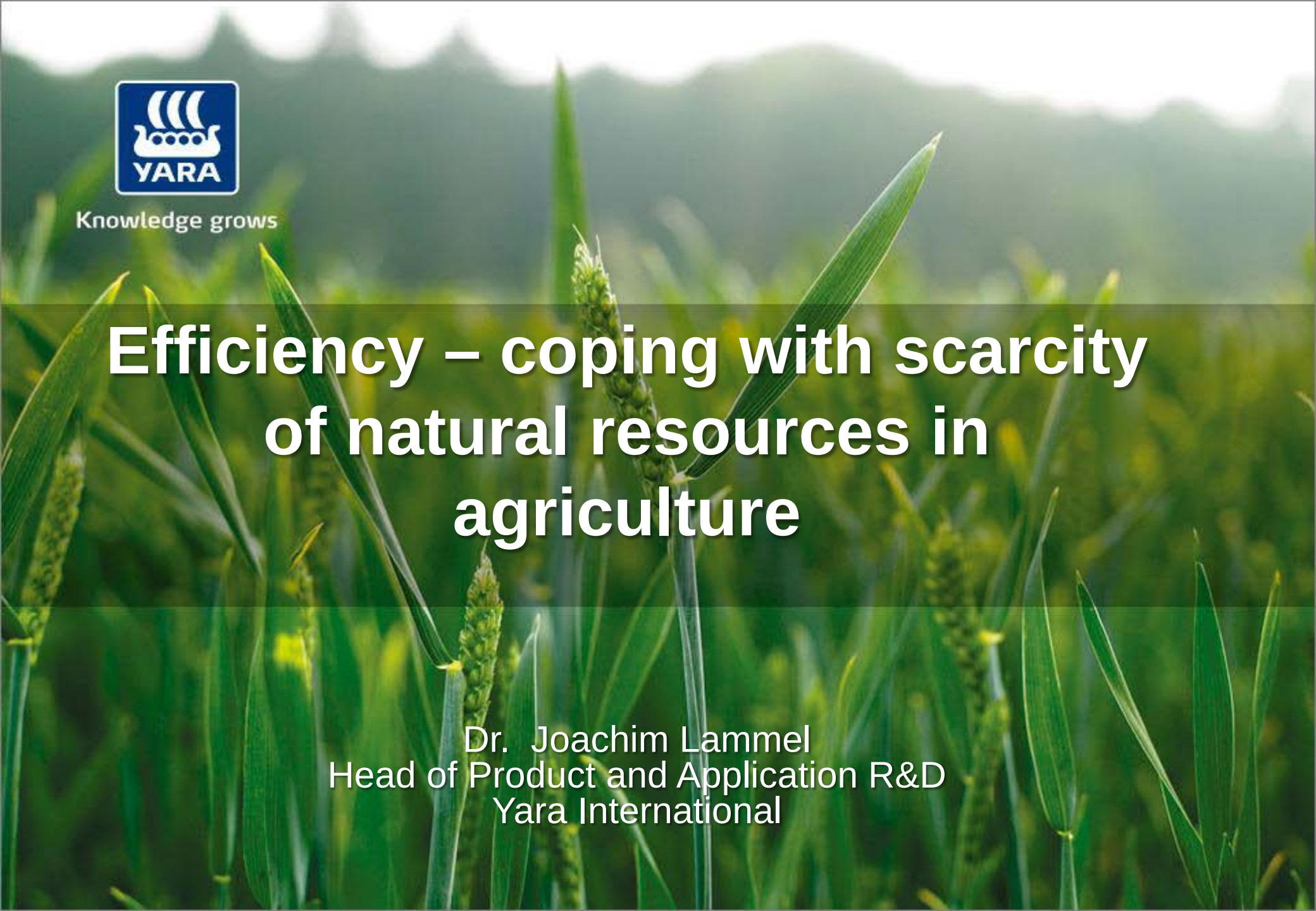
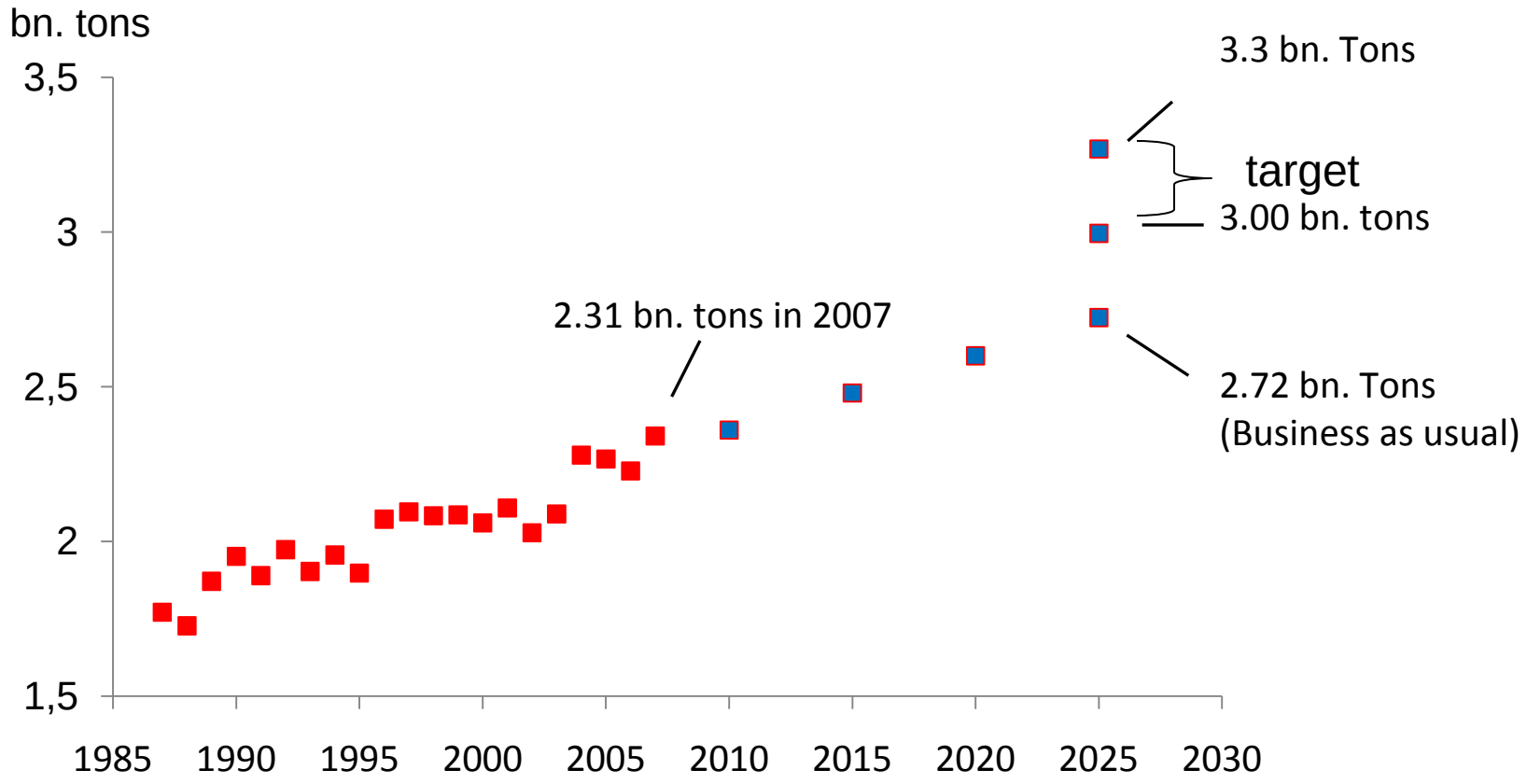


