CRISPR-food:

Disrupting public opinion

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research consortium

NCE HEIDNER Biocluster
Norwegian Centres of Expertise

GENEinnovate

Euroopa Liit maaelu arenguks

Euroopa Maaelu Arengu Põllumajandusfond: Euroopa investeeringud maapiirkondadesse

2010:

EUROBAROMETER

Special Eurobarometer

European Commission

SPECIAL EUROBAROMETER 354

Food-related risks

4th issue respondents were most worried about

QF4.2 Genetically modified organisms in food or drinks

	Total Worried	Shift since 2005
LT	81%	18
PT	67%	13
LU	75%	10
DE	71%	9
SK	61%	8
BE	60%	8
CZ	58%	8
NL	50%	8
HU	70%	7
ES	62%	6
EU27	**66%**	**4**
UK	48%	-6

Forbrukerne vil ikke ha genmodifisert mat (GMO) i butikkene

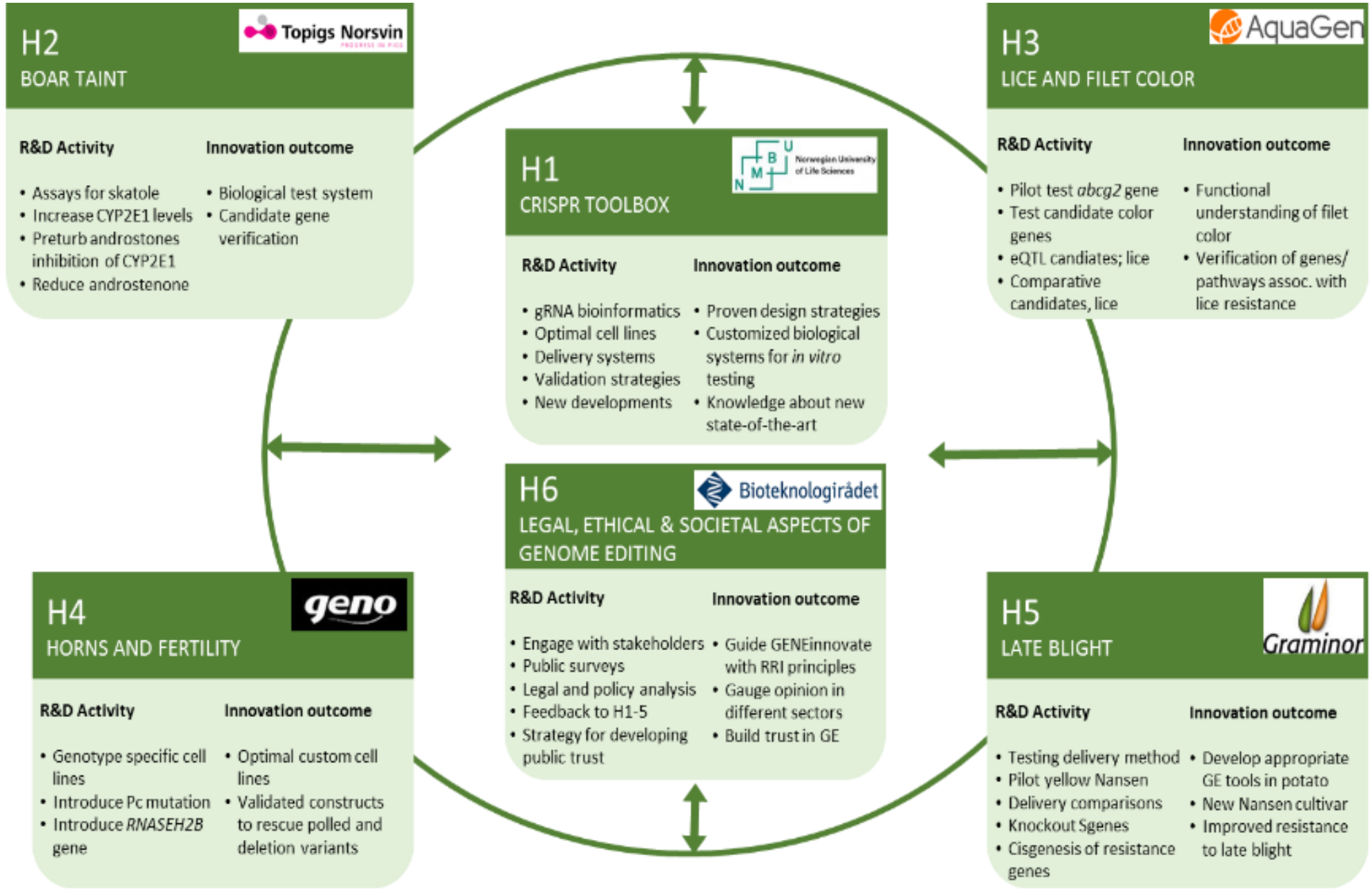
Norske forbrukere er delte i synet på genmodifisert mat, men svært få ønsker det i norske matbutikker. Kvinner og folk med høy utdanning er de mest kritiske. Uheldige konsekvenser for natur og økosystemer skaper mest bekymring.

Rapporten undersøker forbrukernes holdninger genmodifisert kjøtt, laks, epler og mais.
Foto: Pixabay

Norwegian consumers' attitudes toward gene editing in Norwegian agriculture and aquaculture

Bioteknologirådet

GENEinnovate


H2
BOAR TAINT
Topigs Norsvin
R&D Activity
Innovation outcome
• Assays for skatole
• Increase CYP2E1 levels
• Preturb androstones inhibition of CYP2E1
• Reduce androstenone
• Biological test system
• Candidate gene verification
H3
LICE AND FILET COLOR
AquaGen
R&D Activity
Innovation outcome
• Pilot test abcg2 gene
• Test candidate color genes
• eQTL candiates; lice
• Comparative candidates, lice
• Functional understanding of filet color
• Verification of genes/ pathways assoc. with lice resistance
H1
CRISPR TOOLBOX
Norwegian University of Life Sciences
R&D Activity
Innovation outcome
• gRNA bioinformatics
• Optimal cell lines
• Delivery systems
• Validation strategies
• New developments
• Proven design strategies
• Customized biological systems for in vitro testing
• Knowledge about new state-of-the-art
H6
LEGAL, ETHICAL & SOCIETAL ASPECTS OF GENOME EDITING
Bioteknologirådet
R&D Activity
Innovation outcome
• Engage with stakeholders
• Public surveys
• Legal and policy analysis
• Feedback to H1-5
• Strategy for developing public trust
• Guide GENEinnovate with RRI principles
• Gauge opinion in different sectors
• Build trust in GE
H4
HORNS AND FERTILITY
geno
R&D Activity
Innovation outcome
• Genotype specific cell lines
• Introduce Pc mutation
• Introduce RNASEH2B gene
• Optimal custom cell lines
• Validated constructs to rescue polled and deletion variants
H5
LATE BLIGHT
Graminor
R&D Activity
Innovation outcome
• Testing delivery method
• Pilot yellow Nansen
• Delivery comparisons
• Knockout Sgenes
• Cisgenesis of resistance genes
• Develop appropriate GE tools in potato
• New Nansen cultivar
• Improved resistance to late blight

Previous surveys primarily focused on «classic» GMOs intended for the global market

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Norske forbrukere er delte i synet på genmodifisert mat, men svært få ønsker det i norske matbutikker. Kvinner og folk med høy utdanning er de mest kritiske. Uheldige konsekvenser for natur og økosystemer skaper mest bekymring.

Rapporten undersøker forbrukernes holdninger genmodifisert kjøtt, laks, epler og mais.
Foto: Pixabay

Qualitative survey (focus groups)

Exploratory with the aim of uncovering relevant nuances and causes of different attitudes towards genetic technologies. It was also used to inform the design of the population survey questionnaire.

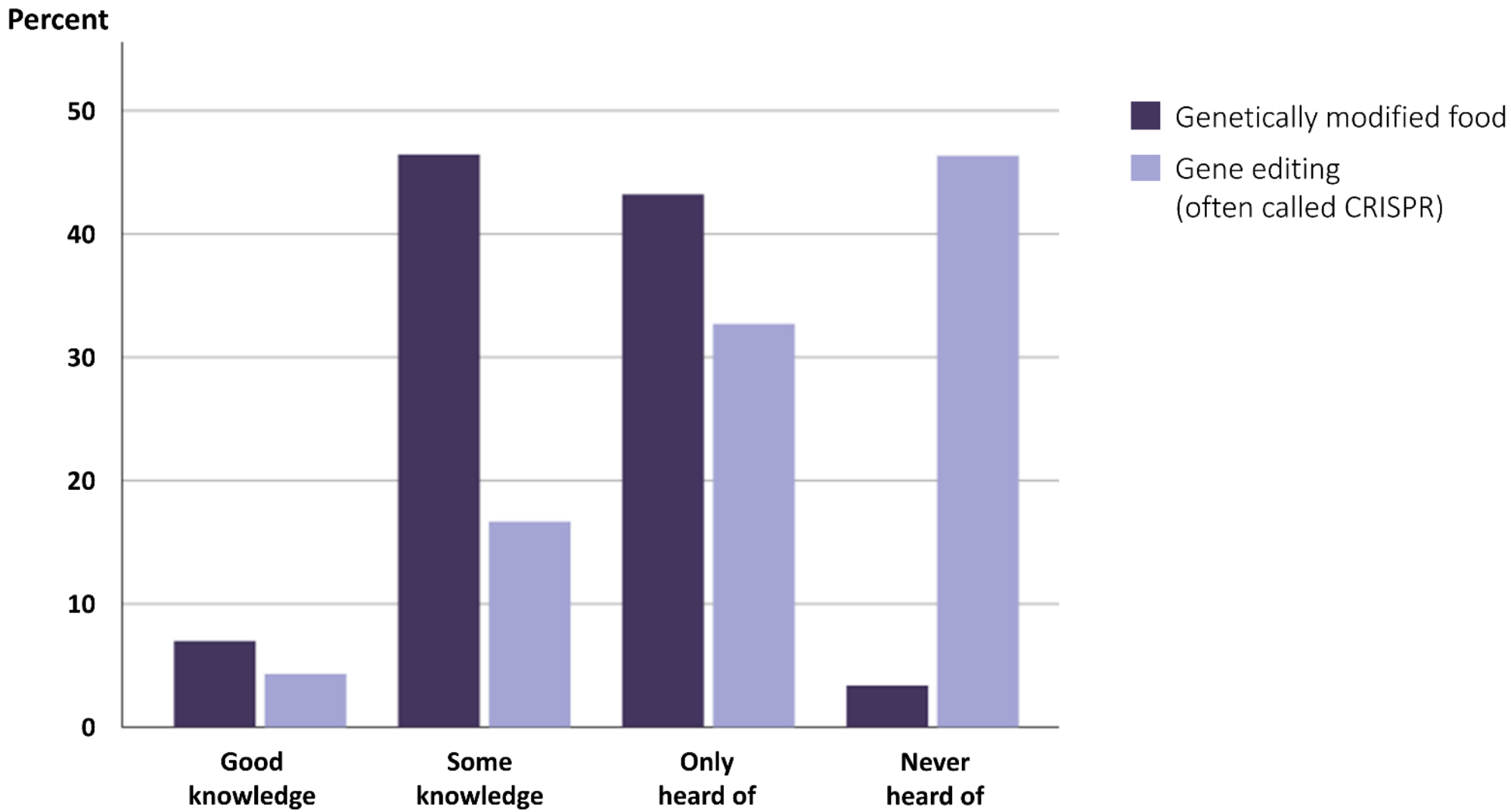
Quantitative population survey

2016 respondents, nationally representative for gender, age and geographical region.

Carried out in november 2019.

Norwegians' knowledge of genetics and genetic engineering

How much do you know about genetically modified food and gene editing (often called CRISPR)?

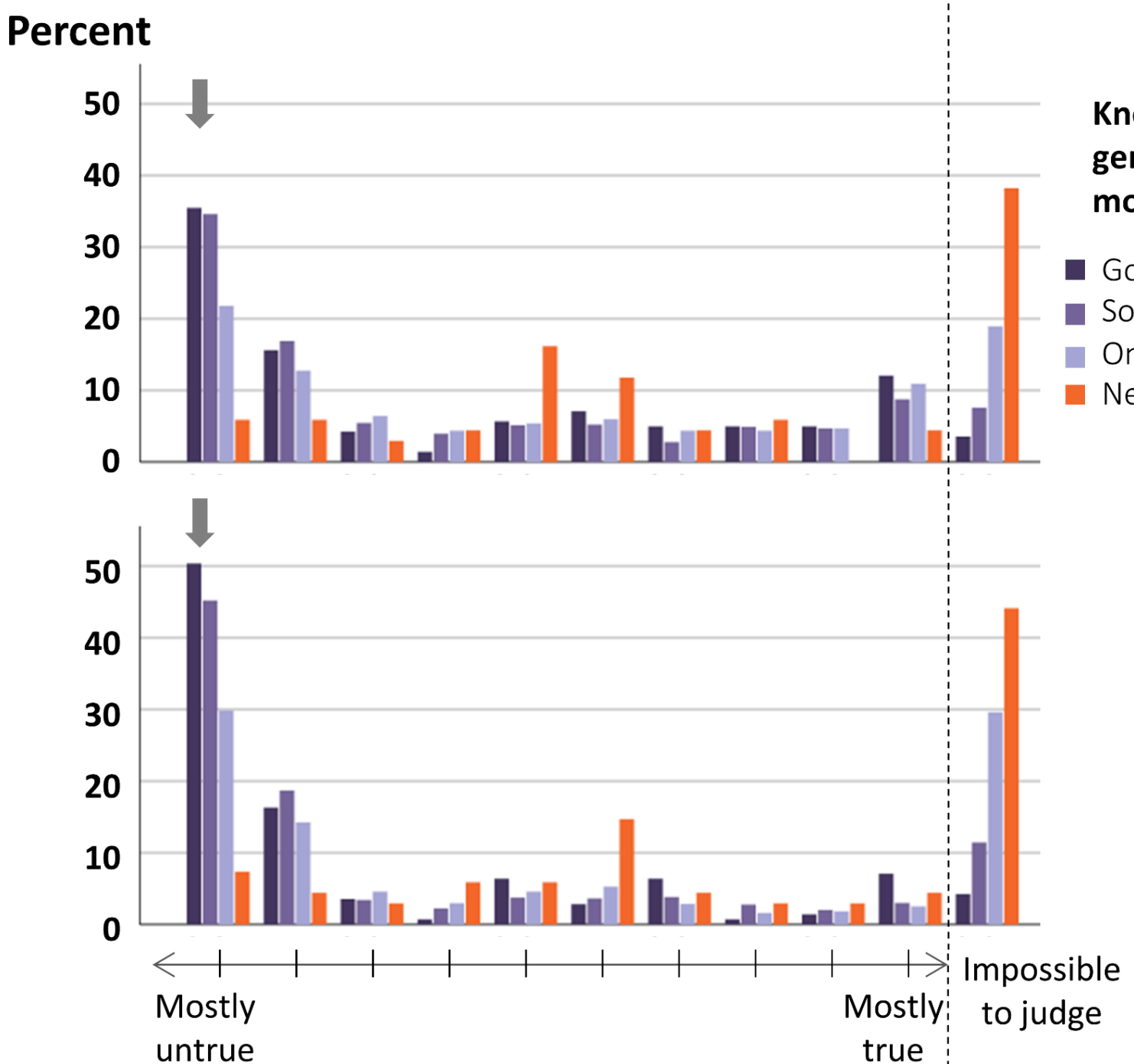


Item:

Traditional breeding has nothing to do with genes.

