Challenges = Opportunities for Agricultural Engineers

Mark Moore – President of the Institution of Agricultural Engineers

Meeting the challenge

The Challenge: Food security vs Climate Change vs Profitability

How do we produce more food in a sustainable way that allows farmers (and others in the supply chain) to make a living?

Food Security

Global population is expected to reach 9b by 2050
- FAO – by 2050 we will need to produce 60% more food
  - World Vision – Hunger is worsening worldwide
- World Food Programme (WFP) – 258 million people across 58 countries faced crisis or higher levels of food insecurity

Sustainability (Climate Change)

- **-VE** One-quarter of the world's greenhouse gas emissions result from food and agriculture
- **+VE** Agriculture can sequester carbon from the atmosphere and store it
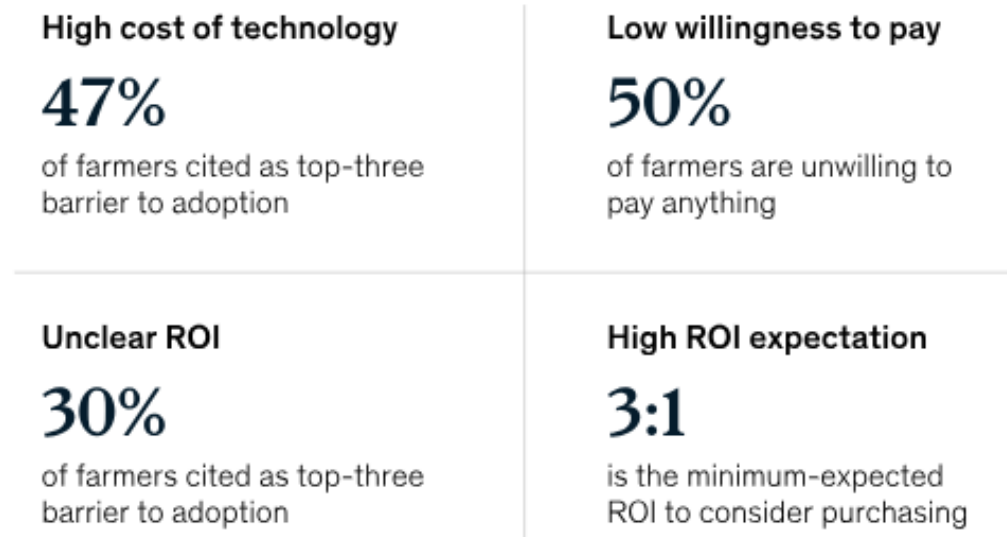
Profitable (ROI)

The high cost of agricultural mechanisation and technology can be a barrier, followed by an unclear ROI
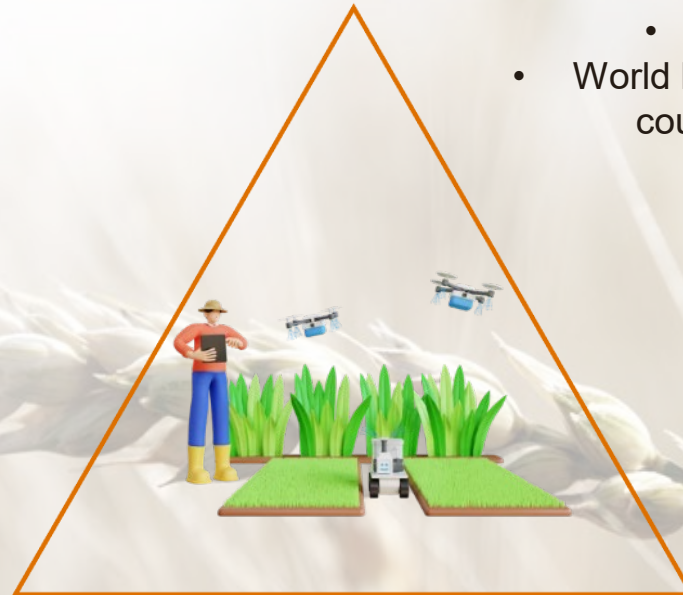
Profitability (ROI)

