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SYMPOSIUM 2022

KNOWLEDGE • OPTIMIZATION • INNOVATION

Stamicarbon 75 YEARS

Stamicarbon's Vision 2030

on sustainable mineral fertilizers

Dr. Harold Borkink

17 May, 2022

Future of agriculture in 2050 (stamicarbon.com)

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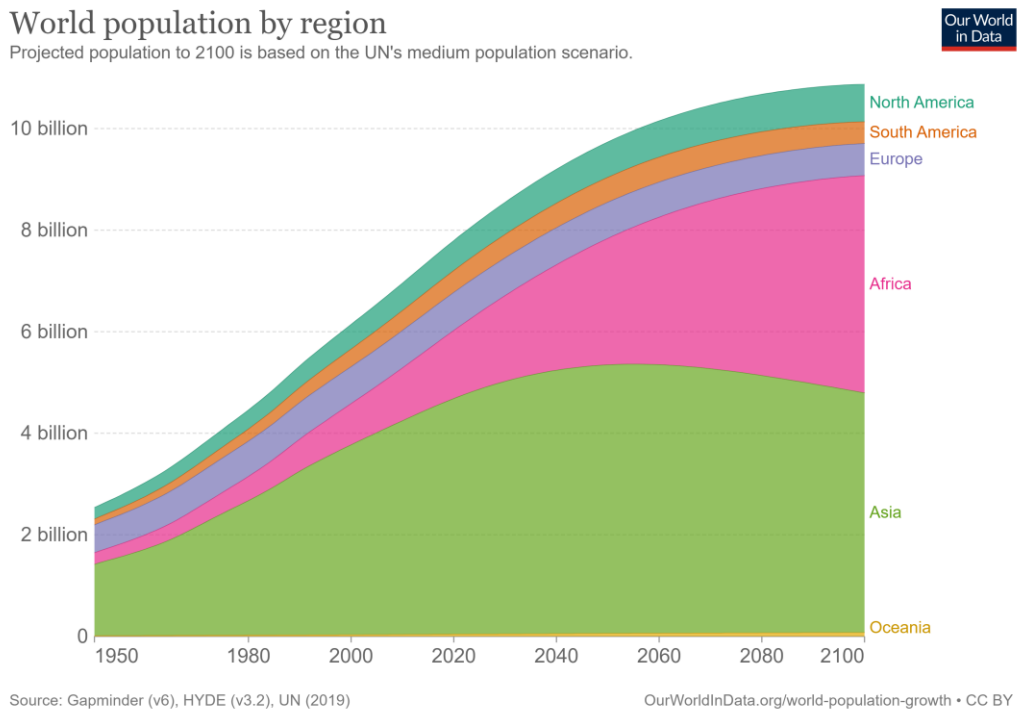
Agenda

- Our world is changing
- Stamicarbon’s vision 2030
- Food/feed system challenges
- Fertilizer's role and challenges
- Technology solutions
- Where it all comes together
- Outlook 2030

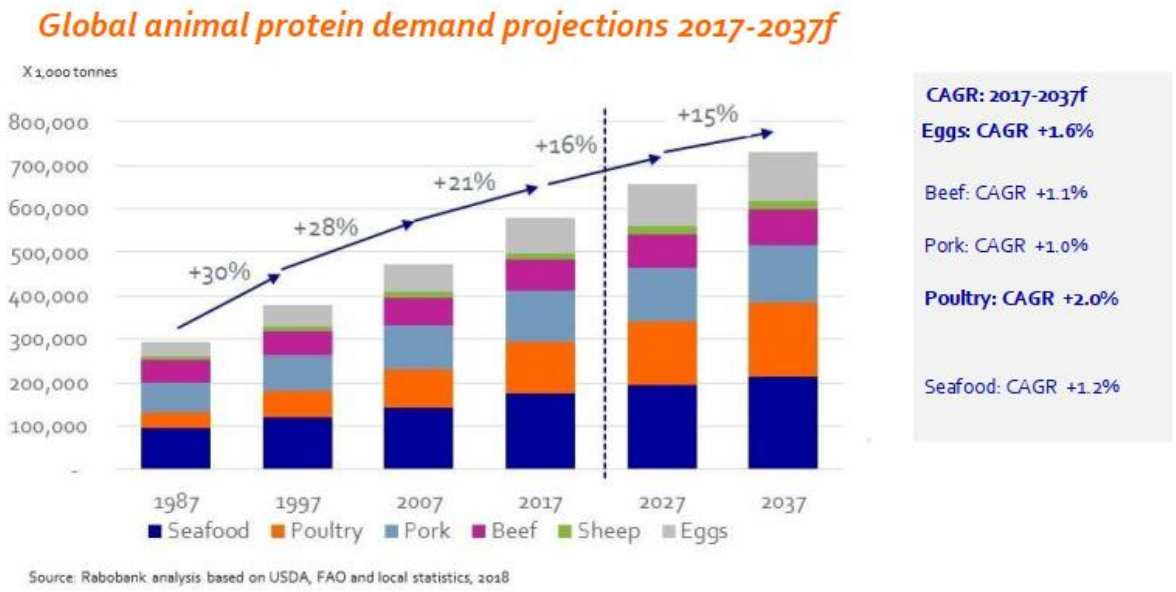
Photo credit: https://www.flickr.com/photos/144683333@N02/

OUR WORLD IS CHANGING…

Growing world population
(2015 => 2030: +1.2 bln)



Increasing livestock
(2015 => 2030: + 20% in weight)



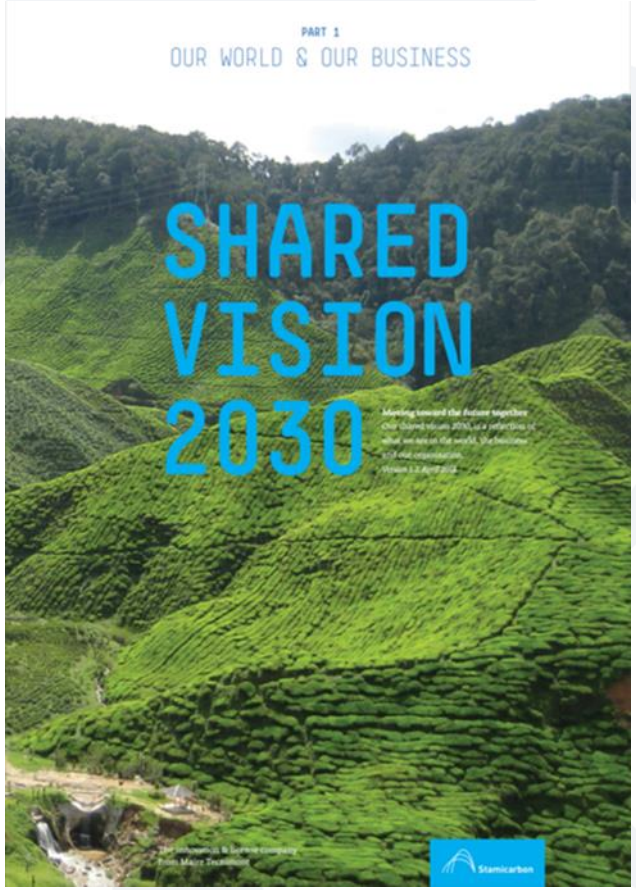
Climate change is impacting our world & agriculture

https://www.noaa.gov/education/resource-collections/climate/climate-change-impacts

Source: The Future Leadership Institute, March 2016

STAMICARBON's VISION 2030

Agriculture will face many challenges in the future and a growing world population will require a drastic increase in food supply.



Questions we asked ourselves:

- How can this growing population be fed, while taking care of our environment?
- What differences can Stamicarbon make?

