

Toiduohutuse konverents 10.02.2022



Euroopa Maaelu Arengu
Põllumajandusfond:
Euroopa investeeringud
maapiirkondadesse



PLANT SIGNAL
RESEARCH GROUP

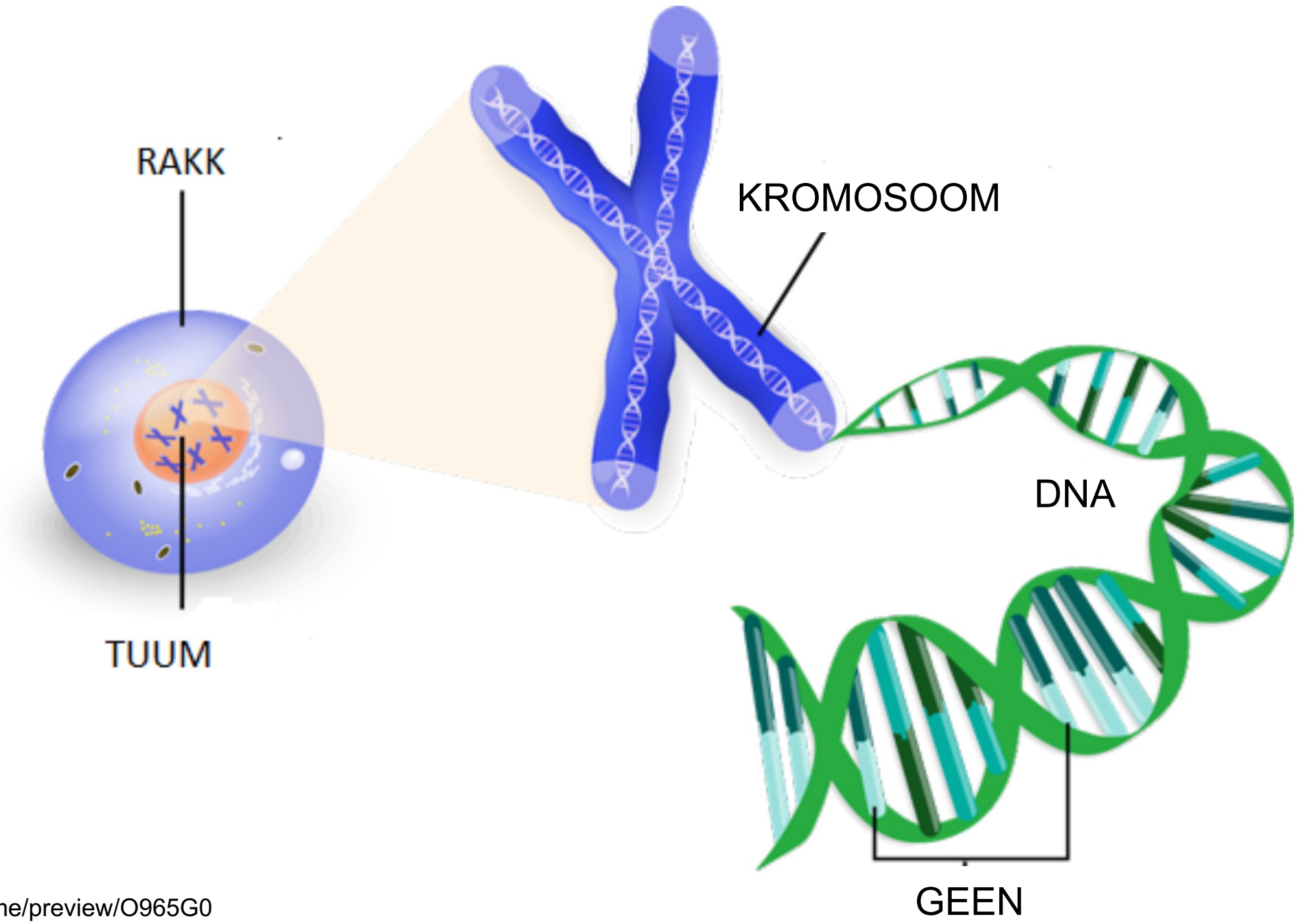
Hirmufaktor GMO

Õpime armastama GM-taimi



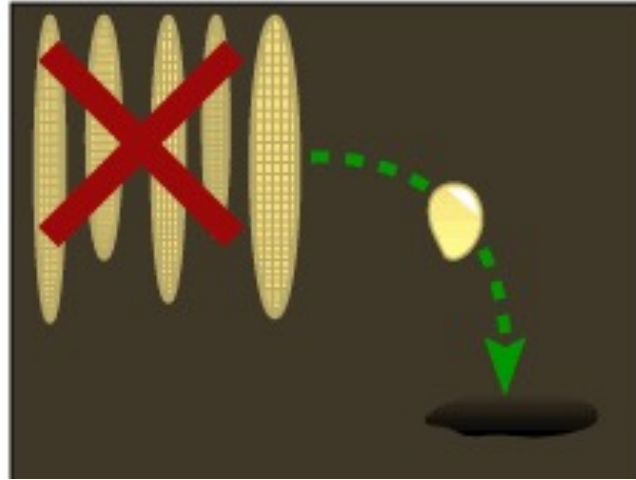
Hannes Kollist

www.plantsignalresearch.com

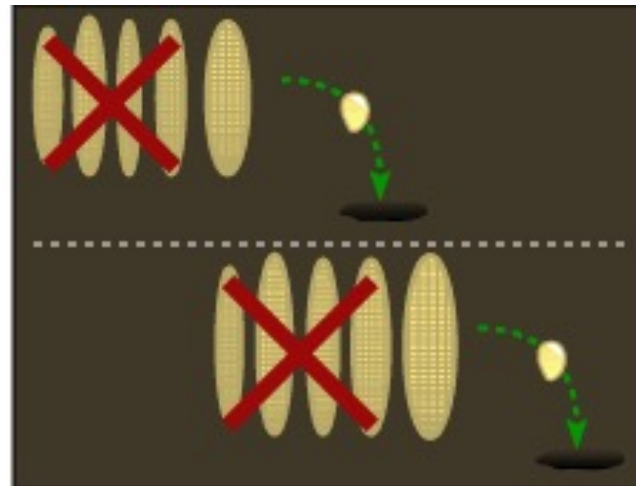




Koos põllumajandusega algas taimede genoomide suunatud muutmine



Valides “häid” taimi suurendati vastavate tunnuste ja nendega seotud mutatsioonide esinemist järgmistes põlvkondades



Loodusliku variatsiooni ja evolutsiooni aluseks on geneetilised mutatsioonid

mutare (lad k.) = muutuma

Each Plot
=10
Bushel Yield



Future



2019



2018



2000



1980



1940

Producing Better

The history of corn production plot demonstrates the great strides we have made in producing more with less, and the opportunity we have to continue to “produce better” through tailored solutions that drive us toward our reduced environmental impact commitment while meeting the needs of a growing population on an increasingly hotter planet.

Aretamata banaan



Cavendish banaan



Devonshire hertsogi William Cavendishi, 1836.