Farmers are considering investing in Precision Farming technology and adoption rates are slowly increasing
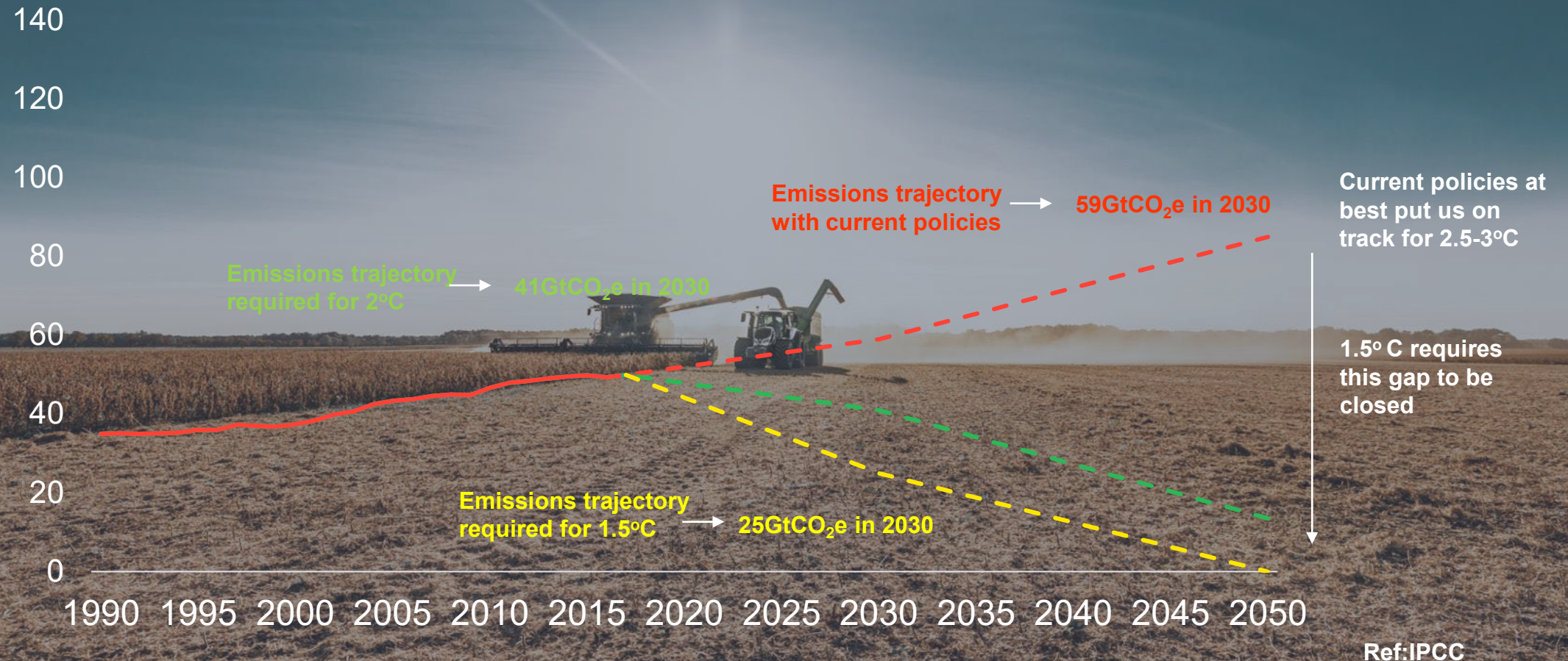- 81% of large farms (5,000+ acres) are most willing to adopt technology
- 76% of medium farms (2,000-5,000 acres)
- 36% of small farms (less than 2,000 acres)
- But:
  - The high cost of agricultural technology is a major barrier, followed by an unclear ROI

High cost of technology

47%

of farmers cited as top-three barrier to adoption

Low willingness to pay

50%

of farmers are unwilling to pay anything

Unclear ROI

30%

of farmers cited as top-three barrier to adoption

High ROI expectation

3:1

is the minimum-expected ROI to consider purchasing

Source: Farmers Global Insights Survey, McKinsey, May 2022; McKinsey analysis

https://www.mckinsey.com/industries/agriculture/our-insights/agtech-breaking-down-the-farmer-adoption-dilemma#/