Item:

Ordinary tomatoes do not have genes, while genetically modified tomatoes have genes.

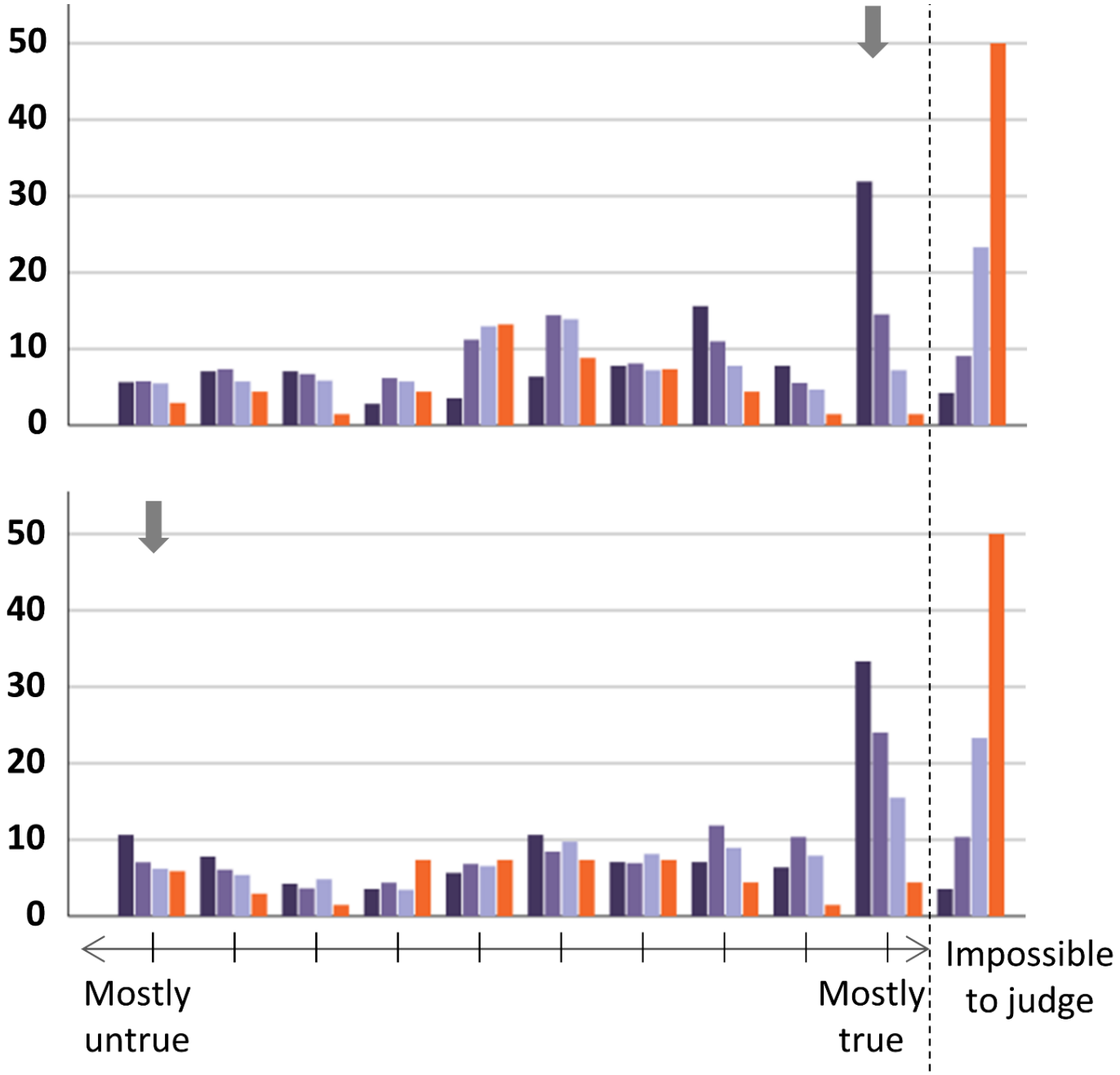


Item:

research shows that the genetically modified products currently found on the international market are safe to eat.

Item:

there are approved genetically modified foods in Norwegian food stores



Attitudes toward the use of gene editing in norwegian agriculture and aquaculture

Traditional breeding, used since the Stone Age:

All plants, animals and microorganisms contain thousands of genes (DNA) that determine their traits. In nature, genetic changes arise naturally that cause the traits to change. This is used to breed crops and livestock with desirable traits, which is done by crossing individuals with different desired traits. This is the way humans around the world have adapted plants and animals to agriculture for thousands of years.

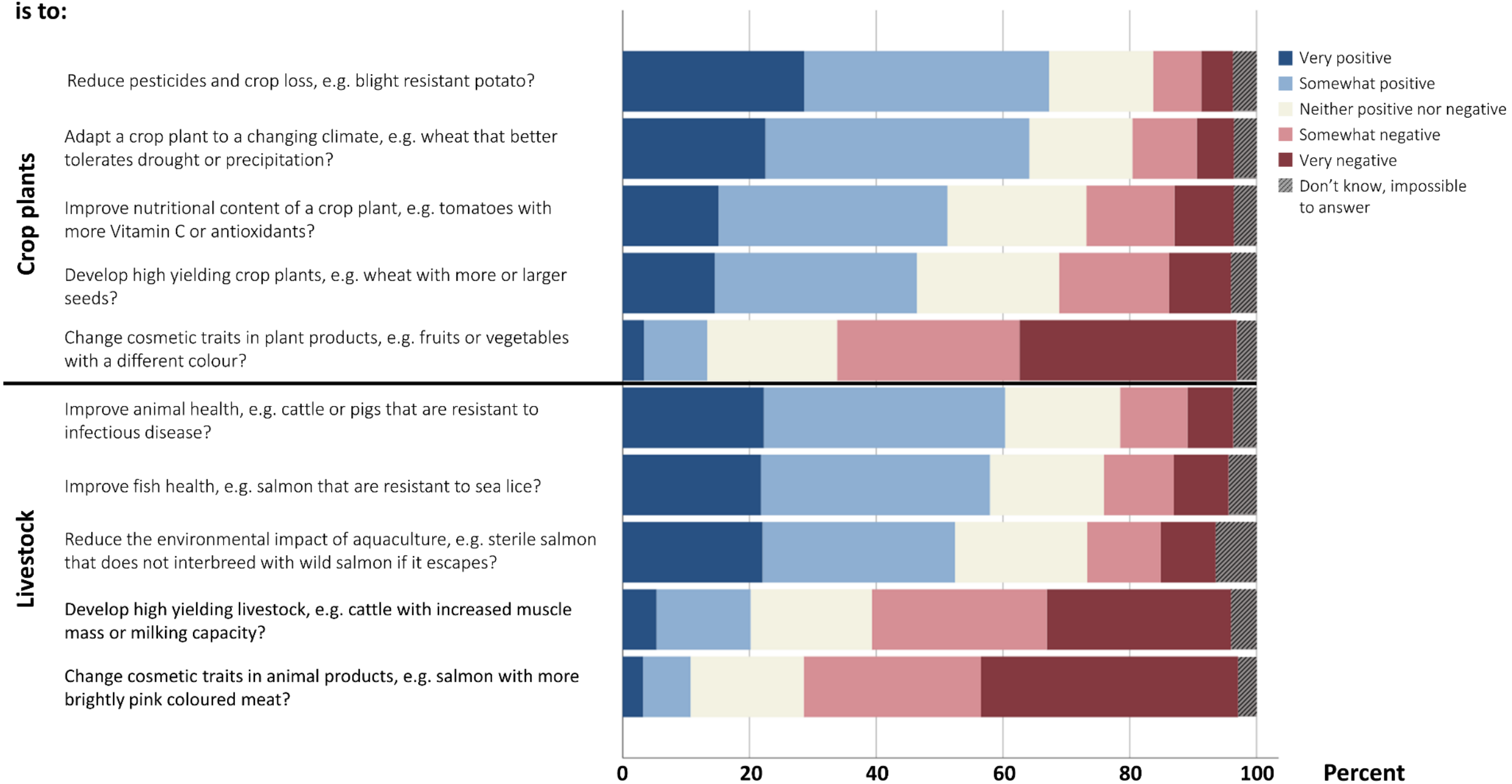
'Classic' genetic modification from the 1970s and 1980s:

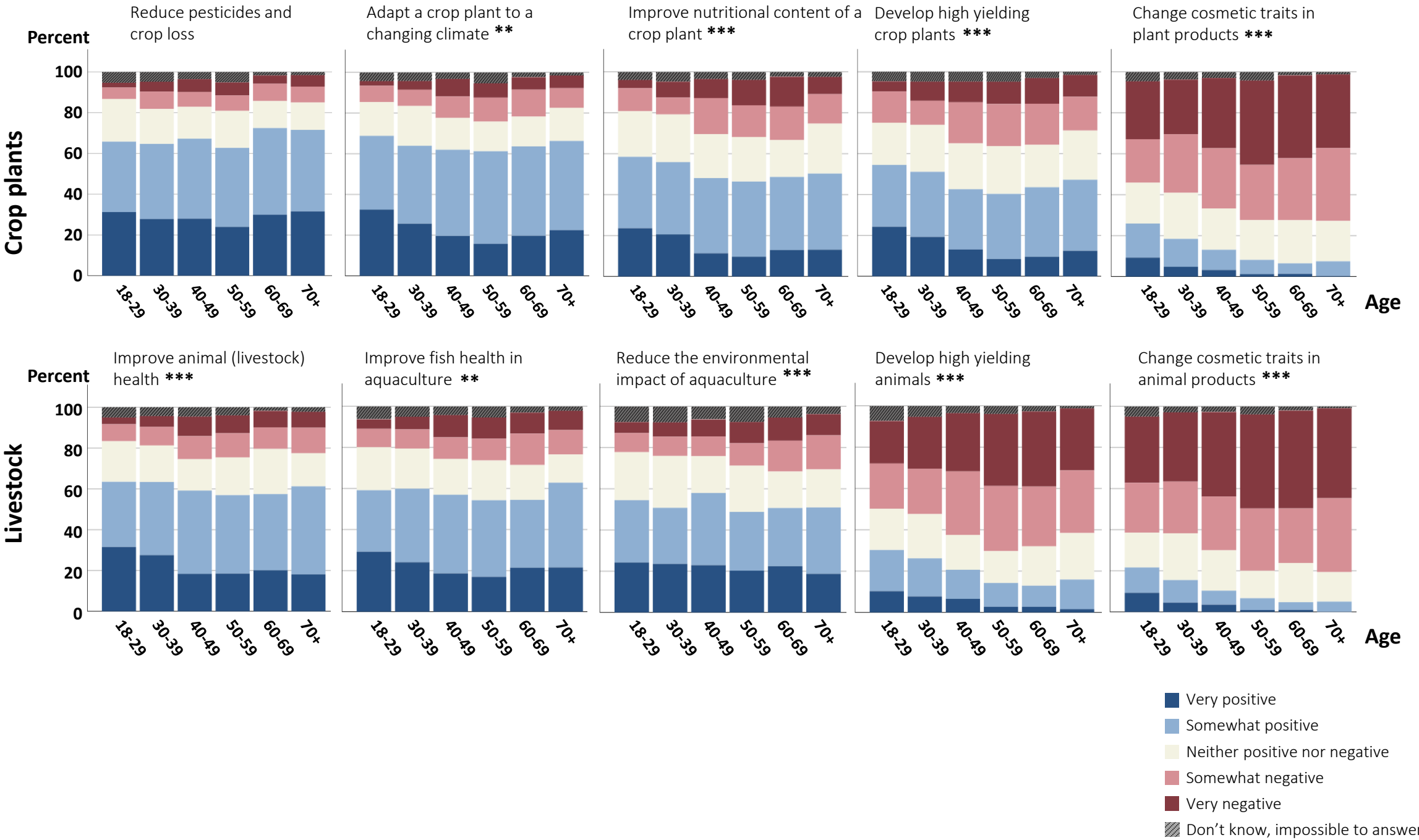
This method was developed by scientists in the 1970s and 1980s. It involves transferring genes from one organism to another, often between species. The method has mostly been used to transfer genes from bacteria to plants to make the plants more tolerant to herbicides or resistant to insects, which allows bigger crops.

