The socio-economic and environmental contributions of plant breeding in the UK and EU

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Content

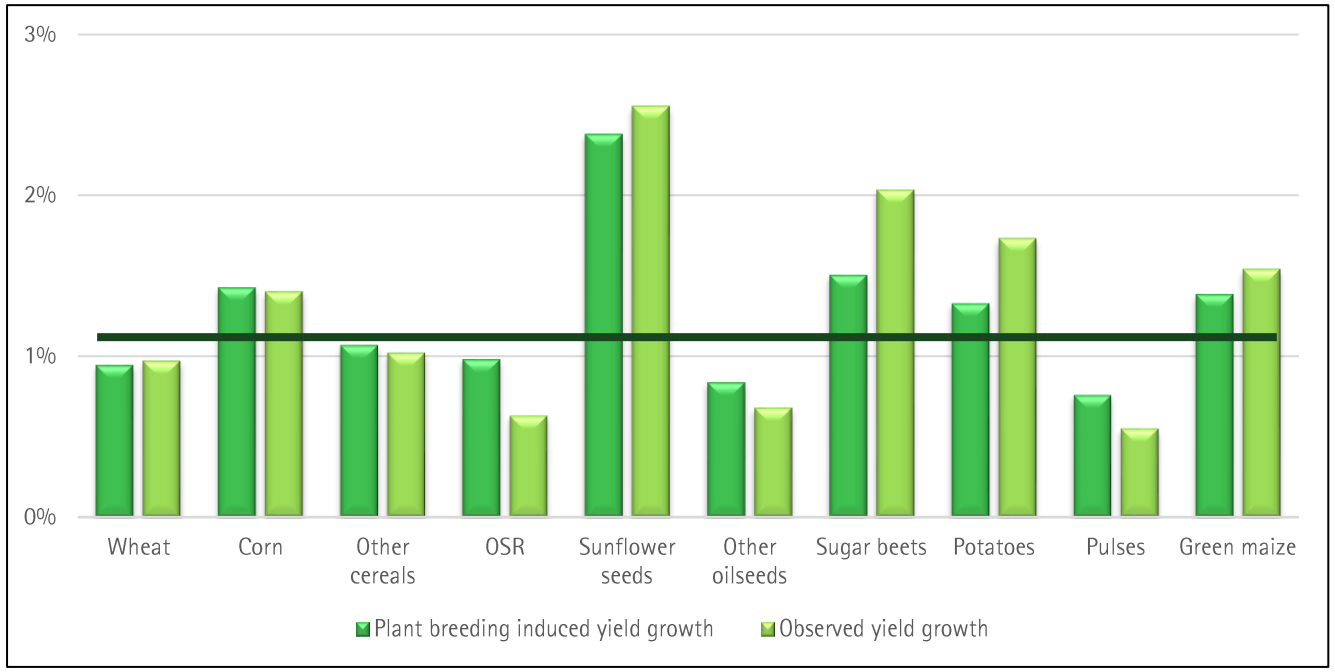
- **Ex-post evaluation (2000-2019)**:
  - → Yield developments and importance of plant breeding for productivity growth
  - → Modelling results referring to the year 2020
- **Ex-ante assessment (2020-2039)**:
  - → Future scenario facing growing pressure to reduce the use of synthetic plant protection and fertiliser inputs
  - → Modelling plant breeding impacts in 2030 / 2040 and effects of the pressure
- **Case study analyses** for the impact of New Plant Breeding Techniques (NPBT)
- **Recommendations** for private business and policy-making

The socio-economic and environmental values of plant breeding were calculated for effects on …

- **Yield growth**
- Market supply
- Market prices
- Food availability
- **Trade**
- **Sector / farm income**
- GDP
- Jobs
- **Land use / net virtual land trade**
- **GHG emissions**
- Biodiversity
- Water use

Plant breeding is responsible for approximately 66 percent of annual productivity growth