Triploidne genoom põhjustab steriilsuse

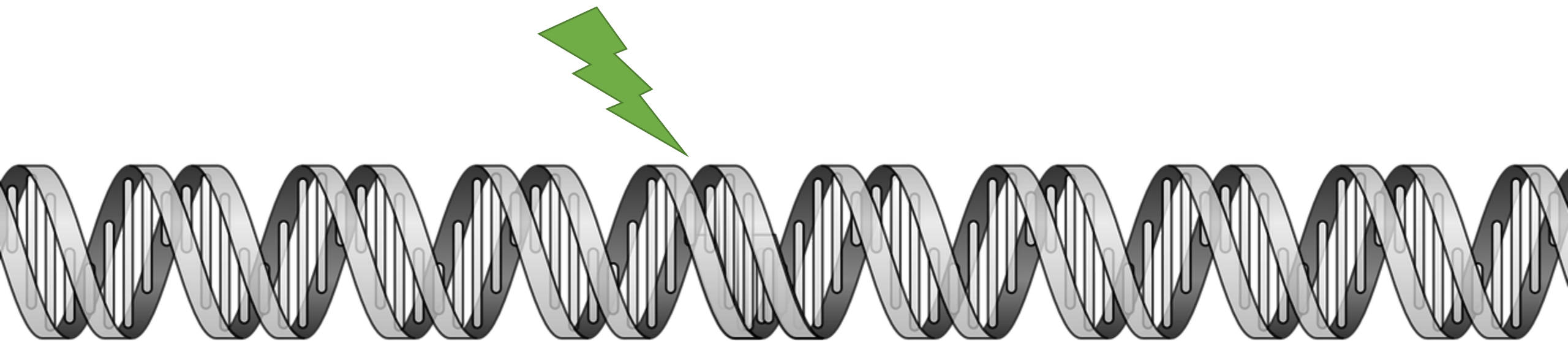
20. sajand - teadlik sordiaretus

Mutagenees kui sordiaretuse võte
– ei ole GMO

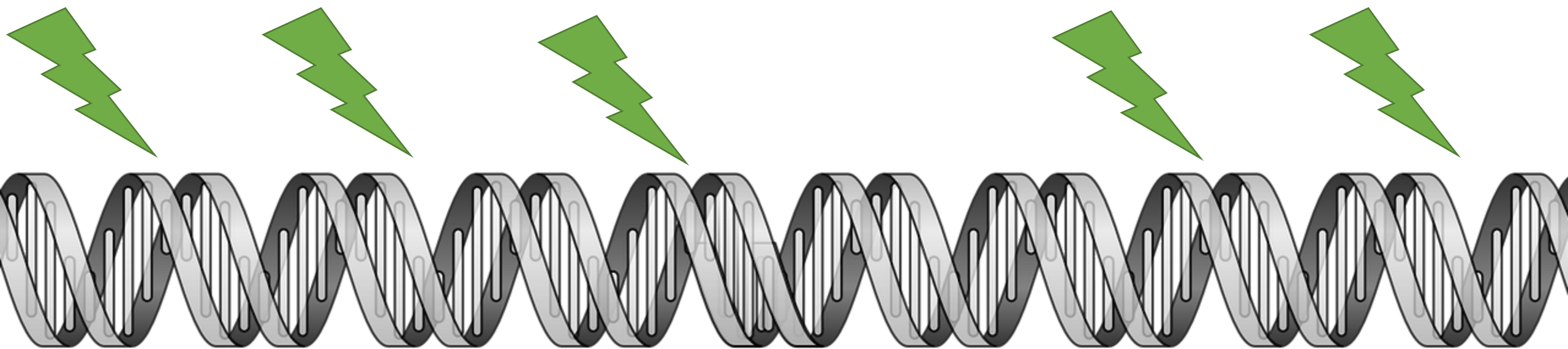
- **1927** - Hermann Joseph Muller (Nobeli preemia 1946) näitas, et ioniseeriv kiirgus põhjustab äädikakärbsel geneetilisi mutatsioone.