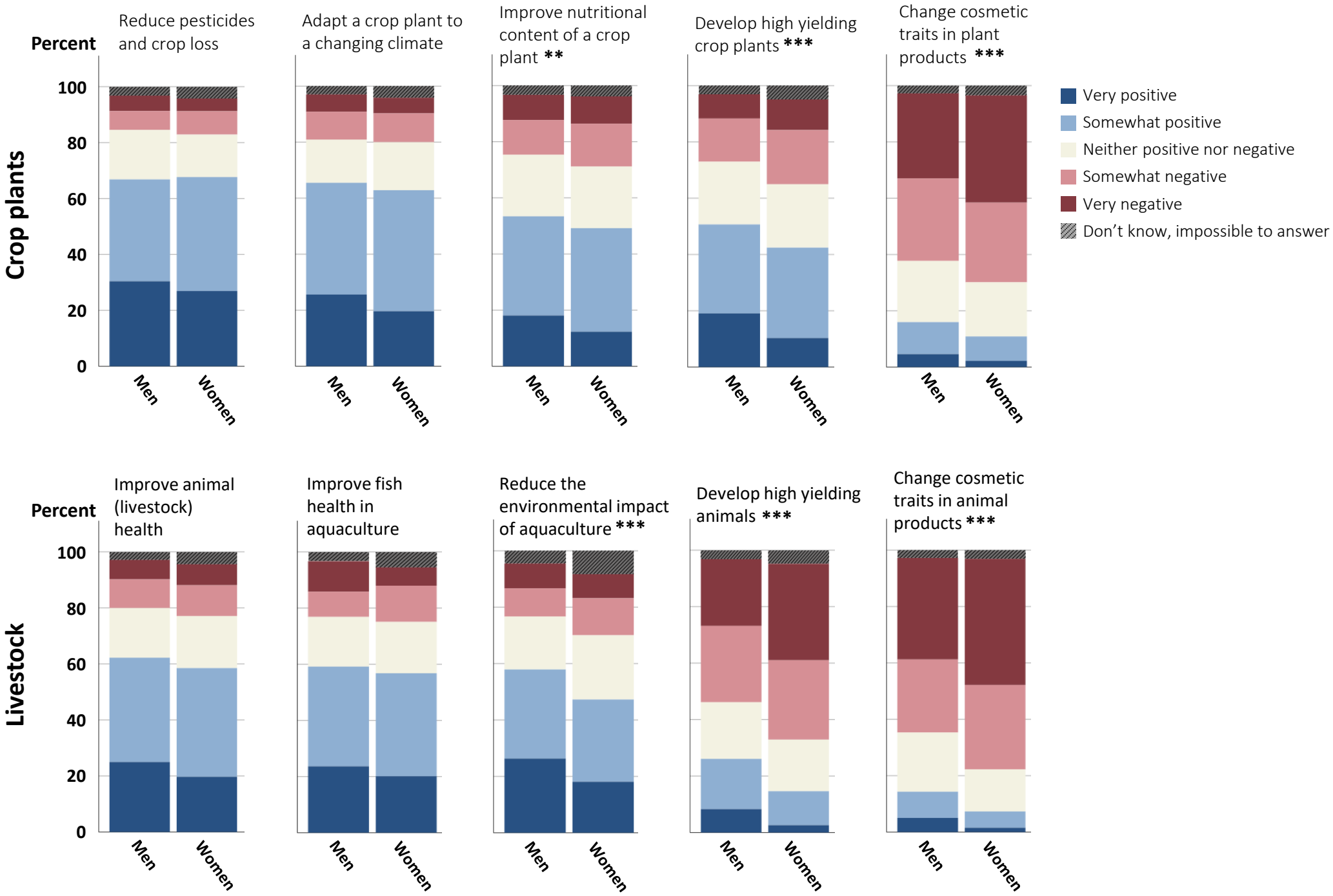
Gene editing, the latest method:

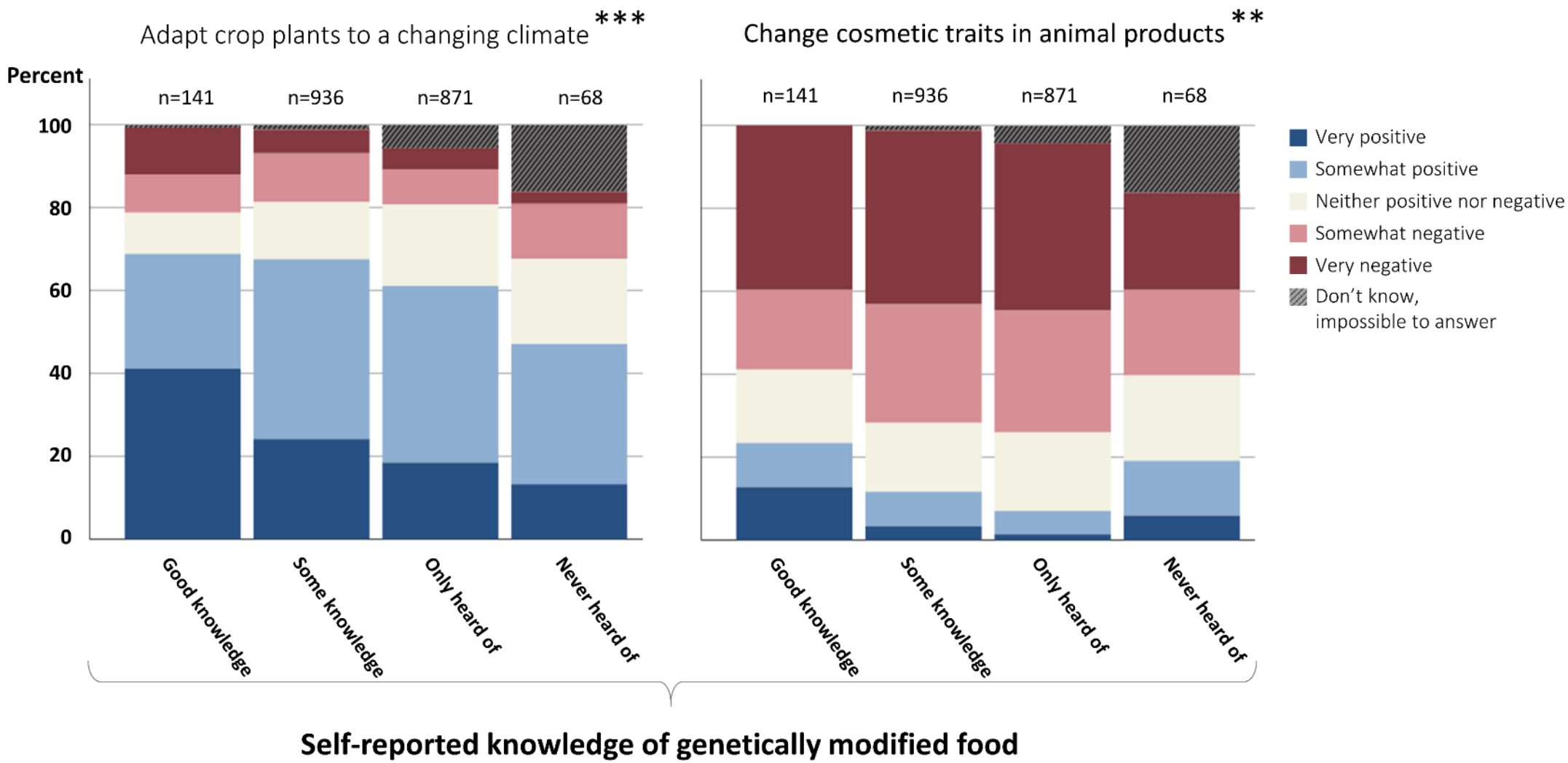
This method makes it possible to make targeted changes to the DNA, for example, removing, adding or exchanging genes or parts of genes (a common method is called CRISPR). In the examples in this study, gene editing refers to making genetic changes that mimic those that can happen by themselves in the wild or the changes one could get through traditional breeding (e.g. inserting genes from one potato variety into another potato variety). In these cases, no genes from other species are inserted. The purpose of gene editing is to adapt plant and animal traits.

How positive or negative are you to using gene editing on crop plants and livestock in Norwegian agri- and aquaculture, if the purpose is to:

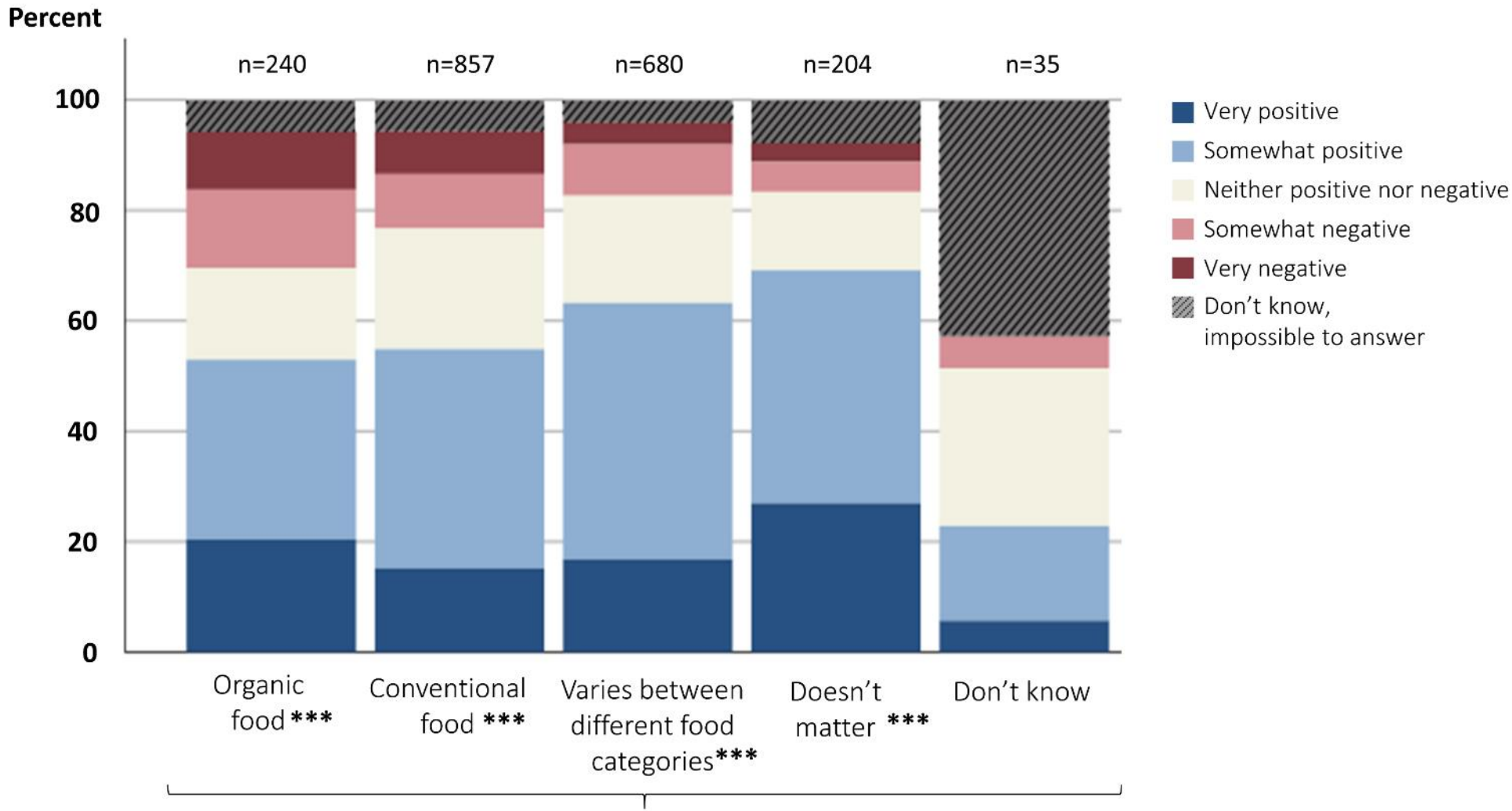



Crop plants
Livestock
Percent
Reduce pesticides and crop loss
Adapt a crop plant to a changing climate **
Improve nutritional content of a crop plant ***
Develop high yielding crop plants ***
Change cosmetic traits in plant products ***
Improve animal (livestock) health ***
Improve fish health in aquaculture **
Reduce the environmental impact of aquaculture ***
Develop high yielding animals ***
Change cosmetic traits in animal products ***
0
20
40
60
80
100
18-29
30-39
40-49
50-59
60-69
70+
Age
Very positive
Somewhat positive
Neither positive nor negative
Somewhat negative
Very negative
Don't know, impossible to answer


Crop plants
Livestock
Percent
Reduce pesticides and crop loss
Adapt a crop plant to a changing climate
Improve nutritional content of a crop plant **
Develop high yielding crop plants ***
Change cosmetic traits in plant products ***
Improve animal (livestock) health
Improve fish health in aquaculture
Reduce the environmental impact of aquaculture ***
Develop high yielding animals ***
Change cosmetic traits in animal products ***
100
80
60
40
20
0
Men
Women
Very positive
Somewhat positive
Neither positive nor negative
Somewhat negative
Very negative
Don't know, impossible to answer


Adapt crop plants to a changing climate ***
Change cosmetic traits in animal products **
Percent
100
80
60
40
20
0
n=141
n=936
n=871
n=68
Good knowledge
Some knowledge
Only heard of
Never heard of
Very positive
Somewhat positive
Neither positive nor negative
Somewhat negative
Very negative
Don't know, impossible to answer
Self-reported knowledge of genetically modified food

