A New Paradigm for Plant Nutrition

Soil Fertility and Plant Nutrition Symposium
15 & 16 September 2021, FERTASA, South Africa

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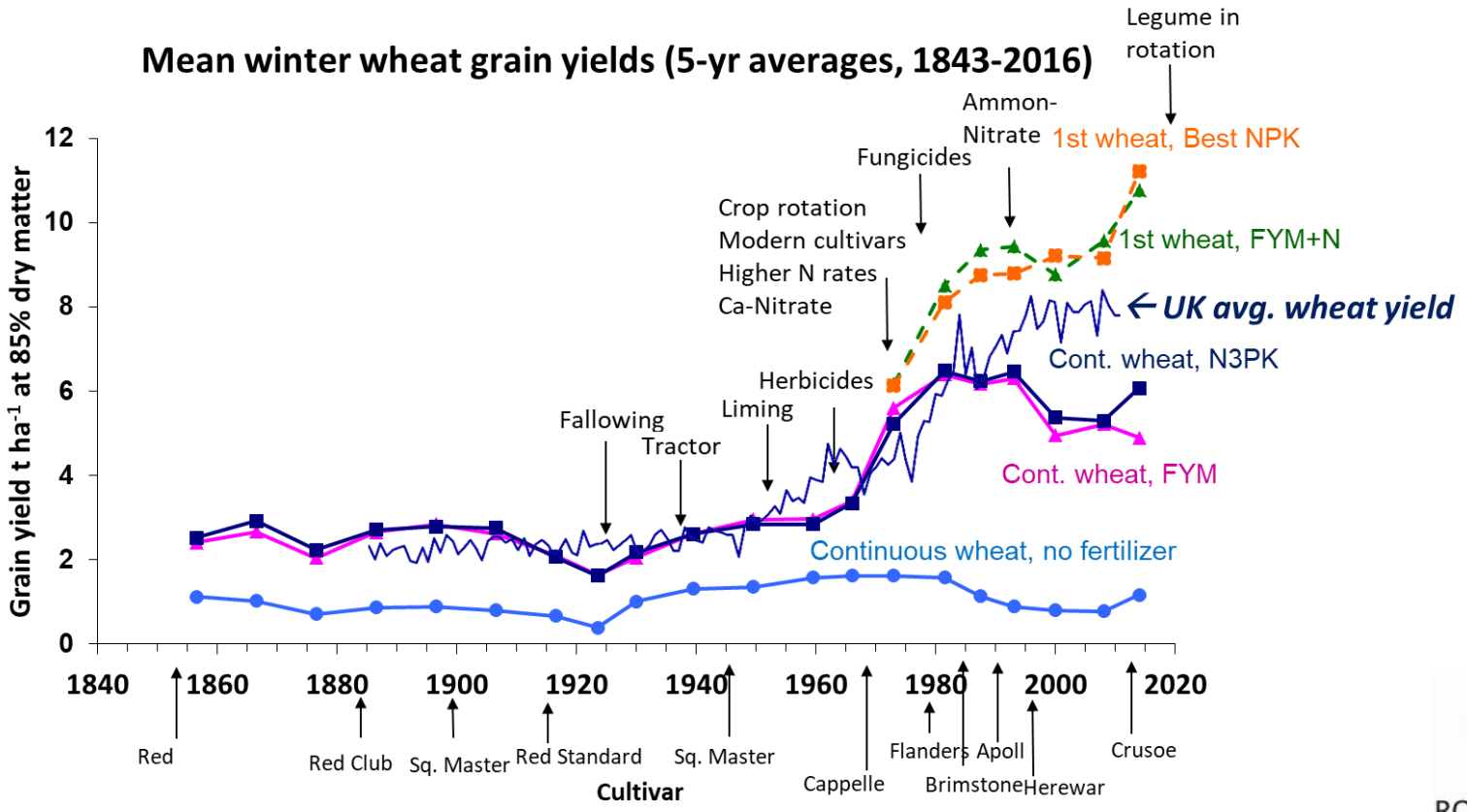
ON RESPONSIBLE PLANT NUTRITION

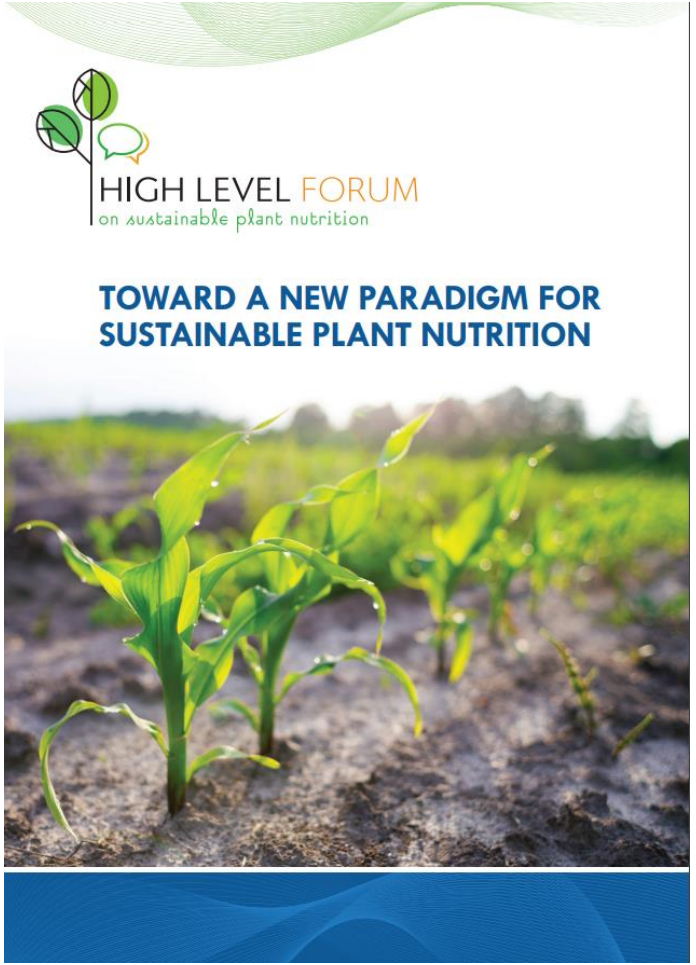
Broadbalk LTE – the story of modern agriculture



ROTHAMSTED RESEARCH

Productivity and food security are still critical needs, but the new paradigm for plant nutrition must embrace a food systems approach with all of its sustainability dimensions, including

- **GHG emission reduction, carbon sequestration**
- **Pollution and biodiversity**
- **Waste and nutrient recycling**
- **Nutrition and health**



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November 2019

Scientific Panel on Responsible Plant Nutrition

Vision: *Responsible plant nutrition nourishes plants in a sustainable manner that enhances earth's capacity to support healthy life*

Objectives: *Provide independent science-based knowledge to IFA and other stakeholders involved in food and agriculture on global issues of responsible plant nutrition*

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Scientific Panel on Responsible Plant Nutrition
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A NEW PARADIGM FOR PLANT NUTRITION

Issue Brief, November 2020

What is the issue?
What can be done?
Who needs to do what?
What will success look like?