Efficiency – coping with scarcity of natural resources in agriculture

Dr. Joachim Lammel
Head of Product and Application R&D
Yara International

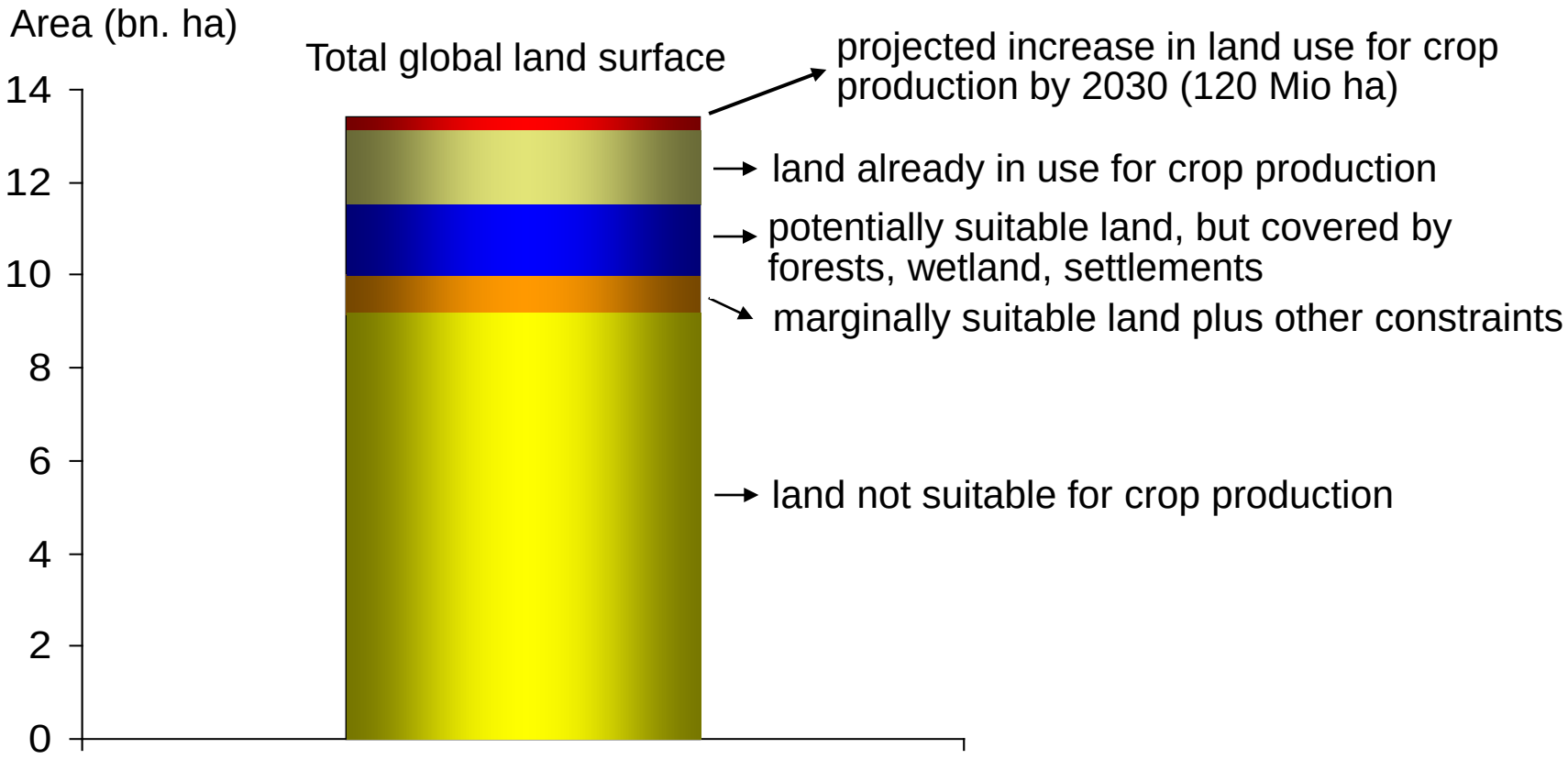
The global cereal* demand in 2025 require growth rates in crop productivity that exceed historic levels



* Corn, wheat, rice, barley etc.