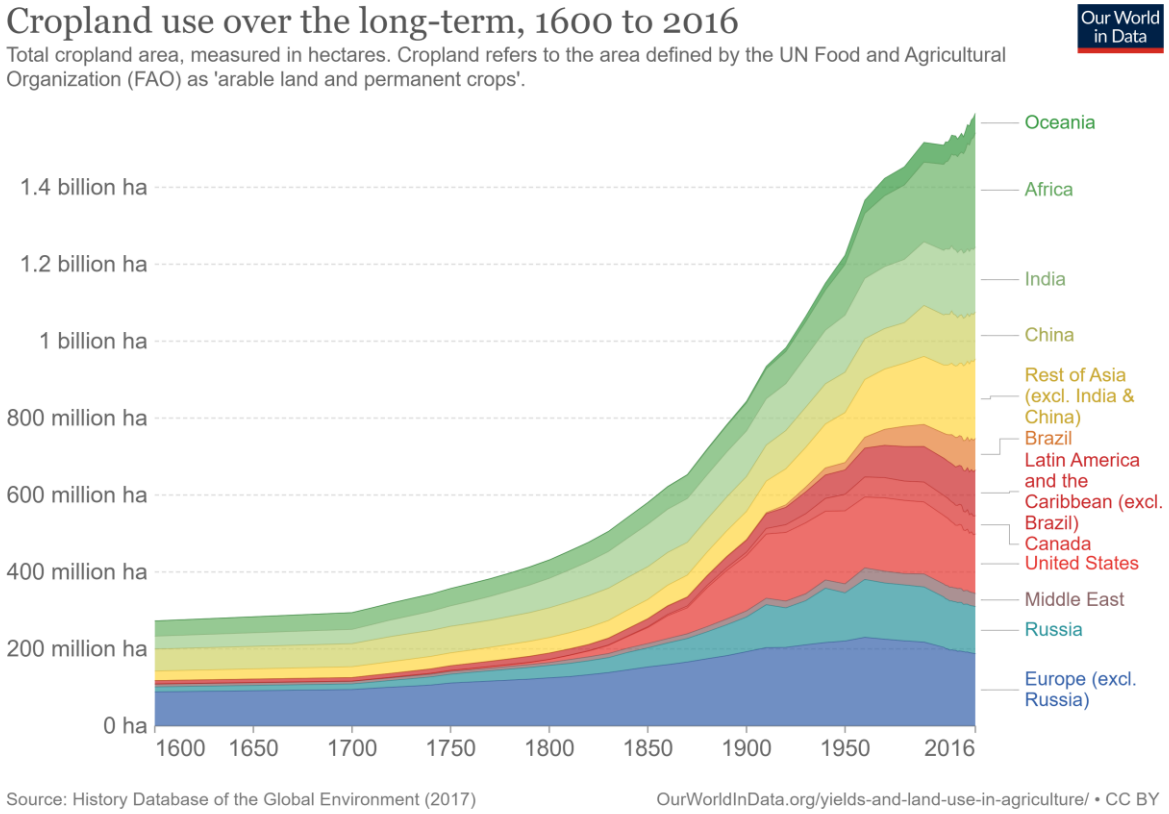
Strategic R&D's innovation ambition focuses on two areas:

✓ Sustainable production of N-based mineral fertilizers
(from sustainable feedstocks and renewable energy sources)

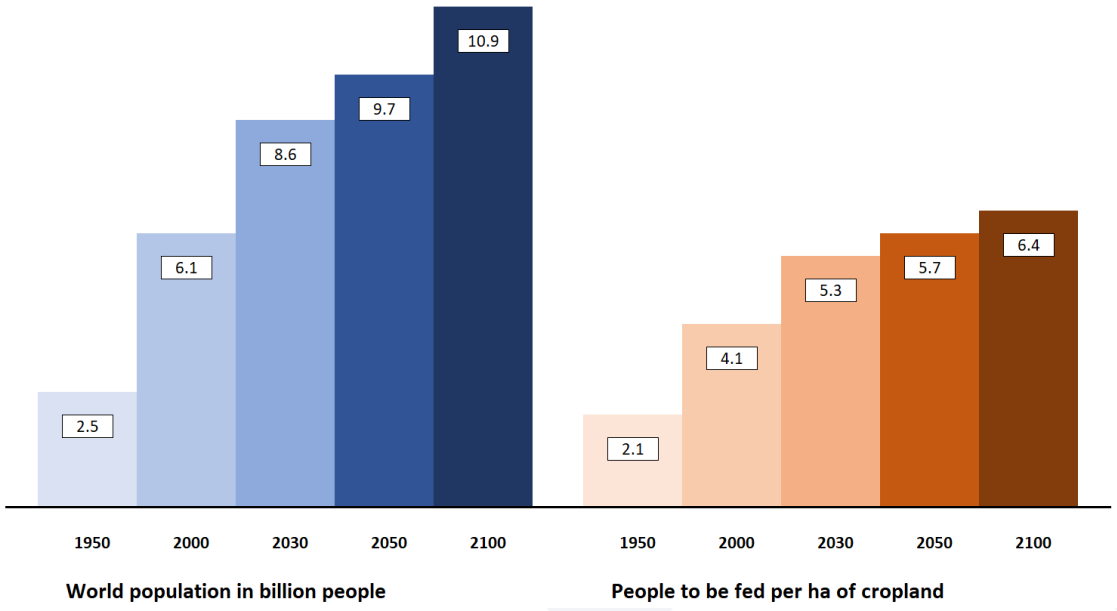
✓ Production of sustainable N-based mineral fertilizers
(delivering the **R**ight nutrients, at the **R**ight rate, at the **R**ight time and in the **R**ight place)

FOOD & FEED SYSTEM CHALLENGES

Limited arable land for crop growing for food and feed.



Increasing # people need to be fed from one hectare of cropland.



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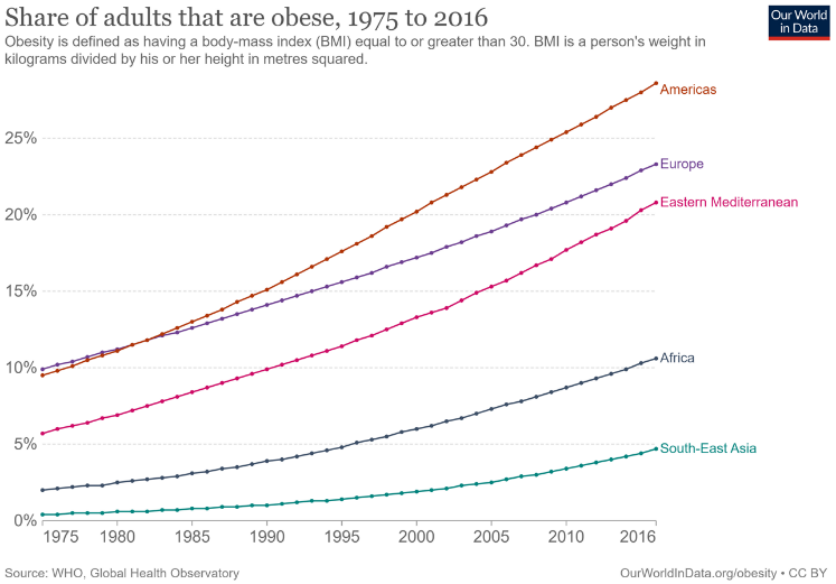
Malnutrition leading to…

