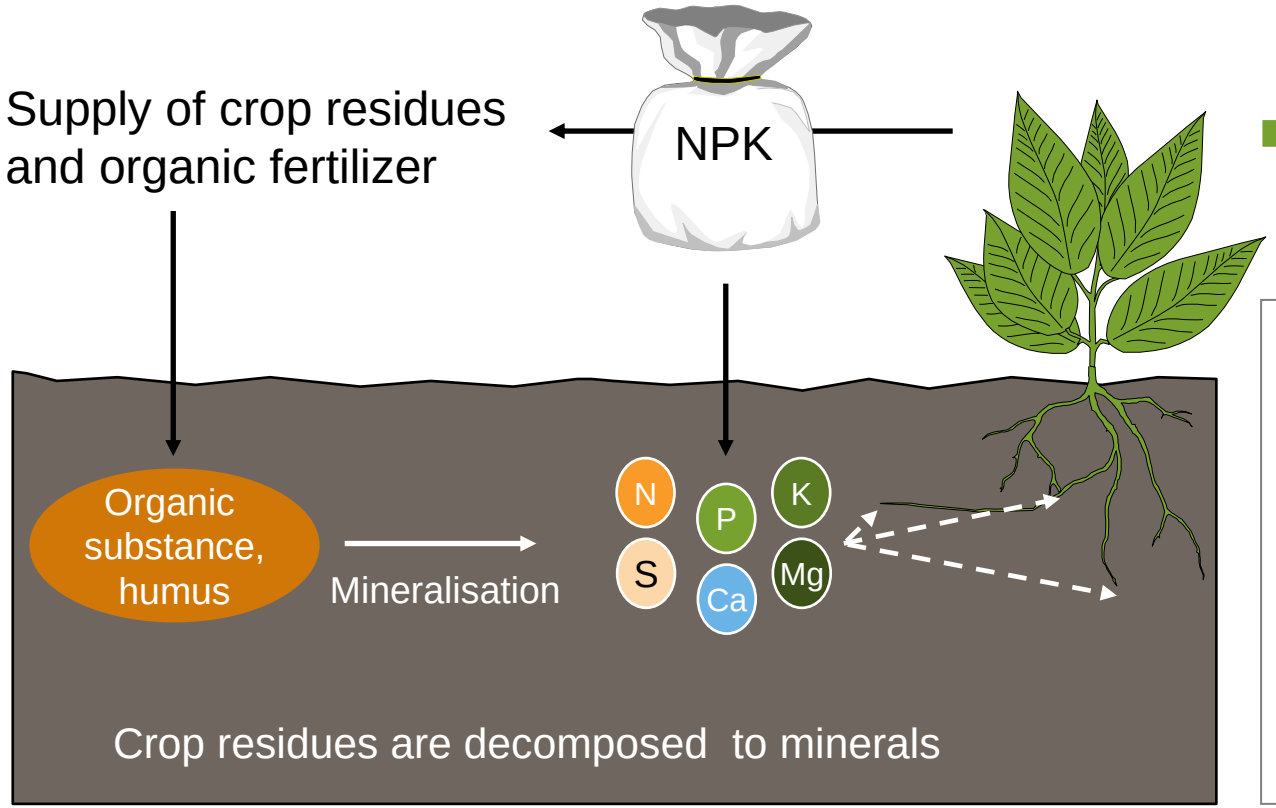
Plant nutrients are necessary building blocks of crop biomass.

Any higher crop yield requires more plant nutrients

Any deficiency of nutrients reduce crop yield

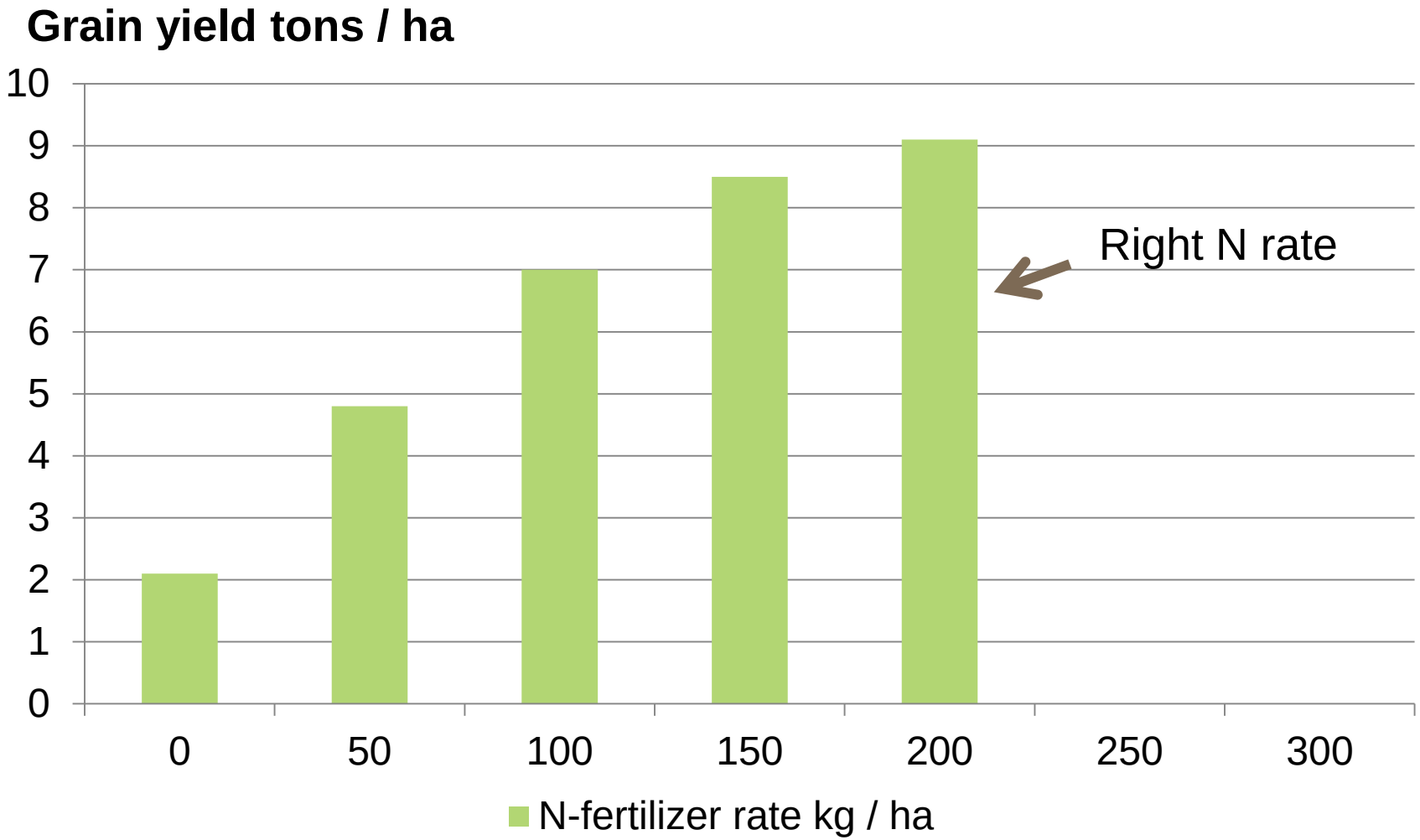


Fertilizer replace nutrients that are removed from the field and add nutrients for higher yield