Source: FAO data and Yara calculations

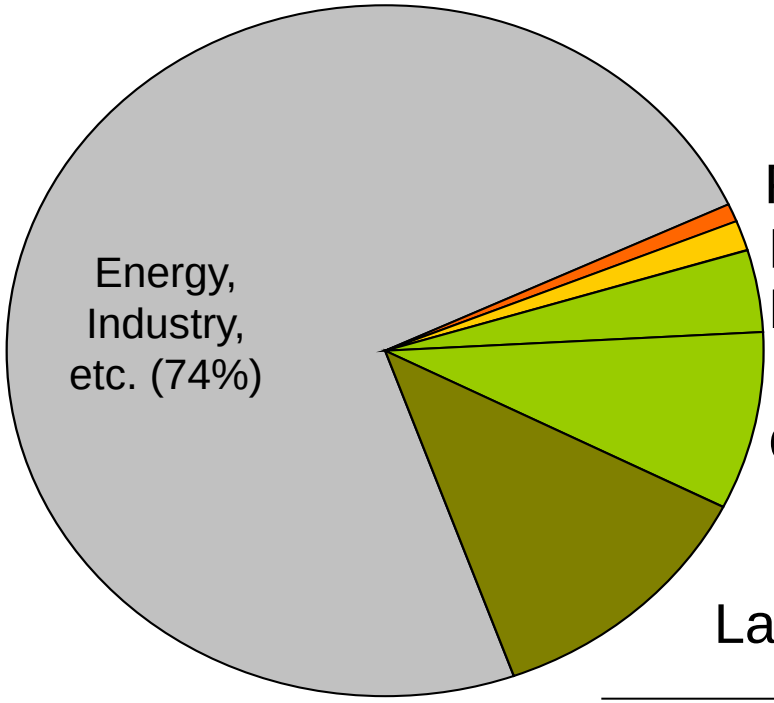
How to increase productivity? Arable land reserves are limited (in billion ha)



Source: FAO (2003): World Agriculture: towards 2015/2030

Large emissions due to land use change for agriculture suggest not to increase the arable land

Total emissions about 50 Gt CO2



Production of mineral N fertilizer (0.8%)*
From mineral N fertilizer use (1.3%)*
From organic N sources (3.8%)

Other agricultural GHG (8.4%)

Land use change for agriculture (avg. 12%)

Agriculture = about 1/4 total global GHG emissions

Based on IPCC (2007), Bellarby et al. (2008), *EFMA calculation

The Yara R&D strategy to meet the future targets of increased crop productivity

The future of nutrient management and crop production has to involve:

- Less use of water
- More efficient use of fertilizers
- Less dependence on soil quality
- Minimal environmental impact

.. which requires innovation and knowledge transfer:

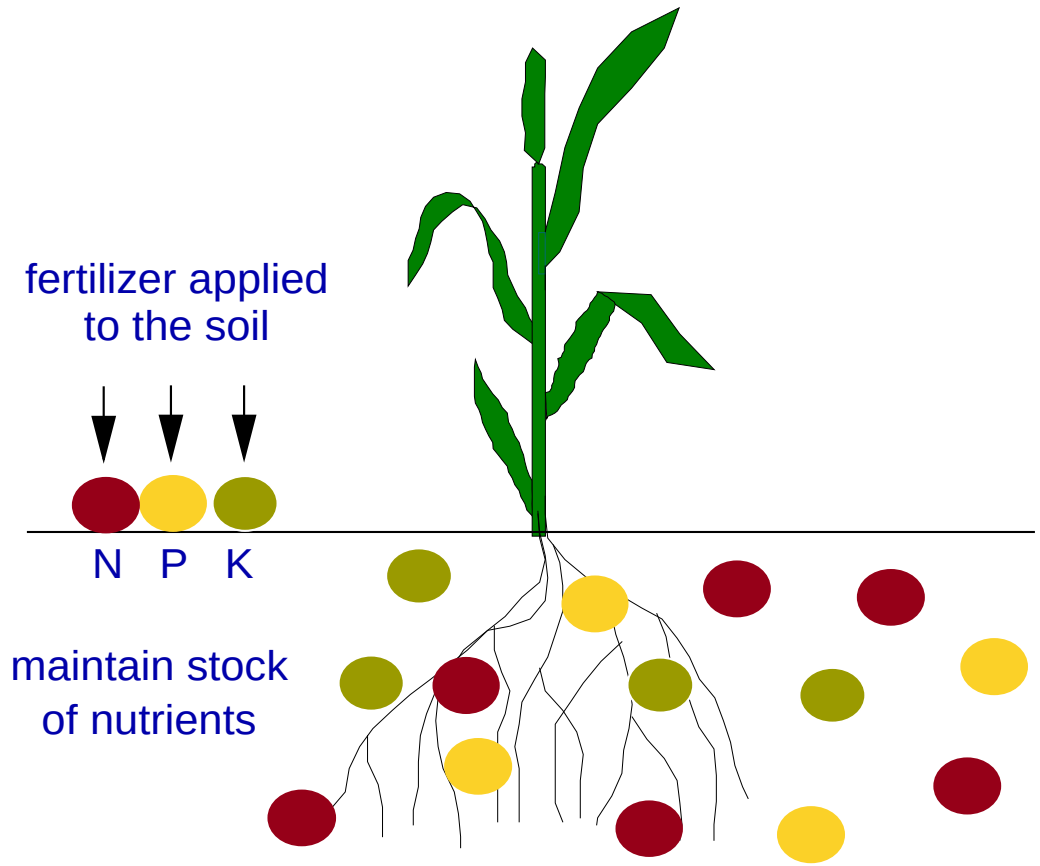
- Innovative crop production and fertilizer application strategies to further optimize production for advanced growers
- Knowledge and technology transfer to developing growers