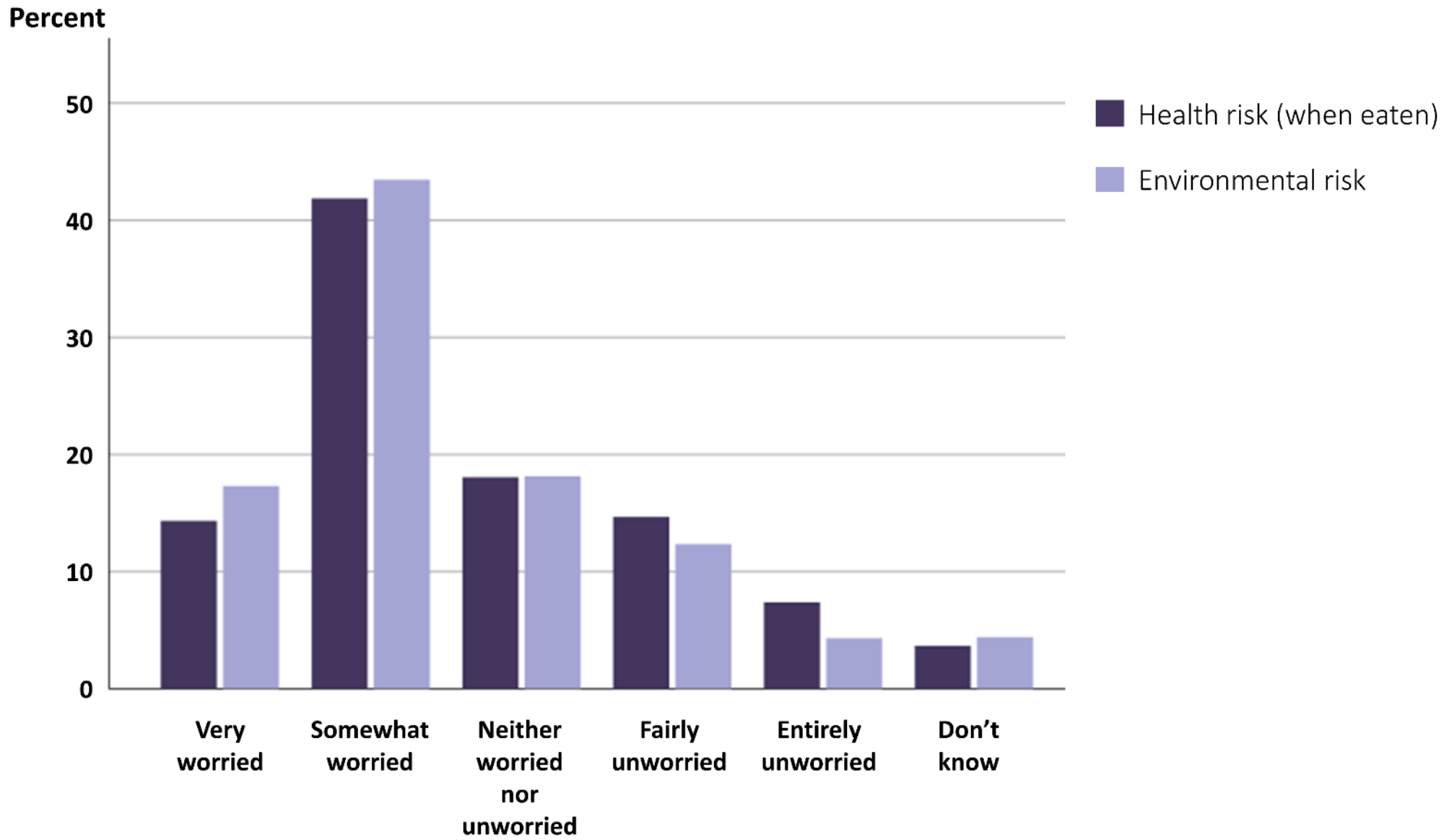
Imagine that gene editing makes it easier to cultivate crop plants without pesticides. How positive or negative are you towards using such a plant in organic food production?

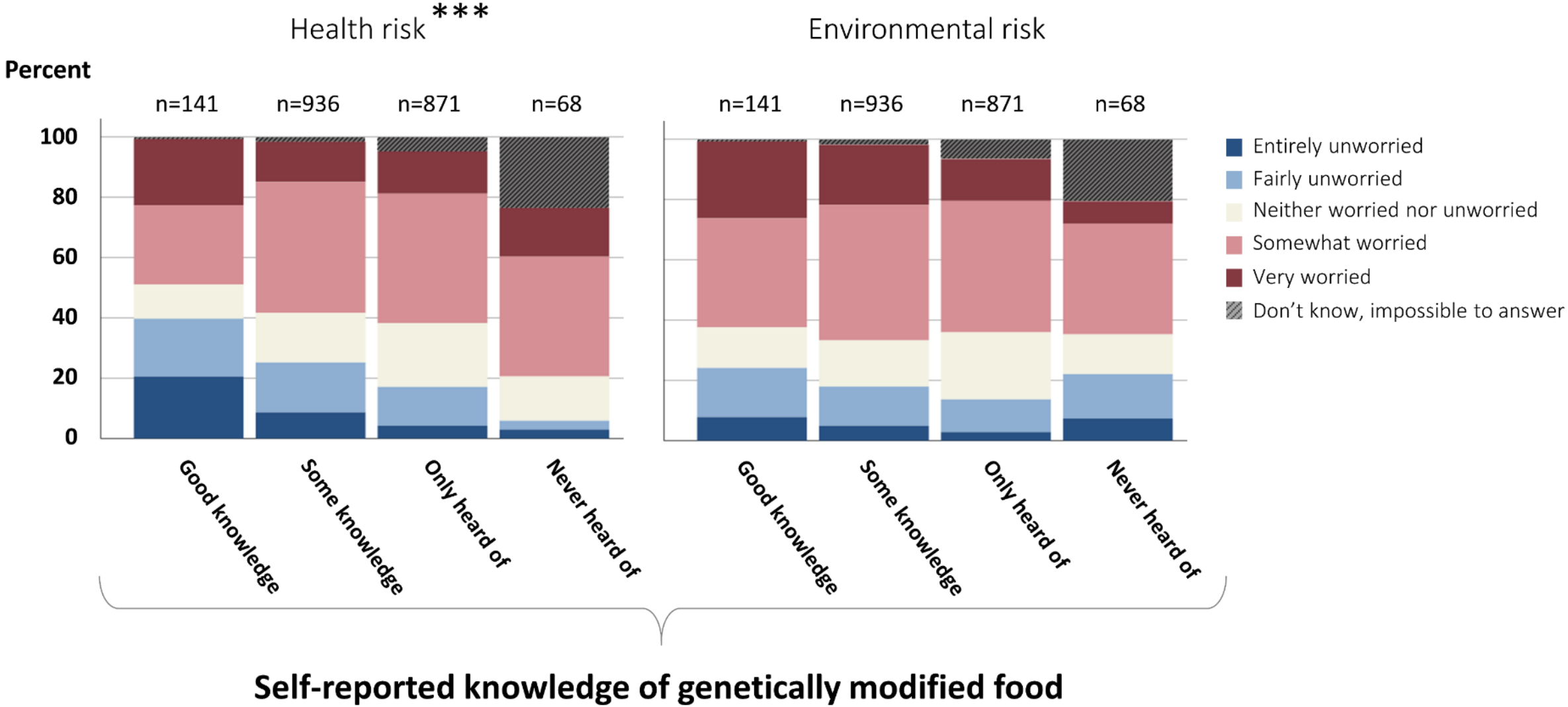


What type of food do you prefer when you go food shopping?

Worry about risk

How worried or unworried are you that gene edited products present risks to your health (when eaten) or to the environment?

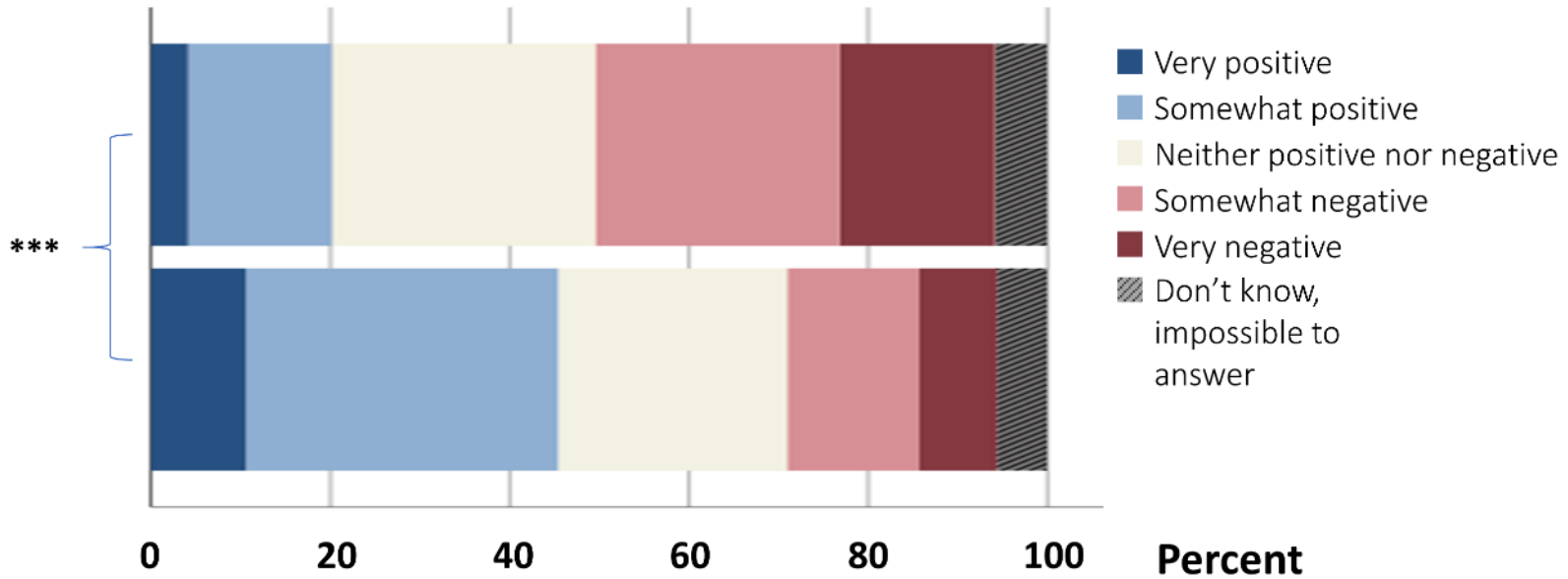



Health risk***
Environmental risk
Percent
n=141
n=936
n=871
n=68
100
80
60
40
20
0
Good knowledge
Some knowledge
Only heard of
Never heard of
Entirely unworried
Fairly unworried
Neither worried nor unworried
Somewhat worried
Very worried
Don't know, impossible to answer
Self-reported knowledge of genetically modified food

Attitudes and trust in producers and authorities

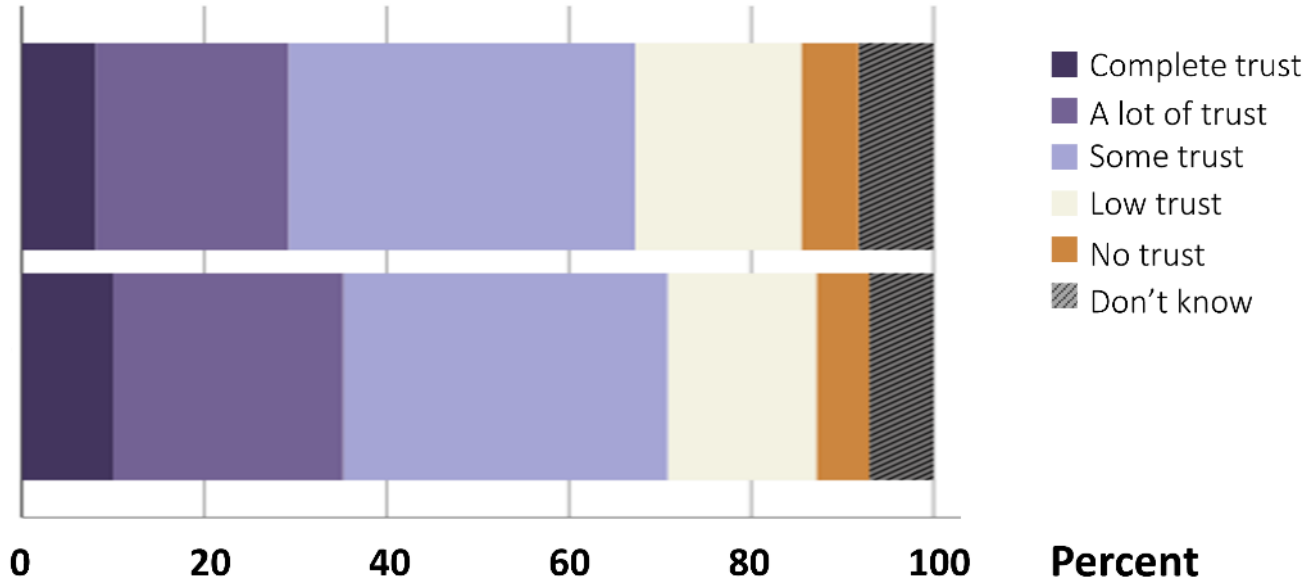
GMOs currently on the international market are developed by international companies. How positive or negative are you towards such products?

