

Global



Harmonization

Advocating science-based
food safety law and trade

Initiative

What could gene technology really deliver for the food sector?



Breeding: The art of finding “good mutants” and keeping them

Wild
cabbage



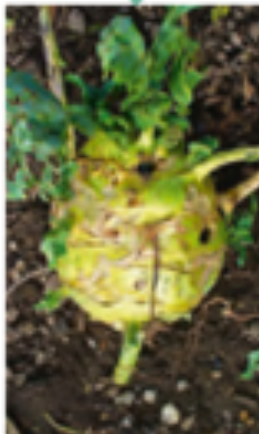
Apical shoots



Side shoots



Stem



Leaves



Flowers



Inflorescence



Gregor Mendel understood the laws of genetics



Breeding since the 1920ties:

- Introducing “supernatural variation”



Institute of Radiation
Breeding (Ibaraki-ken)



Chemical
mutagenesis



Random events causes damage to the DNA



...the plant repairs it, but a piece may get lost



Mutation breeding has been enormously successful – over 2 500 registered varieties



The green revolution



Agrobacterium – a tool for introducing novel genes into plants



Biotechnology made easy



The big thing with biotechnology – Change one gene/trait at the time



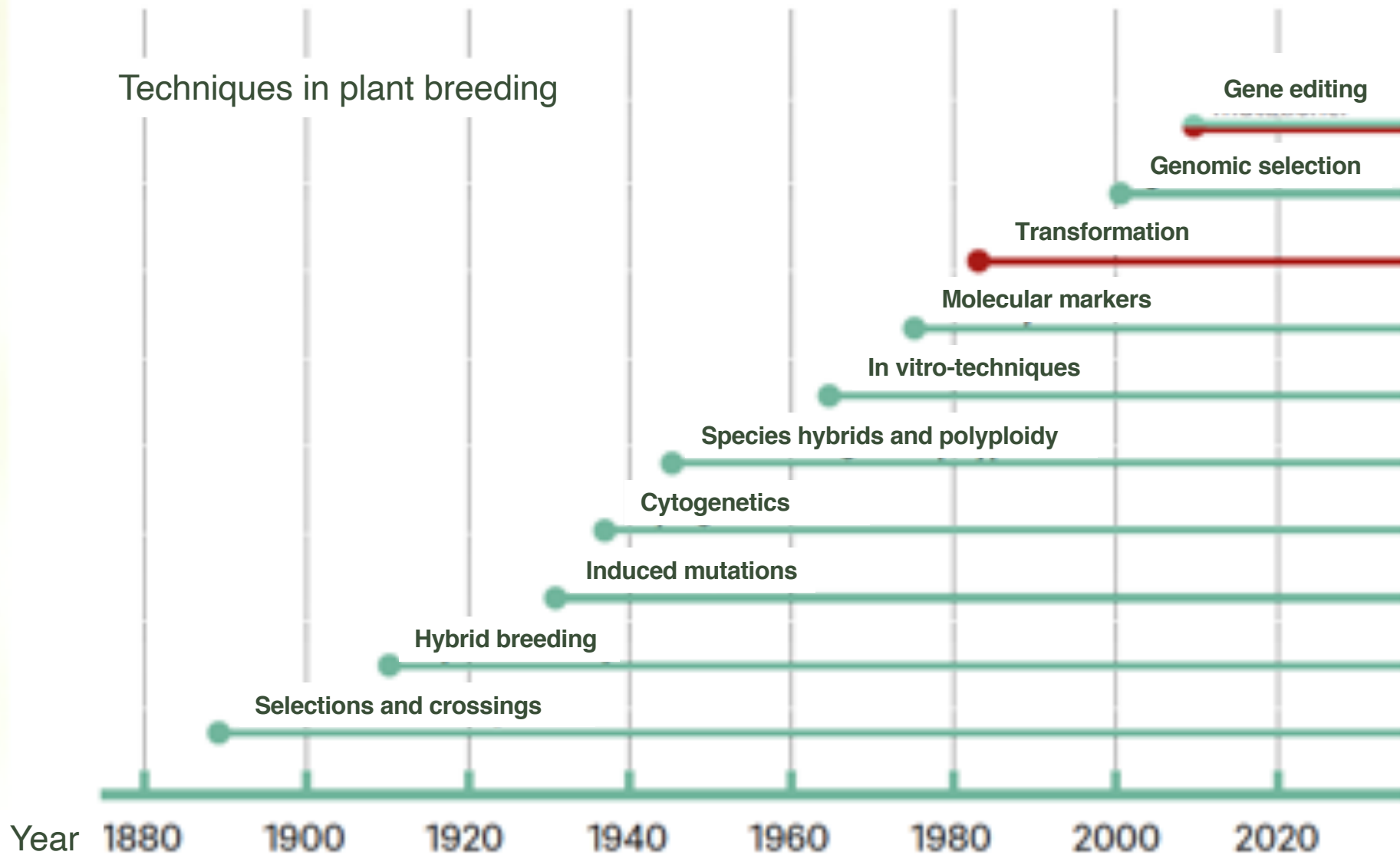
Put away the sprays - Sárpo spuds look after themselves