Yara promote a new Plant Nutrition Concept

“Just in time”

Target:
To increase fertilizer use efficiency

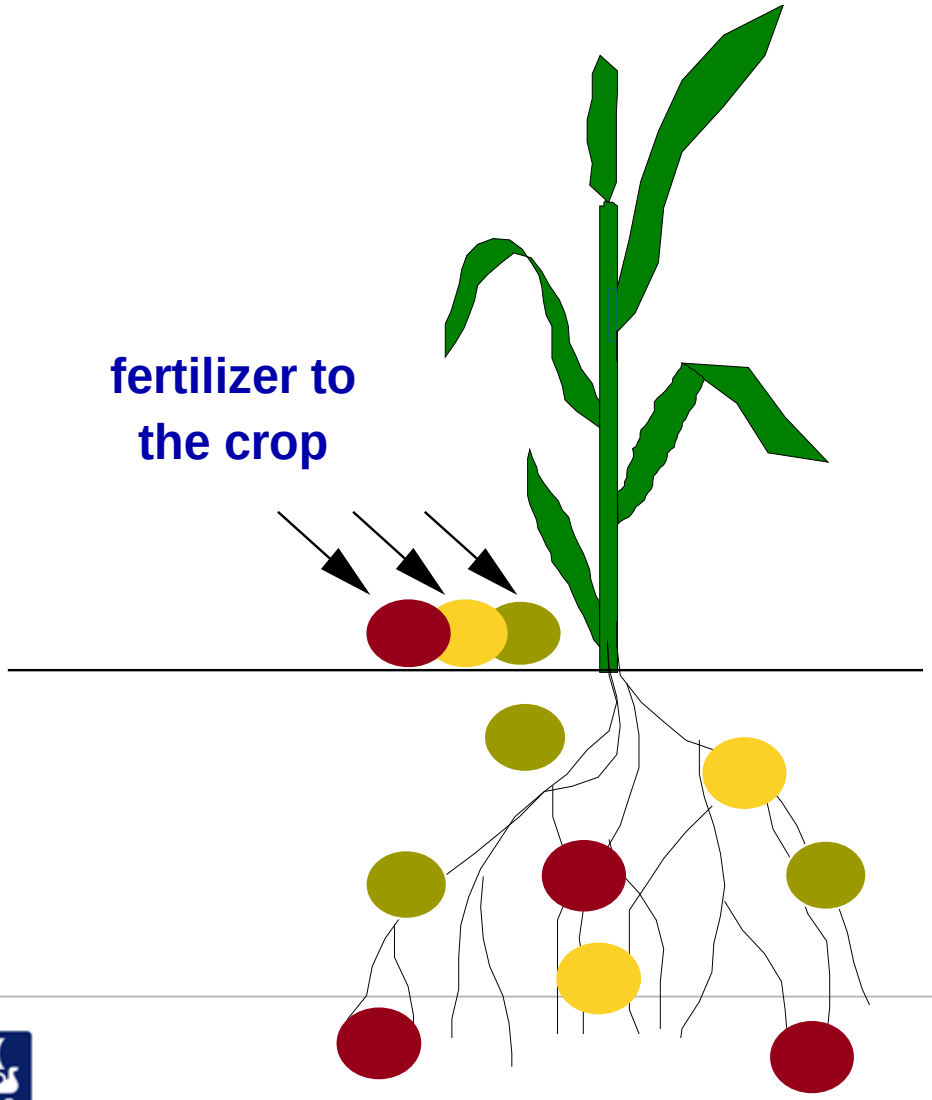
Common fertiliser strategy: “soil management”



Principle

- ✓ The crop absorbs nutrients from the soil. A certain nutrient content of the soil is recommended and shall be maintained through fertilizer application.
- ✓ weak relation between the nutrient content in the soil and crop yield
- ✓ nutrients in the soil are not always plant available

Yara: "Just-in-time" plant nutrition



Principle

- ✓ the nutritional status of the crop determines the fertilizer application rate and timing

Benefits

- ✓ higher nutrient use efficiency because nutrients applied when needed

Prerequisites ~ areas of research

- ✓ efficient fertilizers
- ✓ balanced nutrition and crop focus
- ✓ Foliar fertilizers and fertigation
- ✓ diagnostic tools

Best fertilizer management practice improve N fertilizer use efficiency

	Average of 139 field trials**
Grain yield t per ha - dry matter	8.0
N-content in grain (%)	2.09
N removal with grain (kg N/ha)	167
N fertilizer application (kg N/ha) N deposition (kg N/ha)	181 20
N use efficiency (N uptake / N input) * 100	83 %