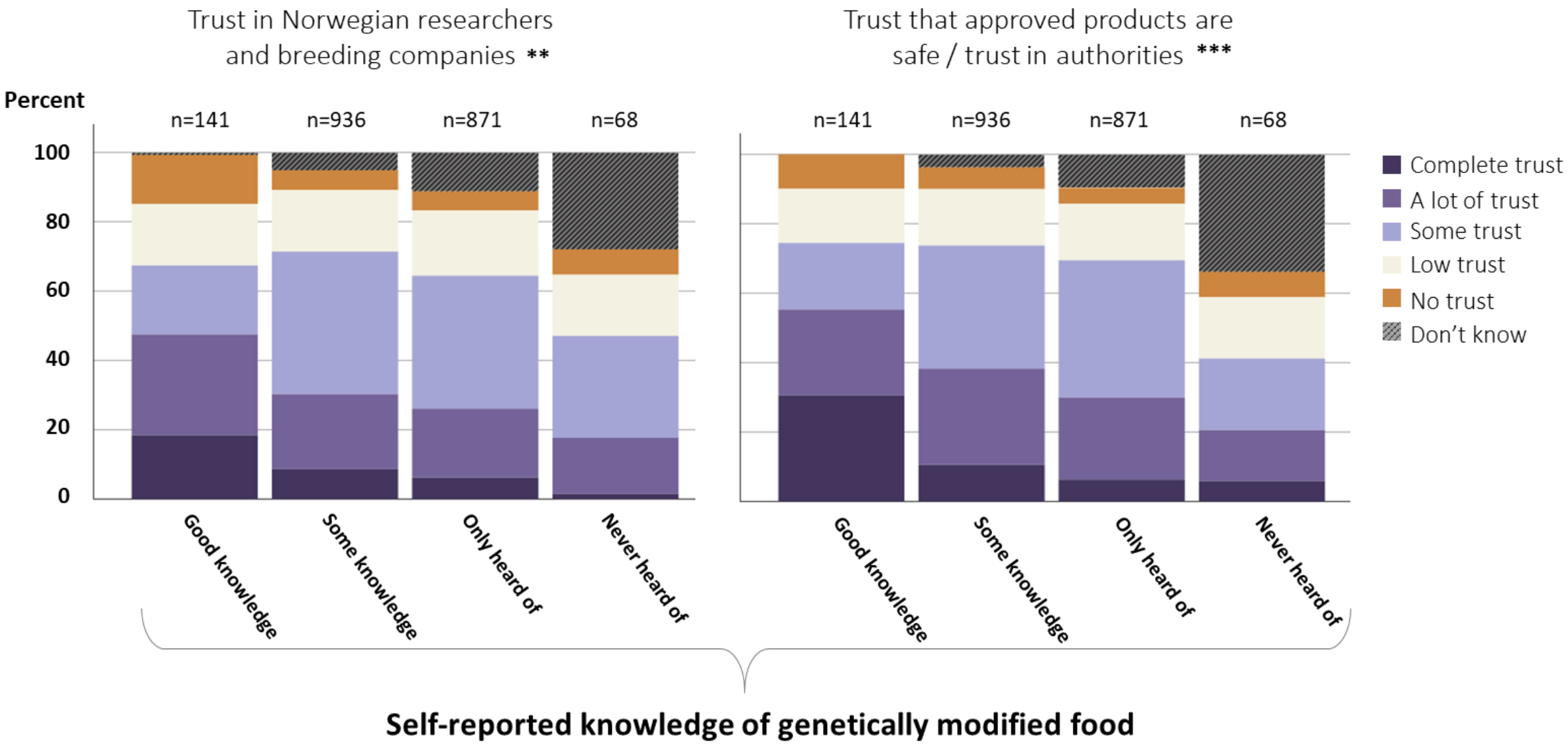
How positive or negative would you be if gene edited products are developed for the Norwegian market by Norwegian researchers and breeding companies?



How much do you trust that Norwegian researchers and breeding companies would use gene editing in ways that benefit society and the environment? ***

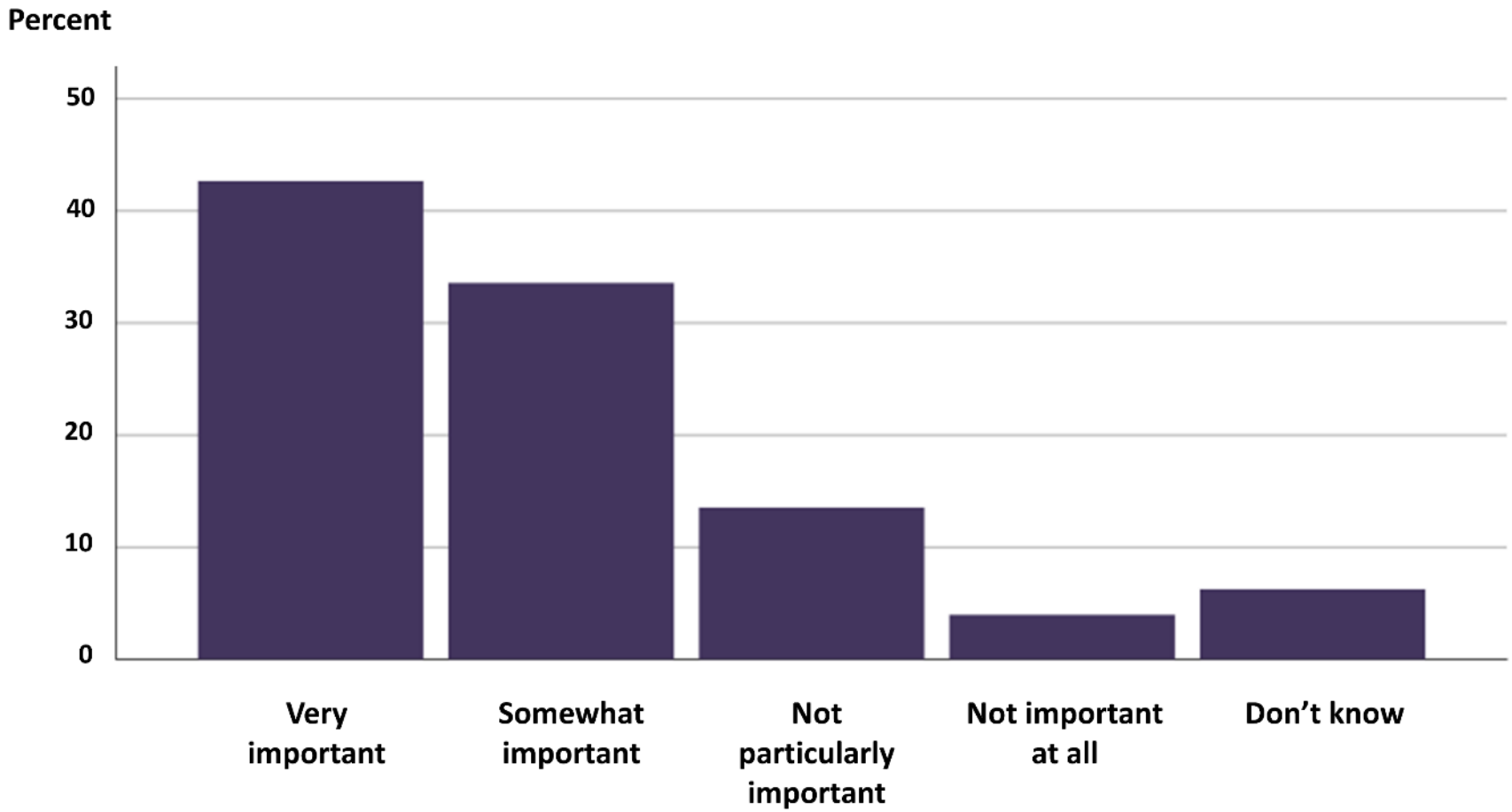
In Norway, all GMOs/gene edited products must be approved by the authorities after health and environmental risk assessments. How much do you trust that such approved products are safe to eat and safe for the environment? ***

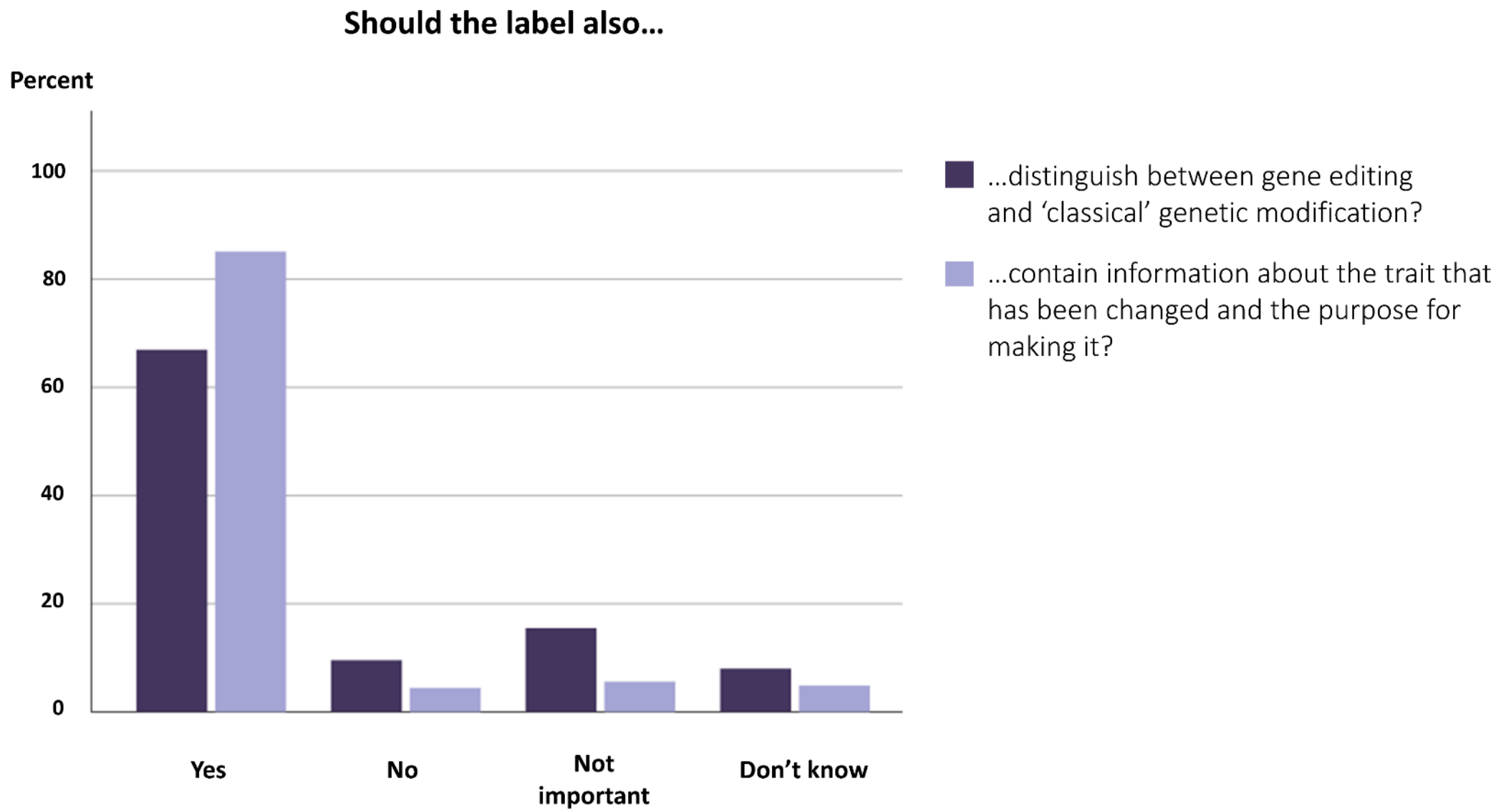



Trust in Norwegian researchers and breeding companies **
Trust that approved products are safe / trust in authorities ***
Percent
100
80
60
40
20
0
n=141
n=936
n=871
n=68
Good knowledge
Some knowledge
Only heard of
Never heard of
Complete trust
A lot of trust
Some trust
Low trust
No trust
Don't know
Self-reported knowledge of genetically modified food

Labelling:

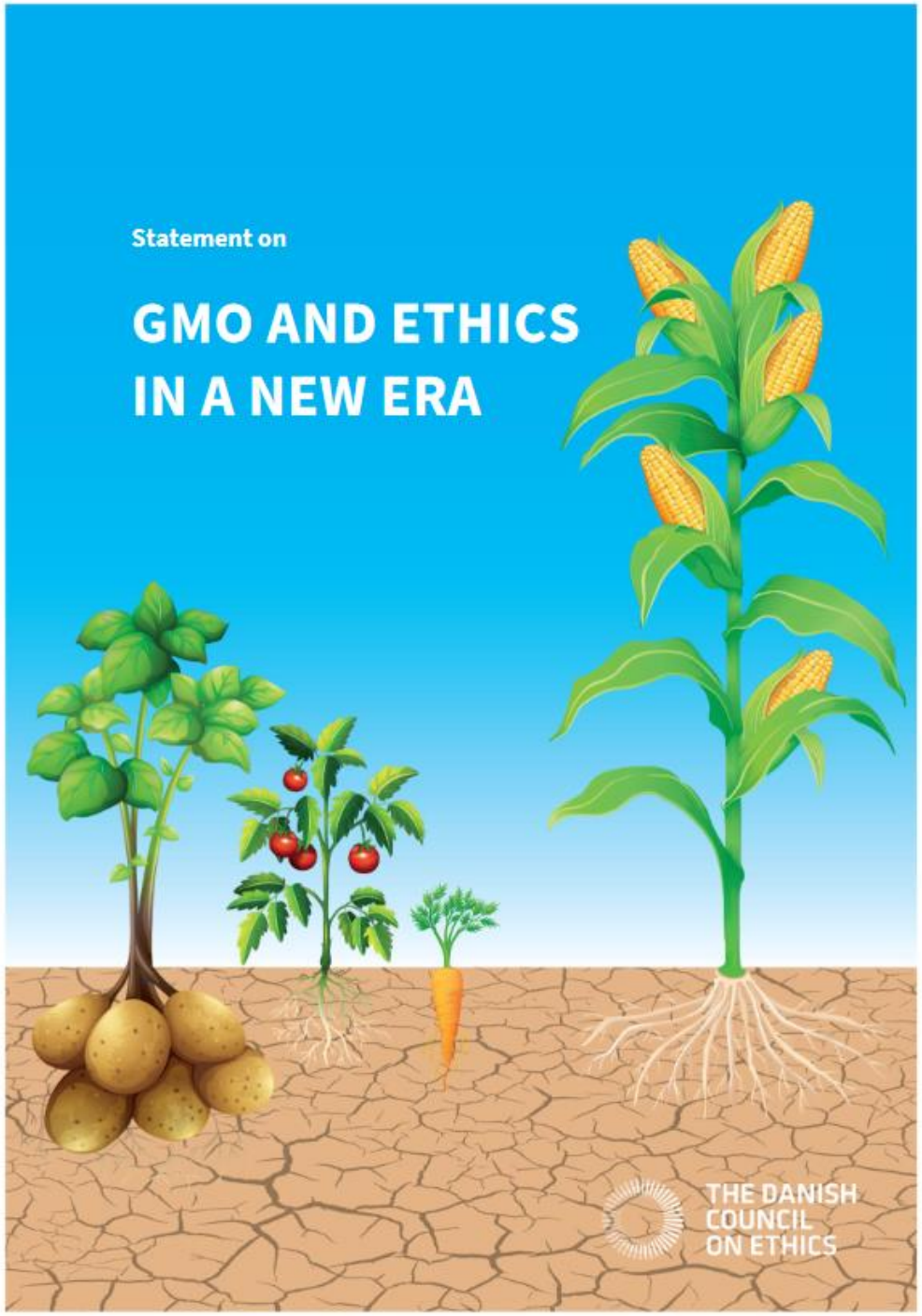
How important or unimportant is it to you that gene edited products in the store are labelled to indicate that they have been produced with genetic engineering?