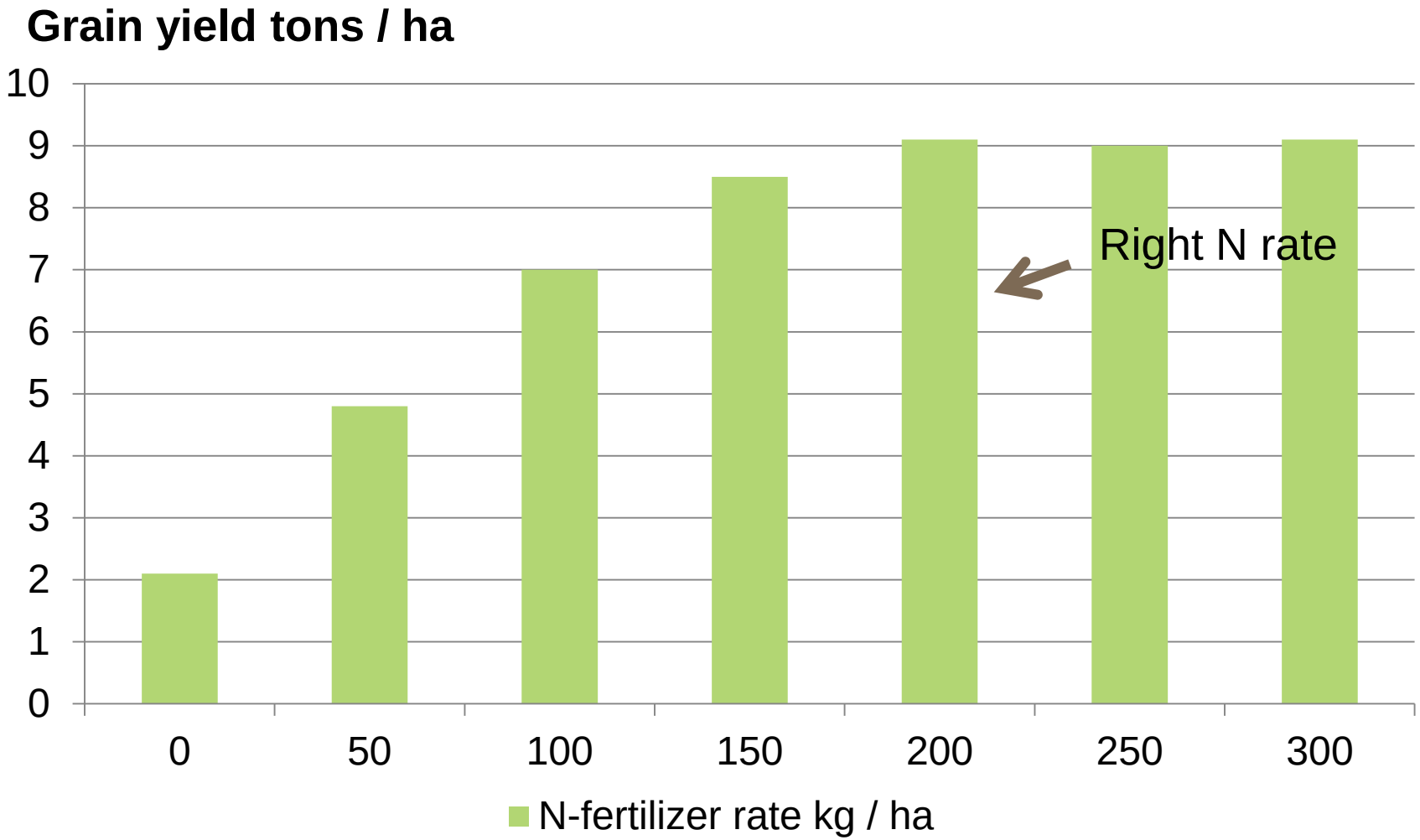
- Export of nutrients with the harvest
- Unavoidable losses from the field
- Growing demand for food & feed

Increasing supply of nitrogen help the crop to produce more protein and more yield



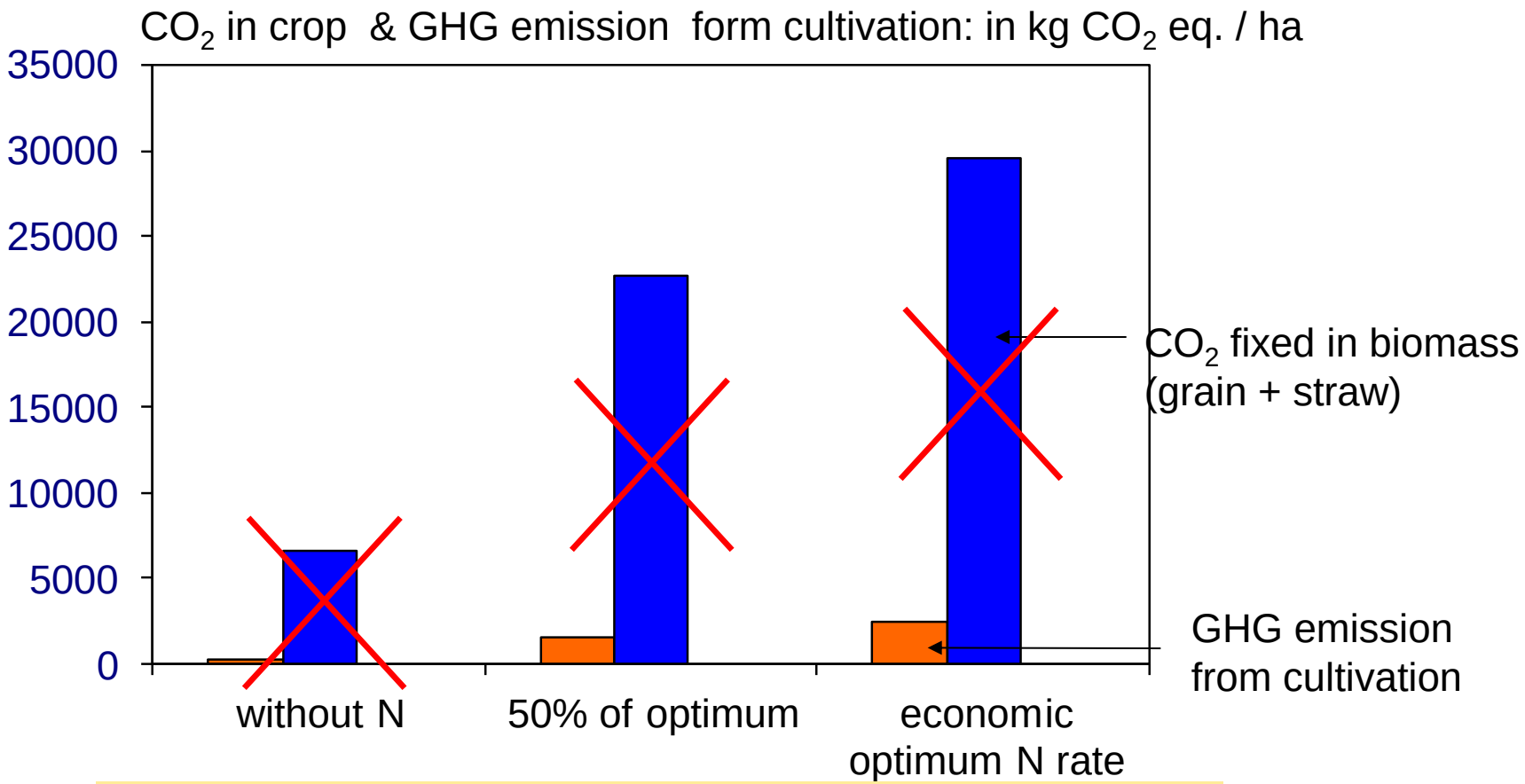
based on Broadbalk Experiment, Rothamsted/UK,