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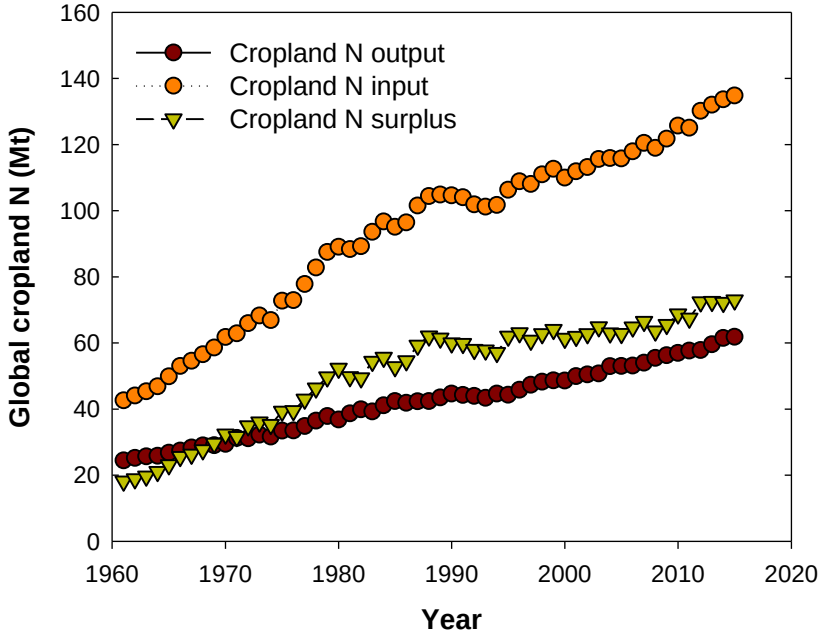
What is the issue?

1 **How can future growth in crop production be decoupled from growth in fertilizer consumption, how can we overcome the global nutrient imbalance?**



Global trends in crop nitrogen inputs and outputs (million t)

N surplus = total N input to cropland minus harvested N as crop products

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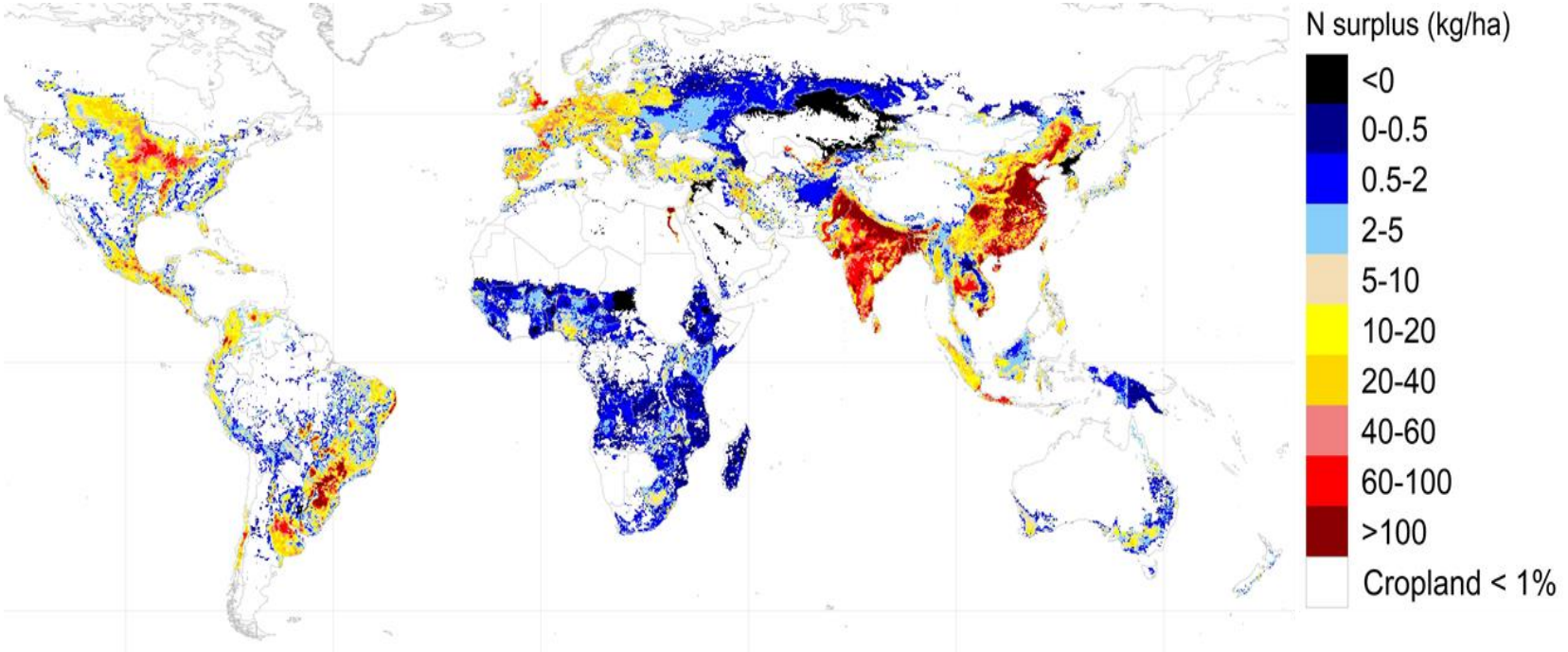
Source: Xin Zhang and Guolin Yao, University of Maryland Center for Environmental Science

What is the issue?