Sárpo Mira • Red-skinned maincrop for baking, fries • Exceptionally high blight resistance • Resistant to virus and blackleg • Drought tolerant • Firm (keeps in the pot) • Good for advanced maturity	Sárpo Shona • White-skinned, early maincrop • General purpose in kitchen • Very good resistance to blight and leafroll virus • Tubers resist powdery mildew, black dot and black scurf • Short, weed-smothering foliage	Blue Danube • Blue-skinned, early maincrop • White flesh, good flavour, general purpose • High resistance to tuber blight • Resistant to virus Y1, leafroll virus • Resistant to blackleg, black scurf and skin spot • Resistant to Potato Cyst Nematode (PCN) Rn1
Axona • Red-skinned maincrop • Makes very tasty mash and bakes potato • Very good blight resistance • Resistant to virus Y1, leafroll virus and blackleg • Chilled good to advanced maturity	Sárpo Una • Pink-skinned second early • Good salad potato and in early season • Good resistance to blight and virus diseases • Tubers resistant to powdery mildew, dry rot, black scurf, silver scurf and skin spot • Very high yield (1 tonne/m²)	Kiri • White-skinned, early maincrop of flowering type • Exceptional for potato flavour (starch) into maturity • Good resistance to blight • Good resistance to virus Y1, leafroll, black dot and skin scurf • Resistant to PCN Rn1

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Techniques in plant breeding



Not covered by GMO regulation

Covered by GMO regulation



Enourmously polarized discussion about GMOs



”...no validated evidence that GM crops have greater adverse impact on health and the environment than any other technology used in plant breeding. There is compelling evidence that GM crops can contribute to sustainable development goals”