> 2 bln people suffering from micronutrient deficiencies

> 2 bln people being overweight or obese

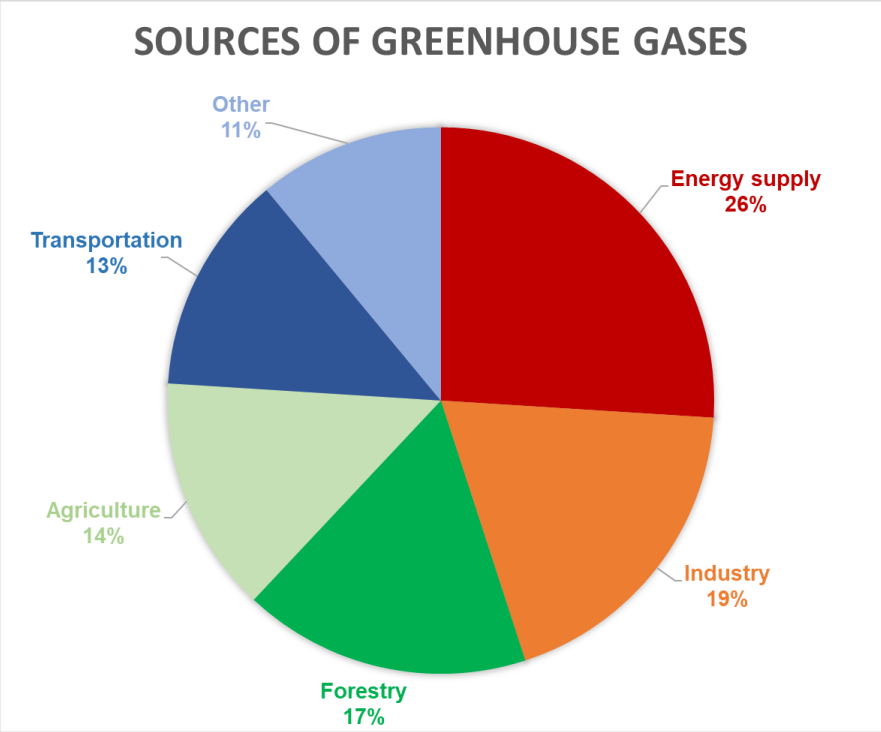
> 650 mln people being undernourished

Photo credit: https://www.flickr.com/photos/byrawpixel/31917913988/



Growing environmental pollution

GHG emissions resulting in climate change



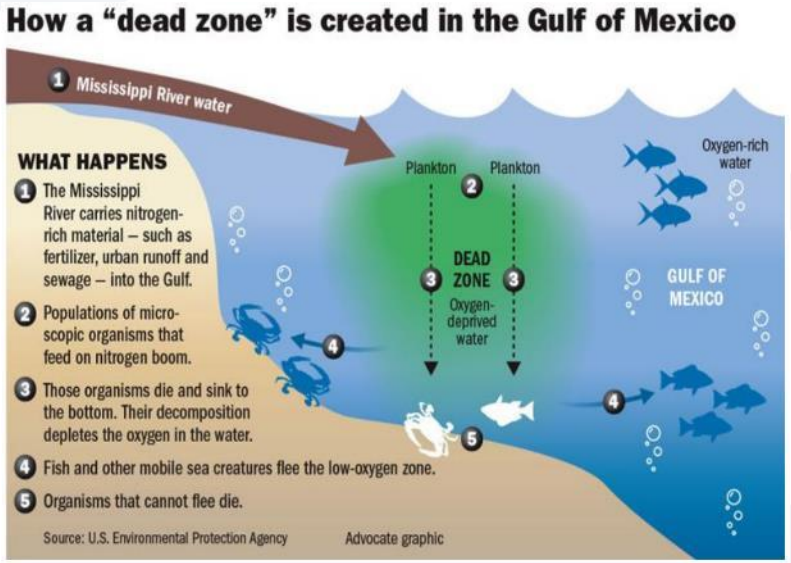
Data source: https://www.agronomy.org/about-agronomy/climate-change/

Photo credit: https://www.flickr.com/photos/48722974@N07/7734530234

Surface water pollution

(from run-off or leaching)

resulting in "dead zones"



Source: Steve Hardy, The Advocate, May 2019

Summarizing:

The food and feed system needs to become:

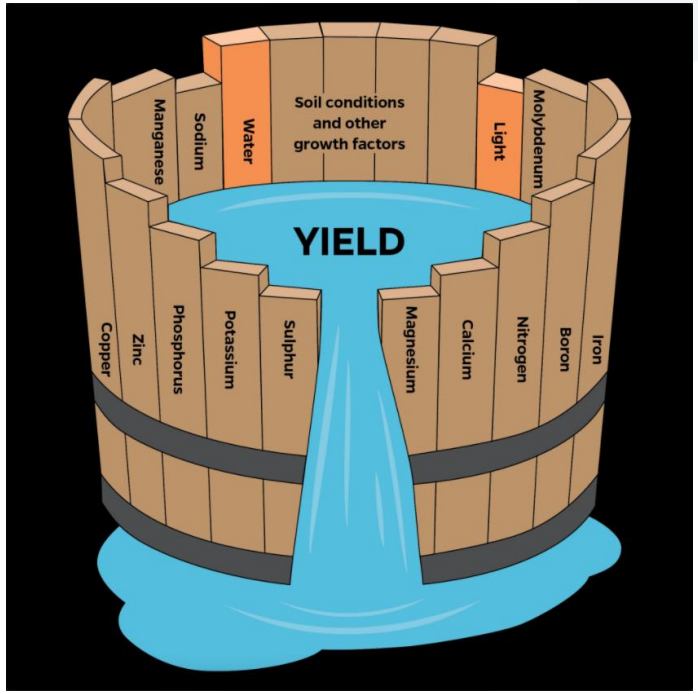
- More FLEXIBLE
- More EFFICIENT
- More HEALTHY
- Less POLLUTING

FERTILIZER'S ROLE AND CHALLENGES

Fertilizers balance the gap between nutrients required for optimal crop development and nutrients supplied by the soil and replenish missing nutrients which are "lost" with harvesting.

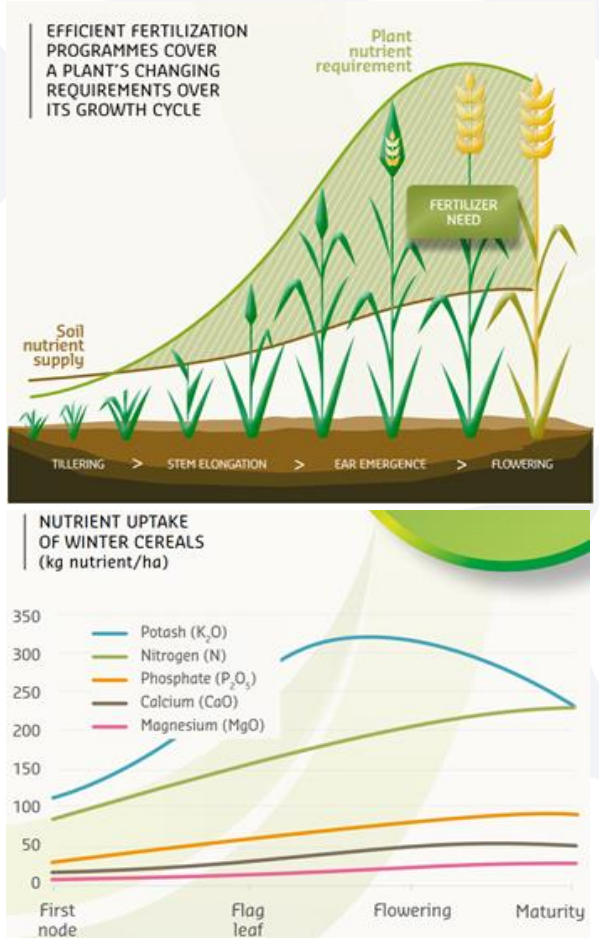
- Liebig's "Law of the Minimum" requires a *balanced supply of nutrients* and of soil and climate conditions.

- Different crops require *different nutrients* for optimal growth and the required *amounts and ratios change during the growth cycle*.