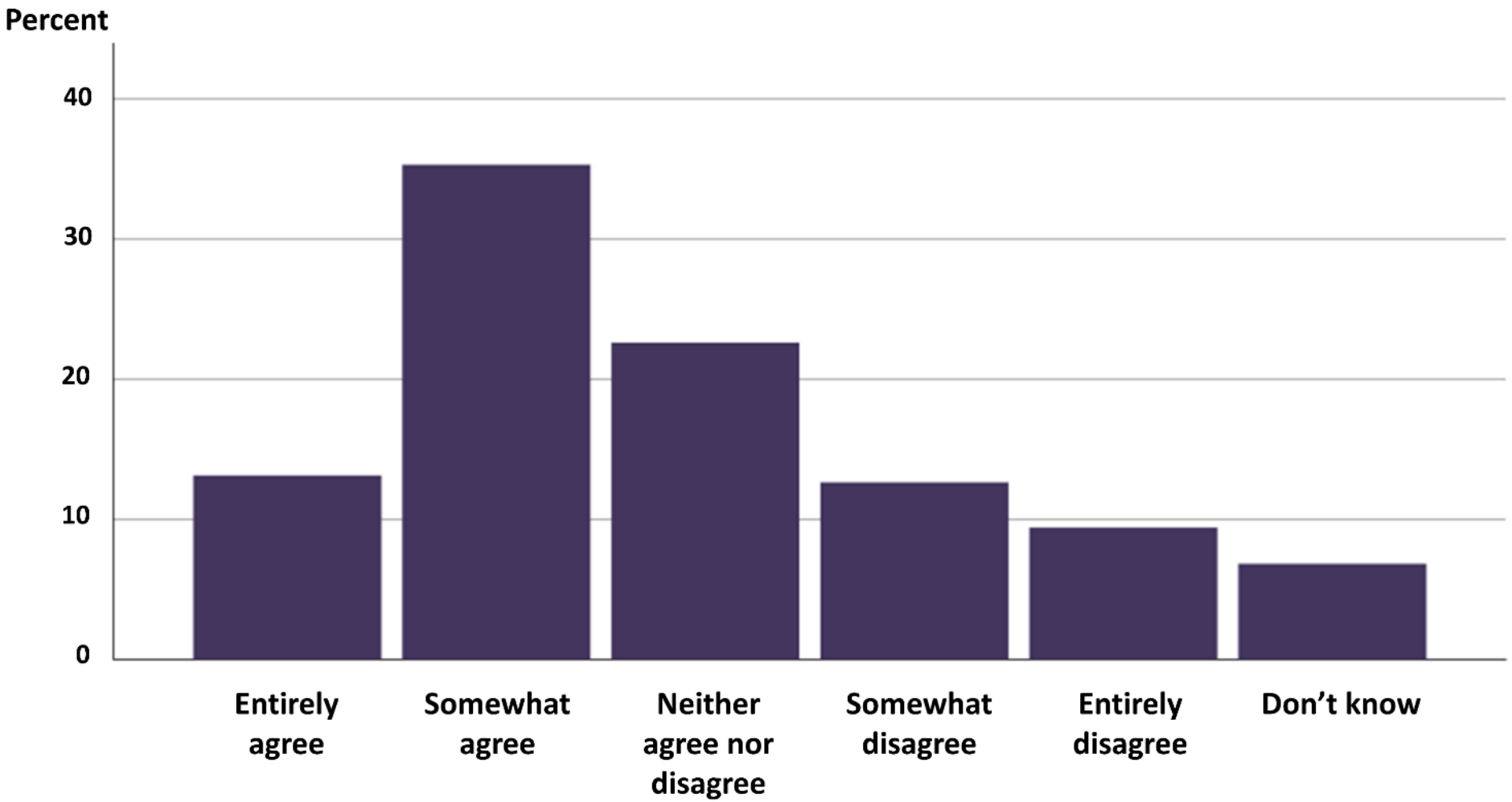

Should the label also…
Percent
100
80
60
40
20
0
Yes
No
Not important
Don't know
…distinguish between gene editing and 'classical' genetic modification?
…contain information about the trait that has been changed and the purpose for making it?

Ethics:

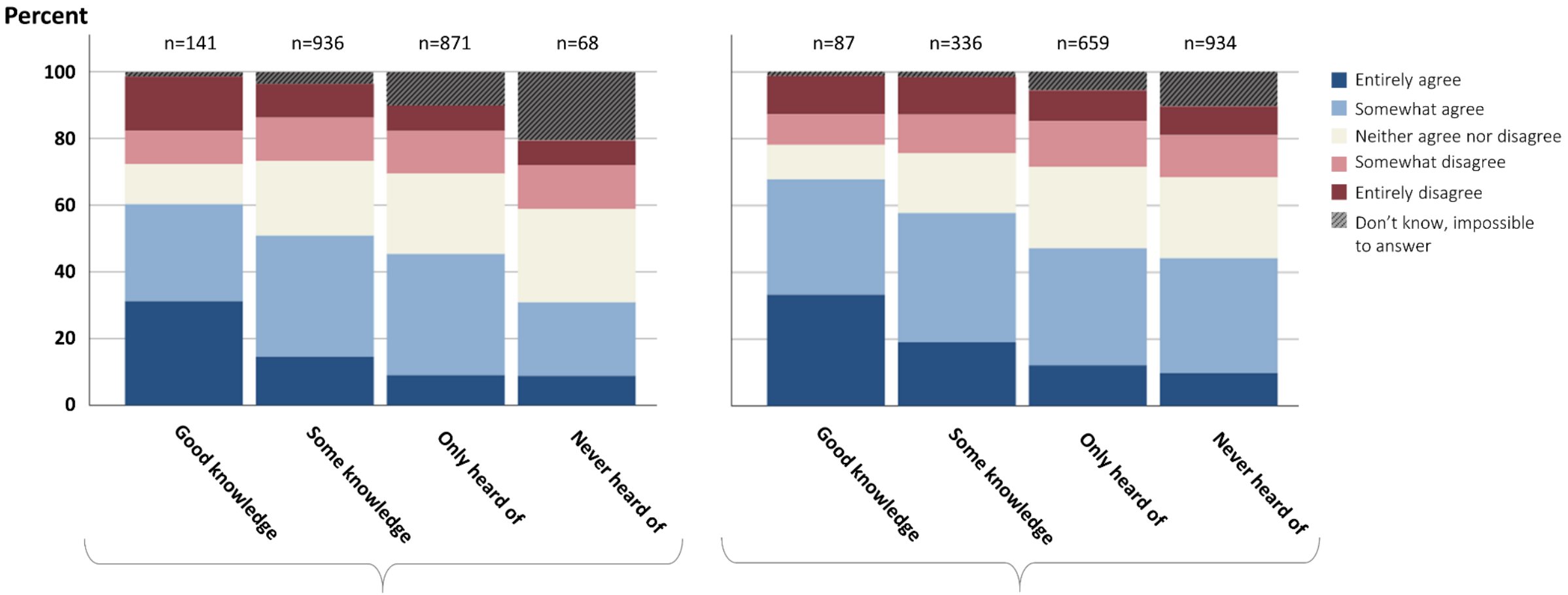
Can it be unethical not to use gene editing to solve major societal challenges?



To what extent do you agree or disagree with the following statement: It can be unethical not to use gene editing in crop plants and livestock if it can contribute towards solving important societal challenges, such as climate adaptation of crops.

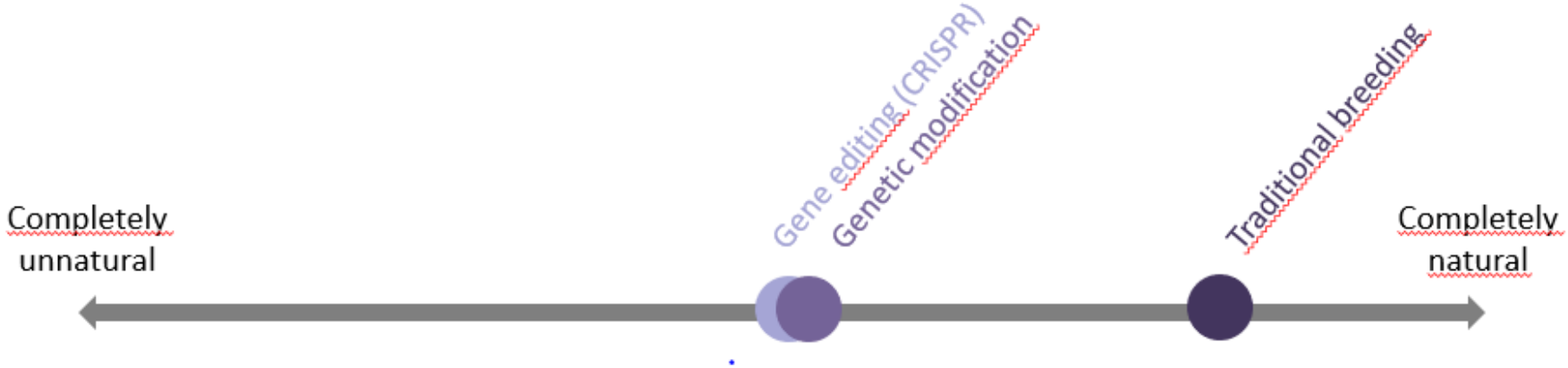


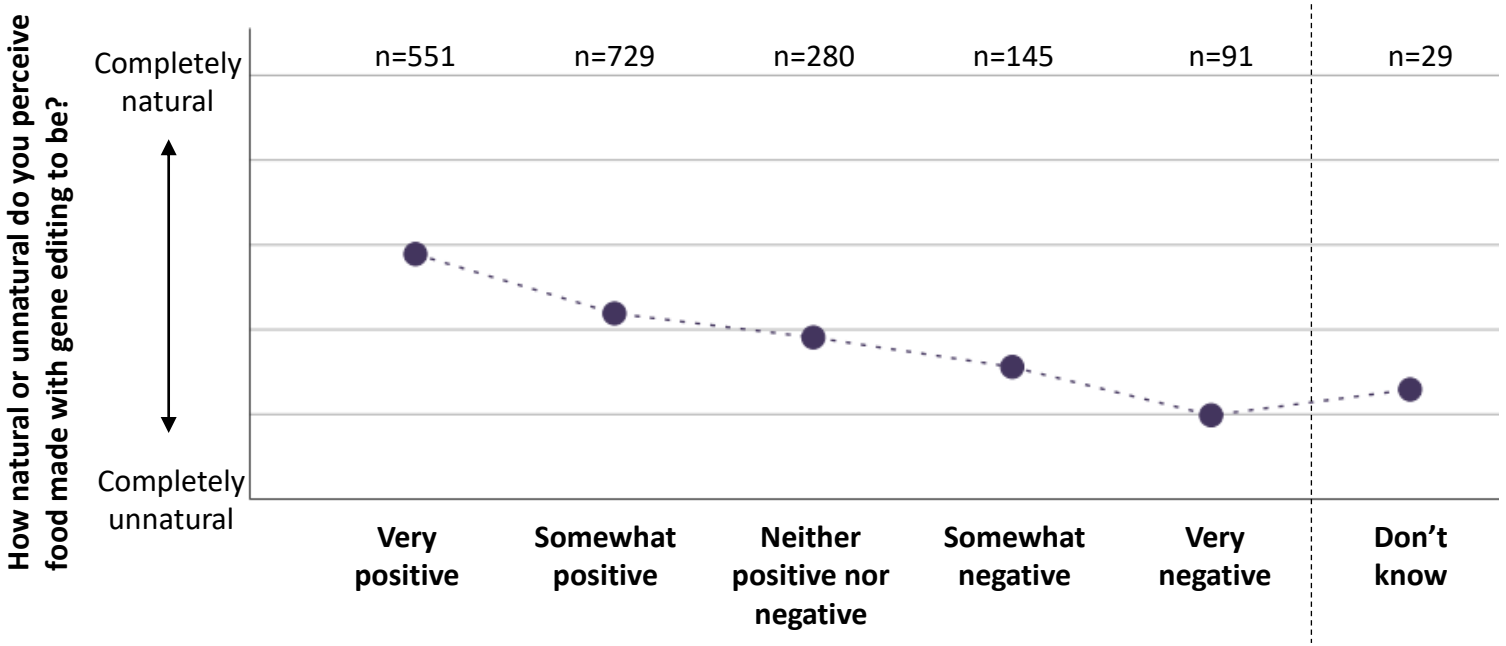
It can be <u>un</u>ethical <u>not</u> to use gene editing in crop plants and livestock if it can contribute towards solving important societal challenges, such as climate adaptation of crops.