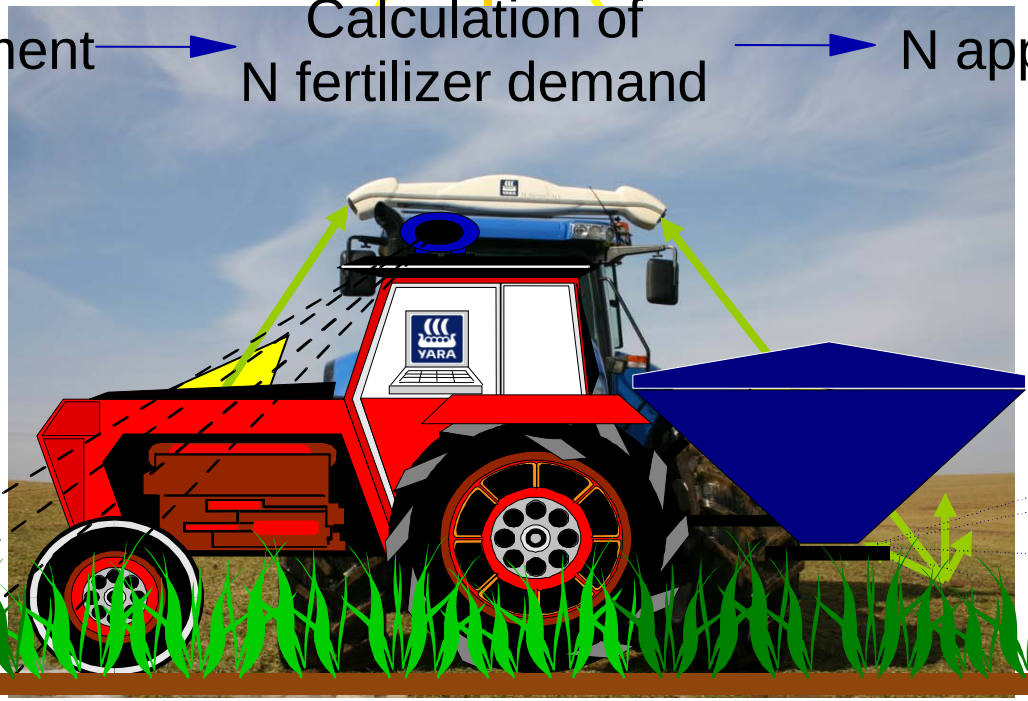
Source: ** Yara field trials Europe

N-Sensor® and N-Sensor® *ALS* – two systems, one philosophy

Crop scanning and fertilizer application on-the-go

N-Sensor® Measurement → Calculation of N fertilizer demand → N application

- passive system
- needs daylight
- 8-10 hours per day



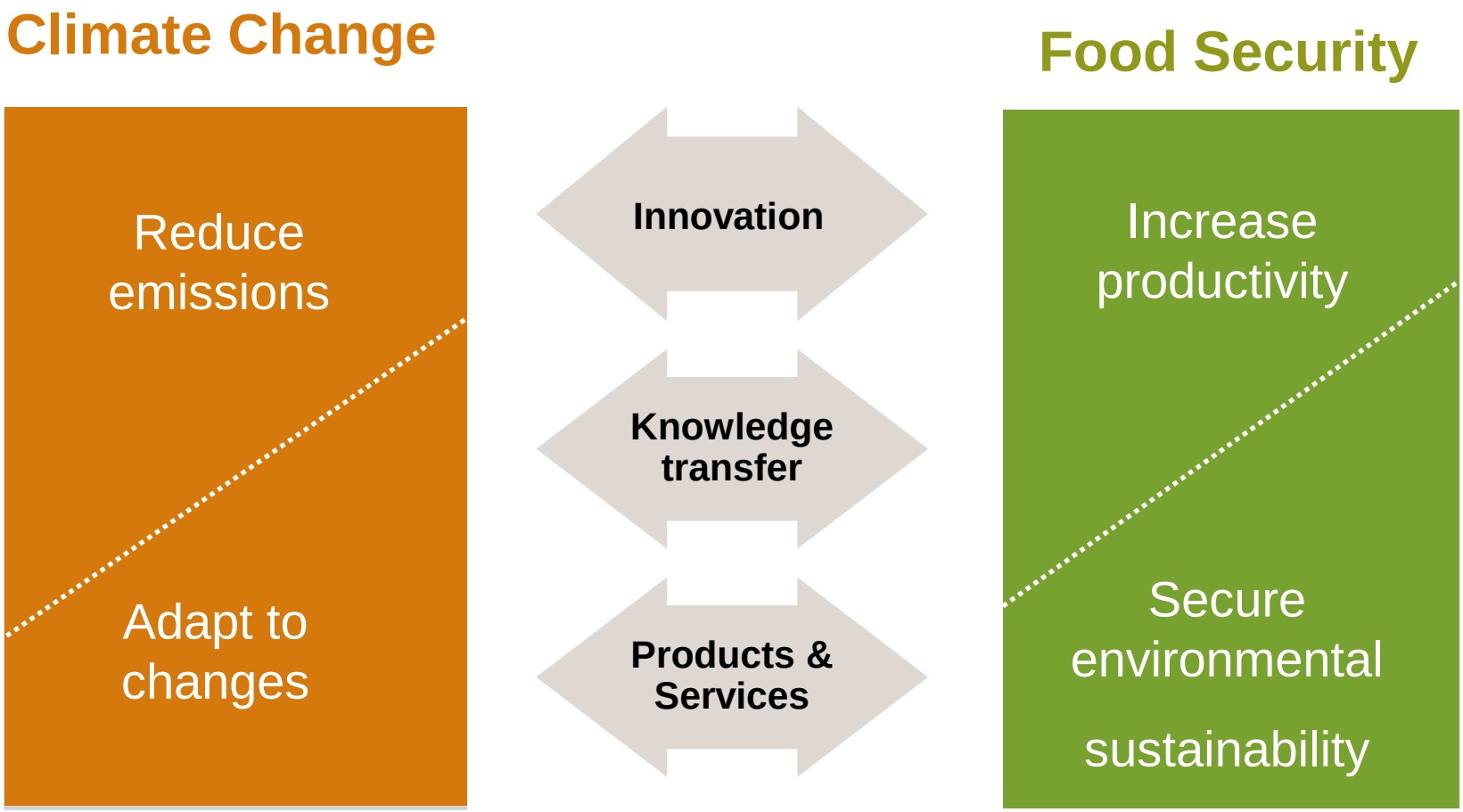
N-Sensor® *ALS*

active system