Cropland nitrogen surplus or deficit in 2015 (kg N/ha)

N surplus (or deficit) is defined as the total N input to cropland minus N harvested as crop products

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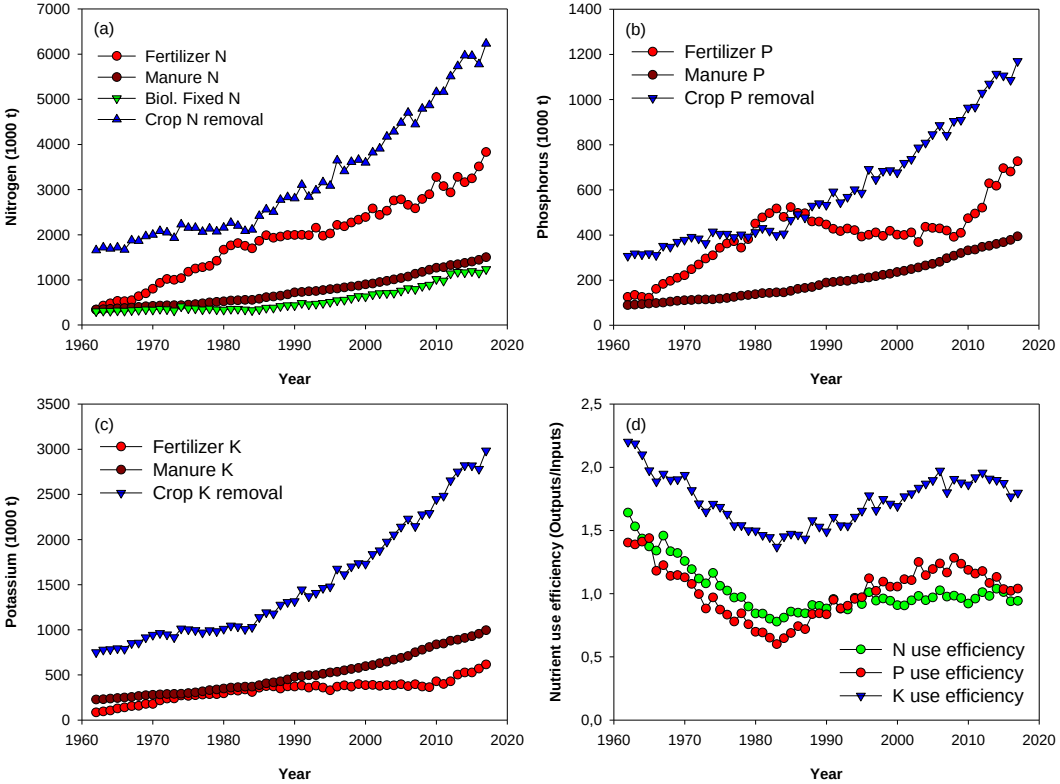
What is the issue?



2 **What are the key measures to double or triple crop yields in Africa with increasing and balanced nutrient inputs?**

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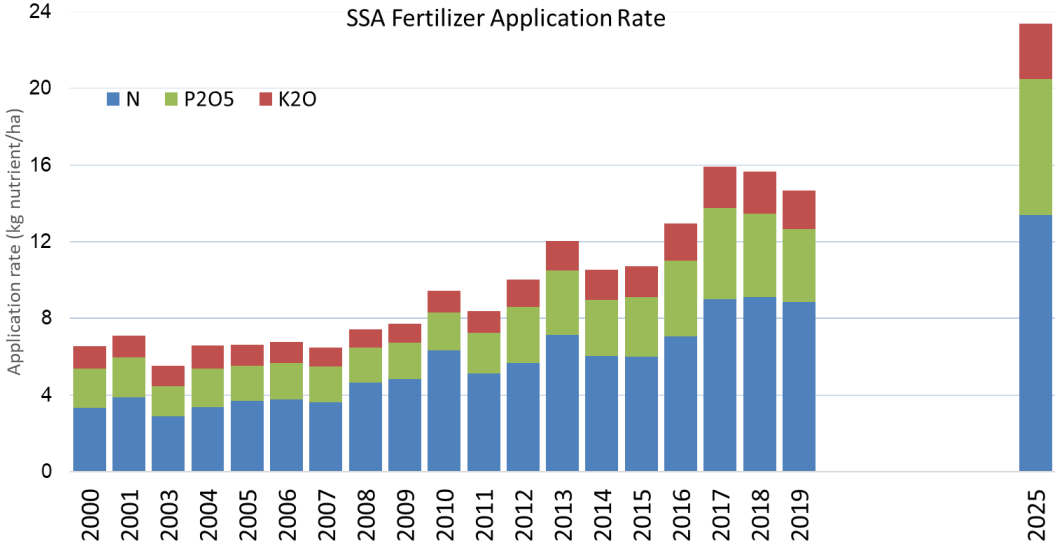
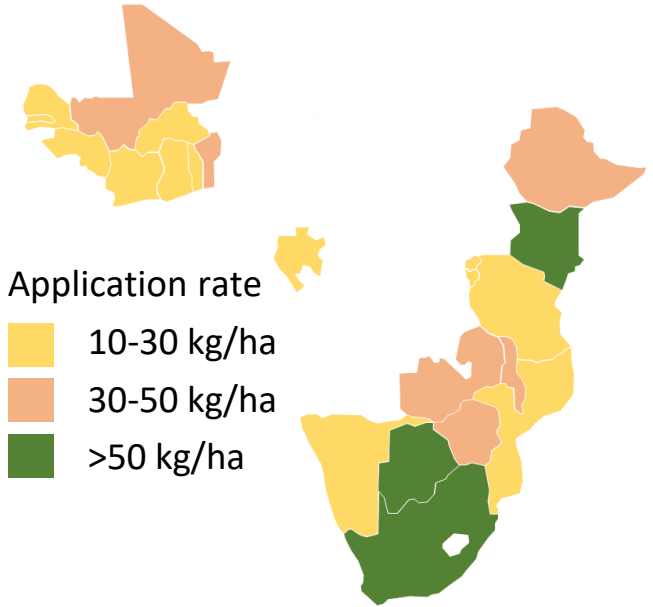
Crop N, P and K removal by far exceeds nutrient inputs from fertilizer, manure and other sources in Africa (1000 tons of N, P and K). Source: IFA Nutrient Use Efficiency database, 1961-2017.

SSA average application rate declines to 15 kg/ha in 2019



2019 average fertilizer use (kg nutrients/ha cropland)



Average rates of fertilizer-nutrient application (NPK) to cropland in Sub-Saharan Africa (excluding South Africa).
Calculated using IFASTAT and FAOSTAT cropland.
2025 forecast from IFA Medium Term, July 2021.

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What is the issue?

3. What data-driven technologies, business solutions and policies will accelerate the adoption of more precise nutrient management solutions by farmers?
4. Can nutrient losses and waste along the whole agri-food chain be halved within one generation?
5. How can nutrient cycles in crop and livestock farming be closed?
6. How can we improve soil health?
7. How should we manage nutrition of crops in changing climates?
8. What are options and targets for reducing fertilizer-related GHG emissions?
9. How can cropping systems deliver high quality, more nutritious food?
10. How can we better monitor nutrients and implement high levels of sustainability stewardship?