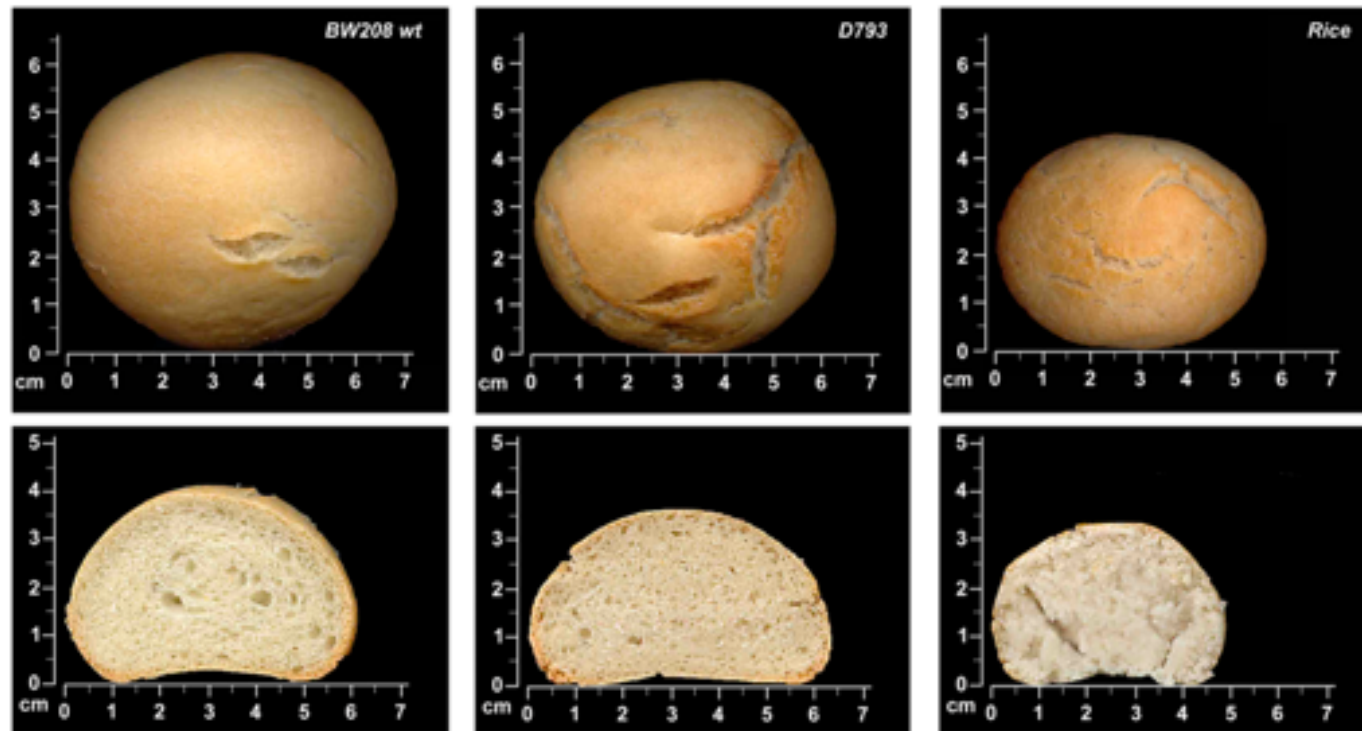
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Picture: Wikipedia

- Breeding using Agrobacterium is not more risky than breeding through e g radiation
- Yet, decision-makers (in particular in EU) has not changed the GMO legislations
- In reality, GMOs are in most countries not allowed outside the lab
- Consumers tend – in this case – to think “better safe than sorry”, hence believe in alternative facts



Do you gluten-free/low gluten wheat?



Developed
in 2008



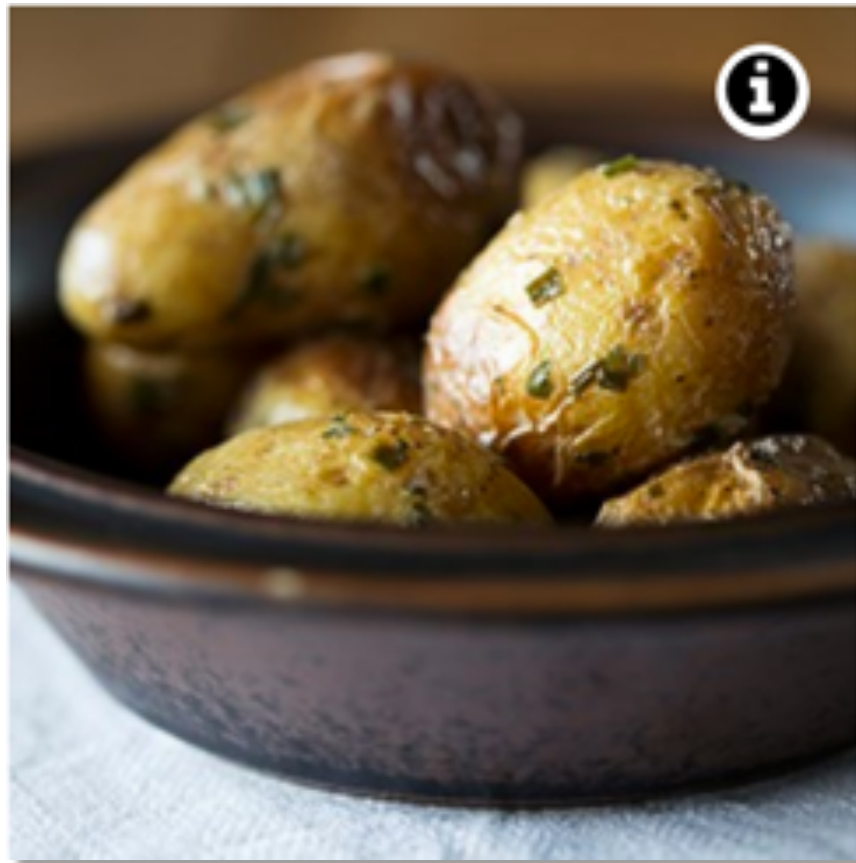
Do you want multi-vitamin corn?