own light source
24 hours per day

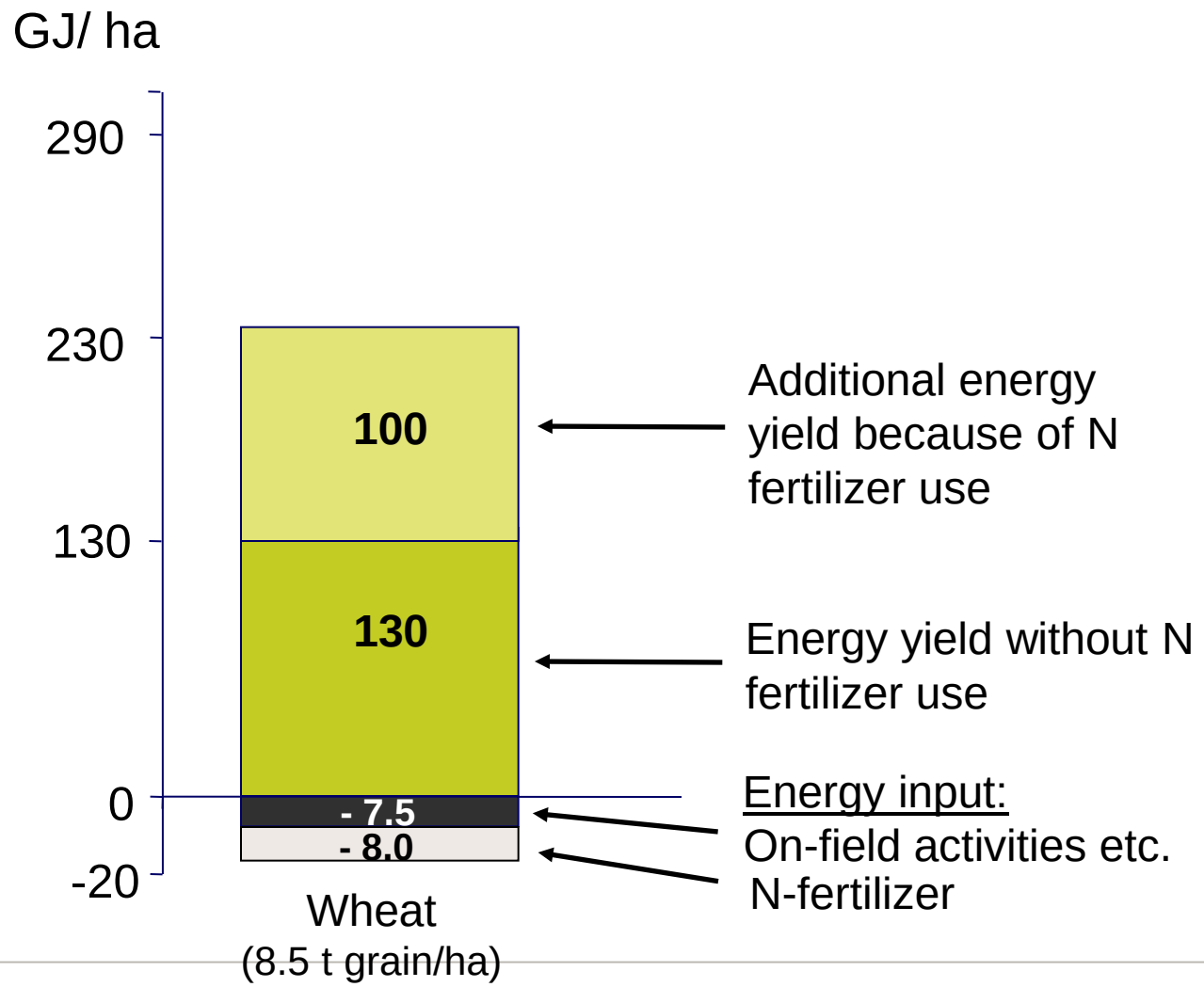
Agronomic use of the Yara N-Sensor®

- Commercial use on farms
  - Cereals (Europe)
  - Canola (Europe)
  - Maize (Europe)
  - Potatoes (Europe)
  - Rice (Japan)
- Testing and adaptation
  - Wheat, Maize (Canada)
  - Cotton (USA)
  - Wheat, Corn (South America)
  - Sugar cane (South America)
  - Wheat, Canola (Australia, NZ)