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What can be done?

Following a food systems & circular economy approach....

a new paradigm of **responsible plant nutrition** encompasses a broad array of scientific and engineering know-how, agronomic practices, business models and policies that directly or indirectly affect the production, utilization and recycling of mineral nutrients in agri-food systems.

towards developing **integrated, targeted plant nutrition solutions that minimize tradeoffs between productivity, environment and health – and are viable in the farming and business systems of different regions, nations and localities**

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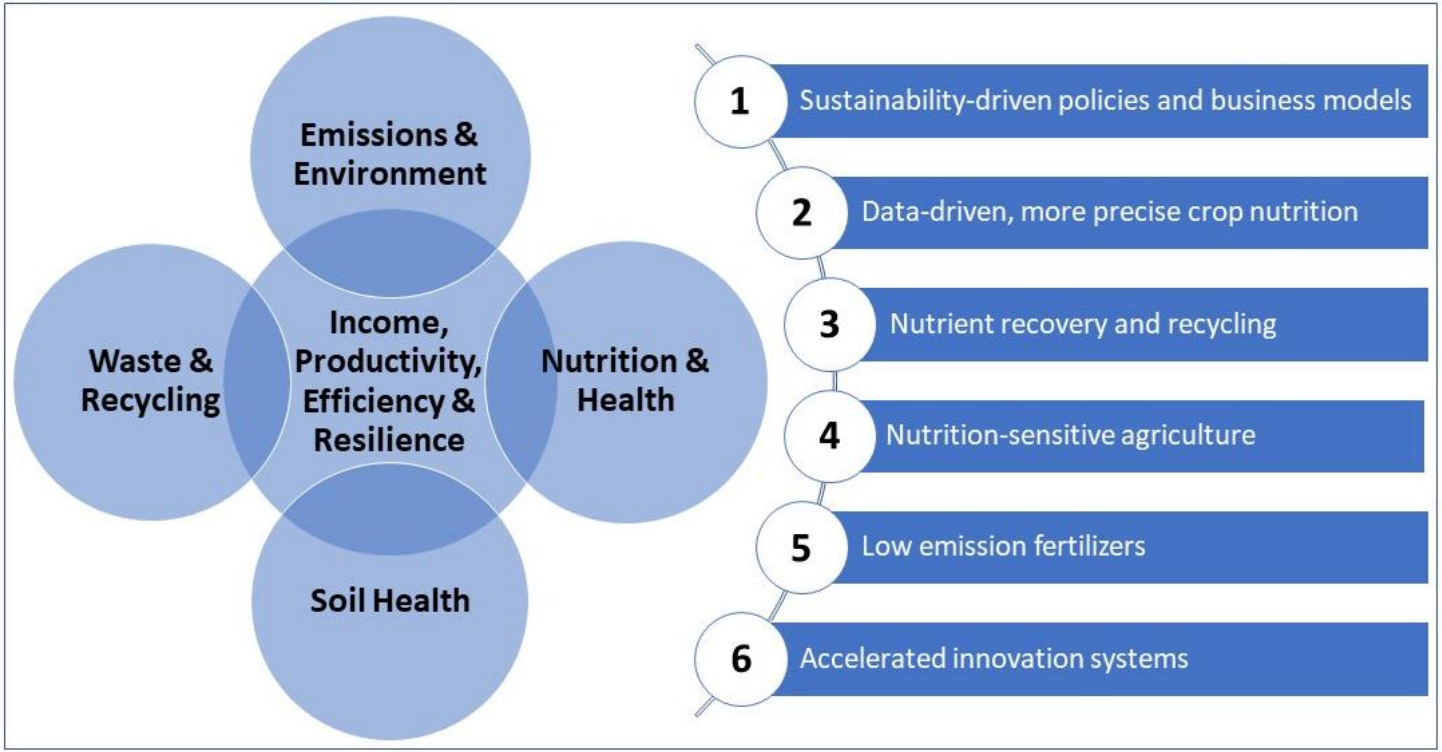
What can be done?

The five interconnected aims of a new paradigm for responsible plant nutrition - and six key actions to take



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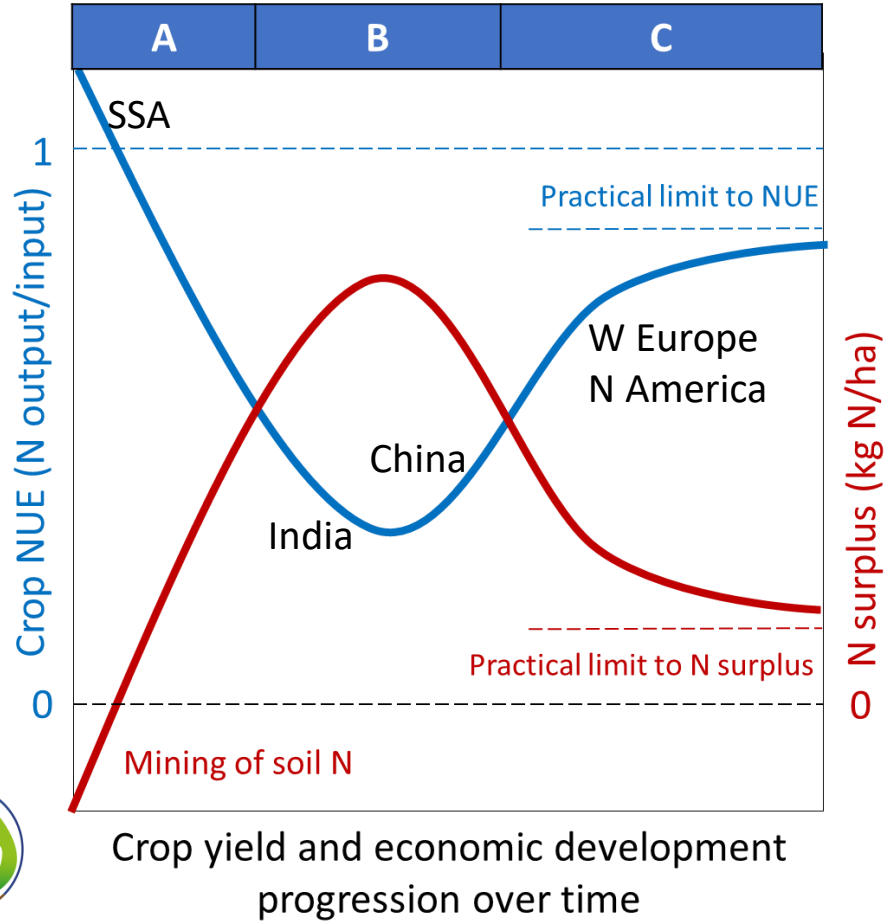
What can be done?



