

# CropBooster-P WP2

Plant breeding priorities impacts  
and issues: Insights from experts  
across the food system



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Horizon 2020  
European Union funding  
for Research & Innovation

# A collaboration between



# This session

20 mins – Recap of main findings of WP2

20 mins – WP2+

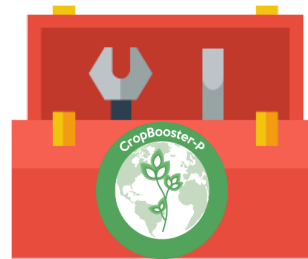
- Further consumer insights
- Simulating impacts through cognitive mapping

10 mins – Questions and discussion

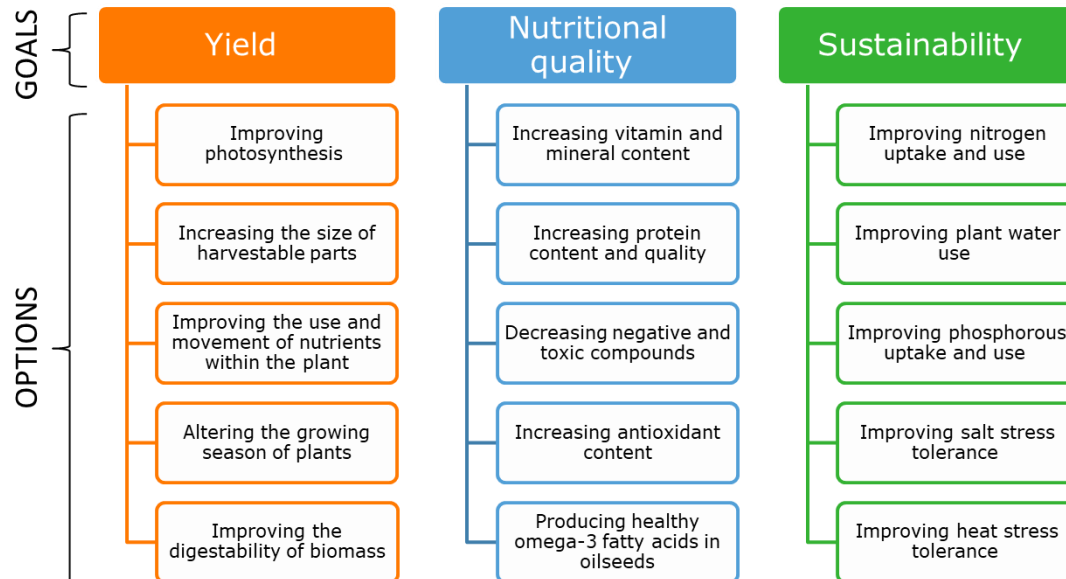


# What we set out to do in WP2

Assess the **potential economic, social and environmental impact** of our toolbox of plant improvement options for improving yield, sustainability and nutritional quality.