Developed
in 2009



Do you want low GI potatoes?



Developed
in 2006



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Stefan Jansson 2020

Do you want low-methane rice?

Low methane rice research wins accolades but could take decades for regulatory approval as genetically modified food

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ABC Rural By Sarina Locke

Posted 5 January 2016 at 2:34 am



Rice paddies, like these in central Java, contribute 100 million tonnes of the heavy greenhouse gas methane a year globally. That's between 7-17 per cent of global emissions. (Sarina Locke)

Developed
in 2016



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Stefan Jansson 2020

What plants do you want?

- Increased vitamin content?
- Increased anthocyanin (antioxidant) content?
- Plants resistant to insects and pathogens that can be grown without pesticides?
- Lack of allergens?
- Need less water and fertilizers?
- Keep fresh longer?

No problem, they already exist (basic science coupled to breeding) – but are not allowed to be used in farming



A game-changing technology



RESEARCH ARTICLE

A Programmable Dual-RNA–Guided DNA Endonuclease in Adaptive Bacterial Immunity

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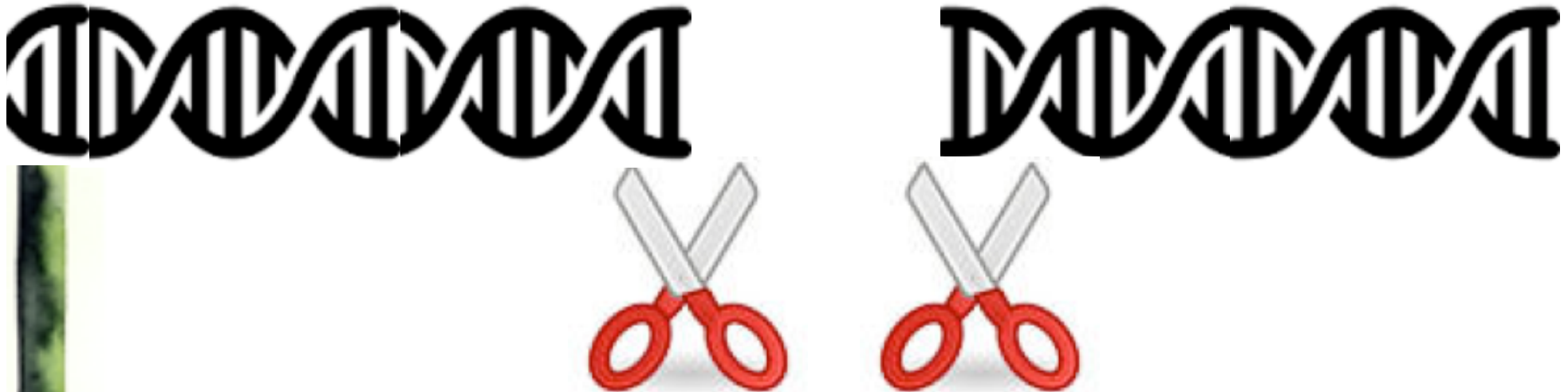
Stefan Jansson 2020

Genome editing using CRISPR/Cas9 – the “Molecular scissors”



Genome editing using CRISPR/Cas9

– the “Molecular scissors” - a piece of DNA get lost



Are CRISPR/Cas9-edited plants lacking PsbS GMOs or not?

Radiation → PsbS gene deleted →  **Not GMO**

EMS → Point mutations in
PsbS gene →  **Not GMO**

CRISPR/Cas9 → PsbS gene deleted →  ???