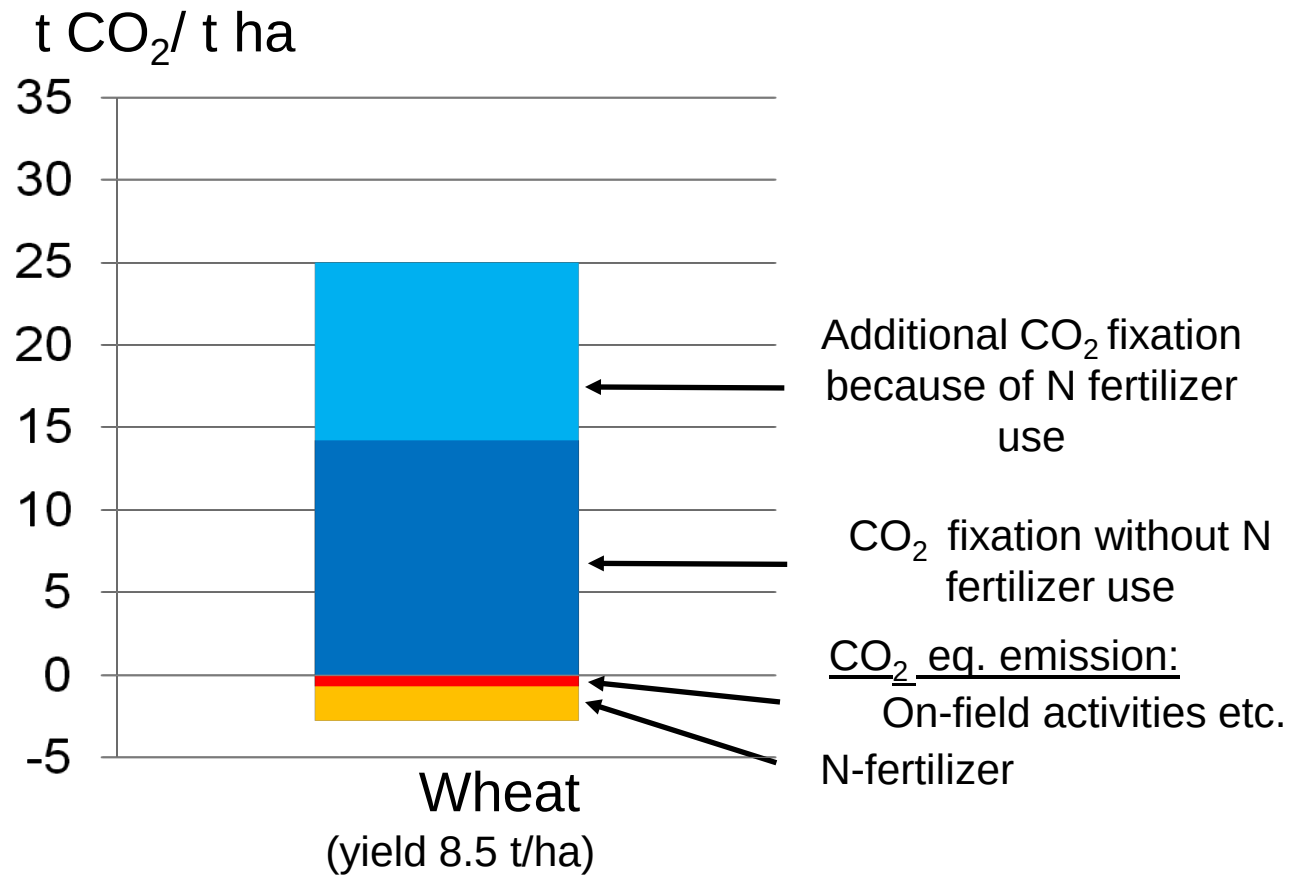
Climate change and food security are linked and present today the main challenges to agriculture



Energy input and energy yield in total biomass with and without N fertilizer use (annual trial)



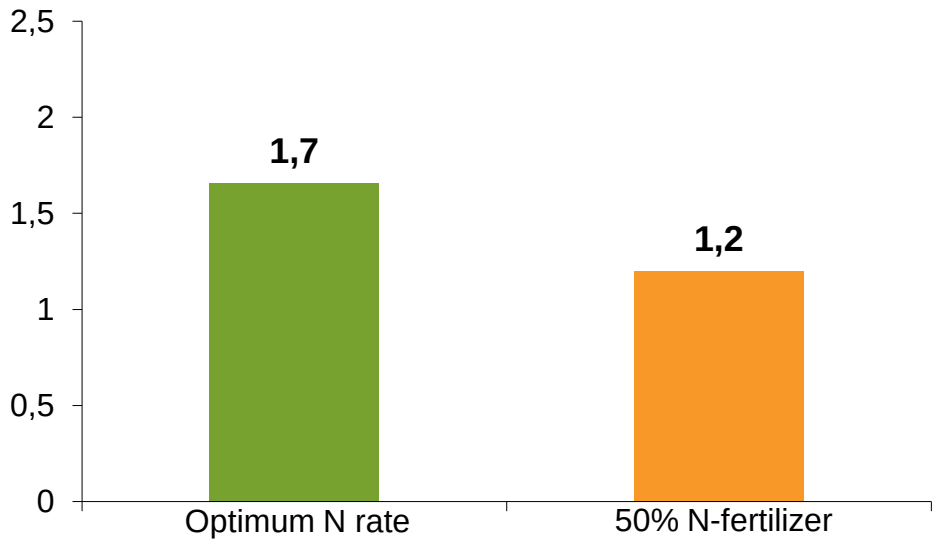
CO_2 fixation in grain and straw compared to CO_2 emission with and without N fertilizer



Appropriate N fertilizer application reduce GHG emission per t of product (e.g. per t wheat)

per unit land

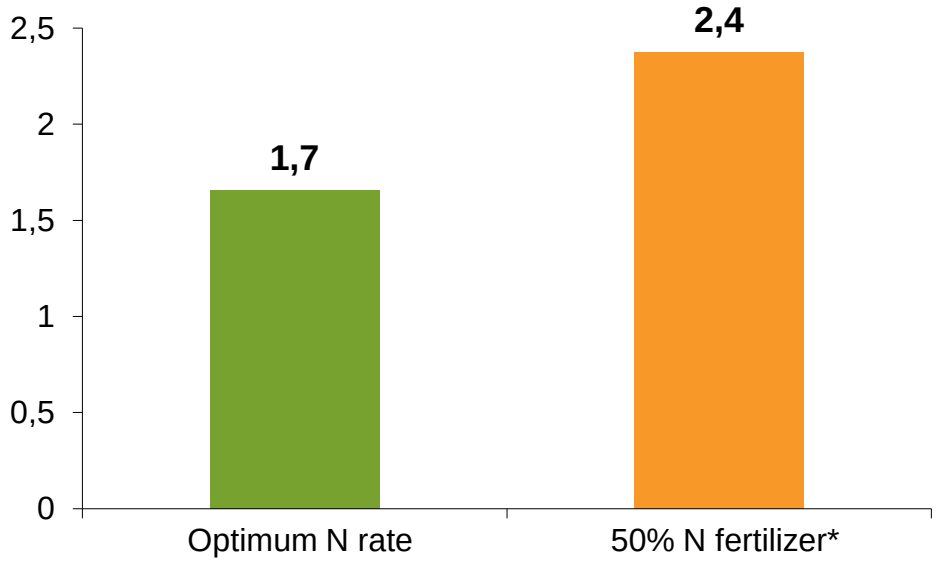
GHG emission
(in t CO_2-Äquivalents/ha)