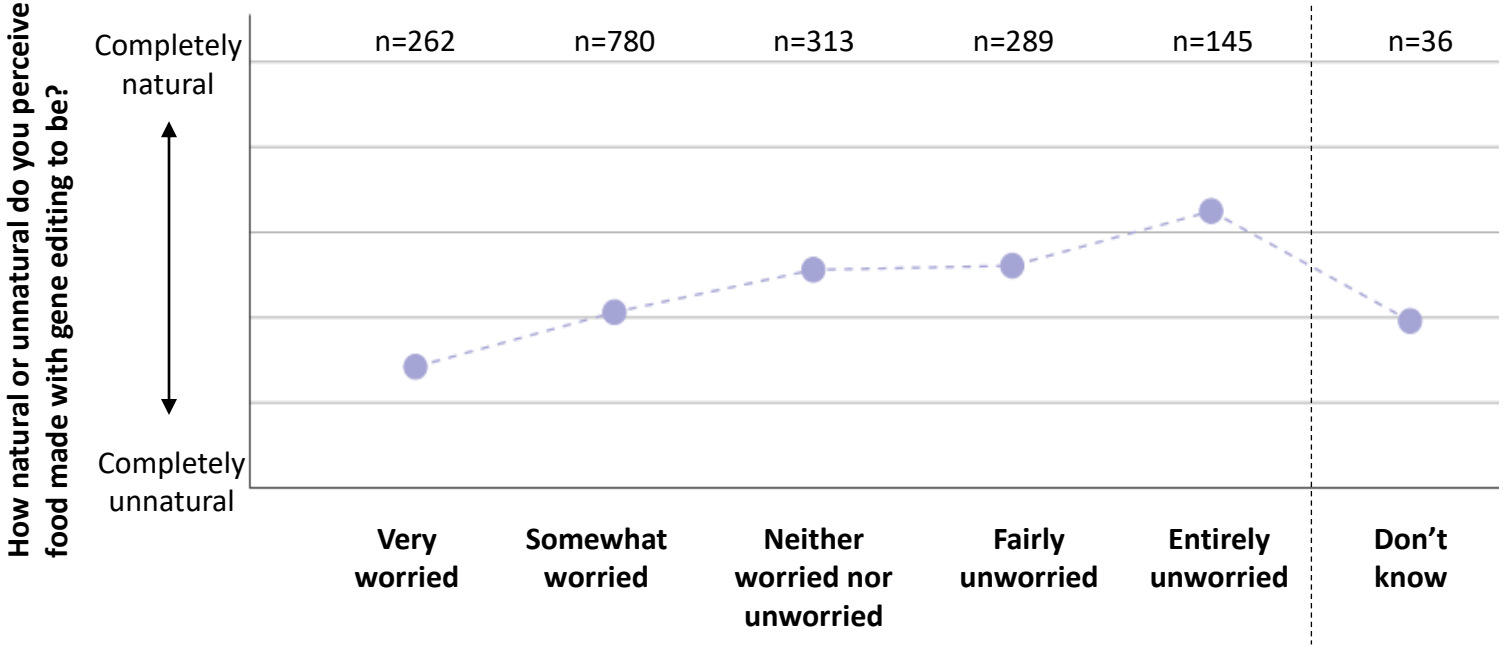
Naturalness:

How natural or unnatural do you consider the following methods to be?





Gene editing to reduce pesticides and crop loss ***



Worry about health risk ***

Limitations and general reflections:

- Representative selection, BUT: they were presented with basic information about methods to ensure adequate understanding. Such info will not be available to consumers. New labeling system? How should benefits be communicated to consumers?

- Knowledge is an important element of the survey. However, it is simplified into one variable, and thus we cannot define an absolute level of knowledge.

- Attitudes to gene editing can be influended by larger political and societal aspects. E.g. in the focus groups, some were negative towards gene editing in livestock because they were opposed to industrial livestock production in general.

- Lack of knowledge about food production in general is a limiting factor. For example, it was challenging to have a meaningful discussion about gene editing pigs to reduce boar taint and prevent castration. Many did not know that castration is routine in pig production, and many did not understand whether gene editing increased or decreased the need for castration.

- Lack of knowledge about genetics and breeding:
  - 35% scored the item «ordinary tomatoes do not have genes, while genetically modified tomatoes do» as more true than untrue, or that it was impossible to answer.
  - >40% thought it was more true than untrue that «traditional breeding has nothing to do with genes» or that this was impossible to answer.

Conclusions

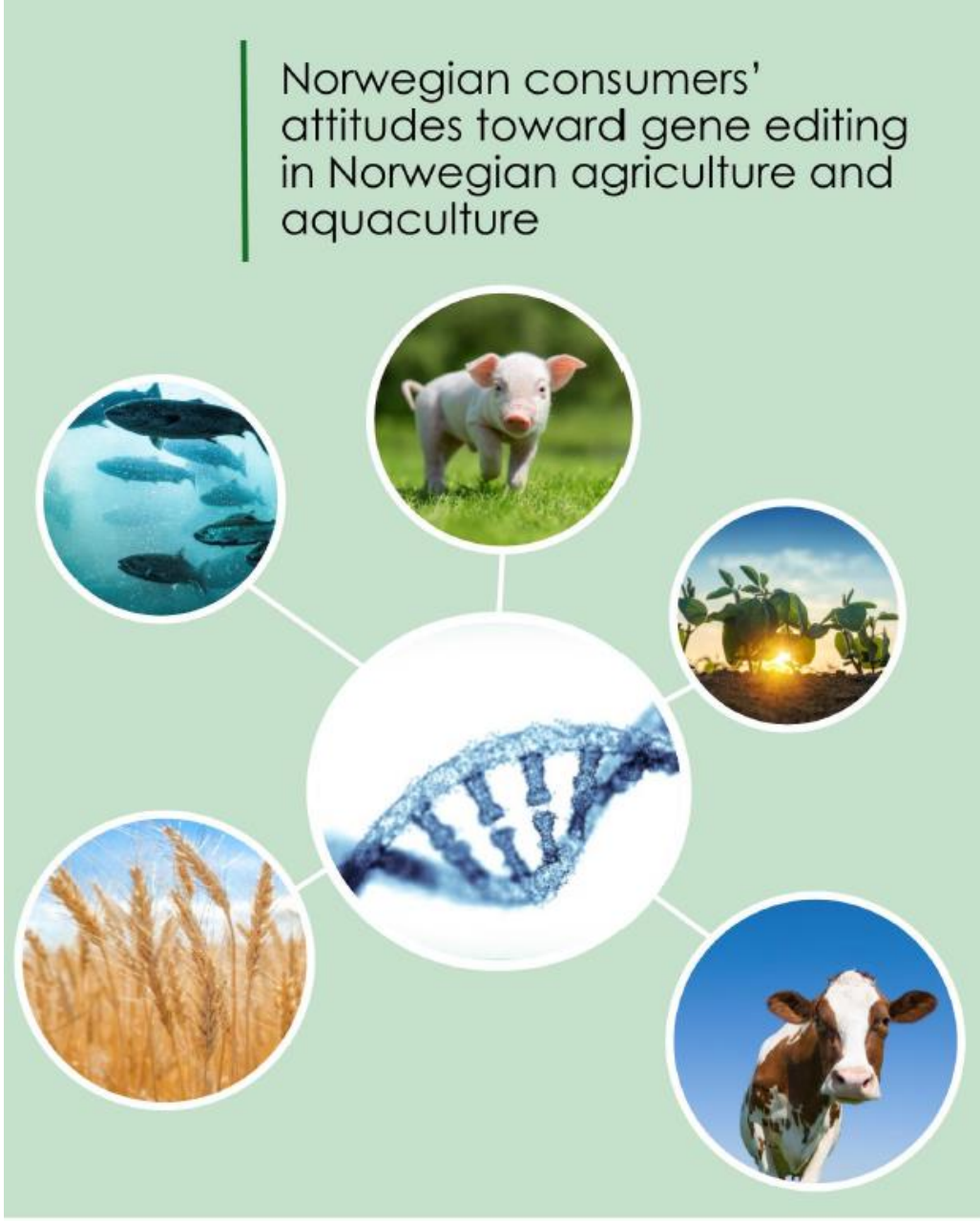
For GENEinnovate:

- Results are important steering tool for the other work packages in the project.
- Information and transparency will be key to building trust.

For the public debate and policy:

- Nuances are important: Not for/against genetic engineering, but what to use it for.

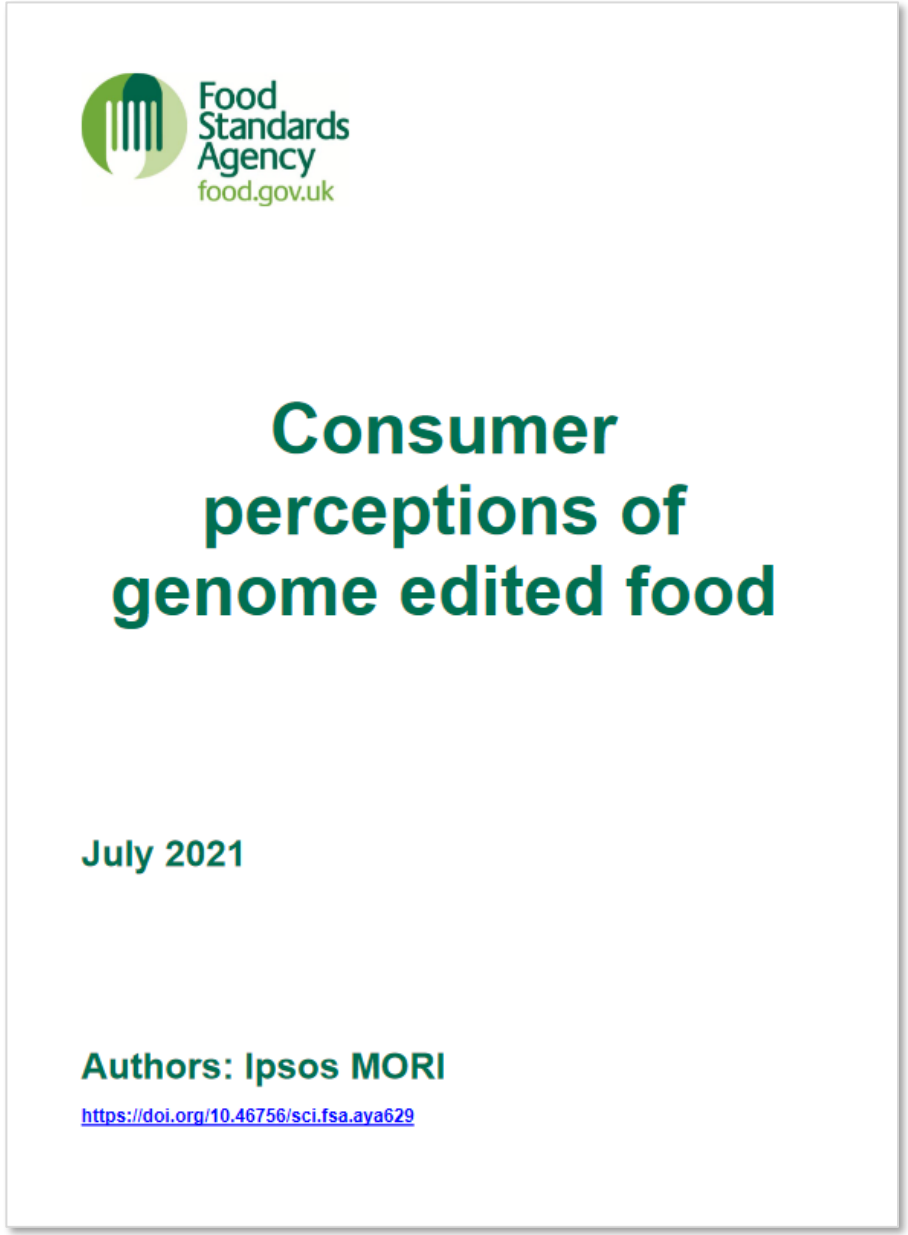
- Need for knowledge building about food, breeding and genetics in general, and gene editing/ genetic engineering in particular.



https://www.bioteknologiradet.no/filarkiv/2020/04/Report-consumer-attitudes-to-gene-editing-agri-and-aqua-FINAL.pdf

Bioteknologirådet

GENEinnovate



• Consumers tended to have very low awareness and very low knowledge of GE food.

- More informed consumers were, or became, more accepting of GE food.

- Consumers tended to find GE food more acceptable than GM food.

- Most consumers felt it would be appropriate to regulate GE foods separately from GM foods.

- Most consumers felt labelling should always inform the consumer of the presence of GE ingredients using the full term ‘genome edited’.