Source: Tripti Vashisth, Citrus Industry Magazine, May 2017,

IMAGE BY UF/IFAS COMMUNICATIONS



Source: Brochure "Nutrient Stewardship", Fertilizers Europe, 2016

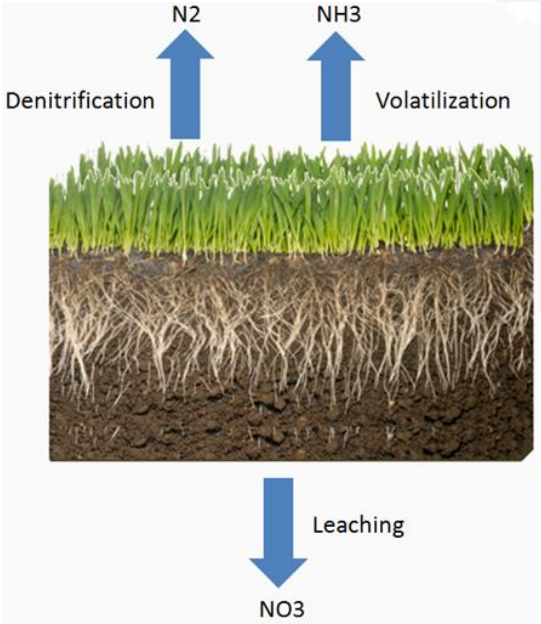
Fertilizers need to become more efficient

N Up to 60% of the nitrogen ends up in the air or in the surface water

P Up to 85% of the phosphorous is unused in 1st year of application

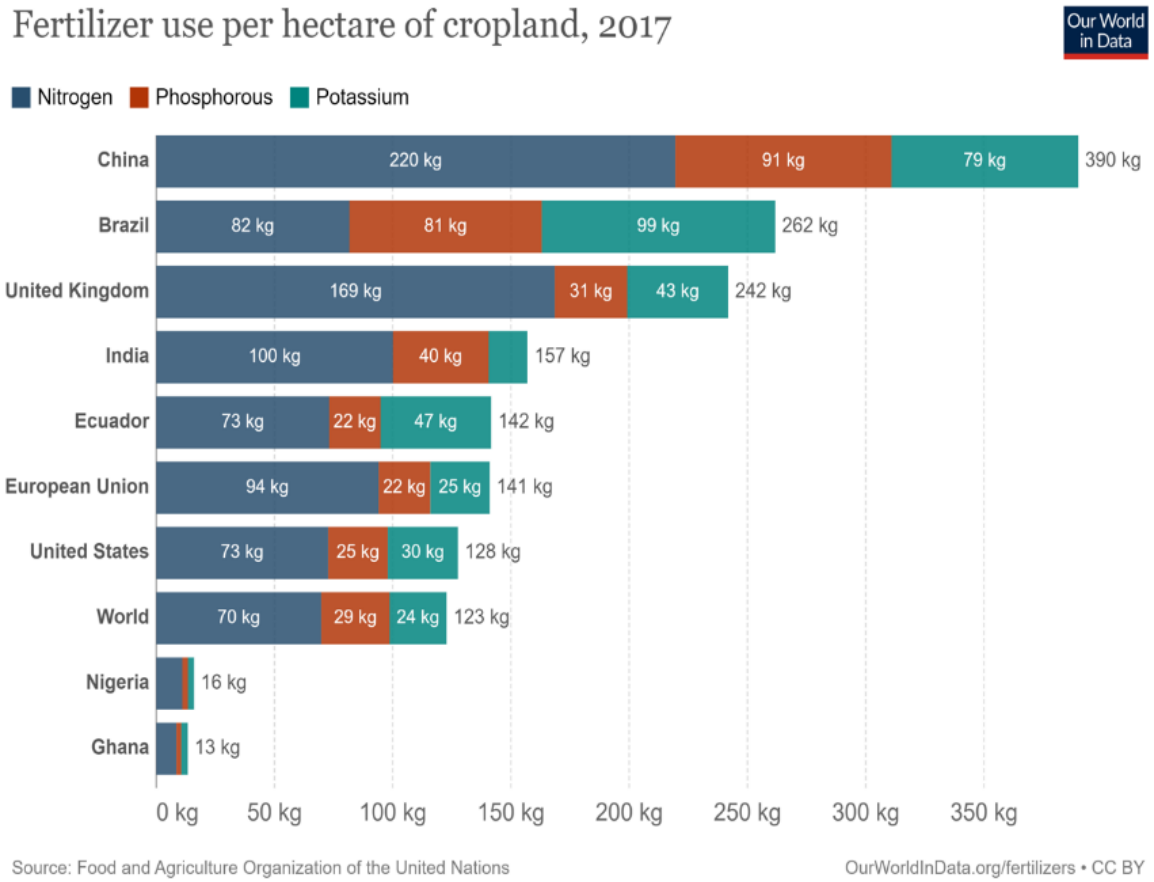
K Up to 55% of the potassium is lost due to leaching or soil erosion

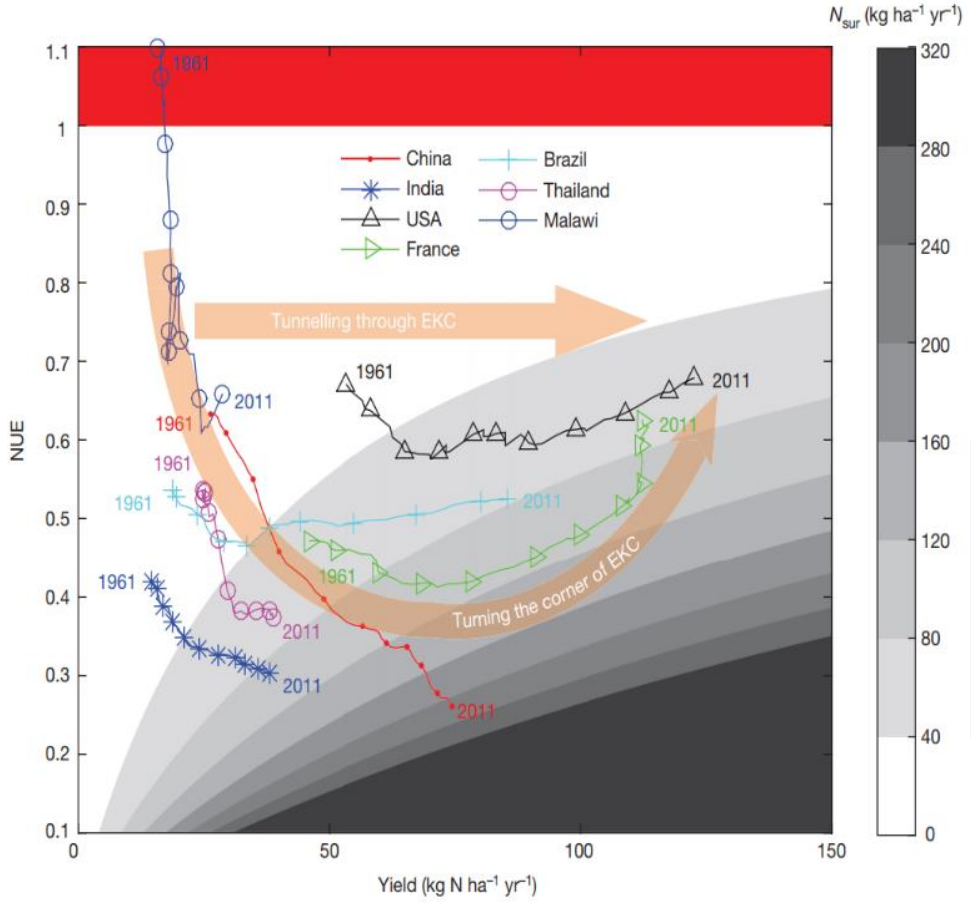
S Up to 80% of the sulfur is immobilized or lost to the surface water



Too high or too low fertilizer application rates

Resulting in low Nutrient Use Efficiencies





Source: Zhang, X., Davidson, E., Mauzerall, D. *et al.* Managing nitrogen for sustainable development. *Nature* **528,** 51–59 (2015). https://doi.org/10.1038/nature15743