Agrobacterium → PsbS gene damaged →  **GMO**



“Green light in the tunnel”! Swedish Board of Agriculture: a CRISPR-Cas9-mutant but not a GMO

Published: 17 November 2015

The Swedish Board of Agriculture has, after questions from researchers in Umeå and Uppsala in Sweden, confirmed the interpretation that some plants in which the genome has been edited using the CRISPR-Cas9 technology do not fall under the European GMO definition. This is important for the wide use of such plants to contribute to solving some of the escalating



Växt- och miljöavdelningen

MEDDELANDE

Dnr 4.6.18-6714/14

2015-11-13

UPSC,
Fysiologisk Botanik,
Umeå Universitet
901 87 Umeå

CRISPR-muterad backtrav

Sammanfattning

Jordbruksverket gör den tolkningen att era växter som bär på T-DNA omfattas av kravet på tillståndsplikt i bestämmelserna i 13 kap. miljöbalken och förordning (2002:1086) om utsättning av genetiskt modifierade organismer i miljön och att de inte omfattas av undantagen från reglering. Ni måste söka tillstånd för fältförsök med dessa växter.

Era växter som inte bär på T-DNA, och är muterade på det sätt som ni beskriver, bedömer Jordbruksverket inte omfattas av kraven på tillståndsplikt med mer i samma bestämmelser. Ni behöver inte söka tillstånd för att göra fältförsök med dessa växter.

Det finns idag ingen gemensam uttolkning av definitioner och undantag i lagstiftningen på EU-nivå och Jordbruksverkets tolkning kan komma att ändras när en sådan finns.

Ärendet

Ni frågade den 15 april 2014 om ni behöver ansöka om tillstånd för att genomföra fältförsök med backtrav som ni har muterat med hjälp av metoden CRISPR/Cas9.

Ni bedömer att era växter inte omfattas av kravet på tillståndsplikt i 13 kap. miljöbalken och förordning (2002:1086) om utsättning av genetiskt modifierade organismer i miljön och att de inte omfattas av undantagen från reglering. Ni måste söka tillstånd för fältförsök med dessa växter.

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NATURE | NEWS



Europe's genetically edited plants stuck in legal limbo

Scientists frustrated at delay in deciding if GM regulations apply to precision gene editing.

Alison Abbott

15 December 2015



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Cultivating CRISPR cabbage in my garden (2016)





Forskarbloggen



Future garden plants are here!

5 september, 2016 | 20 Kommentarer | Naturvetenskap | Stefan Jansson

A diary about the world's first CRISPR-edited plants

This blog entry will describe my modest Summer 2016 cultivation containing a few plants that might not look like much, but are the beginning of making available knowledge help "save the world"



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Tagliatelle with CRISPRy fried vegetables

300g CRISPR genome-edited cabbage (flowers and young leaves) – can be replaced by broccoli or similar

200g Swiss chard

20 mange-tout

10 leaves of mysterious onion plant – to be replaced with a third of a leek

Good quality olive oil

2 large, chopped cloves of garlic

1/2 tsp chili flakes

400g fresh tagliatelle pasta

100ml of freshly grated Västerbotten cheese – can be replaced with Parmesan cheese

50–100ml chopped, fresh herbs, in particular marjoram, thyme, oregano, tarragon and parsley, 2 coriander leaves, 2 peppermint leaves

Recipe:

- Boil the pasta according to the instructions on the packaging.
- Pour the oil in a hot frying pan and fry the garlic and chili flakes for one minute.
- Cut the vegetables in large chunk and add them to the frying pan. Fry on high heat for 3–4 minutes until they brown and turn CRISPRy.
- Drain the pasta and pour in a bowl together with the vegetables. Grind some salt over the mixture, sprinkle the cheese and finely chopped herbs on top and mix the ingredients around gently.
- Serve immediately with bruschetta (rub chopped garlic onto some toasted bread and add a mixture of olive oil, chopped basil and chopped tomatoes).

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26



93



A Swedish scientist included cabbage engineered with CRISPR-Cas9 in this pasta

Stefan Jansson/Umeå University

Then came the ECJ decision...



July 24 2018 –
Not a GMO



July 25 2018 –
Perhaps a GMO



What could gene technology really deliver for the food sector?

- Scientist/breeders "reinvent the wheel" with CRISPR, hoping that now plants can be used
- Many novel opportunities
- In most of the world; No new DNA, not a GMO. But EU different
- EU farmers not allowed to use the new varieties
- Import to EU not allowed (unless each passes the needle's eye of the EU GMO legislation)
- Impossible task for EU: Keep out something untraceable