Plant breeding-induced vs. real yield growth per year

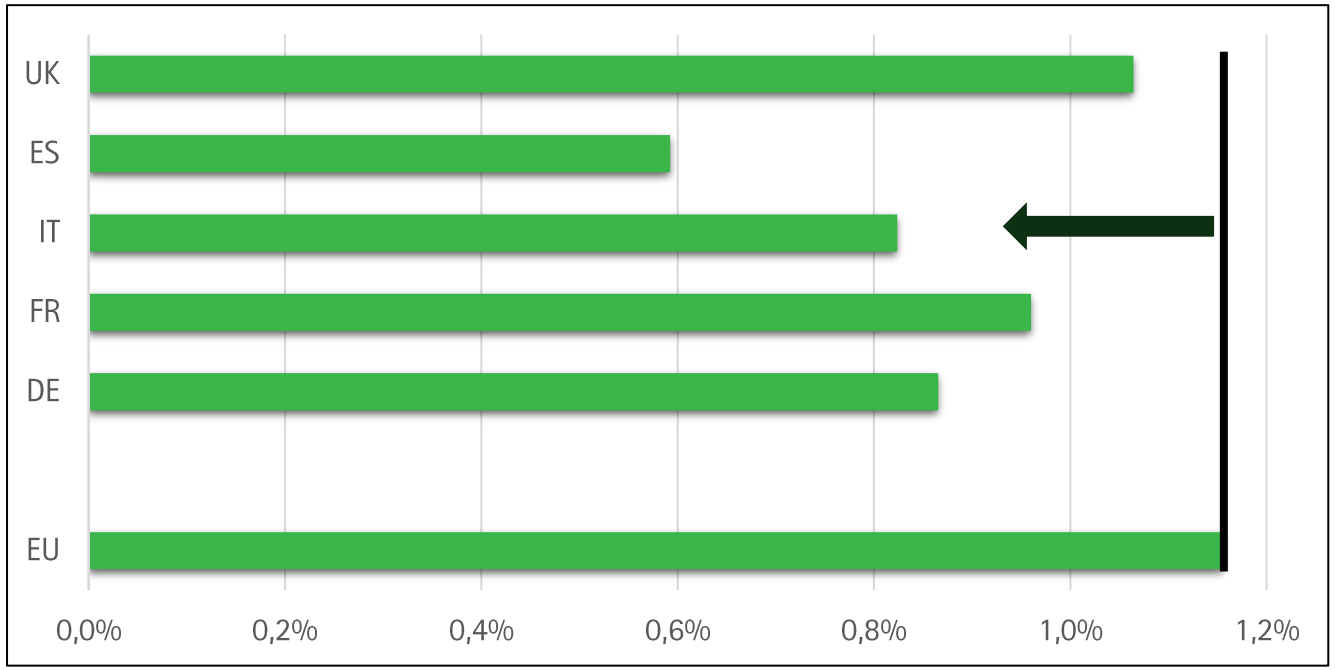


- Shares of plant breeding in innovation-induced yield growth are between 59 and 75 percent.
- On average, weighted by hectare:

  → **1.16 percent per annum** productivity growth through plant breeding.
- Plant breeding has a tremendous impact on EU arable farming.

Plant breeding is responsible for more than 1.0 percent of yield growth per annum in arable farming of the UK

Plant breeding-induced yield growth by member state



- Plant breeding-induced yield growth in the UK is below the EU average
- However, it is also higher than in other "old" EU member states
- Hence, it is likely (well) above average in "new" member states.
- Why? – Has EU accession had an impact (PBR, royalty fees etc.)?

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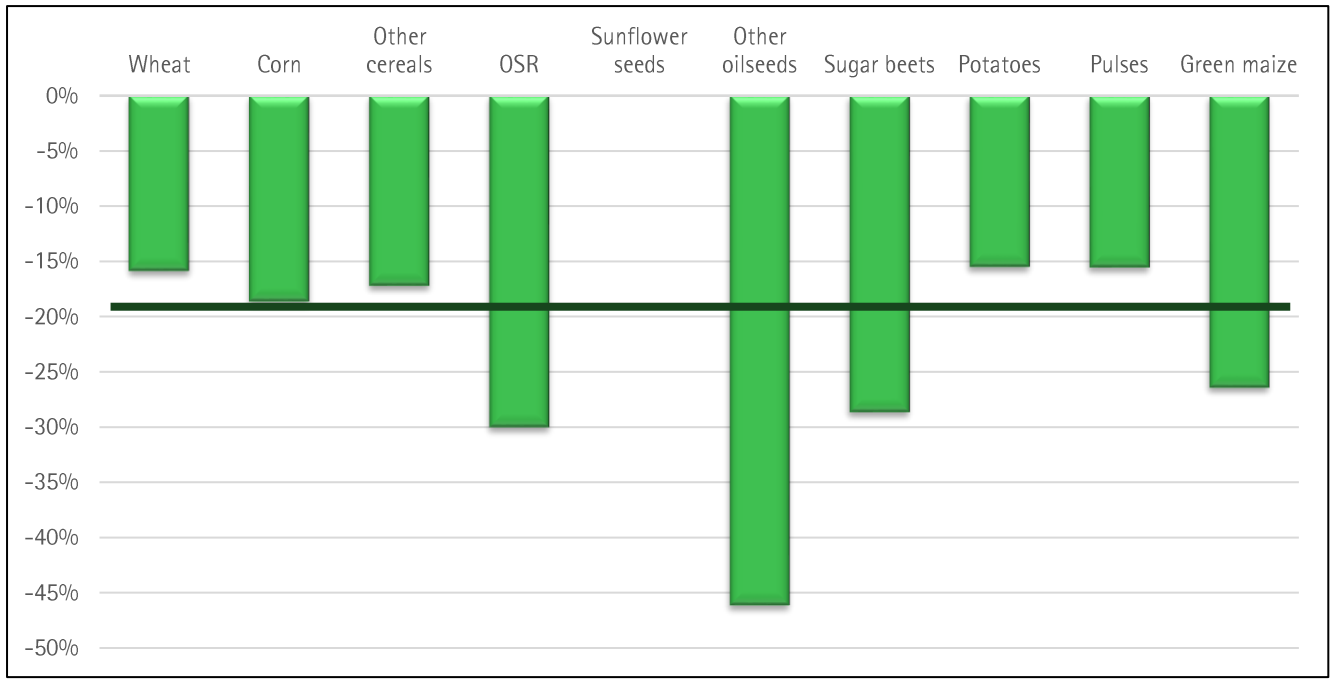
Without 20 years of plant breeding in the UK yields would be almost 20 percent lower