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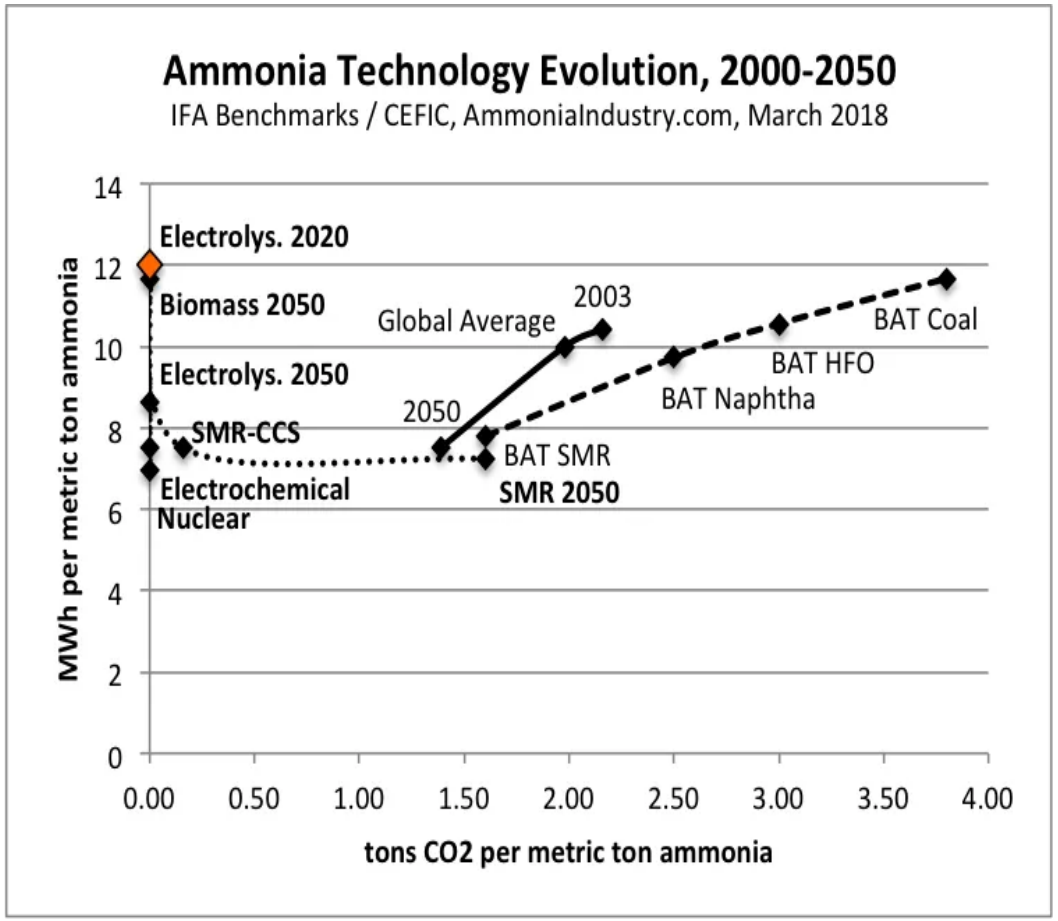
Phosphorous and Potassium are limited resources

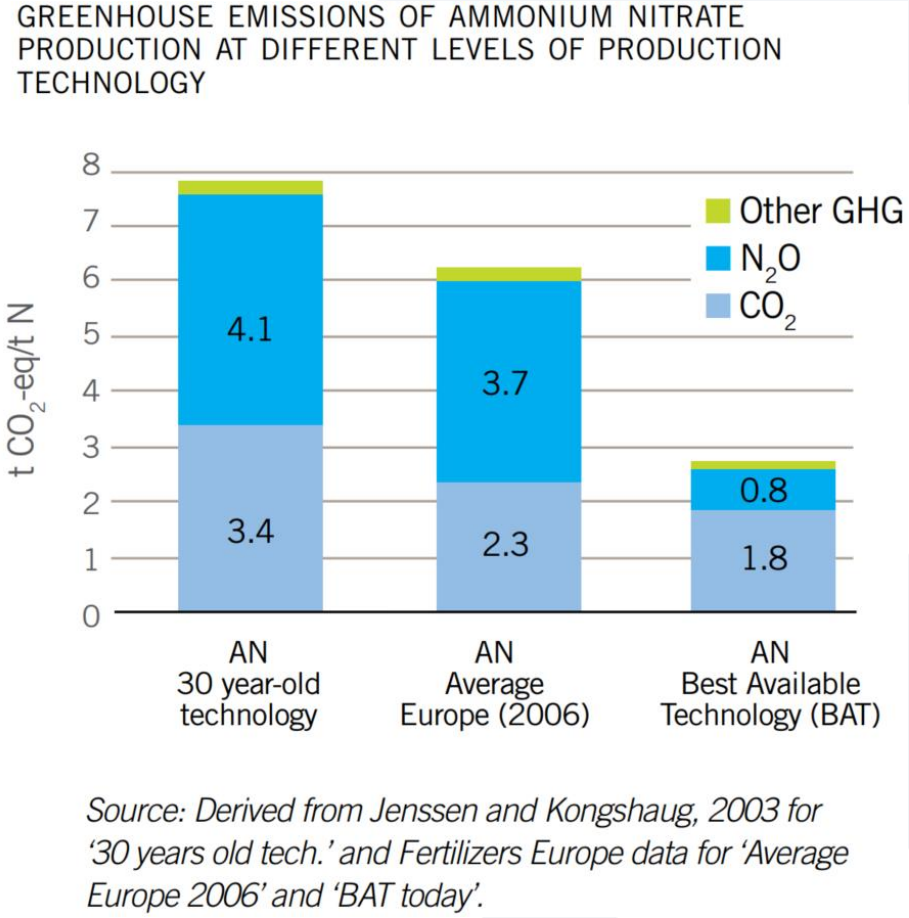
Source: Chris Bennet in Farm Journal AG WEB, August 2020

https://earthobservatory.nasa.gov/images/83905/potash-mine-near-moab-utah

GHG emissions from production of N-based fertilizers



Source: Trevor Brown, "Ammonia technology portfolio: Optimize for energy efficiency and carbon efficiency", Ammonia Energy Association, March 2018



Source: Brentrup and Pallière, "Energy Efficiency and Greenhouse Gas Emissions in European Nitrogen Fertilizer Production and Use", Fertilizers Europe, March 2014

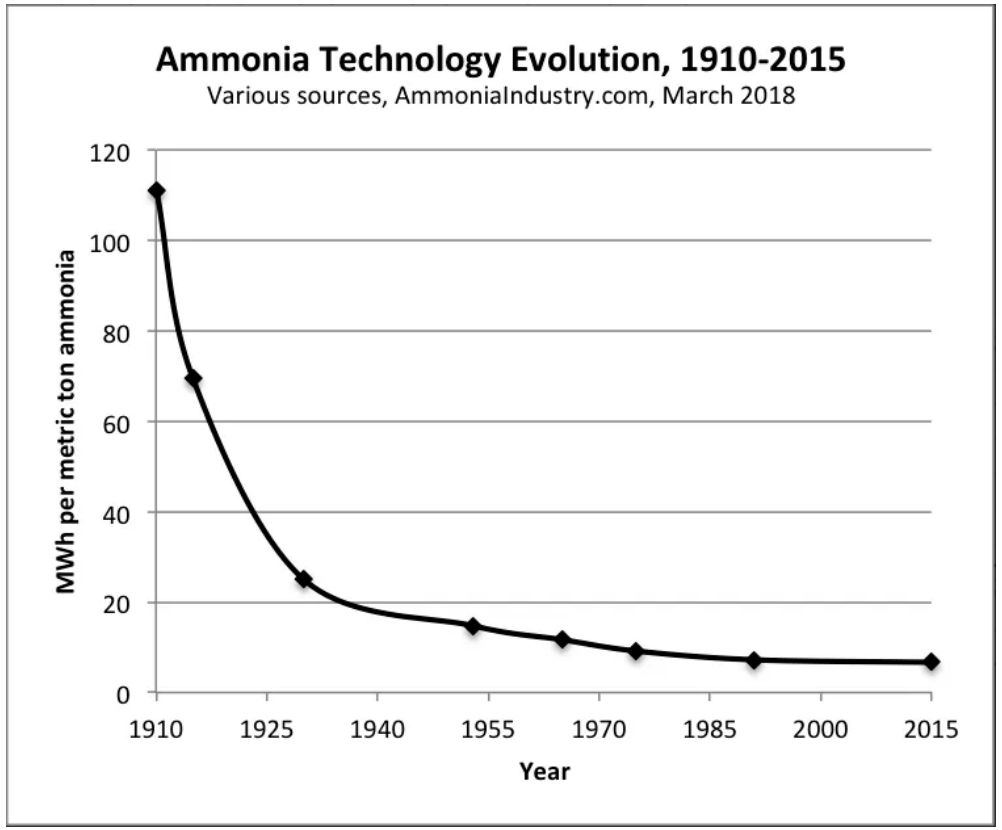
Summarizing:

Fertilizers need to:

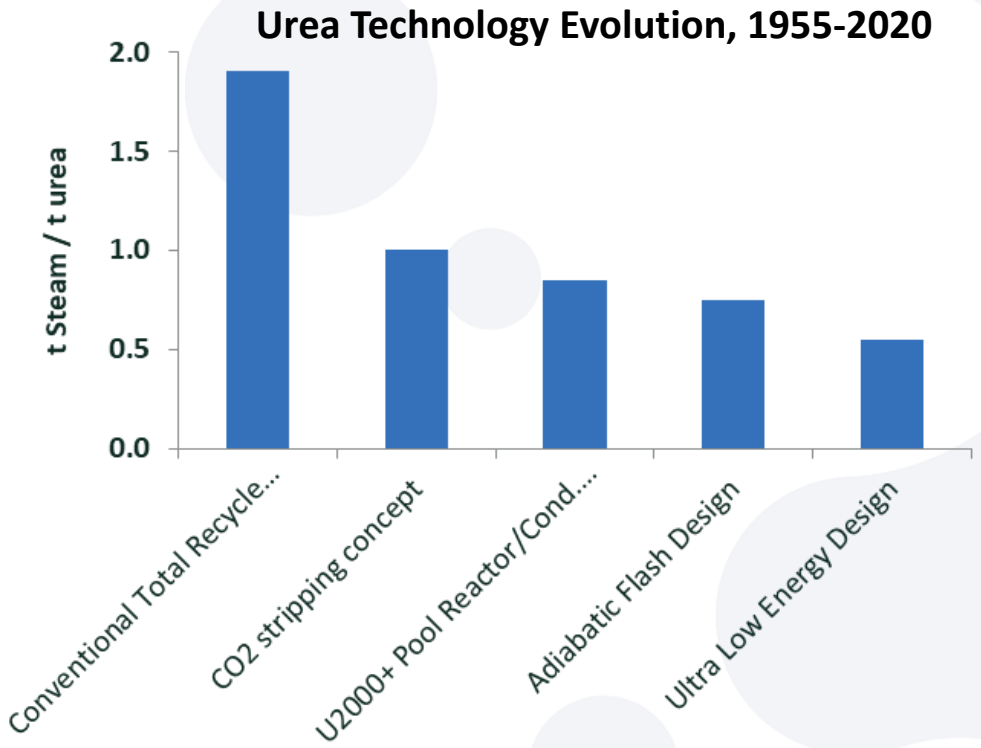
- Supply the RIGHT NUTRIENTS at the RIGHT TIME and in the RIGHT RATE
- Become MORE EFFICIENT and LESS POLLUTING
- Use RECYCLED NUTRIENTS as much as possible
- Be produced with the LOWEST POSSIBLE FOOTPRINT

TECHNOLOGY SOLUTIONS

Lower the energy consumption of fertilizer production



Source: Trevor Brown, "Ammonia technology portfolio: Optimize for energy efficiency and carbon efficiency", Ammonia Energy Association, March 2018



Stamicarbon's continuous technology innovation has reduced the HP steam intake by more than 70%

Make the production of N-based fertilizers green

Step 1: Produce *green Ammonia*

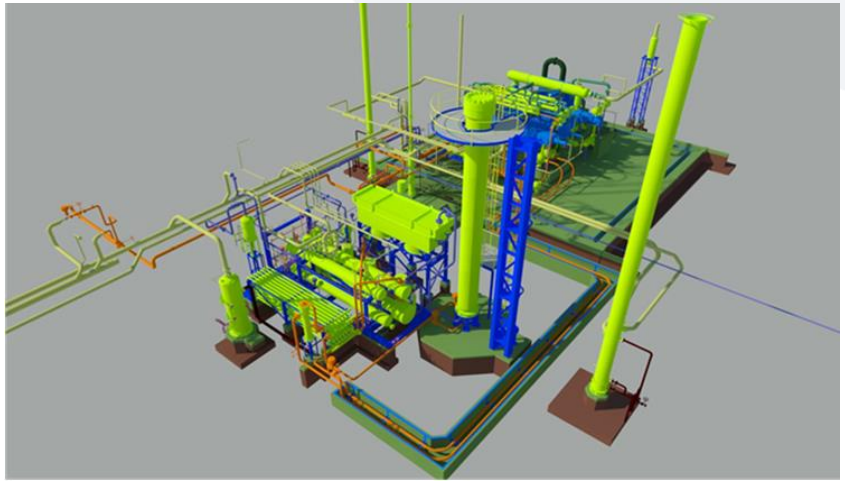
from water and air.

Step 2: Produce *green Nitric Acid*

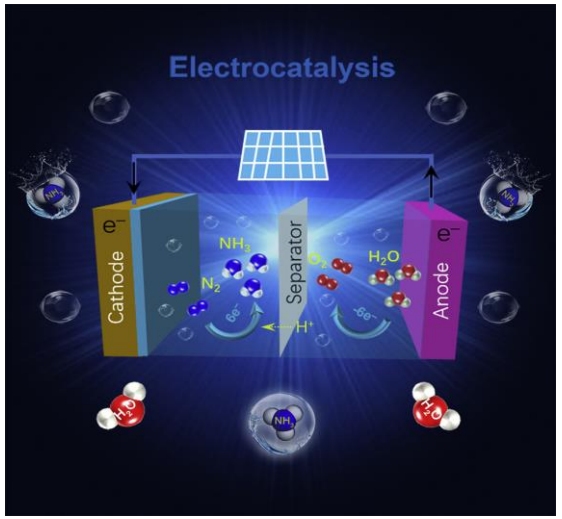
from green ammonia.

Step 3: Produce *green Ammonium Nitrate*

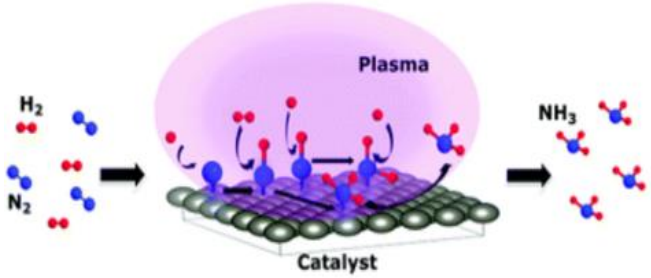
from green Ammonia and green Nitric Acid.



Develop technologies that further lower the footprint



https://www.sciencedirect.com/science/article/abs/pii/S2451929421000383#undfig1



https://pubs.rsc.org/en/content/articlelanding/2019/cp/c9cp01139k

Science 21 NOV 2021 11:38 AM AEDT Share

Pathway for 'green ammonia' opens in new study

https://www.miragenews.com/pathway-for-green-ammonia-opens-in-new-study-677754/

ENERGY

Green ammonia electrolysis breakthrough could finally kill Haber-Bosch

By Loz Blain
November 29, 2021

Listen To This Article

Nearly all the world's current ammonia production uses dirty, steam-reformed hydrogen and a massive amount of energy via the Haber-Bosch process, but Jupiter Ionics' electrolysis device promises to disrupt this landscape saoirse2010/Depositphotos

https://newatlas.com/energy/green-ammonia-phosphonium-production/

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Use small scale units, operated by local people