Toolbox of “cropboosting” options compiled by leading plant scientists



# Our approach: Ask food system experts

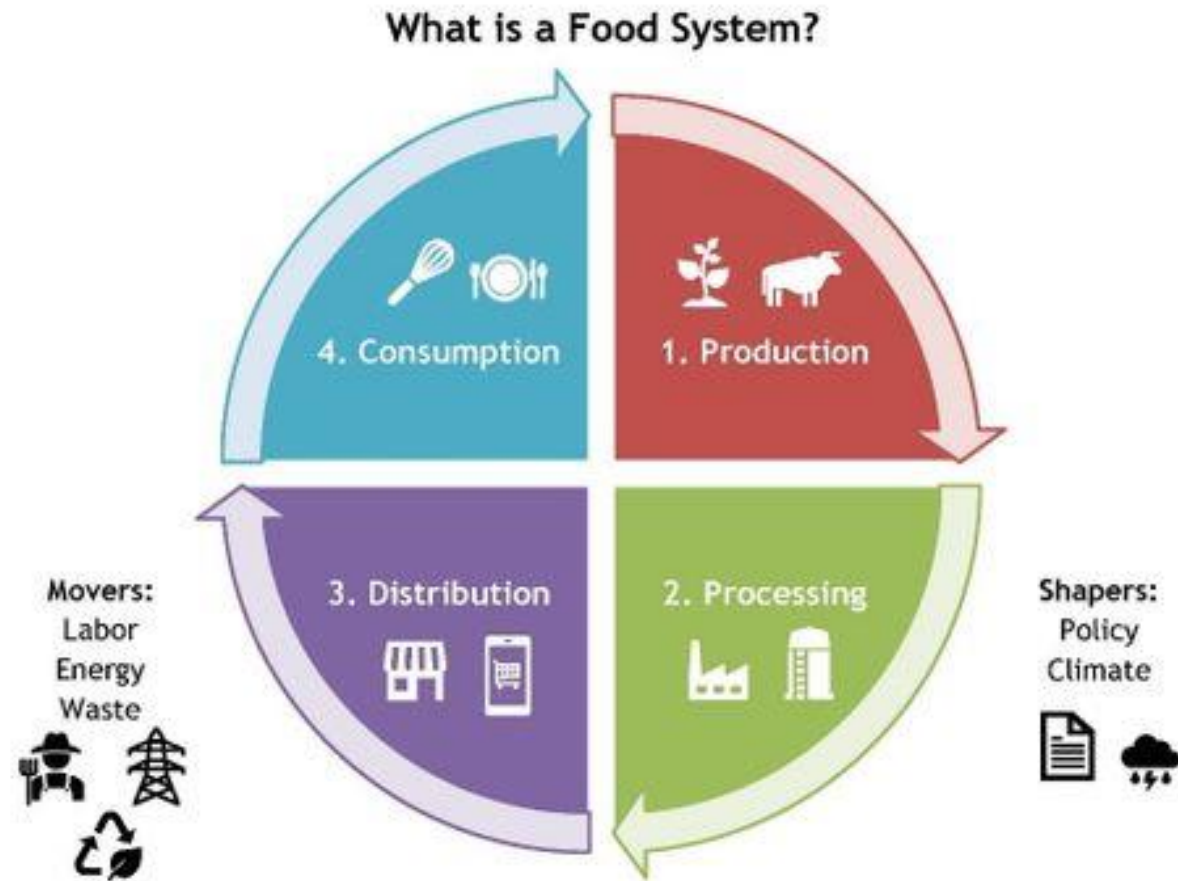
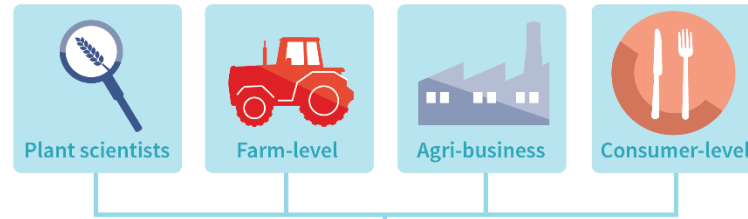


Image: Sustainable Food Center

# Our Approach: Ask with a robust mixed methodology



Manuscript that integrates findings currently under review with Nature Food  
Included in D2.4