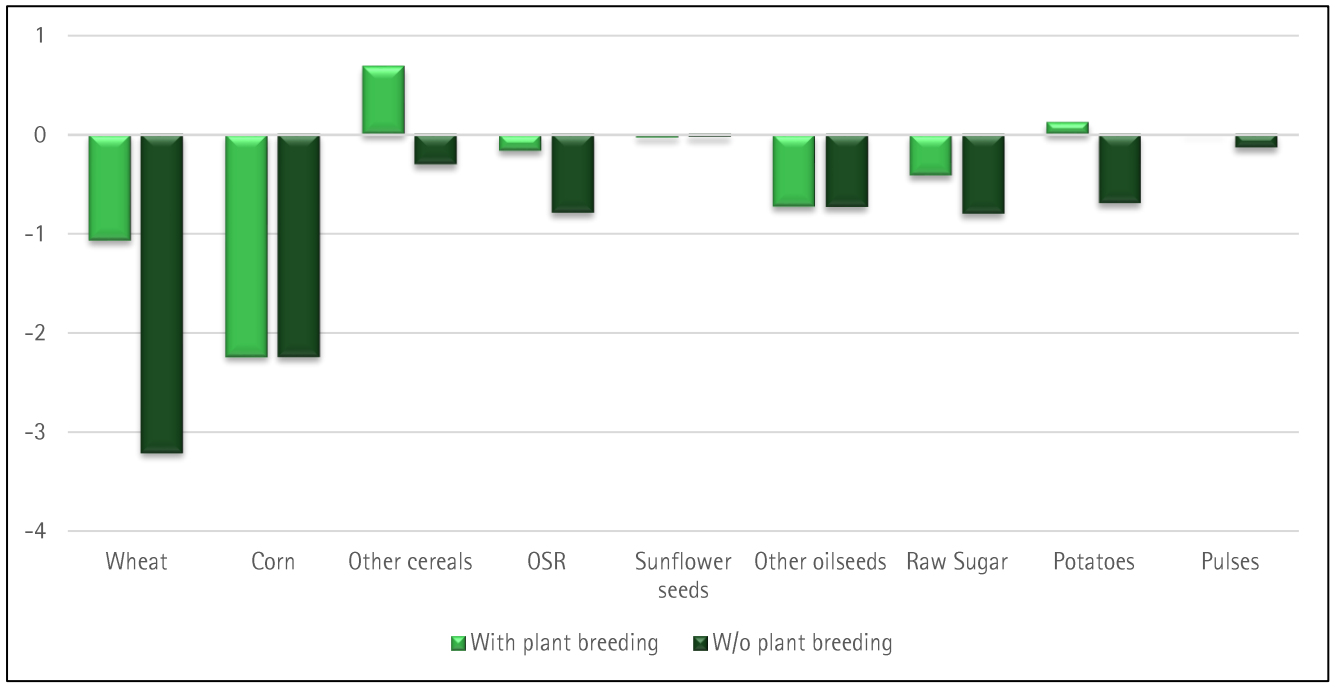
Yield shock (2020) w/o UK plant breeding (2000–2019)



- Without 20 years of plant breeding, yields in UK arable farming today would be significantly lower.
- On average, hectare-weighted, **a minus of 19.1 percent** would have occurred.
- Considerable amounts of wheat, corn, etc. would be missing!