Sustainability
Without rapid decarbonization we are heading towards 2.5-3°C

Emissions trajectory
with current policies → 59GtCO$_2$e in 2030

Current policies at
best put us on
track for 2.5-3°C

Emissions trajectory
required for 2°C → 41GtCO$_2$e in 2030

1.5°C requires
this gap to be
closed

Emissions trajectory
required for 1.5°C → 25GtCO$_2$e in 2030

140

120

100

80

60

40

20

0

1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
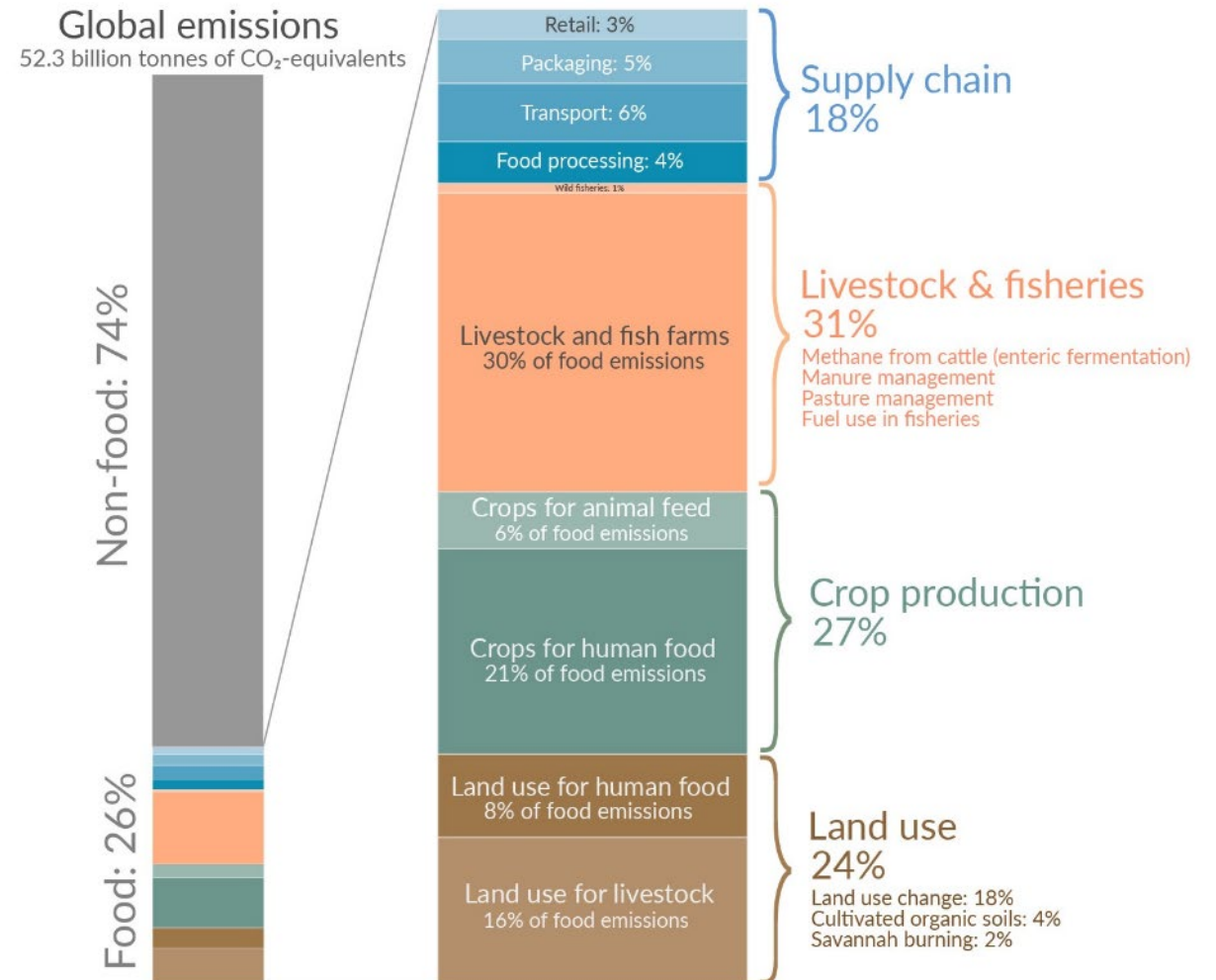
Ref:IPCC

Sustainability
Global greenhouse gas emissions from food production

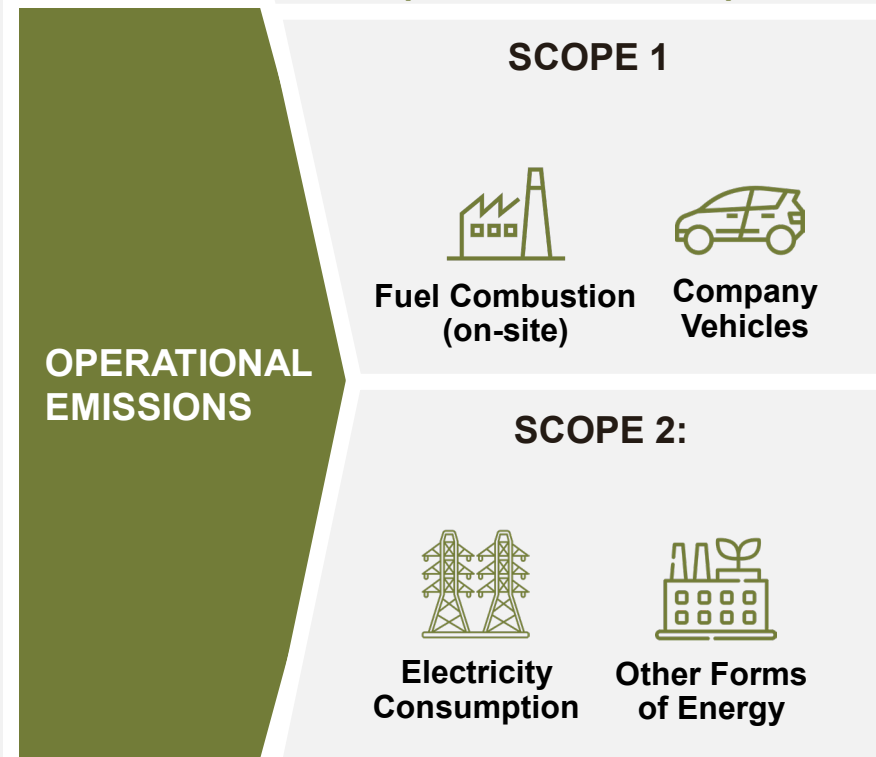Agriculture emissions are bigger than you think