# A lot of this the work of our researchers

- Stacia Stetkiewicz
- Jonathan Menary
- Abhishek Nair





# Survey



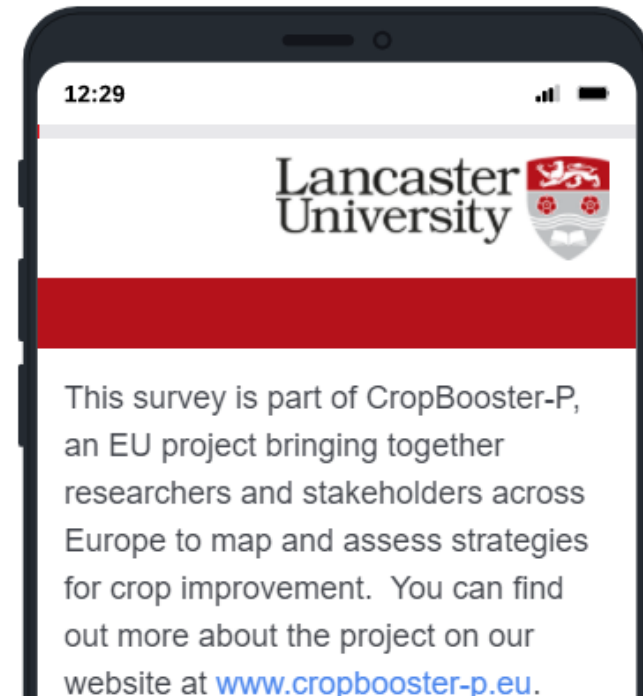
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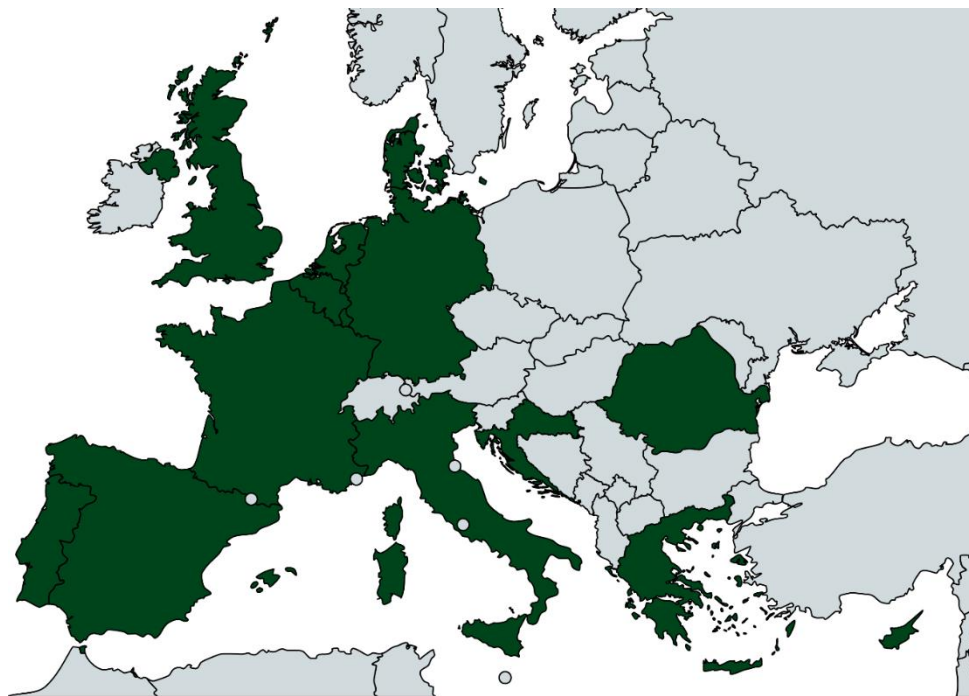
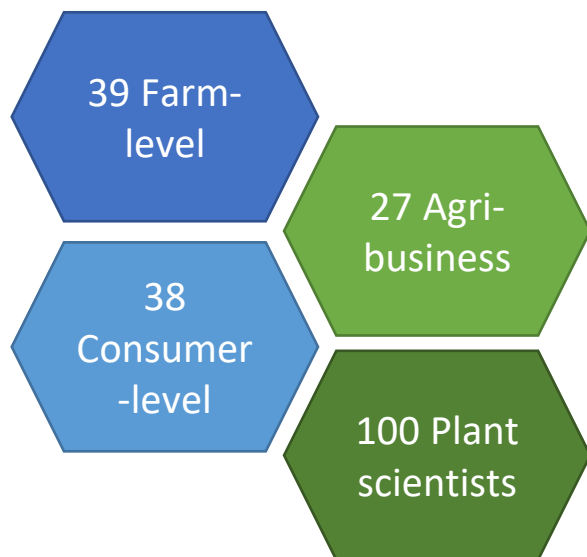
# Survey