Without 20 years of plant breeding the UK would suffer from a worsening EU-extra trade situation

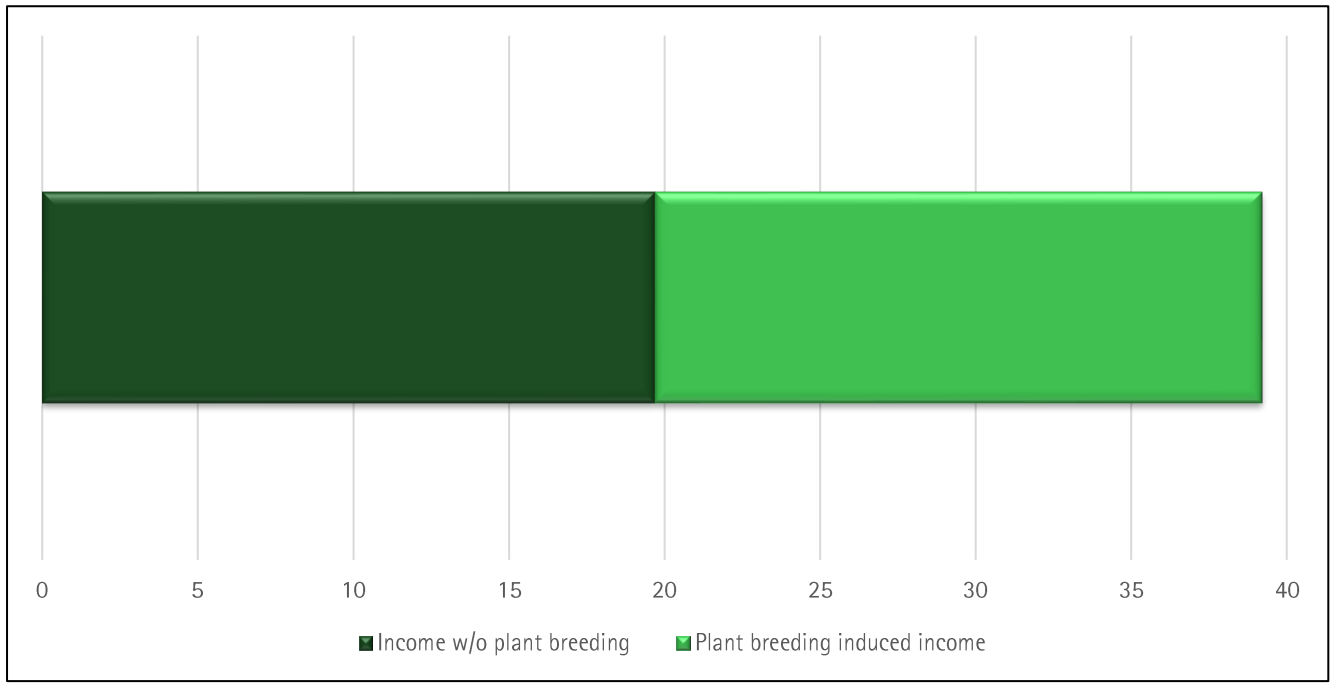
Net trade with and w/o plant breeding (in million tons)



- Without 20 years of plant breeding, the UK would become a net importer in all arable crops:
  → **including other cereals and potatoes**
- International competitors would gain in competitiveness and increase their market shares.

Without 20 years of plant breeding UK arable farmers would have a considerably lower income

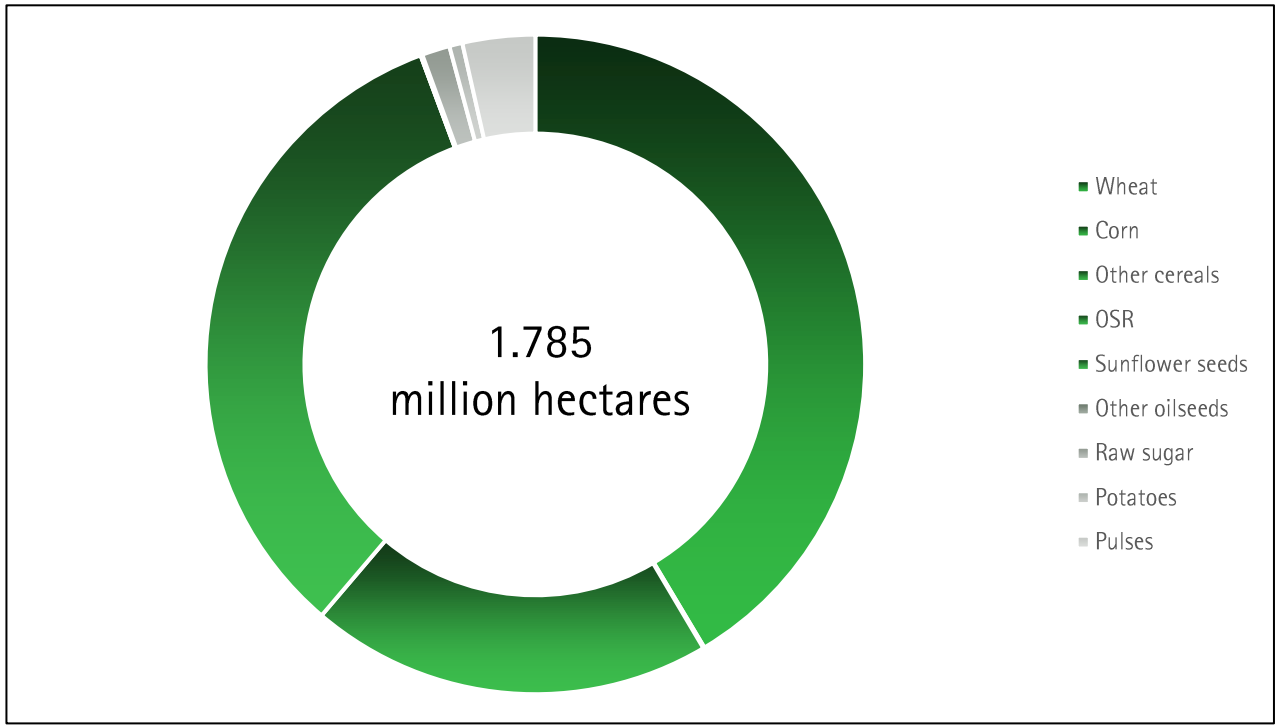
Income with and w/o plant breeding (in 1,000 EUR/AWU)