- One-quarter of the world's greenhouse gas emissions result from food and agriculture

- Agriculture and soil management account for 74% of US Nitrous Oxide emissions
  - N_2O is 300 times more harmful than CO_2
  - It also depletes the ozone layer

- Agriculture contributes to 36% of US Methane emissions
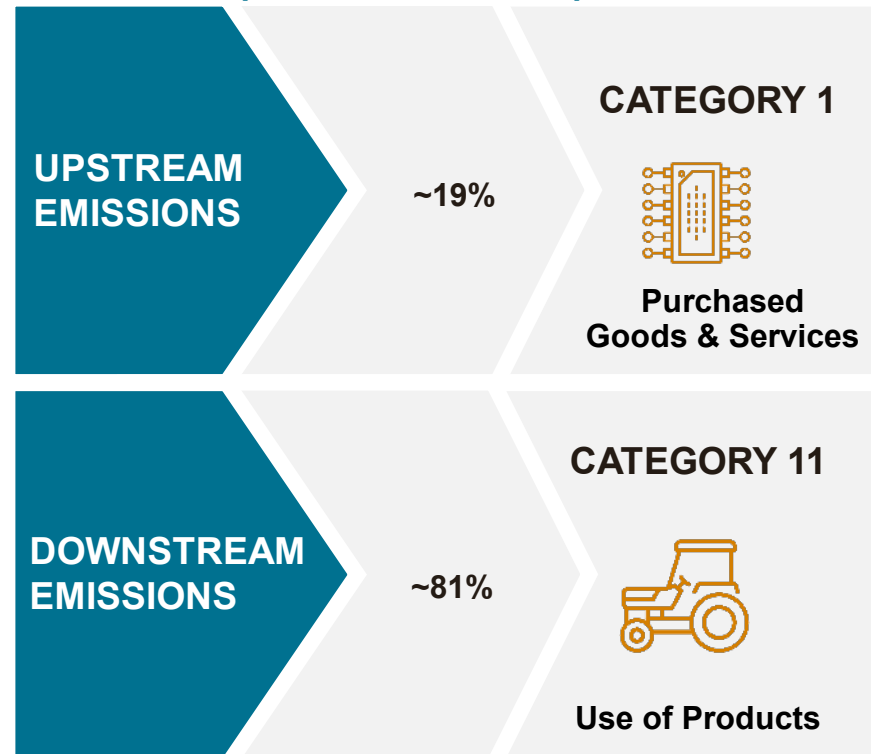 - Methane is 80 times more harmful than CO_2

Global emissions
52.3 billion tonnes of CO_2-equivalents

Non-food: 74%

Food: 26%

Retail: 3%
Packaging: 5%
Transport: 6%
Food processing: 4%
Supply chain 18%

Wild fisheries: 1%

Livestock and fish farms
30% of food emissions

Livestock & fisheries 31%
Methane from cattle (enteric fermentation)
Manure management
Pasture management
Fuel use in fisheries

Crops for animal feed
6% of food emissions

Crops for human food
21% of food emissions

Crop production 27%

Land use for human food
8% of food emissions

Land use for livestock
16% of food emissions

Land use 24%
Land use change: 18%
Cultivated organic soils: 4%
Savannah burning: 2%

5

Sustainability
Decarbonising Value Chains

SUB-TITLE

SCOPE 1 AND 2 (OPERATIONS)

SCOPE 3 (VALUE CHAIN)

SCOPE 4 (ON FARM)?