Action 1

Sustainability-driven nutrient policies and business models must be tailored to specific food systems in every country.

Specific targets and priorities for managing nutrients will vary, depending on a country's position along the general nutrient use efficiency pathway.

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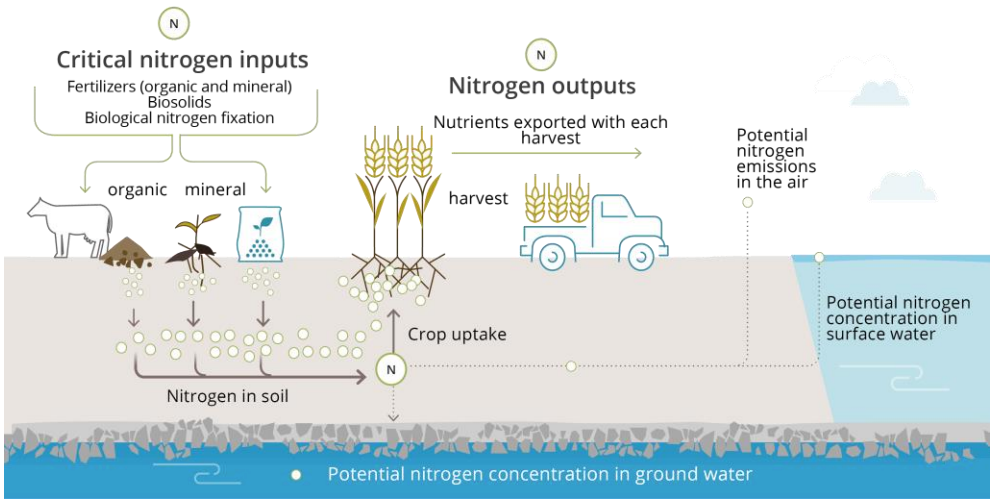
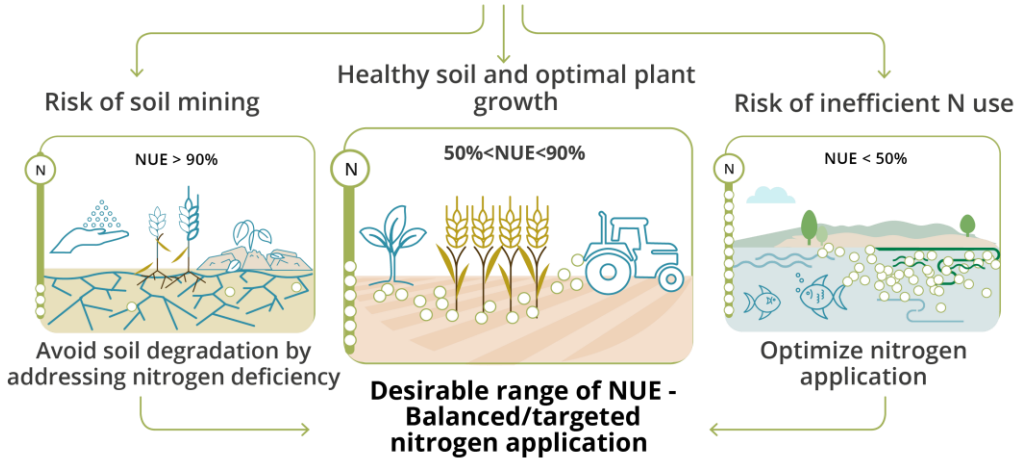


3 Crop production scenarios



EU Nitrogen Expert Panel

What can be done?

Action 2

Knowledge-driven solutions and novel technologies will allow tailoring nutrient formulations and applications to local needs in an increasingly precise manner.

They need to be upscaled to millions of farmers through digitally supported advisory systems and integrated business solutions.

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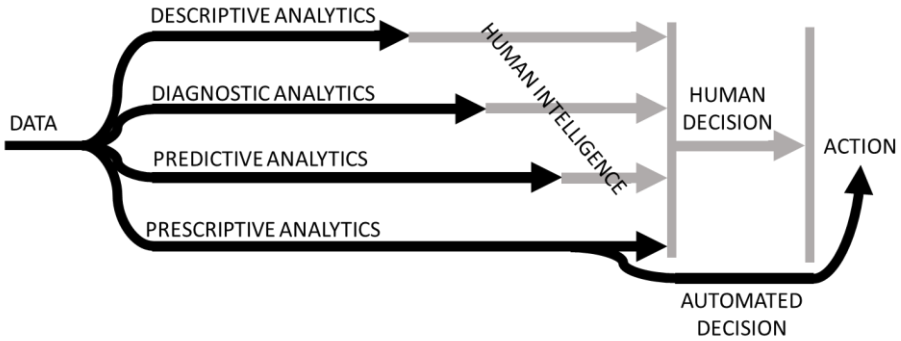
Precision agronomy = small details make a big difference

Strategic practices that require change in behavior

1. **Choose the right crop rotation and crop**
2. **Prepare the land early and properly**
3. **Get good seed and plant it at the right time, depth & density**
4. **Early weed control**
5. **Balanced plant nutrition with high N efficiency**
6. **Irrigate at the right time & well (if available)**
7. **Preventive, integrated pest management**
8. **Harvest at the right time**
9. **Manage the field after harvest**

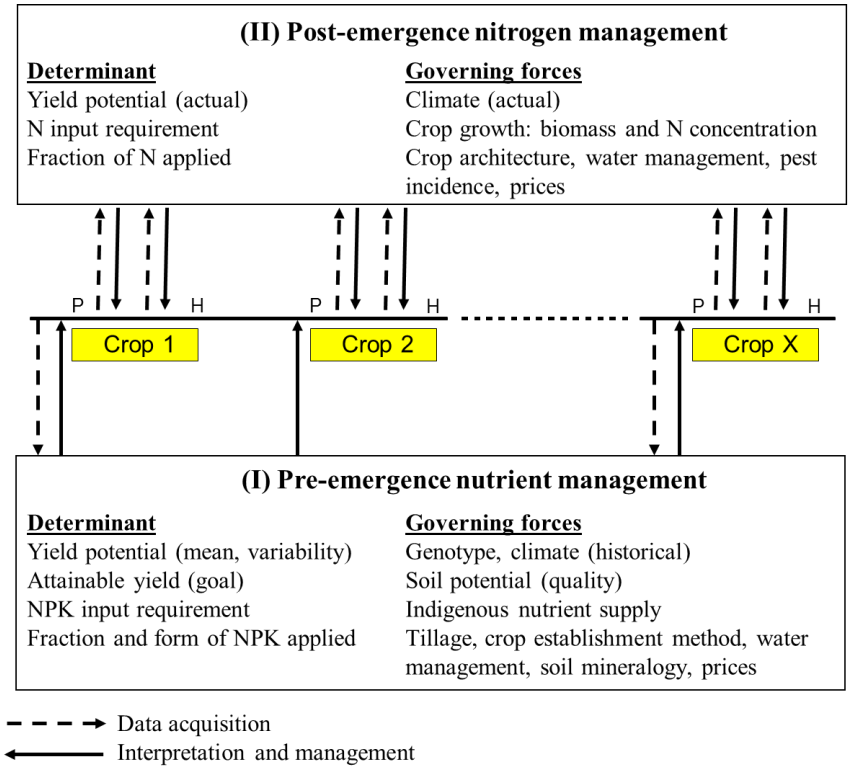
10-20 specific management decisions per crop cycle
Data, metrics and targets for each
Ability to implement each at high quality in the field