- Without 20 years of plant breeding, the current annual income of an UK arable farmer would be **17,000 GBP lower** (i.e., half of the current income).
- In terms of the agricultural value added, approximately **800 million GBP** would be missing today.

Without 20 years of plant breeding in the UK 1.8 million hectares of additional land would be needed

Additional global land use w/o plant breeding in the UK



- Without 20 years of plant breeding **scarce global resources** would additionally be exploited:

→ N. Am.: 279 000 ha
→ S. Am.: 106 000 ha
→ Asia: 186 000 ha
→ MENA: 297 000 ha
→ SSA: 184 000 ha
→ Oceania: 308 000 ha
→ CIS: 388 000 ha
→ RoW: 37 000 ha

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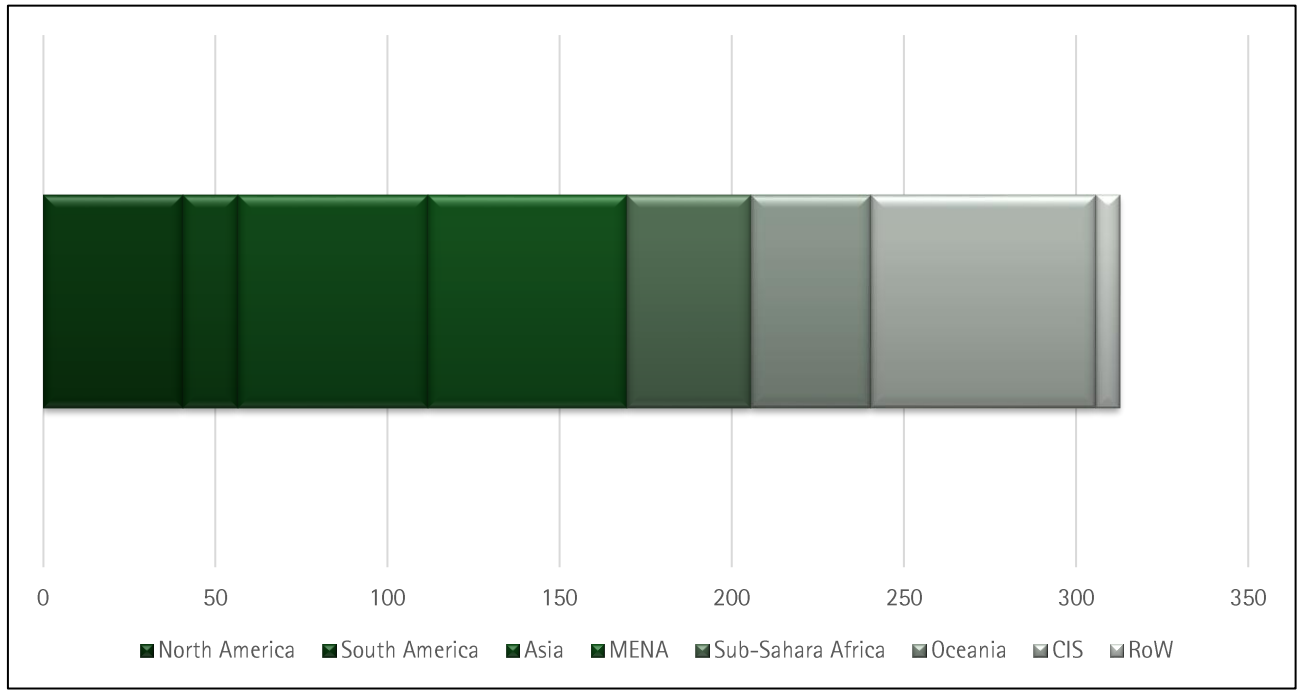
Without 20 years of plant breeding in the UK more than 300 million tons of extra GHG would have been emitted

Avoided global GHG emissions due to UK plant breeding (in million tons of CO_2-equivalents)



- More than 300 million tons of CO_2 emissions did not occur due to avoided land use effects:
  - → Being a one-time-only effect, it equals **two thirds of the annual GHG emissions of the UK.**
  - → Annualised it is as large as the yearly GHG emissions of Slovakia.