Additional nitrogen will not contribute to more yield because other factors limit crop yield



based on Broadbalk Experiment, Rothamsted/UK,

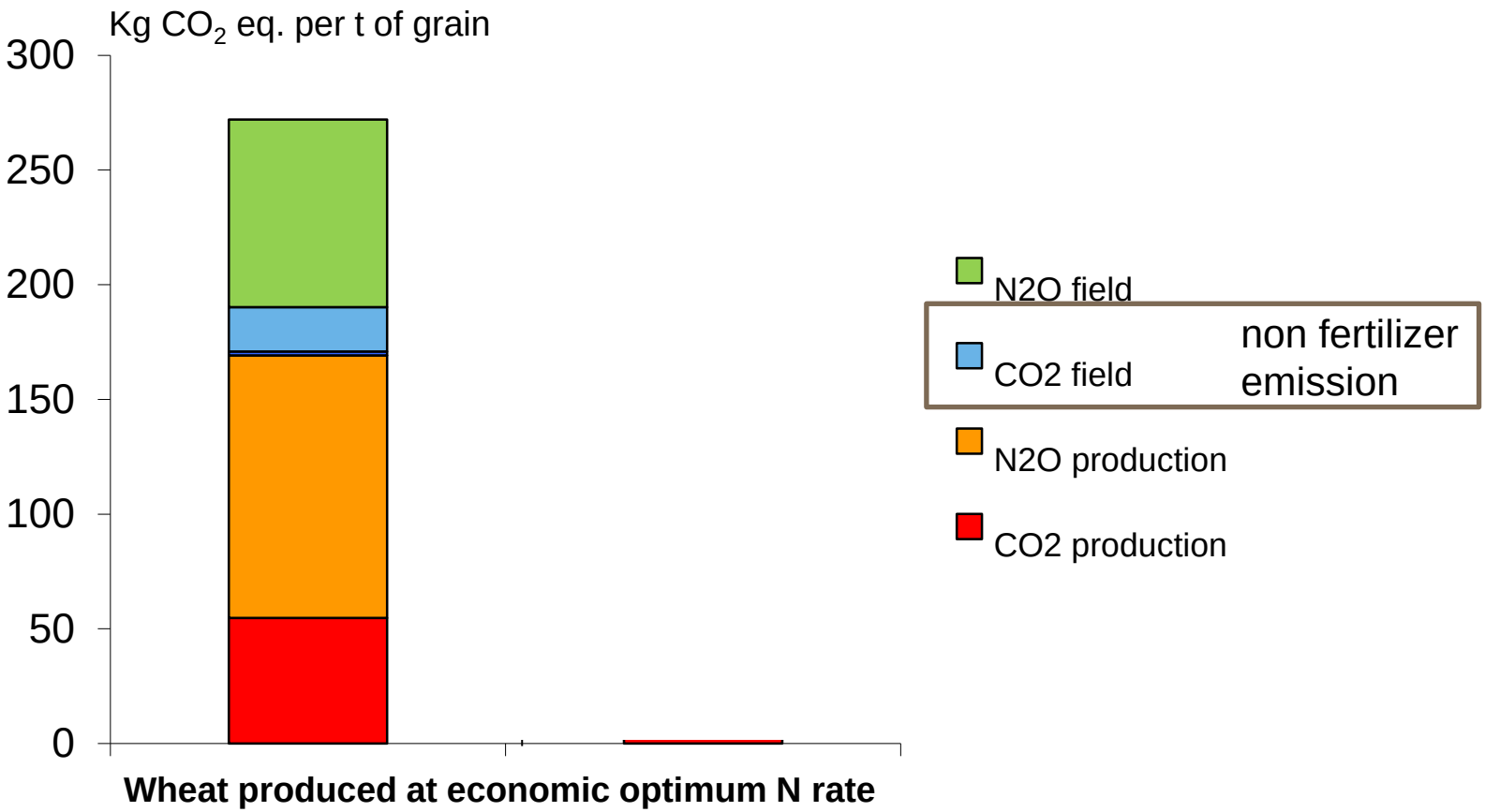
Crops capture by far more CO_2 than what is emitted during their cultivation – fertilizer enhance this effect



If the harvested crop is used as food or feed, the CO2 fixation is only short-term and cannot be considered

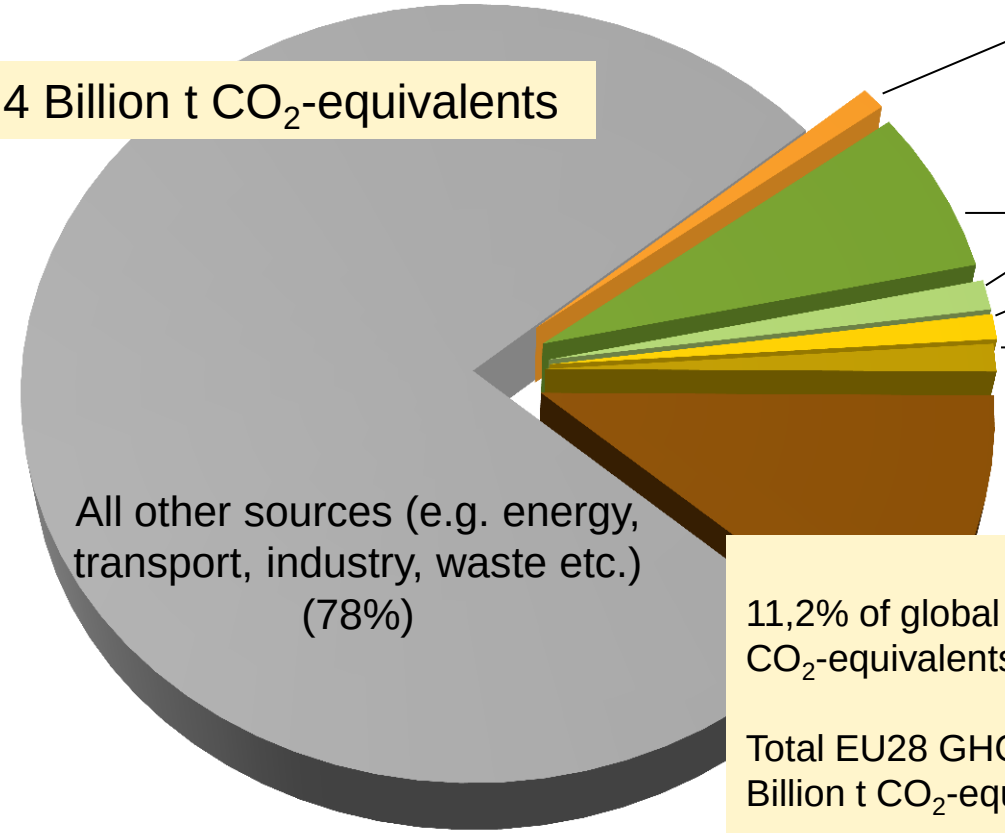
Fertilizer and Climate

For arable farms, N fertilizer induced GHG emission dominate the carbon footprint of crop production



Based on a long-term field trial data with winter wheat (UK), N source = Ammoniumnitrate

Contribution of the agricultural sector and land use change to global GHG emission

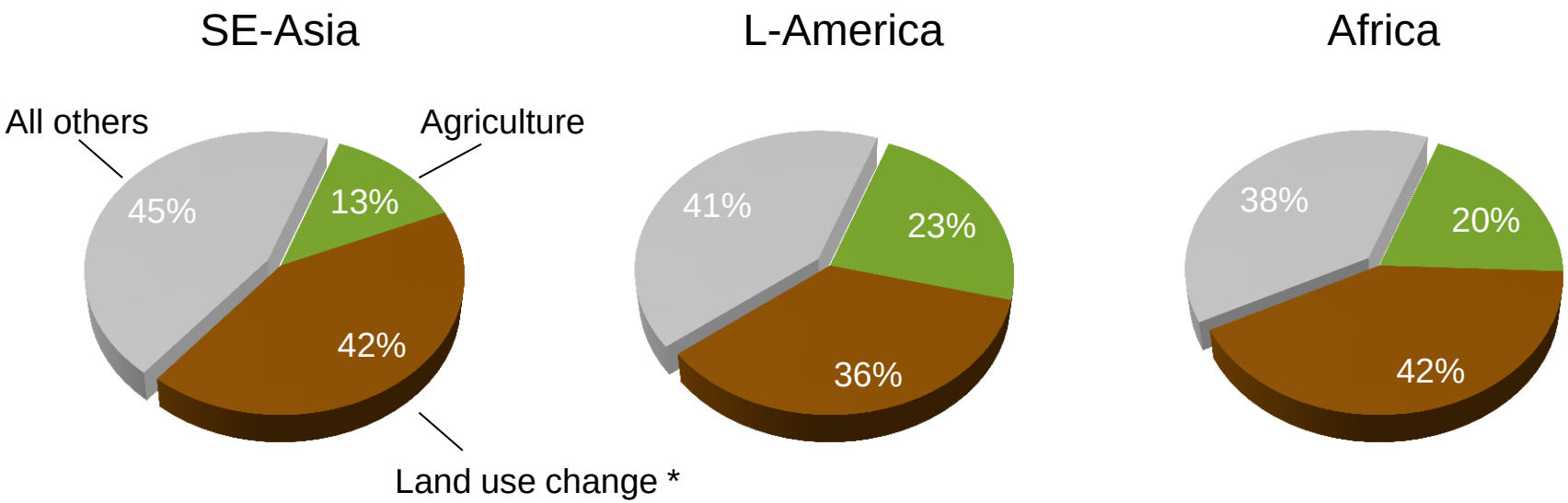


11,2% of global GHG emission are ~ 5.5 Billion t CO_2-equivalents.