Data- and AI-driven site-specific nutrient management?



Matthew Smith, Agrimetrics, UK
Getting value from artificial intelligence in agriculture. *Animal Production Science* (2018), https://doi.org/10.1071/AN18522

Self-learning fertilizer recommendations + real-time guidance throughout the life cycle of a crop, and for whole cropping systems



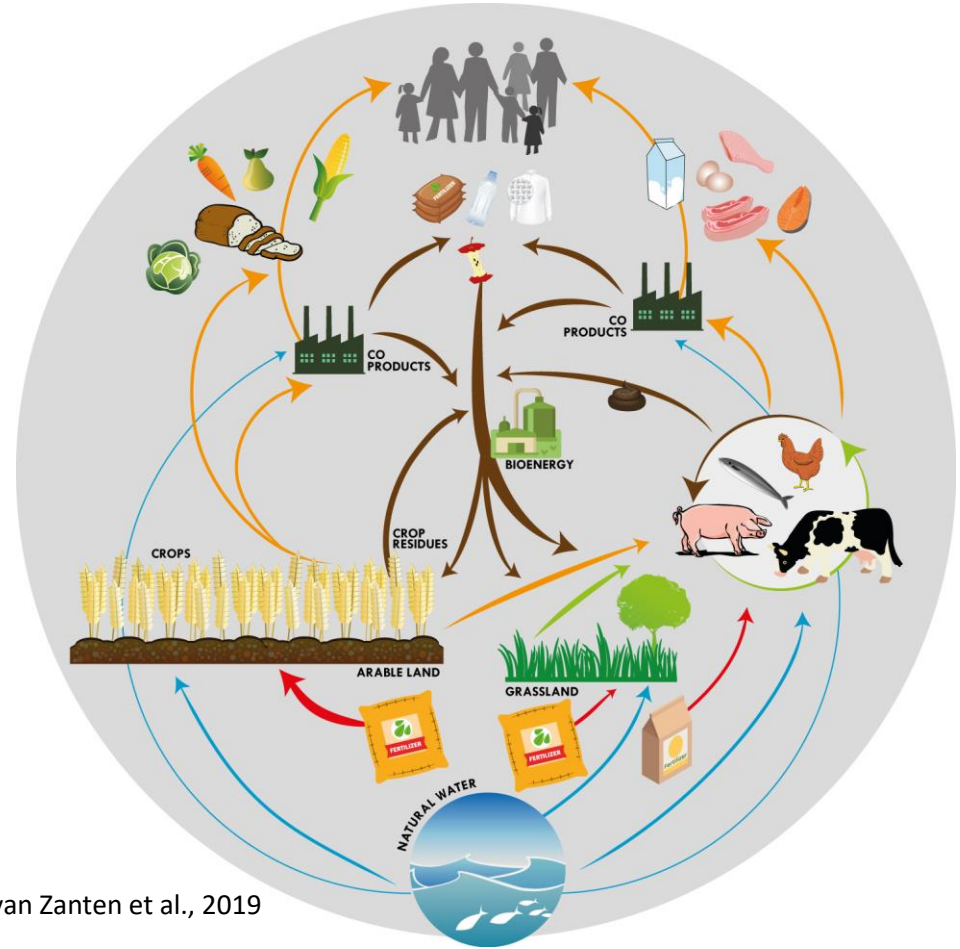
Dobermann, A. & Cassman, K.G. 2002. Plant nutrient management for enhanced productivity in intensive grain production systems of the United States and Asia. Plant Soil 247: 153-175. (modified)

What can be done?

Action 3

Crop-livestock integration, less food waste, by-products use and increased nutrient recycling are key measures to optimize nutrient use efficiency across the full food chain.

Political incentives, novel technologies and shifts in behavior will drive greater nutrient recovery from multiple waste streams, as part of circular, bio-based economies.



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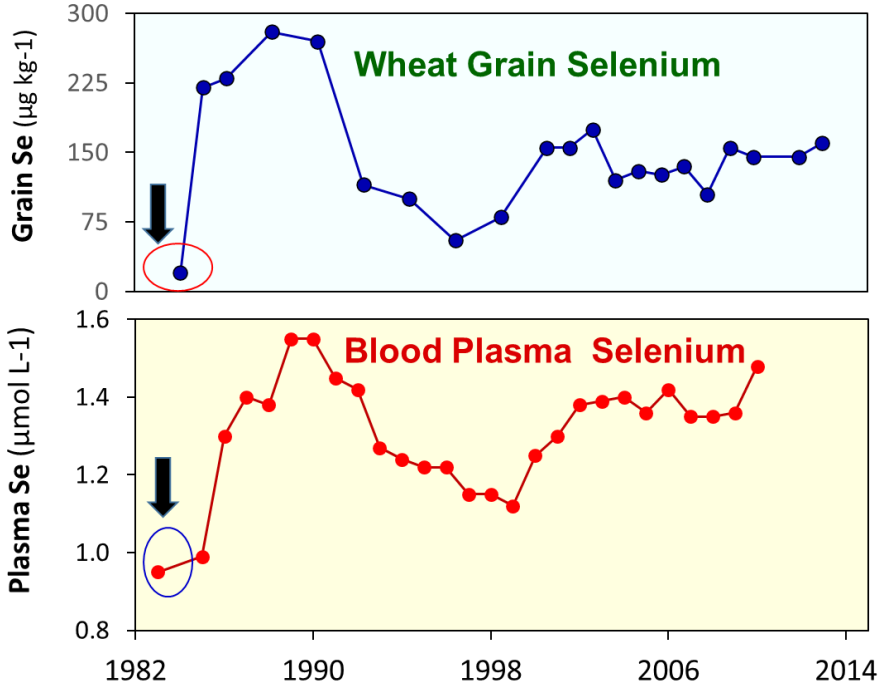
Re-drawn and modified from van Zanten et al., 2019

What can be done?