- Aim to provide a quantitative overview of the priorities
- Open online questionnaire (English, French, German translation)
- More than 200 experts in the same domains (farmer, business, consumer) responded



# Survey uptake

- Online April – May 2020
- >200 responses



# Survey: Prioritising goals

## Goal priorities



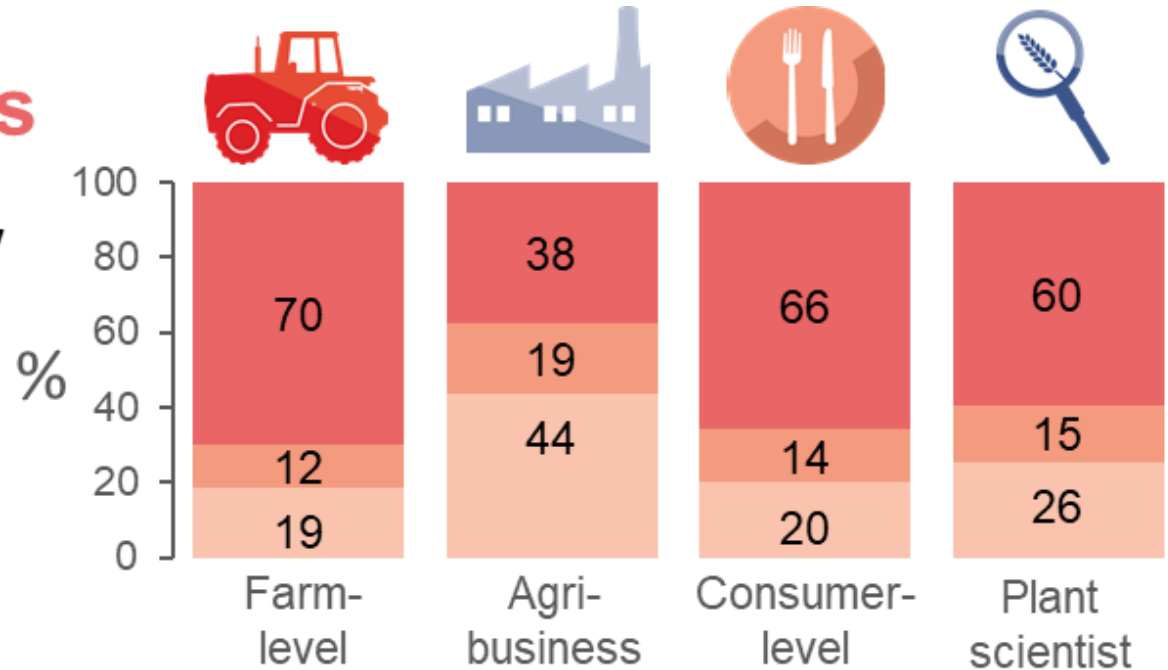
■ **Sustainability**



■ **Nutrition**



■ **Yield**



- Sustainability important across the board
- Agribusiness puts yield first
- Farm-level & consumer-level almost say the same thing!