Total EU28 GHG emission in 2010 were ~ 5.0 Billion t CO_2-equivalents

Source: FAOSTAT Date: Wed Sep 28 12:56:11 CEST 2016 (http://faostat3.fao.org)
* Based on IFA (2009)

GHG emission of regions with strong agricultural growth are dominated by land use change and agriculture



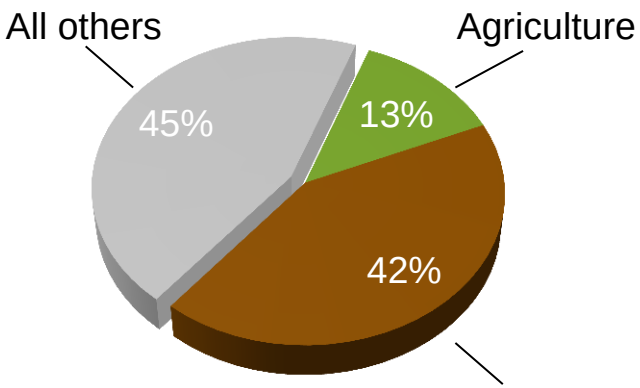
* Net emissions (sources – sinks)

Emissions from land use change are mainly related to deforestation

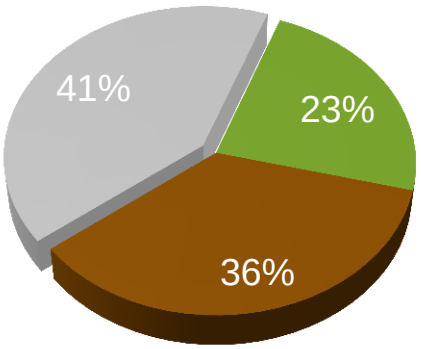
FAOSTAT data

GHG emission of regions with strong agricultural growth in comparison to Europe and N-America

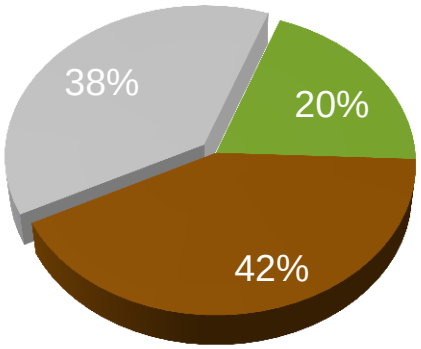
SE-Asia



L-America

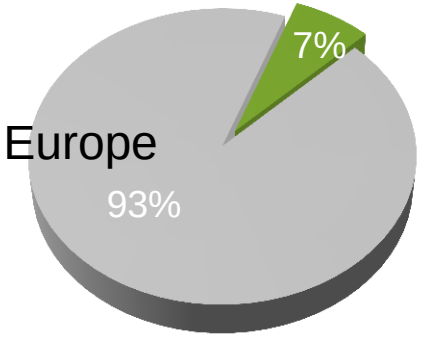


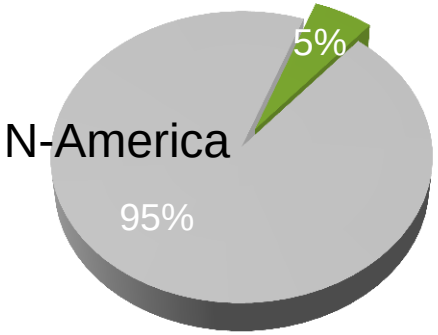
Africa



Large emission caused by land use change to agriculture suggest not to increase arable land but to increase productivity on existing agricultural land by closing yield gaps.

For comparison:





In Europe and N-America forests are a net-sink for CO2

FAOSTAT data

Example: Cocoa production in Africa

Current practice:

2 million tons of cocoa beans
are produced on 5 million hectares of land

Modern agriculture with best fertilizer management

2 million tons of cocoa beans can be produced on on 1 million ha

Good agricultural practices including mineral fertilizer make agricultural land productive and mitigate land use change

Example from Tanzania (average of 3 years, 2012-14; Welela, Njombe region)

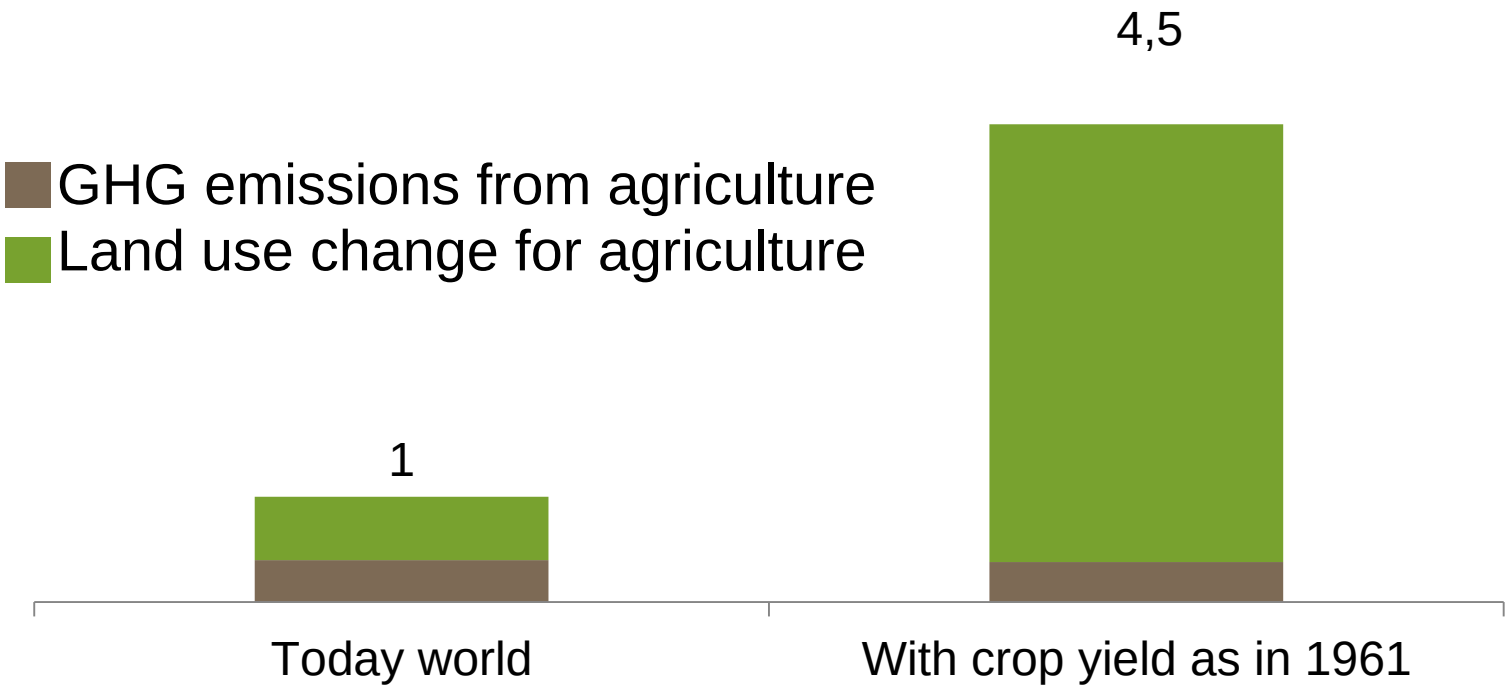
Good agricultural practices including mineral fertilizer make agricultural land productive and mitigate land use change