Action 4

Nutrition-sensitive agriculture includes the targeted enrichment and application of fertilizers to deliver micronutrients of importance to crop, animal and human health (e.g. Fe, Zn, Se, I).



Changes in grain and blood selenium since 1985 in Finland after Se-enrichment of NPK fertilizers

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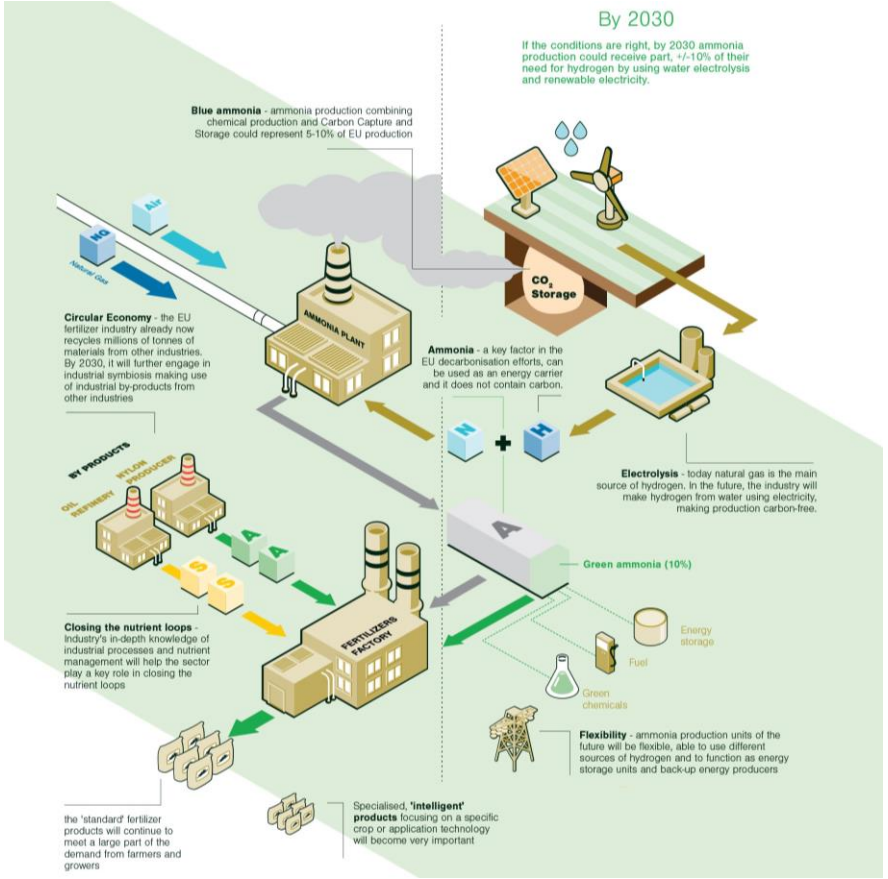
What can be done?

Action 5

Fertilizers will increasingly be produced in an environmentally friendly manner and they will embody greater amounts of knowledge to control the release of nutrients to the plant.

A new “green ammonia economy” could feed and power the world in a whole new, decentralized manner.



Fertilizers Europe

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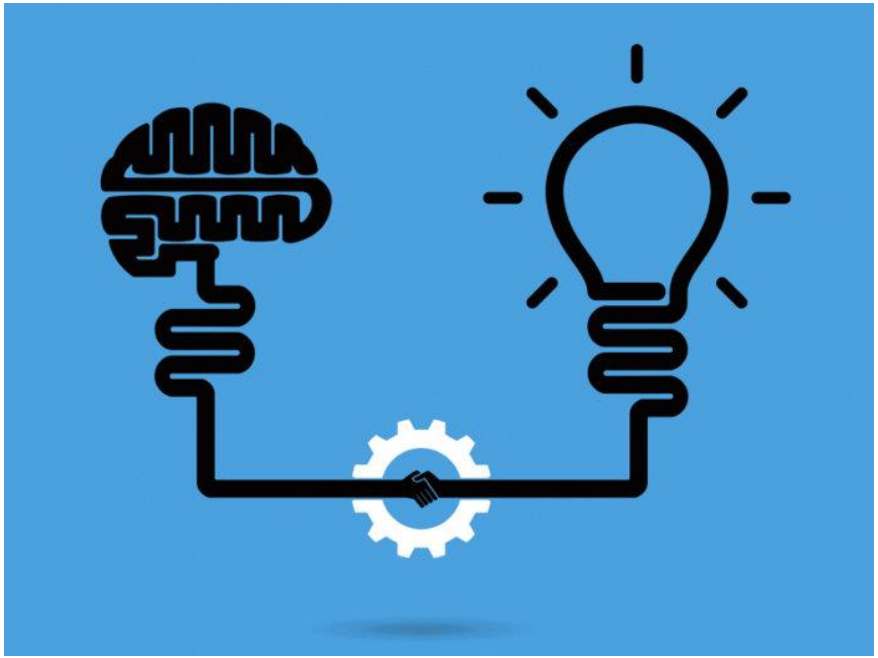
What can be done?

Action 6

Accelerated, more open innovation systems for faster translation of new ideas into practice.

This requires more investment, collaboration, risk taking and entrepreneurship by industry, but also a massive culture change in science and science funding.