# Survey: Prioritising goals

## Goal priorities



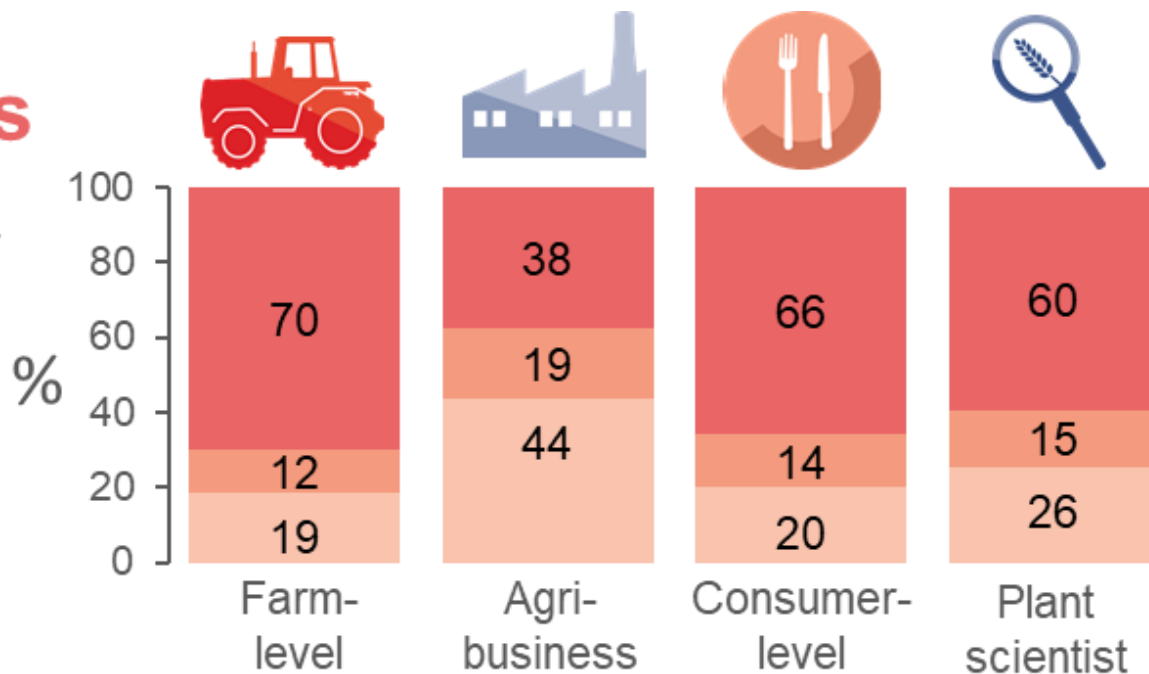
■ Sustainability



■ Nutrition



■ Yield



But many respondents wanted it all...

*"...All must be sustainable in longer term. These are not mutually exclusive and we should be aiming to have them all"*



# Survey: Option importance

Please indicate how important you feel this option is for future-proofing European crops:

## IMPROVING PLANT WATER USE



Lack of water affects plant productivity and can decrease crop quality.

This option includes a range of breeding technologies that aim to improve uptake of water from soil, reduce water loss in the plant and help it use water more efficiently.

Very  
unimportant

Unimportant

Neither  
important  
nor  
unimportant

Important


Very  
important

Don't  
know



# Survey: Option Importance

## Option priorities

		Farm-level	Agri-business	Consumer-level	Plant scientist
<b>Sustainability</b> 	Improving plant water use	92	96	97	97
	Improving heat stress tolerance	90	73	94	74
	Improving nitrogen uptake and use	85	85	92	85
	Improving phosphorus uptake and use	79	85	80	85
	Improving salt stress tolerance	58	54	68	54

- Importance is high across all options and groups (always >50% & often in the 90s% said it was important or very important)
- Not much difference between groups
- Farm and consumer once again very aligned
- Salt tolerance least frequently thought of as important



# Survey: Option Importance

## Option priorities



### Yield

Improving photosynthesis

Improving digestibility of biomass

Use and movement of nutrients within the plant

Altering growing season of plants

Increasing the size of harvestable parts

Farm-  
level

Agri-  
business

Consumer-  
level

Plant  
scientist

79

69

62

70

50

38

46

39

53

65

57

66

55

65

54

66

41

38

42

39


- Less frequently selected as important compared to sustainability (38-79%)
- Not much difference between groups
- Photosynthesis most frequently thought as of important for every group
- Increasing size of harvestable parts least frequently thought of as important for every group