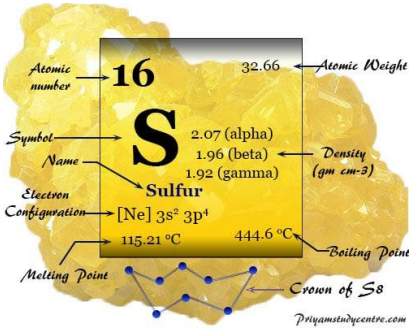
- Distributed production near customer and feedstock
- Source of work and income for local people
- Add units, following the demand for fertilizer
- Enabling multi-purpose plants and production

https://n2applied.com/

https://www.nitricity.co/

https://www.stockholmresilience.org/research/research-news/2016-06-14-the-sdgs-wedding-cake.html

Develop a flexible technology for compounding Urea or Ammonium Nitrate with other nutrients



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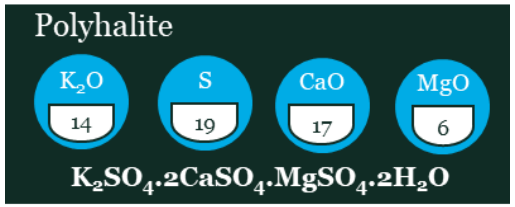
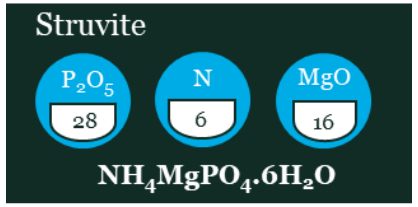
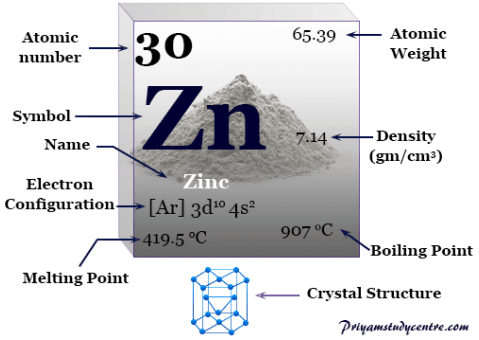
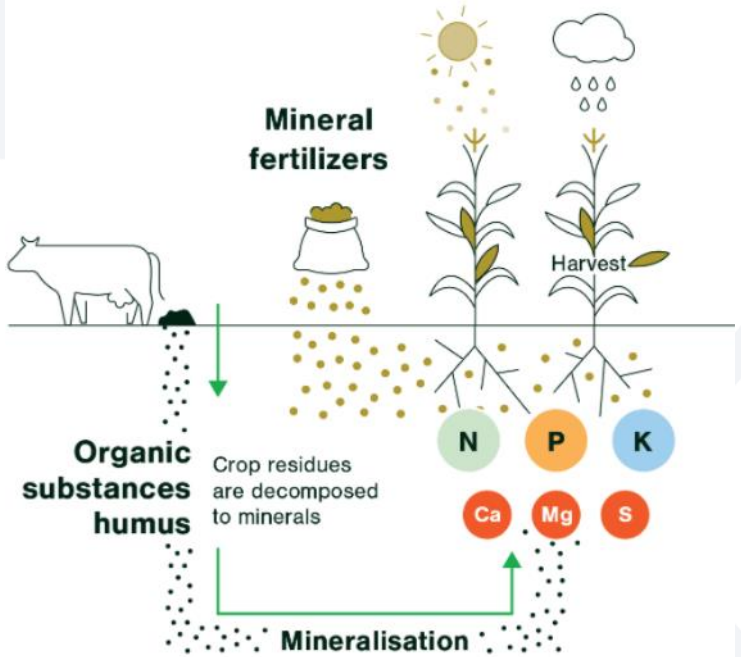




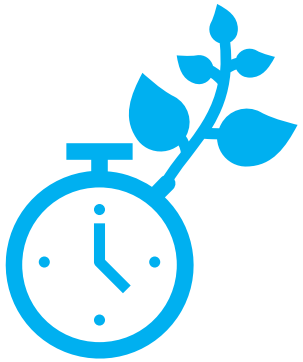


https://www.priyamstudycentre.com/



https://www.fertilizerseurope.com/fertilizers-in-europe/types-of-fertilizer/

Develop flexible technologies for the production of compounded efficiency enhanced fertilizers (EEF's).



Slow-release fertilizers

Controlled-release fertilizers

Stabilized fertilizers

Bio-stimulants

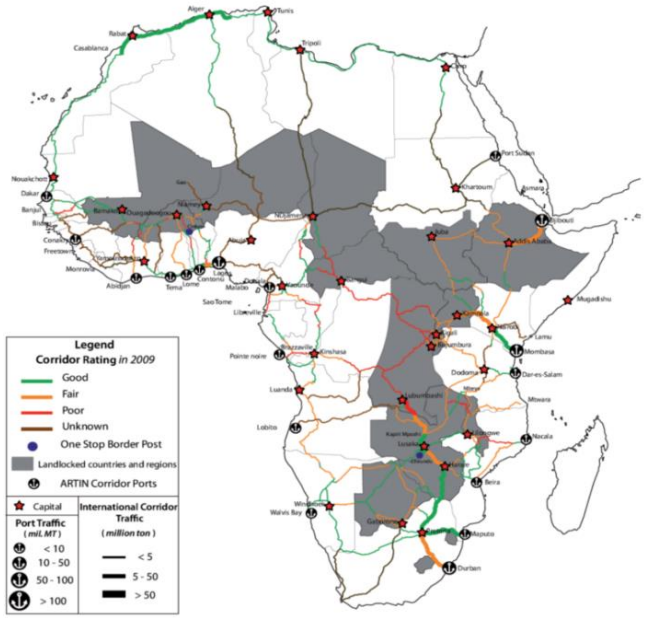
Summarizing:

Fertilizer production technologies are needed that:

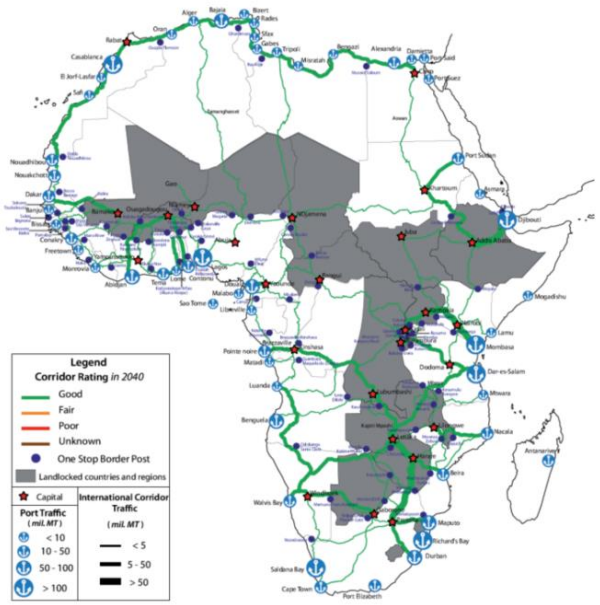
- Have the lowest possible energy usage and emissions
- Do not need a carbon-based feedstock nor energy source
- Are flexible with changing the fertilizer nutrient composition
- Minimize the transportation of feedstock and/or final product