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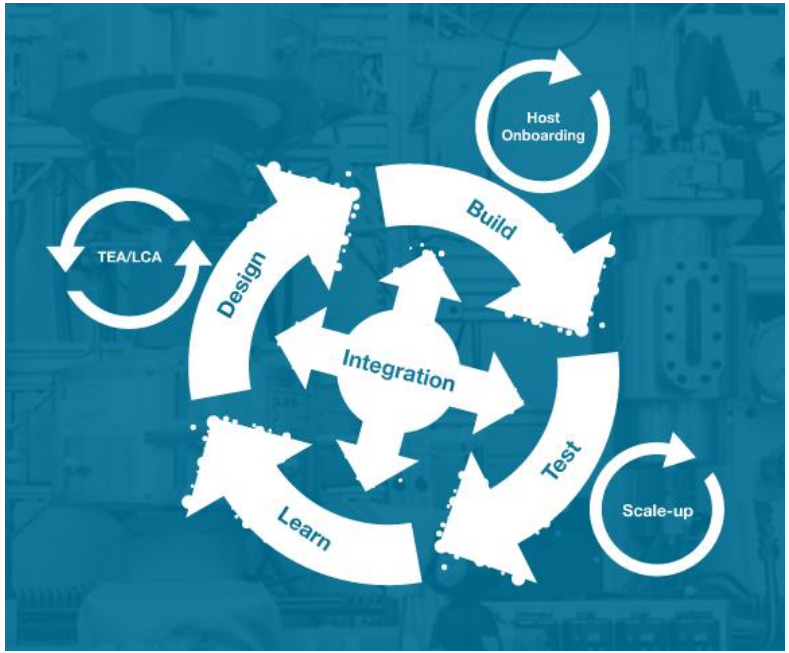
Science is about discovery, ideas generation and building knowledge

Invention is about making something no-one has made before

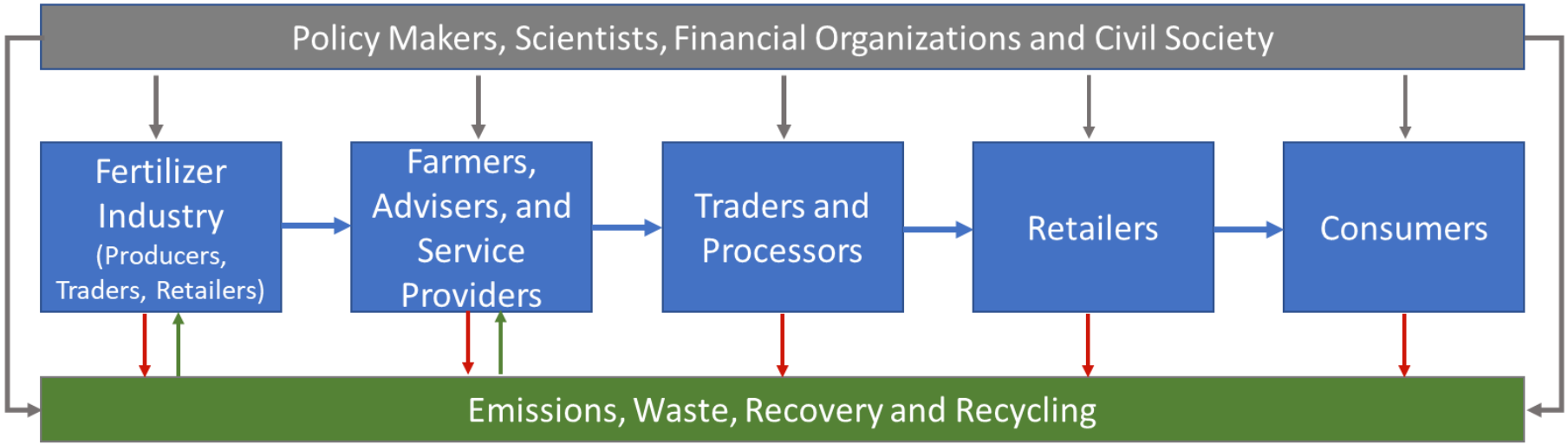
Innovation is the process by which ideas, previous knowledge and inventions are converted into commercially viable products. This requires that they can be translated into practice at scale and their continued use is supported by a viable business model.

Lean Science & innovation



Common: Excellent science – Poor innovation

Who needs to do what?



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Fertilizer Industry Ambitions

1. Reduce greenhouse gas emissions associated with the production of nitrogen fertilizers by at least 30 % per tonne by 2040
2. Improve average global nitrogen use efficiency in crop production from the current level of 50% to 70% by 2040
3. Improve soil health and soil carbon sequestration
4. Double nutrient application rates in sub-Saharan Africa by 2030 and triple them by 2040 to close the large nutrient and yield gaps and eliminate hunger
5. Contribute to eliminating malnutrition caused by micronutrient deficiencies
6. Contribute to increasing nutrient efficiency across the whole food chain

IFA, May 2021

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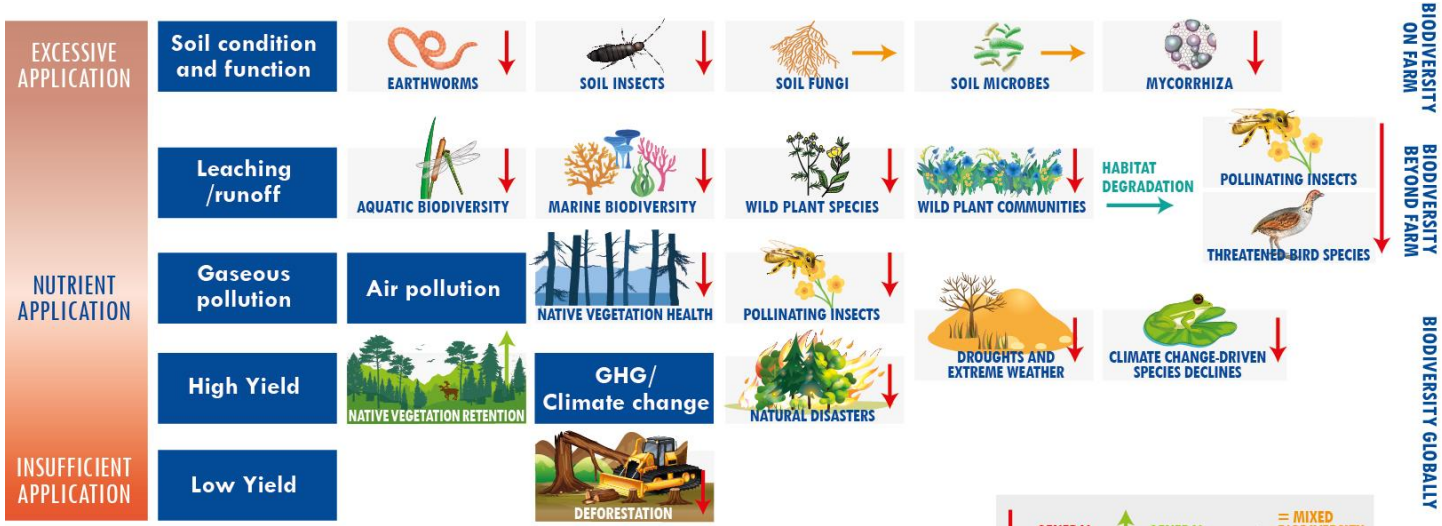
ACHIEVING NATURE-POSITIVE PLANT NUTRITION: FERTILIZERS AND BIODIVERSITY

Issue Brief 02, August 2021



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