# Survey: Option Importance




## Option priorities

		Farm-level	Agri-business	Consumer-level	Plant scientist
<b>Nutrition</b> 	Improving protein content and quality	64	73	69	74
	Increasing vitamin and mineral content	55	65	72	66
	Increasing antioxidant content	58	50	57	51
	Decreasing negative and toxic compounds	51	54	69	54
	Producing healthy omega-3 fatty acids in oilseeds	53	50	60	51

- Less frequently selected as important compared to sustainability, but more frequently than yield in general (50-74%) – even though not often prioritised as a main goal earlier
- Not much difference between groups – consumers overall thought these slightly more important?
- Protein seems to be most frequently selected important



# Survey: Option Importance

Option priorities		Farm-level	Agri-business	Consumer-level	Plant scientist
<b>Sustainability</b> 	Improving plant water use	92	96	97	97
	Improving heat stress tolerance	90	73	94	74
	Improving nitrogen uptake and use	85	85	92	85
	Improving phosphorus uptake and use	79	85	80	85
	Improving salt stress tolerance	58	54	68	54
<b>Yield</b> 	Improving photosynthesis	79	69	62	70
	Improving digestibility of biomass	50	38	46	39
	Use and movement of nutrients within the plant	53	65	57	66
	Altering growing season of plants	55	65	54	66
	Increasing the size of harvestable parts	41	38	42	39
<b>Nutrition</b> 	Improving protein content and quality	64	73	69	74
	Increasing vitamin and mineral content	55	65	72	66
	Increasing antioxidant content	58	50	57	51
	Decreasing negative and toxic compounds	51	54	69	54
	Producing healthy omega-3 fatty acids in oilseeds	53	50	60	51



# Survey: Summary of Expert Priorities

- A lot of agreement across groups on sustainability as a priority area for plant breeding – particularly between farm-level and consumer-level
- Yield slightly ahead of sustainability for business groups
- Many options considered important and impactful
  - Very few options where less than 50% of people thought they were important



# Expert Focus Groups







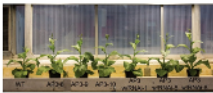




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# Expert focus groups


Hosted total of **24 hours of focus groups**, with **35 expert participants**



YIELD	YIELD
<p><b><u>IMPROVING PHOTOSYNTHESIS</u></b></p>  <p>Photosynthesis is the process of turning the energy from the sun into usable energy in the form of sugar.</p> <p>This option includes a range of breeding technologies that aim to increase the efficiency of photosynthesis.</p>	<p><b>EXAMPLE: Improving photosynthesis for more biomass</b></p>  <p>By reducing the amount of energy the plant spends on respiration, scientists were able to increase plant biomass by 40% in tobacco (South et al., 2019).</p>
NUTRITION	NUTRITION
<p><b><u>INCREASING PROTEIN CONTENT AND QUALITY</u></b></p>  <p>Protein is an essential part of the human diet and is made of amino acids. Certain types of protein are useful because they contain high levels of specific amino acids that humans need to build muscle.</p> <p>This option includes a range of breeding technologies that aim to increase the protein content of crops whilst maintaining yield.</p>	<p><b>EXAMPLE: Improving protein content of wheat</b></p>  <p>The <i>NAM-A1</i> gene has been linked to increased protein content in wheat (Jauay et al., 2006). By breeding for this gene, it is possible to improve grain protein content.</p>
SUSTAINABILITY	SUSTAINABILITY
<p><b><u>IMPROVING PLANT WATER USE</u></b></p>  <p>Lack of water affects plant productivity and can decrease crop quality.</p> <p>This option includes a range of breeding technologies that aim to improve uptake of water from soil, reduce water loss in the plant and help it use water more efficiently.</p>	<p><b>EXAMPLE: Improving roots to cope with water stress</b></p>  <p>Larger root systems can extract more water and nutrients under stress conditions. In crops – improving root systems could improve plant stress tolerance (Ye et al., 2021).</p>

**OPTION CARD #16**

**NAME:** \_\_\_\_\_



**Description:** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

# Expert (online) focus groups, Spring 2020

We wrote a methods paper on how to adapt in person focus groups to online and retain robust, high quality data collection

YIELD

## IMPROVING PHOTOSYNTHESIS



Photosynthesis is the process of turning the energy from the sun into usable energy in the form of sugar.