WHERE IT ALL COMES TOGETHER

SSA has an inadequate infrastructure and many countries are landlocked



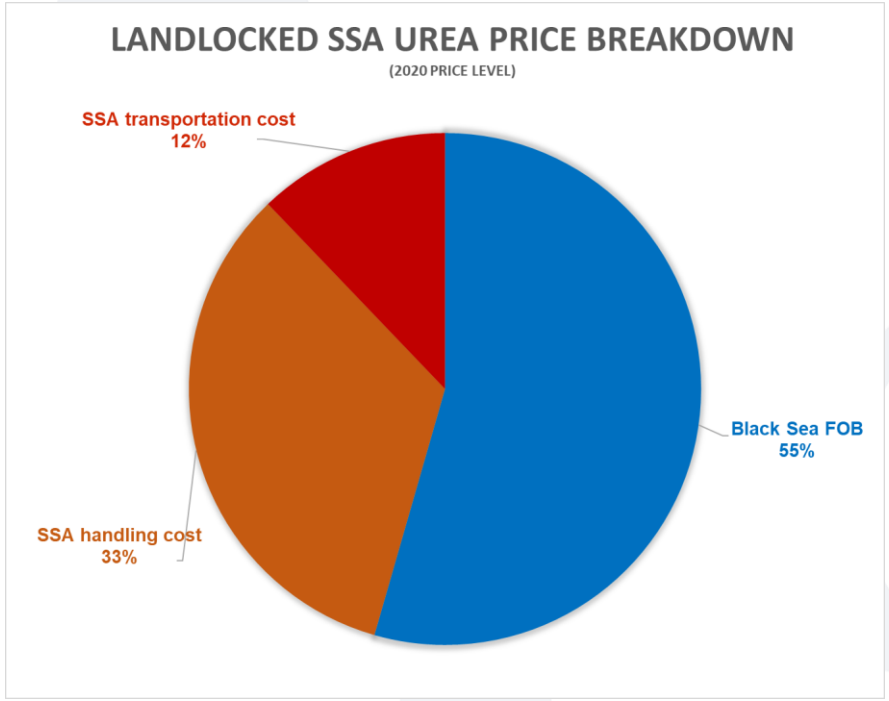
a. 2009

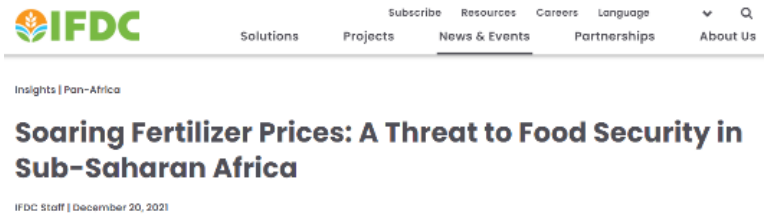


b.2040

Source: Programme for Infrastructure Development in Africa (PIDA), Report "Infrastructure Outlook 2040".

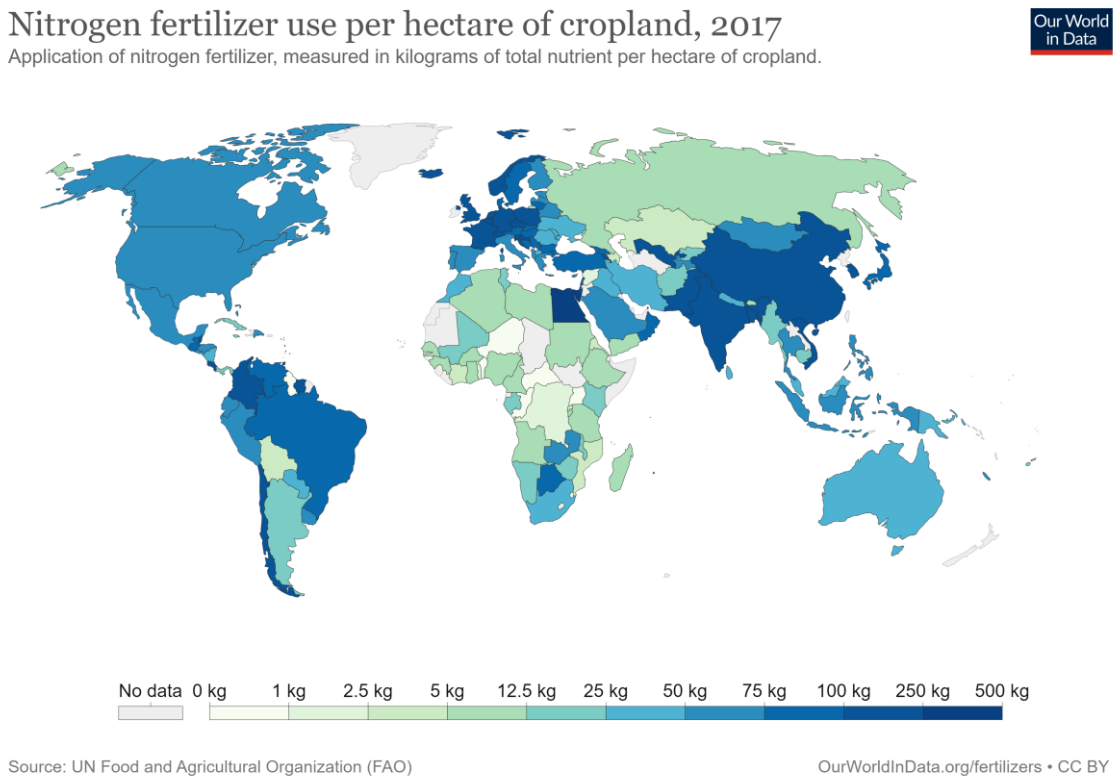
Resulting in high logistics cost and high local fertilizer prices



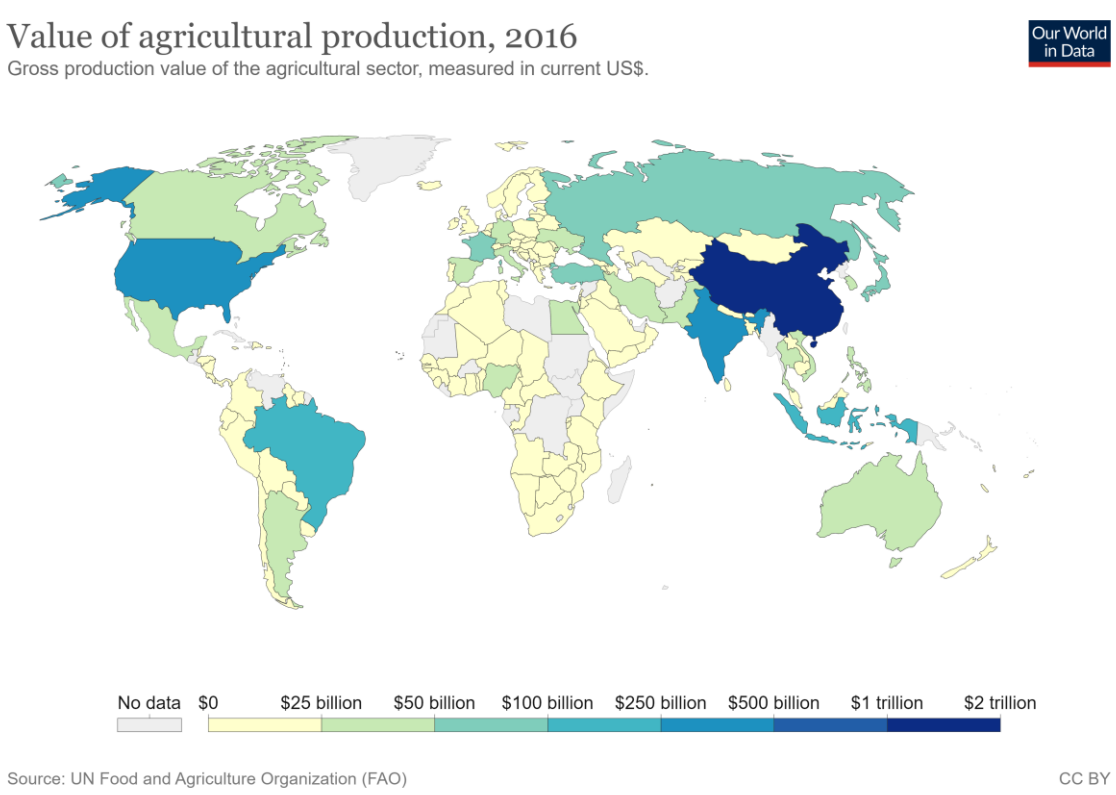


High fertilizer prices in Sub-Saharan Africa

Resulting in a low fertilizer usage



and in low agricultural production



Outlook 2030

What if <u>together</u> we would develop technologies:

- For the sustainable production, carbonless and with the lowest possible energy usage and emissions, of a nitrogen-based fertilizer,
- which can be compounded together with other nutrients in a flexible way, based on local crop and soil needs,
- which releases the nutrients when they are needed, and
- which make use of small-scale units, serving local needs ?

Stamicarbon has embarked on this journey, will you join us ?

Thank you!

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