Example from Tanzania (average of 3 years, 2012-14; Welela, Njombe region)

Good agricultural practices including mineral fertilizer make agricultural land productive and mitigate land use change

Example from Tanzania (average of 3 years, 2012-14; Welela, Njombe region)

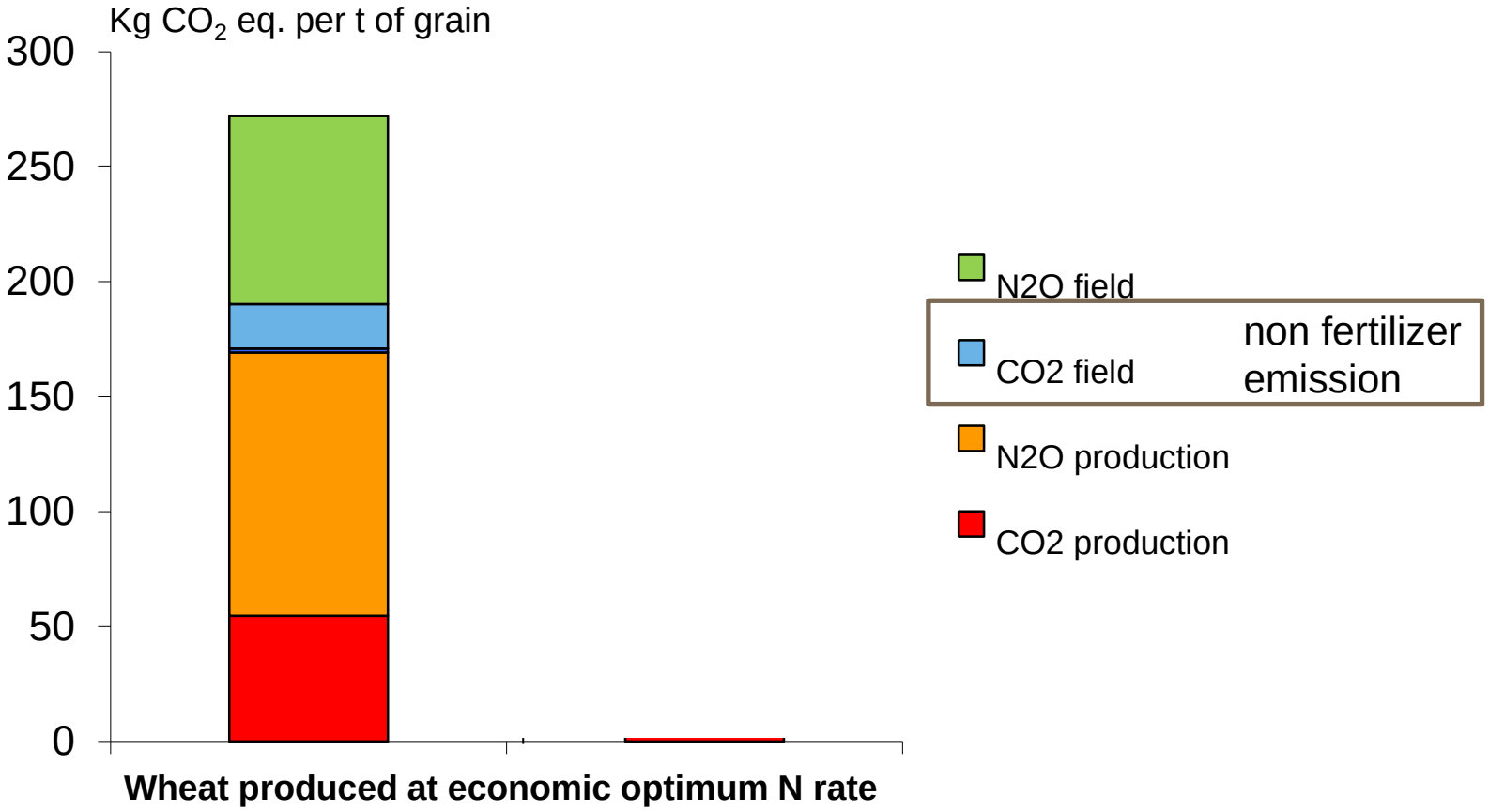
If crop yields were still at the 1961 level, GHG emission from agriculture at current production would be 4,5 times higher than today.



Source: acc. Burney et al. (2010); Stanford Univ.

The carbon footprint of mineral fertilizer

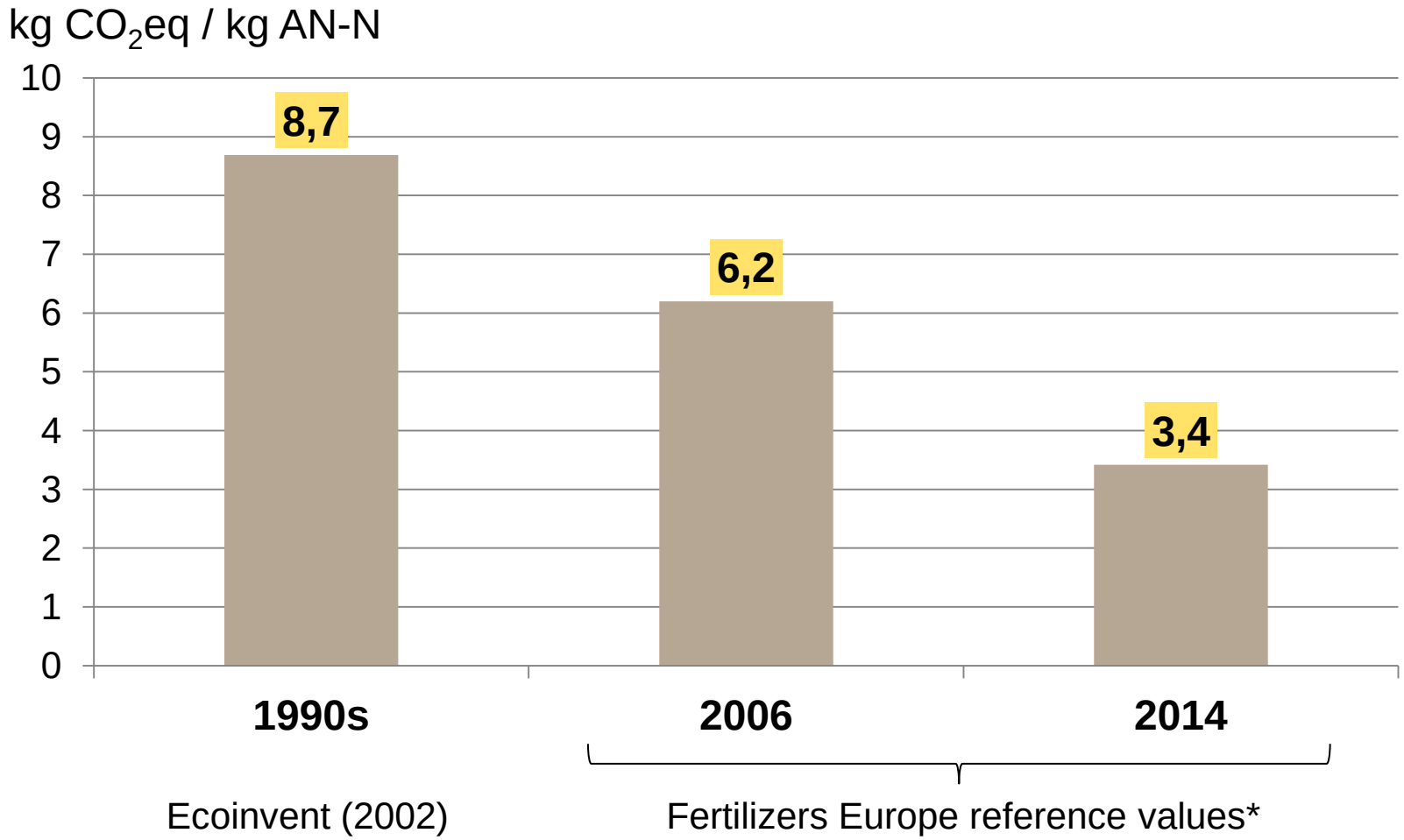
In arable farms, N fertilizer induced GHG emission dominate the carbon footprint of crop production