Future scenario including F2F and Biodiversity strategies *(or a move towards more extensification in agriculture!)*

- **Future reference scenario**:
  - → In accordance with latest projections of the European Commission
  - → Plus, organic farming on 25 percent of all utilised agricultural area
  - → In addition, 10 percent of non-productive land
  - → Moreover, 50 percent less plant protection products and measures
  - → Finally, 20 percent less nitrogen fertilisers

  Until 2030
- **Mitigation scenario**:
  - → Plant breeding in the next 10 and 20 years
  - → Can it close the gap arising from (non-intended) effects of the two strategies?

Production losses of more than a quarter can be expected if an "extensification" is implemented by 2030

Production losses until 2030 (in percent)

Crop/Region	EU	DE	FR	IT	ES	UK
Wheat	26	32	29	23	22	31
Corn	22	30	22	19	19	23
Other cereals	23	31	22	22	21	23
OSR	24	28	25	19	19	26
Sunflower seeds	22	28	22	19	19	23
Other oilseeds	22	28	22	19	19	23
Raw sugar	21	19	25	27	27	26
Potatoes	23	29	24	22	22	26
Pulses	20	30	18	24	24	19
Green maize	23	30	24	22	22	26

- On average, hectare-weighted, production losses of more than **26 percent** might be the outcome for the UK in total if an "extensification" is fully implemented by 2030:
  - → **10 percent** from non-productive land
  - → **16 percent** from lower yields due to input change.

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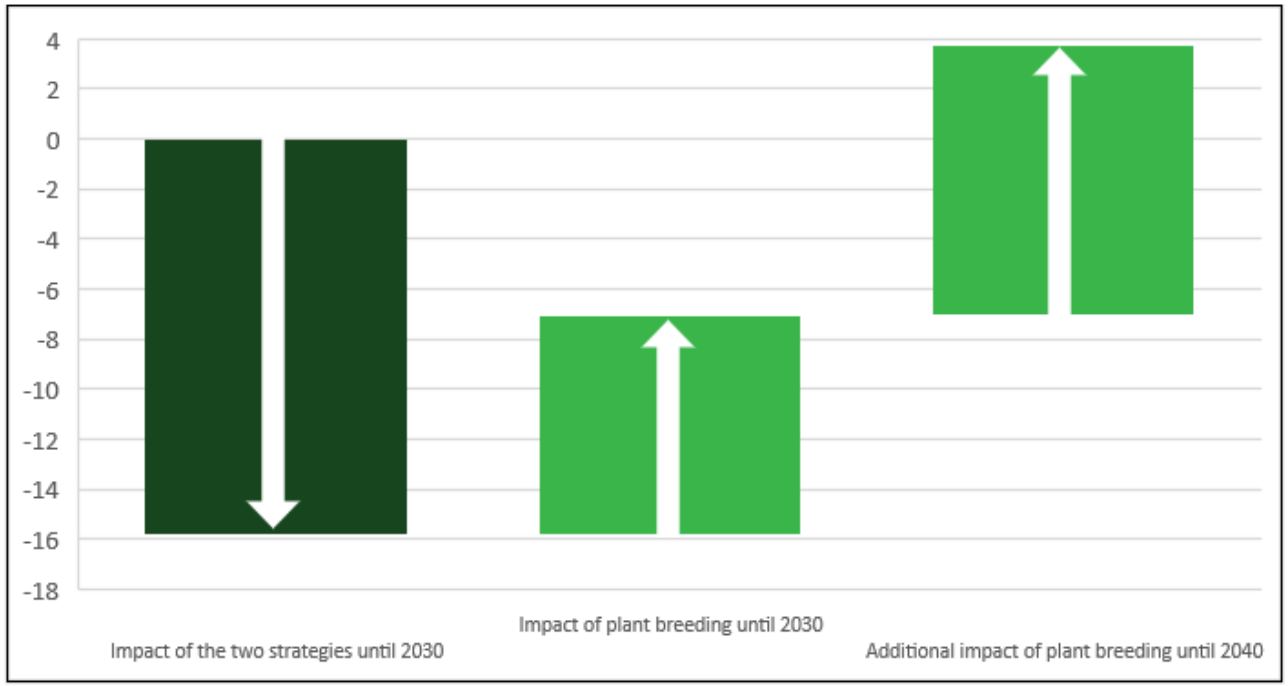
UK plant breeding until 2030 will only be able to partially compensate for production losses of an "extensification"

Comparing and balancing partial production effects

- The potential plant breeding-induced production surplus in 2030 will be considerably lower than the production loss that can be attributed to an "extensification".
- Weighted by hectare, the production **loss** would amount to **26 percent**, whereas the production increase due to plant breeding is "just" **11** (24) **percent** until 2030 (2040).
- Plant breeding **should speed up**.