This option includes a range of breeding technologies that aim to increase the efficiency of photosynthesis.

YIELD

## EXAMPLE: Improving photosynthesis for more biomass



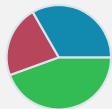
By reducing the amount of energy the plant spends on respiration, scientists were able to increase plant biomass by 40% in tobacco (South et al., 2019).

Menary J, Stetkiewicz S, Nair A *et al.* Going virtual: adapting in-person interactive focus groups to the online environment, *Emerald Open Res* 2021, **3**:6  
(<https://doi.org/10.35241/emeraldopenres.14163.2>)



# Focus Group: Breakdown

## Focus groups



Farm level	4
Agri-business	2
Consumer	3

## Experts



Farm-level	16
Agri-business	11
Consumer	8

Workshops



Farm-level  
(May 2020)



Agri-business  
(May 2020)

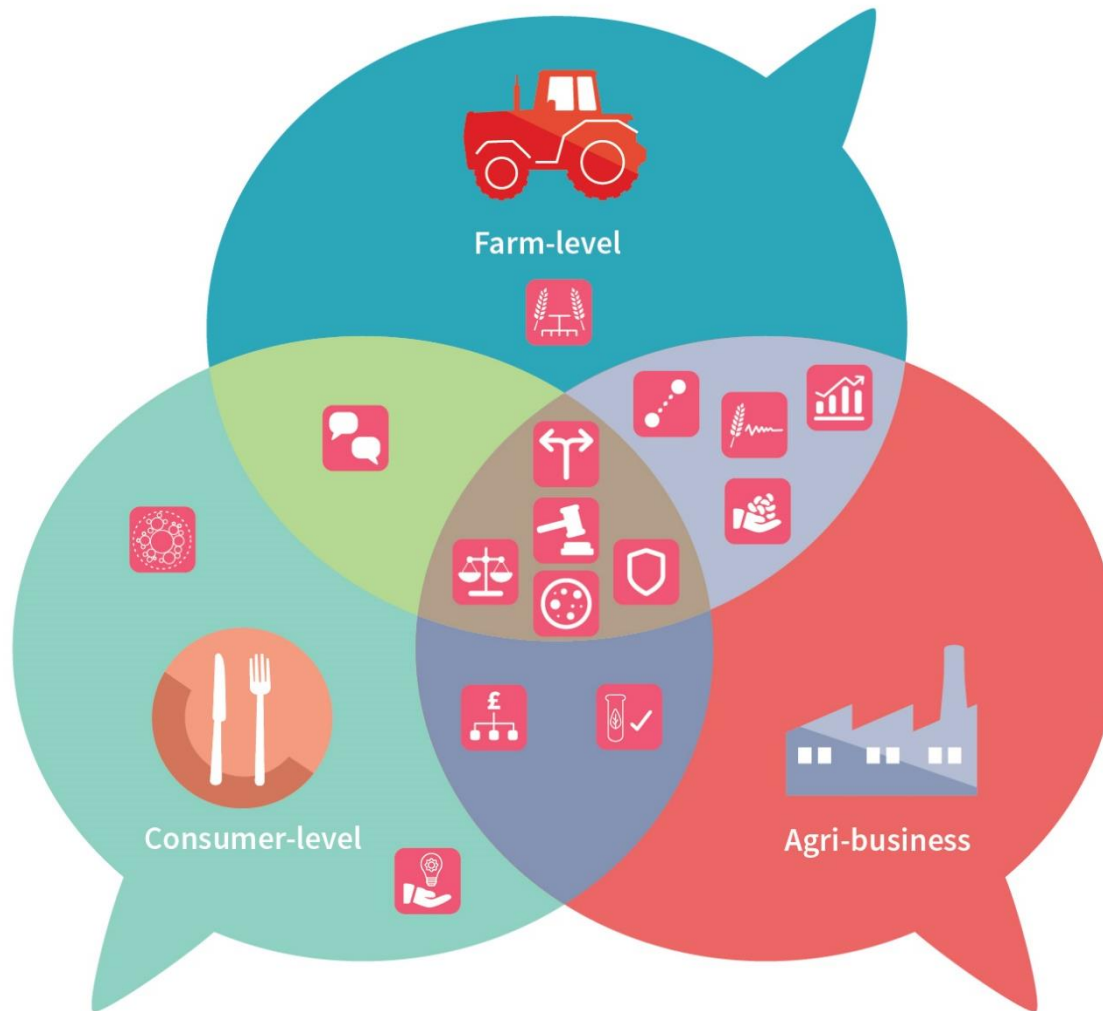


Consumer  
(June 2020)





# Five key shared themes identified



## **Alternatives**

Consider whether other, non-plant breeding interventions can better achieve a societal, economic or environmental goal.



## **Tradeoffs**

Consider the potential risks and benefits of different crop improvement strategies



## **Resilience**

Importance of making agriculture and food more resilient to climatic and other changes



## **Variation and universality**

Some crop improvement strategies are important for specific regions; others are universal



## **Plant biotechnology and regulation**

The legal status of certain plant biotechnology could pose a barrier to certain types of crop improvement



# Focus Group: Summary

- Consider if there are options other than plant breeding that work better first – don't make solutions for which there are good alternatives already
- Consider potential trade-offs between traits
- Focus on local or regional crop improvement challenges
- Focus on the many challenges posed by climate change
- Don't solely rely on biotechnology



# Literature Review



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# Rapid Evidence Synthesis

- **QUESTION:** What does the literature say about the environmental, economic and social impacts of adopting crop boosting technologies?
- **ANSWER:** Not a lot!
- For the top three CropBoosting options: improving water use; improving protein content; and improving yield:
  - 1,398 papers were screened
  - Only ~20 gave contained studies of environmental, social, and economic impacts of breeding



# Rapid Evidence Synthesis



- Very limited evidence – major research gap and stumbling block for plant research and impact



# Takeaways & input to WP5



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# WP2 Overall: Main takeaways

- 1. Sustainability is a shared clear priority** goal for plant breeding although agri-businesses put yield slightly ahead – but basically we need **multi-purpose crops**
- 2. The experts agree:** Farmers and consumers are well aligned in they're thinking on what is important for future food in the EU and agri-business and farmers have many shared recommendations for the future plant breeding
- 3. Farm, business and consumer experts are moderately in favour of improving crop plants with technology** when it makes sense:
  - when it provides a major improvement to an important cause (i.e. climate change), and
  - where there is no better existing alternative
- 4. There is very little robust evidence on the potential *systemic* impacts of adopting improved crops** – this is a major barrier to plant biotechnology adoption. Understanding this is key to make the case and avoid unintended consequences





# WP2 Inputs to WP5

- 1. Sustainability is a shared clear priority** and a need for **multi-purpose crops**
- 2. The experts agree**
- 3. Farm, business and consumer experts are moderately in favour of improving crop plants with technology** when it makes sense:
- 4. There is very little robust evidence on the potential *systemic* impacts of adopting improved crops**

- 1. Helps shapes the plant science direction**
- 2. Good, but... continued multi-actor engagement important** to support continued agreement
- 3. Plant improvement relating to climate and resilience** and plan to frame research in **comparison to alternatives**
- 4. We need a major interdisciplinary research effort to estimate food system impacts of adopting crop improvements** that includes:
  - Agri-environmental science, economics and social science
  - Compelling case studies
  - Benchmarking in comparison to and combined with alternative approaches



# WP2+



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