Genteknikmnden
The Swedish Gene Technology Advisory Board

Stockholm
October 20 2021

Swedes attitudes towards genome editing in plant breeding surveyed

In short:

1. Swedes have in general little knowledge and awareness about genetics, genetically modified plants and genome editing.

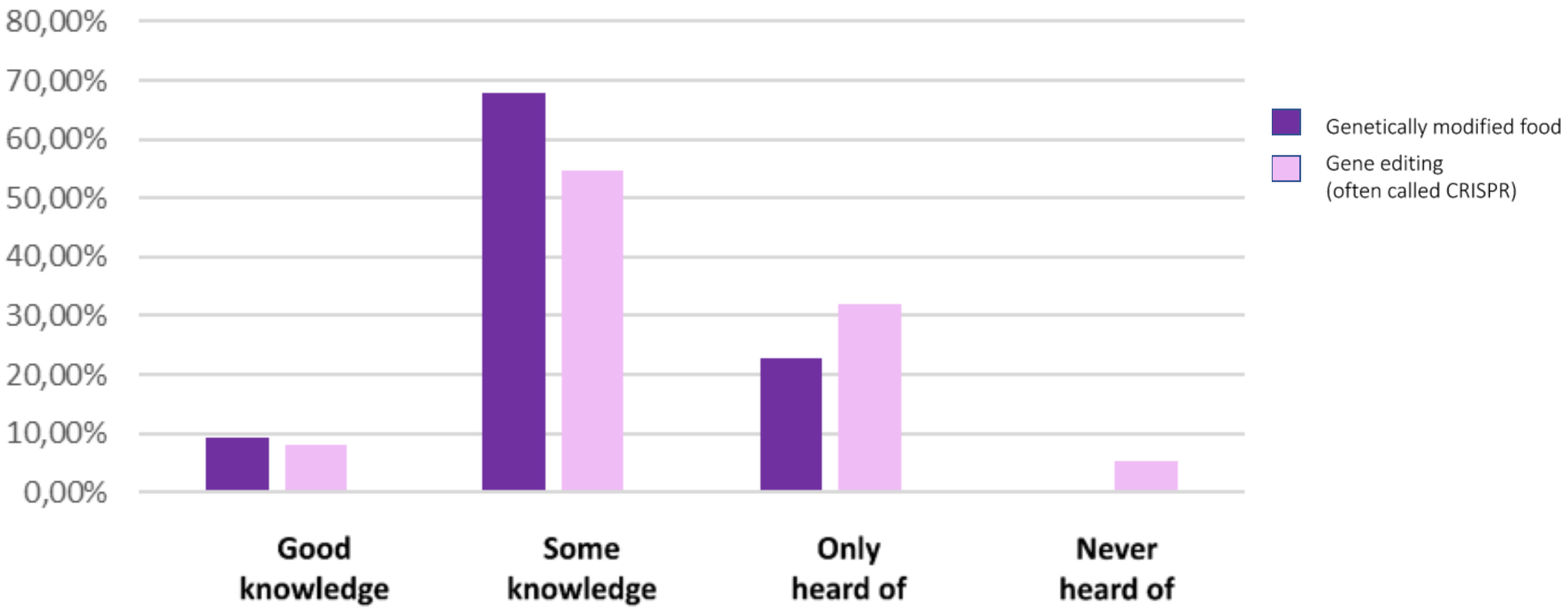
2. The majority of Swedes are positive towards the use of genome editing in plant breeding if the aim is beneficial for the environment and the society. Younger people, well-educated people, men, and people with previous knowledge about CRISPS/Cas9, are in general more positive.

3. The majority of Swedes are also worried about potential risks associated with genome editing.

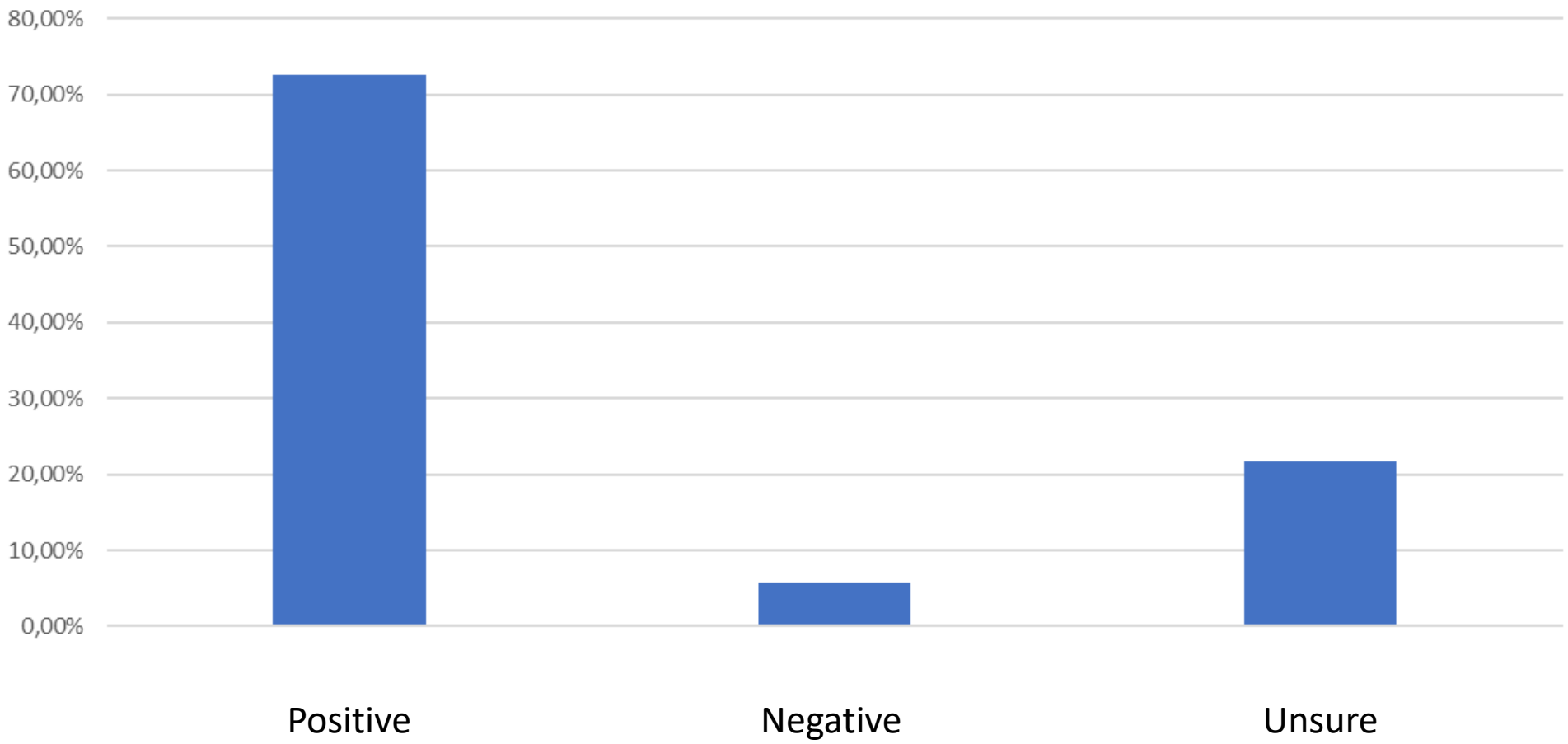
Attitudes to genome editing among producers/farmers

- 175 producers (greens, vegetables, berries)
- Cooperative members

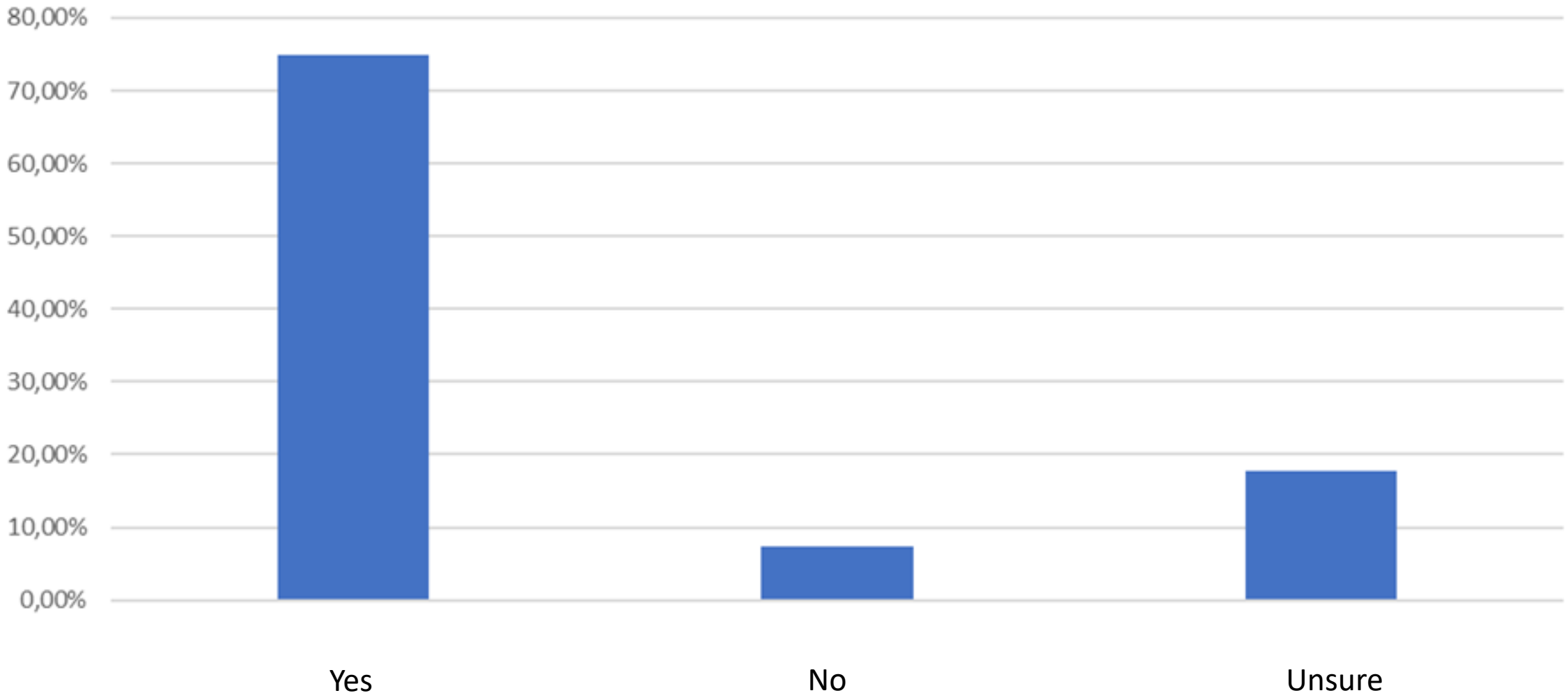
How much do you know about genetically modified food and gene editing (often called CRISPR)?



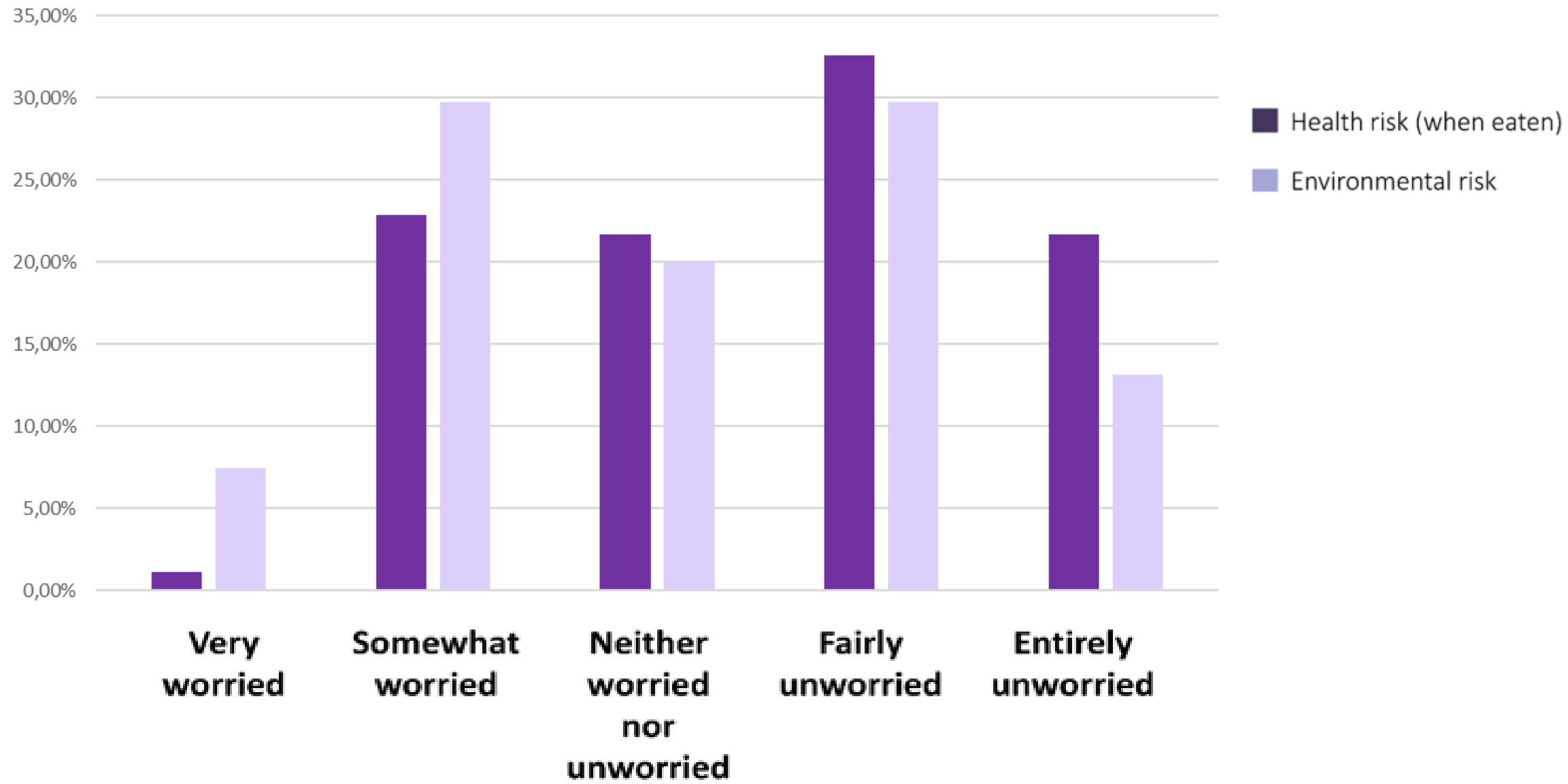
What is your opinion on using genome editing to make crops more disease resistant, e.g. blight resistant potatoes?



Would you consider having genome edited crops in your own production if the products were developed by norwegian breeding companies/scientists and approved for use in Norway?



How worried or unworried are you that gene edited products present risks to your health (when eaten) or to the environment?



Questions and conclusions:

- What about the rest of the value chain, in particular the retailers?
- Products that are relevant to the norwegian market
- Communication to stakeholders and the public

Outlook in Norway

- Changing narrative
- Changing attitudes
- Changing policy


1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS

Thank you for your attention

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