OPERATIONAL EMISSIONS

SCOPE 1

Fuel Combustion (on-site)

Company Vehicles

SCOPE 2:

Electricity Consumption

Other Forms of Energy

UPSTREAM EMISSIONS

~19%

CATEGORY 1

Purchased Goods & Services

DOWNSTREAM EMISSIONS

~81%

CATEGORY 11

Use of Products

AVOIDED EMISSIONS
On Farm

Food security

UN population projections to 2100

Global population is expected to reach 9b by 2050

FAO– by 2050 we will need to produce 60 per cent more food

World Vision– Hunger is worsening worldwide

World Food Programme (WFP) 258 million people across 58 countries faced crisis or higher levels of food insecurity

- Food waste is a problem mainly in industrialized countries
    - Per capita waste by consumers is between 95 and 115 kilogrammes a year in Europe and North America
- Can the planet sustain 9b people on an animal rich diet by 2050?
    - It takes 1,500 litres of water to produce a kilogramme of cereal and 15,000 to produce one kilogramme of meat
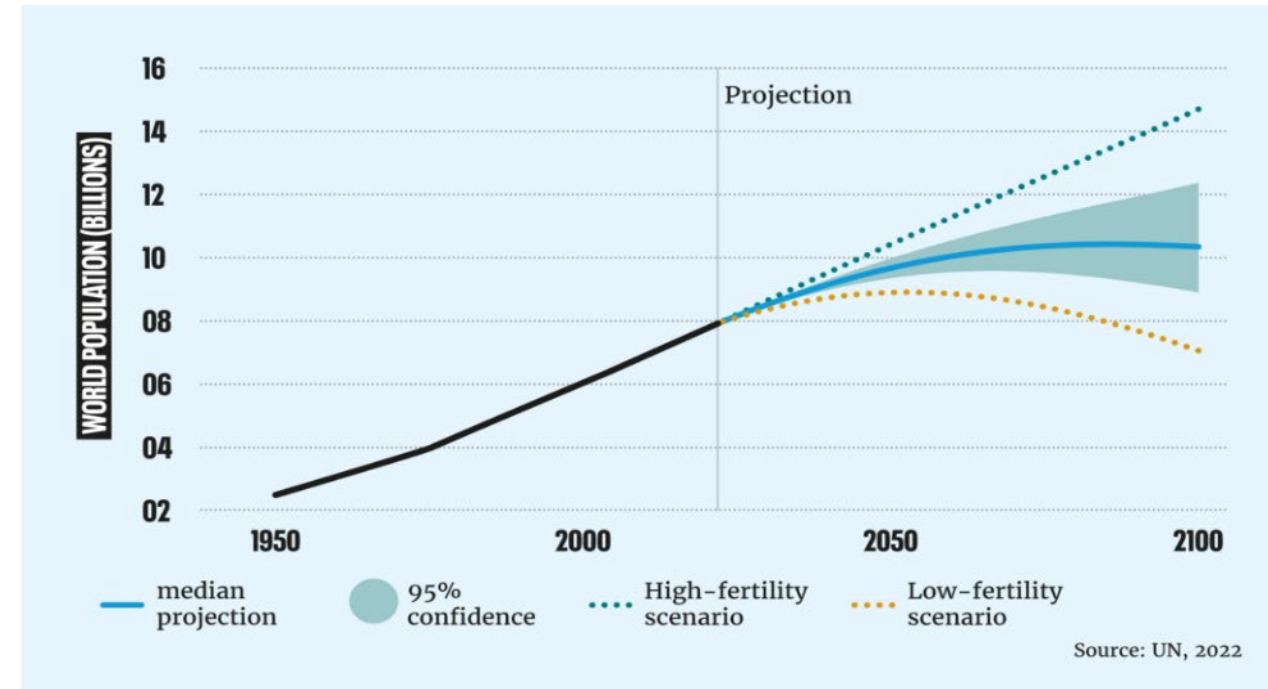
Food security

The resilience of food production

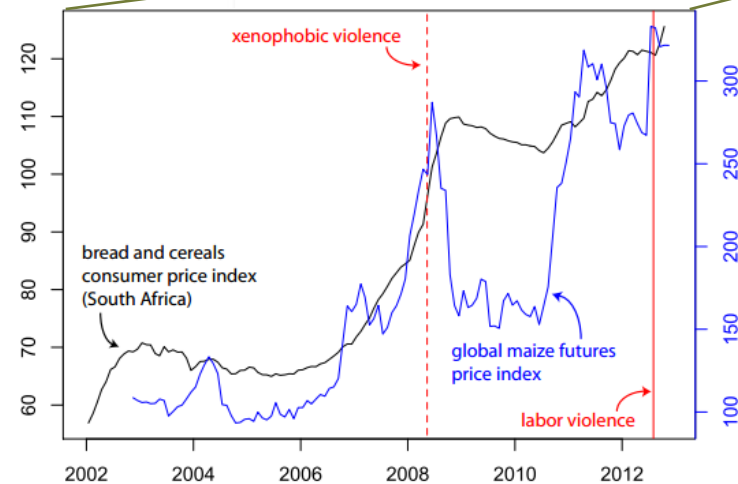2008 – food crisis caused by droughts and other weather-related events