Plant breeding until 2040 can help compensate apparent negative consequences of an "extensification" until 2030

Comparing and balancing sectoral income effects (EU)



- Only in the long-term, plant breeding can help compensate for non-intended impacts of a rather short-term extensification in terms of:
  - → shrinking income
  - → market and trade losses
  - → lower food availability
  - → additional global land use
  - → increasing CO_2 emissions
  - → additional biodiversity losses
  - → etc.
- Plant breeding **must speed up**!

NPBT can speed up breeding and help achieve goals which can be related to an "extensification" of arable farming

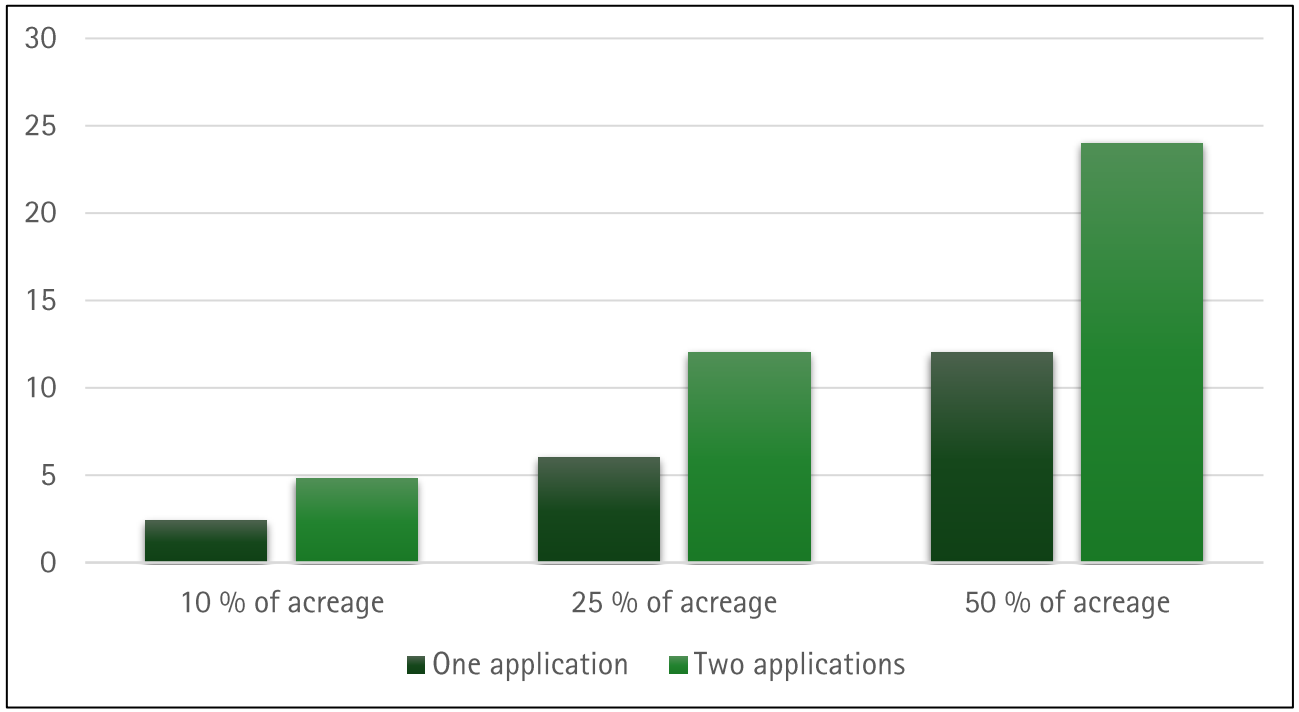
- **Scenario:**
  - → Conservative calculation: Saving two years of variety development
  - → Speed up plant breeding progress per time unit by 18 percent
  - → Not only more than 1.1 but more than 1.3 percent plant breeding-induced yield progress per annum in few years from now
  - → Until 2040: an extra yield increase of 2.6 percent

- **Positive effects:**
  - → Provide extra food for almost 20 million additional people
  - → Avoid global GHG emissions of roundabout 350 million tons
  - → Preserve biodiversity living on about 2.0 million hectares (global average)