Based on a long-term field trial data with winter wheat (UK), N source = Ammoniumnitrate

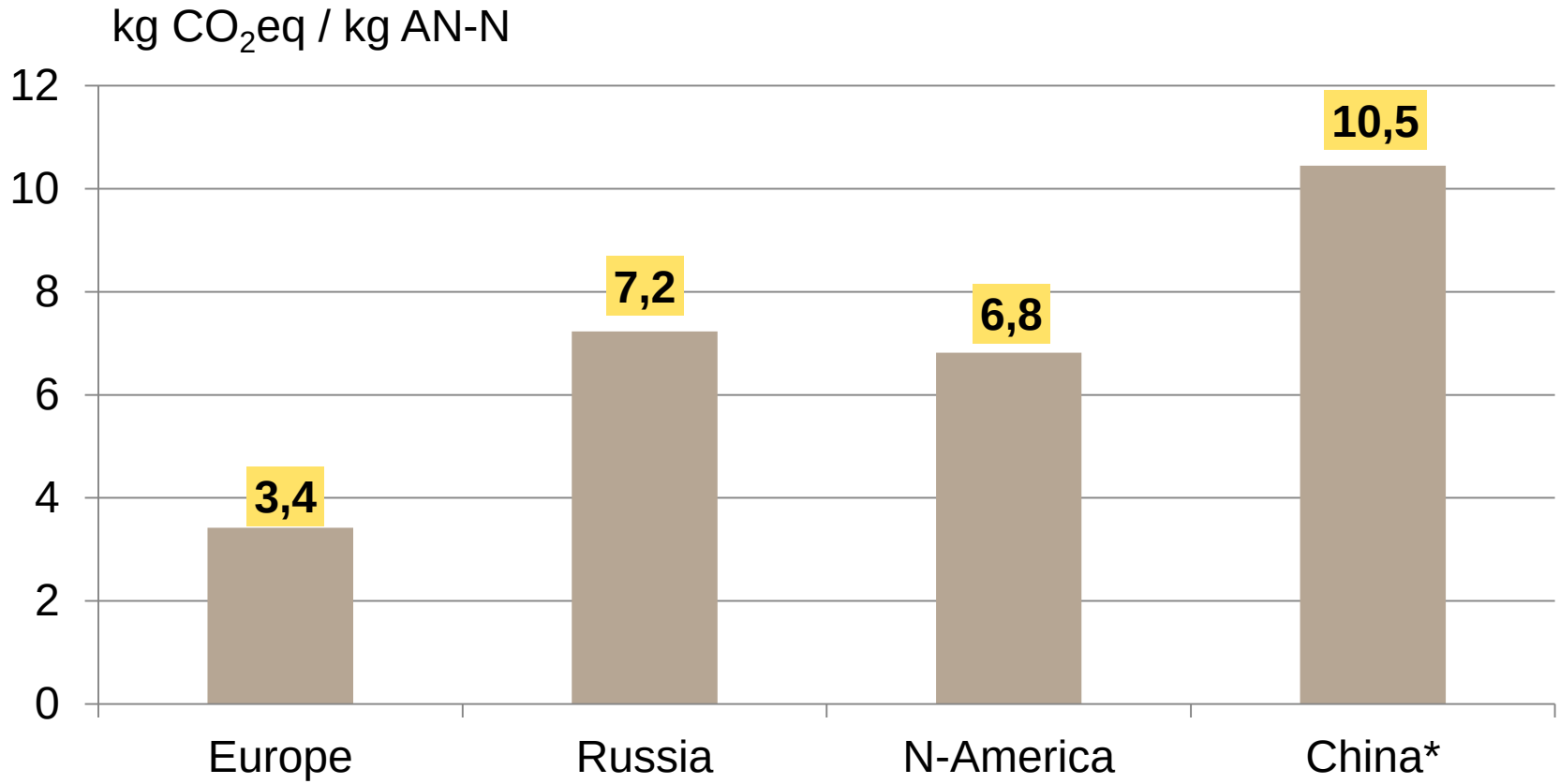
Reduction of GHG emissions from European fertilizer production through technology development

(example Ammonium Nitrate, AN)



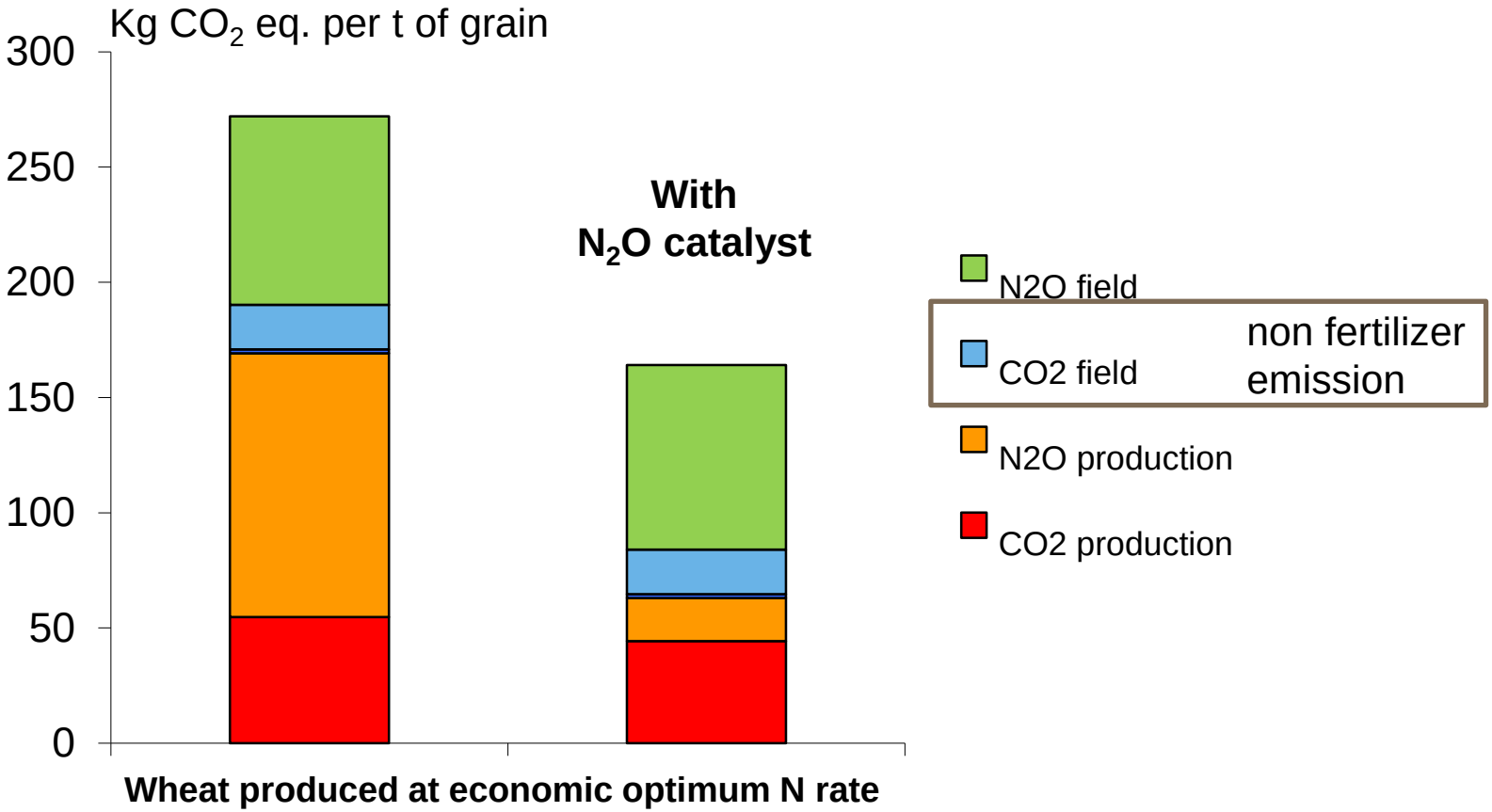
* 2006 value from Brentrup & Palliere (2008); 2014 value derived from Fertilizers Europe Carbon Footprint Calculator v2.1 (2016)