2011 – high prices caused by very dry conditions in the United stated and Europe, and high oil prices increasing demand for biofuels

- The World Bank warned the global economy was "one shock away" from a food price crisis

- Food prices continue to be high, especially in Africa

2021 – war in Ukraine, Covid 19, and the influence of climate change

FAO Food Price Index

The FAO Food Price Index (FFPI) is a measure of the monthly change in international prices of a basket of food commodities
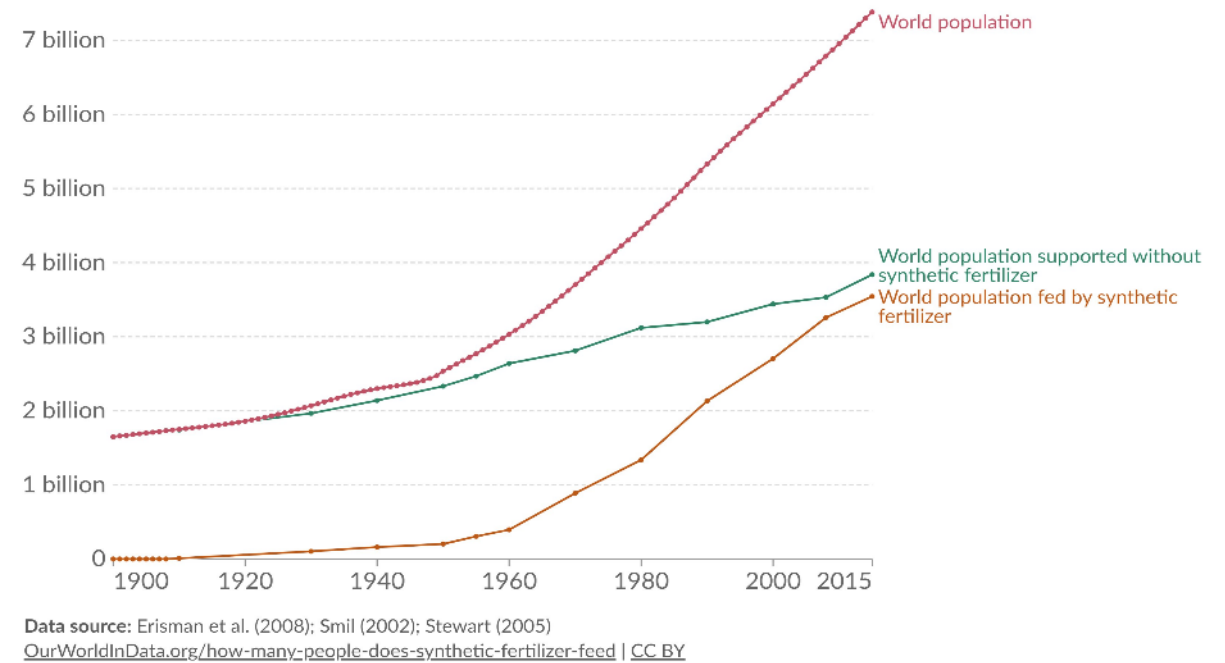

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https://www.bbc.co.uk/news/av/business-13110449
https://www.un.org/en/food-systems-summit/news/2021-going-be-bad-year-world-hunger
https://www.technologyreview.com/2013/07/24/15598/south-africa-riots-and-the-price-of-food/

Food security

Fertiliser

Nitrogen fertiliser supports approximately half of the global population

How do we reduce reliance on N while maintaining food security and employing sustainable farming practices?

Data source: Erisman et al. (2008); Smil (2002); Stewart (2005)
OurWorldInData.org/how-many-people-does-synthetic-fertilizer-feed | CC BY

https://ourworldindata.org/how-many-people-does-synthetic-fertilizer-feed

Food security

Pesticides

Pesticides play a critical role in reducing diseases and increasing crop yields worldwide

Without pesticides, 35 % of the potential global crop yield is lost to pre-harvest pests

- 78% loss of fruit
- 54% loss of vegetable
- 32% loss of cereals

However:

- 75% of insects in Germany have declined in the last 30 years
- ~ 40% of all flying insect species world-wide are threatened with extinction
- 80% of soils in the EU are already polluted with pesticides, which could affect their fertility and productivity
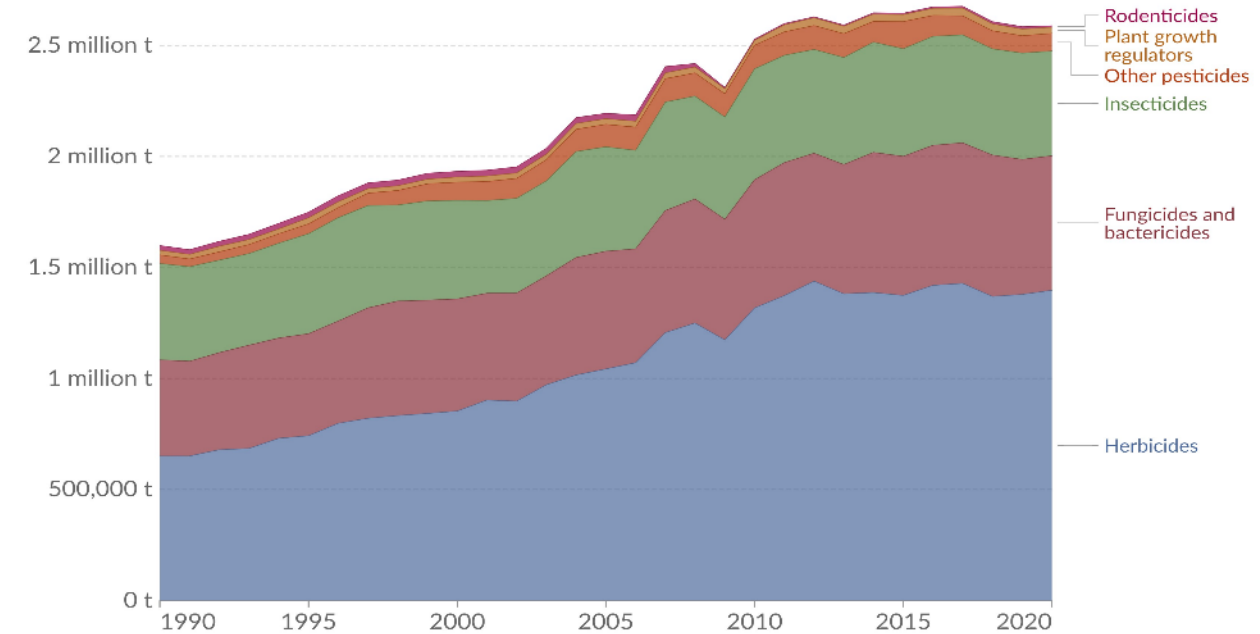
Data source: Food and Agriculture Organization of the United Nations   OurWorldInData.org/pesticides | CC BY

https://link.springer.com/article/10.1007/s13593-012-0105-x
https://ourworldindata.org/pesticides
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7908628/#:~:text=About%20one%2Dthird%20of%20agricultural,32%25%20loss%20of%20cereal%20production

The challenge requires farmers to modernise farming practices

Soil Preparation
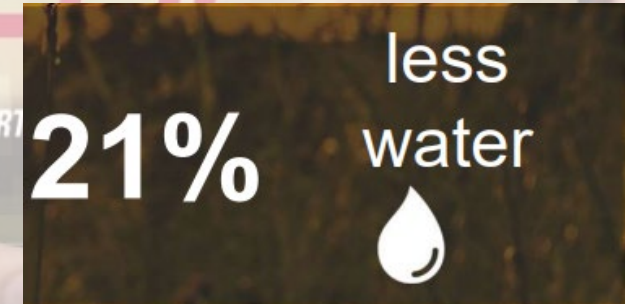

Planting

Nutrition & Protection

Harvest

Harvest

IAgrE

Opportunities – Precision Agriculture – Further Potential

Annual crop production could increase a further 6% with a broader adoption of Precision Farming technologies

Wider adoption of precision ag technology has the potential to provide significant improvements

14% Improvement in fertilizer placement efficiency	**15%** Improvement in herbicide application efficiency
16% fewer fossil fuels	**21%** less water

Source: AEM

Opportunities – Machine Automation

Tractor guidance systems

Auto headland turns

Central Tyre Inflation System

Auto seed depth control according soil moisture content

Opportunities – Robotics

- **Probably the first sector to adopt robotics**
- **Specialist high value growers**
  - **Fruit**
  - **Salad**
  - **Vegetables**
- **Replace labour, which is getting harder to find**