  - → Various contributions towards meeting the objectives of the "Farm to Fork" and Biodiversity strategies of the EU

NPBT can help reduce the number of fungicide applications in wheat by fungi-resistant varieties

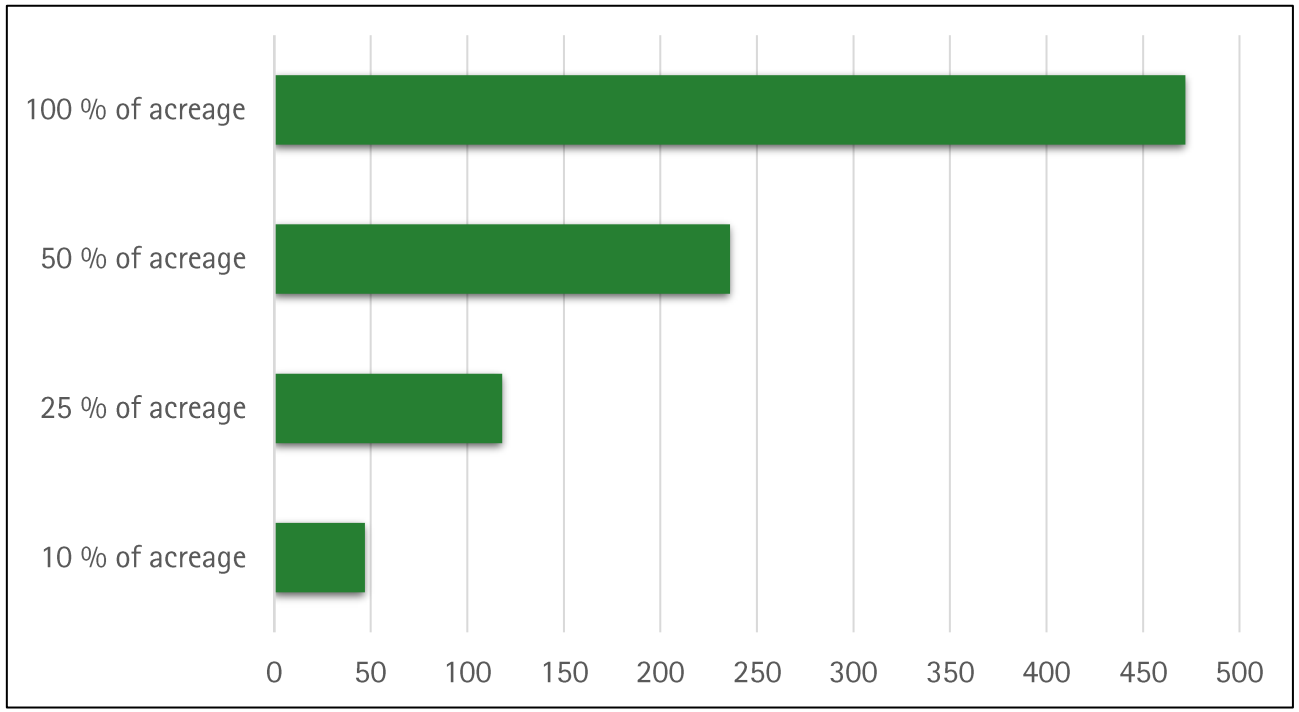
Avoidable fungicide applications in wheat (in millions)



- Example - PILTON:
  - → Breeding for multiple fungi resistance
  - → May avoid fungicide application
- Assumptions:
  - → One (two) application(s) less per season at current acreage
- Potential effects at EU level:
  - → Up to **25 million applications** less alone in EU wheat
  - → Thousands of tons of fungicides can be substituted

NPBT can help avoid pre-harvest losses in oilseed rape by increasing pod shatter resistance in new varieties

Avoidable land use for oilseed rape (in 1,000 hectares)



- Example - Project John Innes Centre:
  - → Breeding for reduced susceptibility to pod shattering
  - → May avoid seed losses and subsequent voluntary seeds
- Assumptions:
  - → Avoid yield losses of 9.0 percent
- Potential effects at EU level:
  - → **500,000 hectares** are almost one tenth of currently used area
  - → Lower pressure on land supports, e.g., mitigation of GHG emissions

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Recommendations

- **For private decision-making**:
  - → Plant breeding is an extremely important area of R&D, and plant breeders must take responsibility by investing even more into innovation.
  - → Targets: higher yields but also, e.g., resistances, agronomic traits, orphan crops etc.
- **For public decision-making**:
  - → Must encourage and not hinder plant breeders to further invest
  - → Strengthen R&D as well as fundamental research
  - → Support public awareness raising through interdisciplinary research and evidence-based information campaigns
  - → Establish differentiated regulatory framework based on proportionate and non-discriminatory safety considerations for individual techniques and resulting products

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Thank you.