The European fertilizer industry has the lowest GHG emission from N fertilizer production (Ammonium Nitrate, AN, 2014)



* Assumption for ammonia production in China: 75% coal-based, 25% gas-based
All data derived from Fertilizers Europe Carbon Footprint Calculator v2.1 (2016)

In arable farms, carbon footprint of crop production is reduced with N fertilizer from European production



Based on a long-term field trial data with winter wheat (UK), N source = Ammoniumnitrate

How to reduce N_2O emission from soils

1. Higher crop Nitrogen Use Efficiency NUE

   NUE = share (%) of fertilizer absorbed by crop

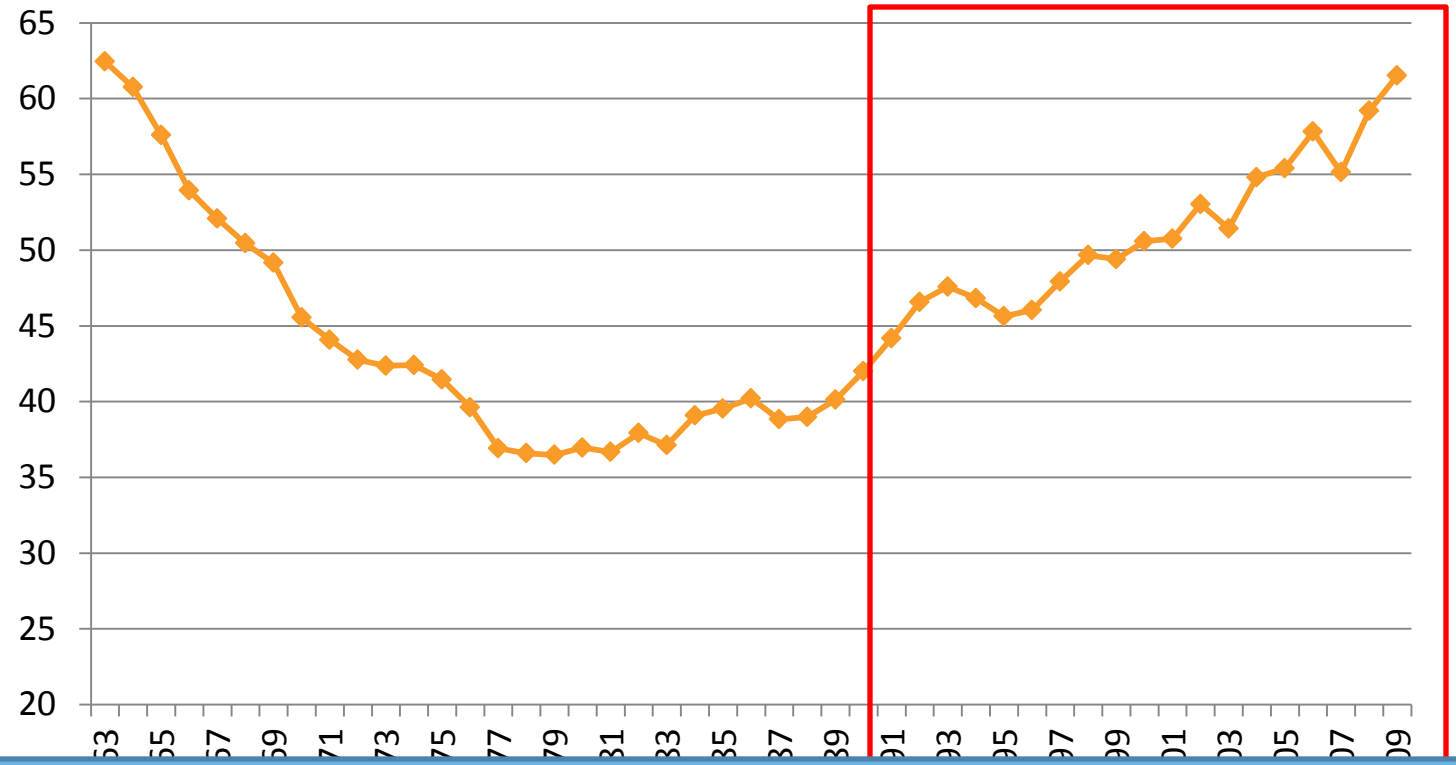
2. What can be measured can be improved

Measures to improve fertilizer use efficiency and to reduce N_2O emission from soil

- Fertilizer planning including organic fertilizer
- Use organic fertilizer in the most efficient way
- Focus on a balanced nutrition of all nutrients
- Use the most efficient mineral fertilizer product, including inhibitors where appropriate
- Adjust fertilizer rate within growth season to actual crop demand

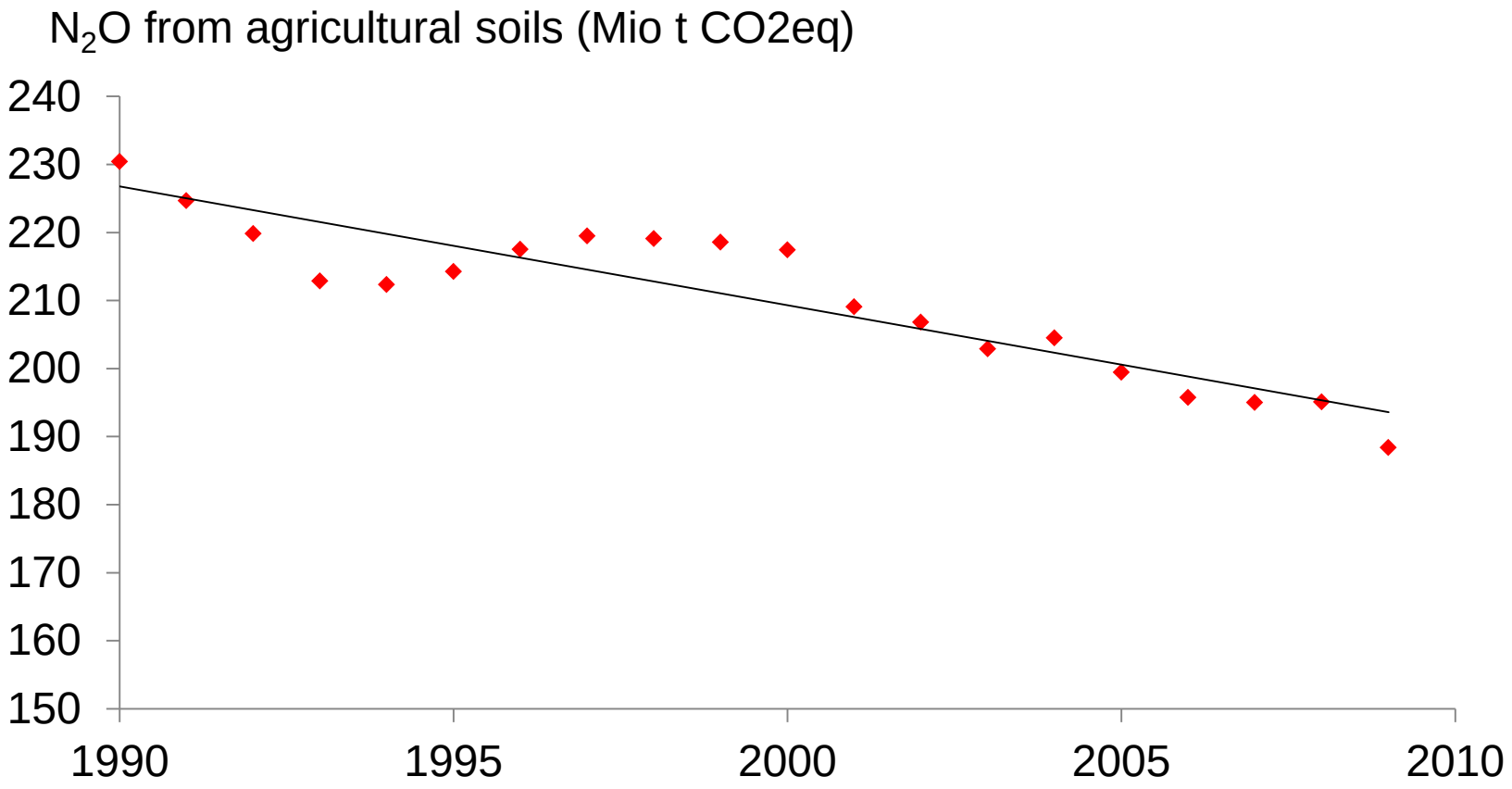
N fertilizer use efficiency (NUE) in EU15 is increasing since the late 1980s

in % (N removal / N fertilizer input * 100, 3yrs moving average)