Opportunities – Carbon Farming

1ha of broadleaf woodland sequesters 4,761kg CO_2 per year

1,000m of flailed hedgerow sequesters 1,175kg CO_2 per year

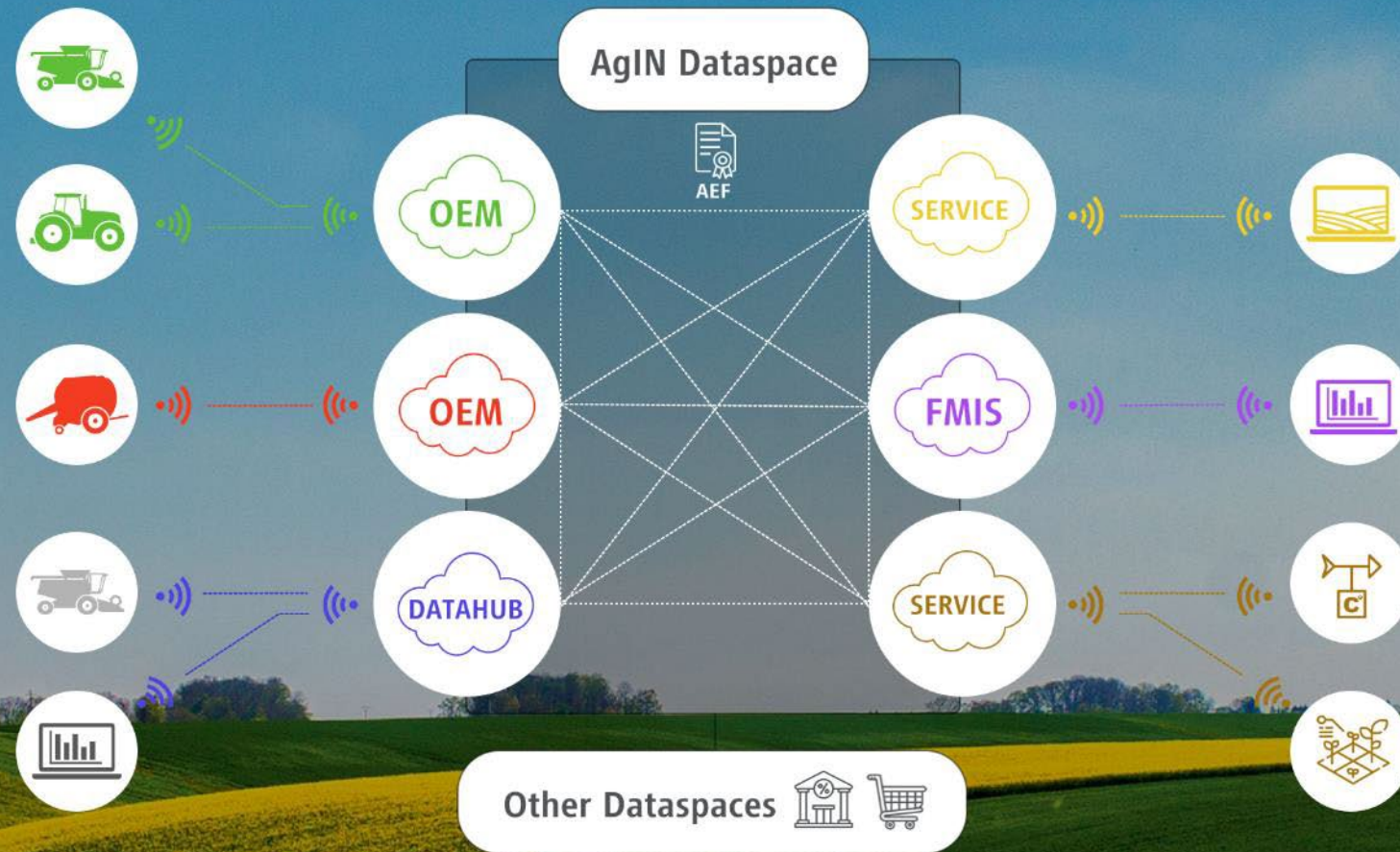

1,000m of uncultivated field margin sequesters 595kg CO_2 per year

0.1% per ha per year increase in soil organic matter sequesters **8,900kg** CO_2

Opportunities – Digital Farming & Interoperability (AEF)

Opportunities – Artificial Intelligence

- **Crops**

- "Expert Systems"

- Digitally simulate farms

- Accurately predict parameters such as output, nutrient losses and pest attacks

- **Machines**

- Increase machine performance & efficiency

- Increase machine up-time

- Predict potential breakdowns based on machine usage

Opportunities – Artificial Intelligence

- **Animal Husbandry**

- Animal monitoring systems

- Detect animal disease & curb contagious diseases

- Behaviour patterns

- **Protein production**

- Animal welfare - Improve conditions for animals

- Reduce animal stress

- Provide avian disease mitigation

Summary

- There has never been a more exciting time to be an agricultural engineer!

- The challenge is enormous
  - FAO – 60% more food by 2050 while reducing impact on the environment and maintaining profitability

- Collaboration is essential
  - We need to communicate across the food sector

- Governments & the food chain recognise sustainable food security cannot be achieved without smart technologies and digital transformation