10 t/ha Wheat 7,5 t/ha Wheat

per 10 t wheat

GHG emission
(in t CO_2-Äquivalents/10 t wheat)

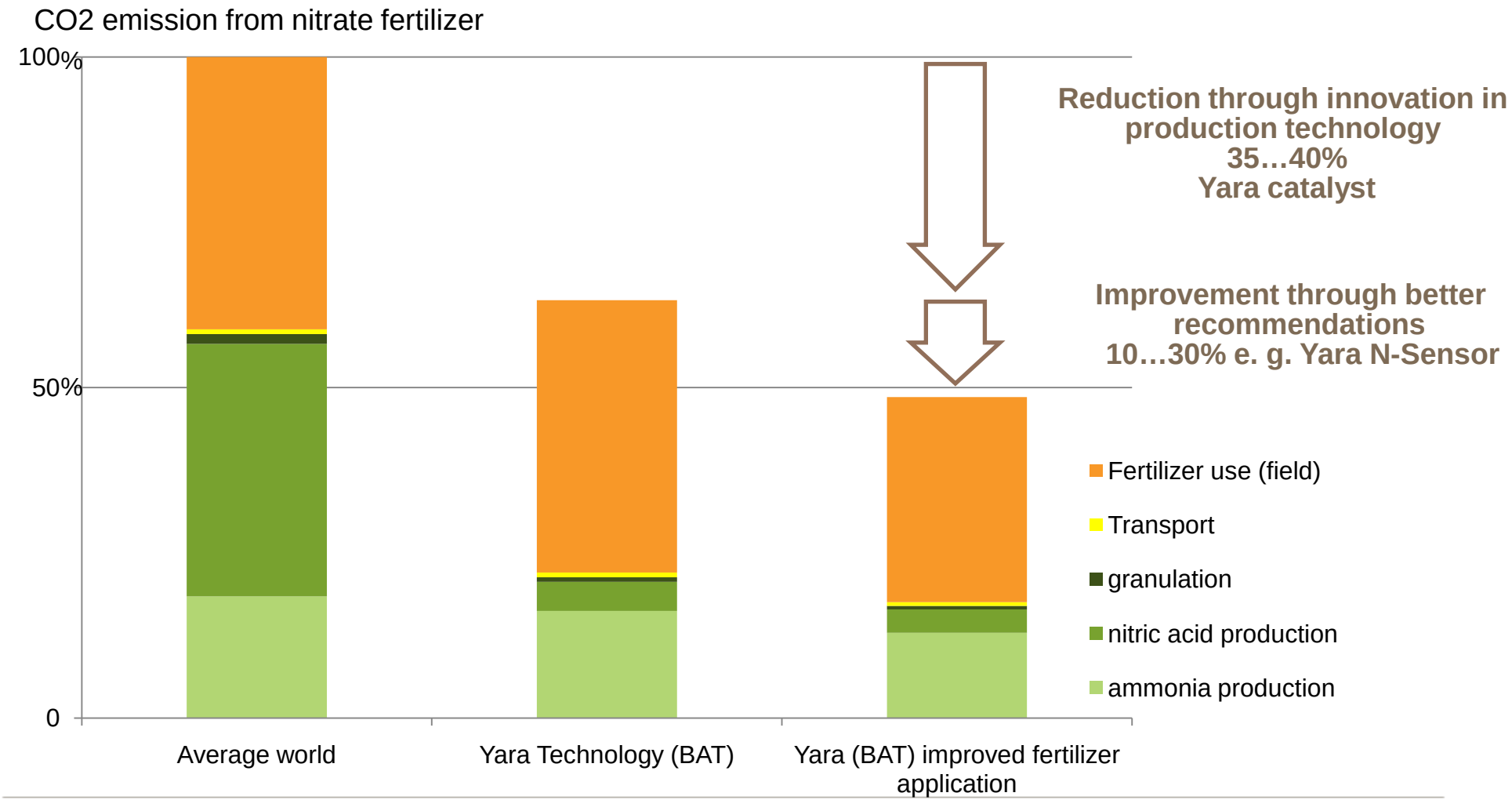


1 ha 1,3 ha

* Lower yields need to be compensated by additional land which cause additional emission

Quelle: Yara, IVA

Recent new technology and improved fertilizer management reduce GHG emission by about 50%



Summary statements

- Arable land and water are probably the most scarce natural resources for agriculture.
- Agricultural efficiency shall therefore be measured as annual crop yield per unit of land and kg crop dry matter per unit of water applied.
- In order to avoid greenhouse gas emissions from land use change for agriculture, to save natural habitats and to protect biodiversity any extension of arable land shall be avoided.
- To meet the future demand of food, feed, fiber and fuel, the intensity of crop production on the existing land has to increase.
- At the same time the environmental impacts have to be minimized.
- Both targets can be achieved if all stakeholders run projects on knowledge and technology transfer to enable growers to employ current best practice and do research for innovative solutions that help to further increase agricultural productivity.