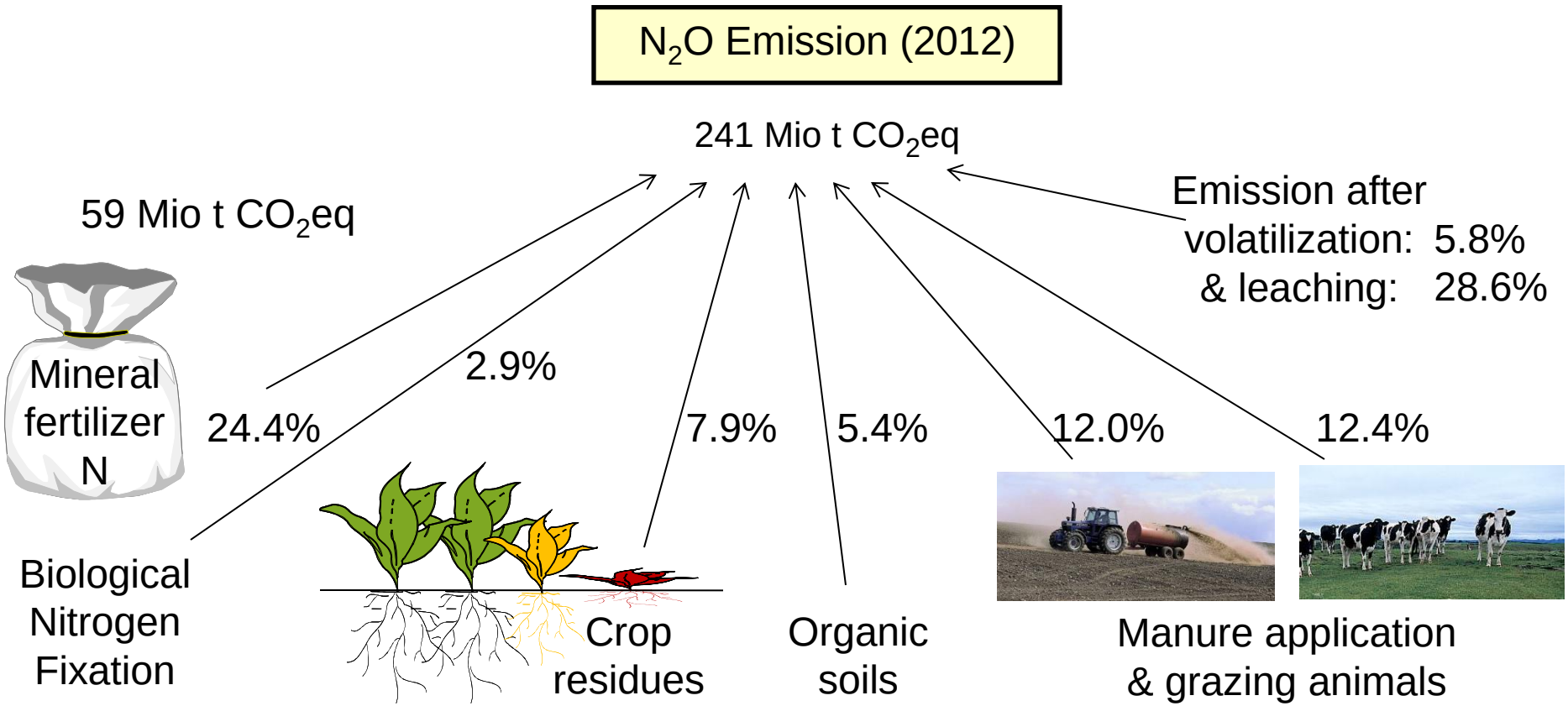
Today Europe has the highest Nitrogen Use Efficiency (NUE) of any region in the world.

In Europe (EU 15) NUE has increased while N_2O emissions from agricultural soils have decreased



Source: United Nations Framework Convention on Climate Change (UNFCCC, 2011)

Sources of N_2O and emission from agricultural soils in Europe



Source: United Nations Framework Convention on Climate Change (UNFCCC, 2016)

The Cool Farm Alliance

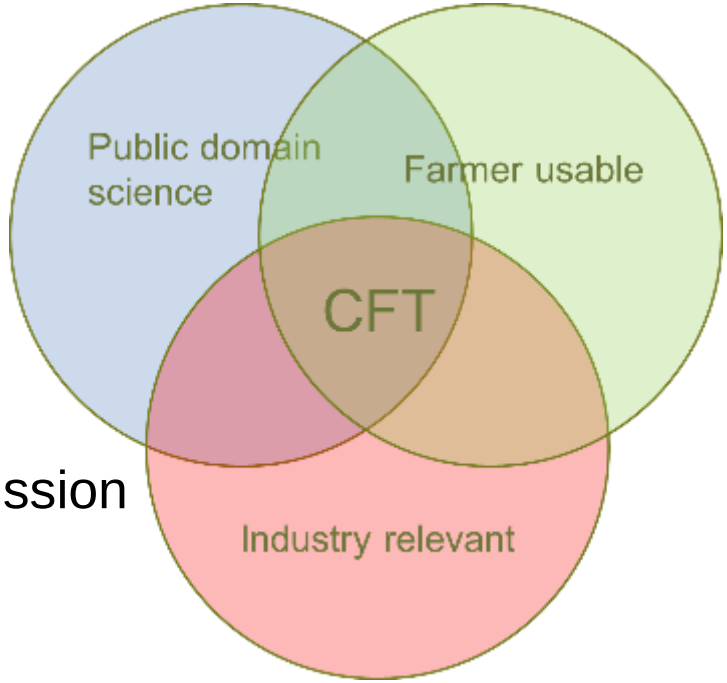
- The Cool Farm Alliance is a group of **multinational companies, NGOs and academics working together** to measure how improved agricultural practices can mitigate greenhouse gas emissions.
- **The aim?** To enable millions of farmers globally to make more informed on farm decisions towards sustainable agriculture.
- The Cool Farm Alliance works together to improve and increase the use of Cool Farm Tool.

What is the Cool Farm Tool?

An **easy to use** and **standardised** online tool for calculating the **on-farm** environmental impacts, currently greenhouse gas emissions, associated with a range of **crop** or **livestock** products, applicable globally

The cool farm tool

- ✓ is scientifically robust
- ✓ is farmer-friendly
- ✓ is Industry-backed
- ✓ will create incentives for low GHG emission



Summary

- Main contributions from the ag. sector to GHG emission are land use change and livestock farming, to a smaller extent mineral fertilizer and rice cultivation.
- Converting natural land into arable land should be avoided by closing yield gaps on existing farm land.
- Mineral fertilizer contribute to productive agriculture and thus contribute to mitigate GHG emission from land use change.
- The European fertilizer industry has developed technologies to reduce the carbon footprint of nitrate fertilizer production by more than 50%.
- Improving crop N use efficiency is climate-smart and has multiple benefits for the farmer and the society.
- N use efficiency is highest in Europe and will further improve through innovation in agricultural practices and balanced crop nutrition.