- **1928** - Lewis John Stadler kasutas ioniseerivat kiirgust odra ja maisi mutageniseerimiseks.



Hermann Joseph Muller (1890-1967)







Mutagenees kui sordiaretuse võtte – ei ole GMO

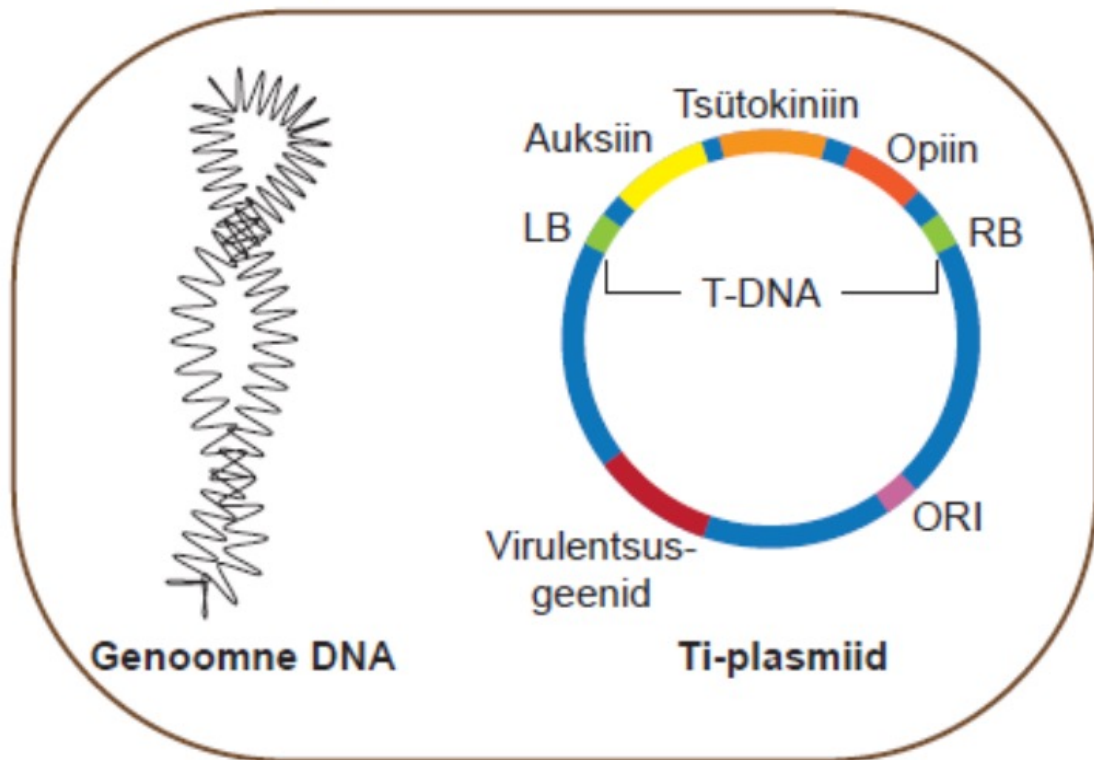


Geenide ülekandmine

e. transgeense taime tegemine

Agrobacterium tumefaciens – kasvajaid põhjustav mullabakter kui väärtuslik tööriist.

Metsiktüüpi agrobakter

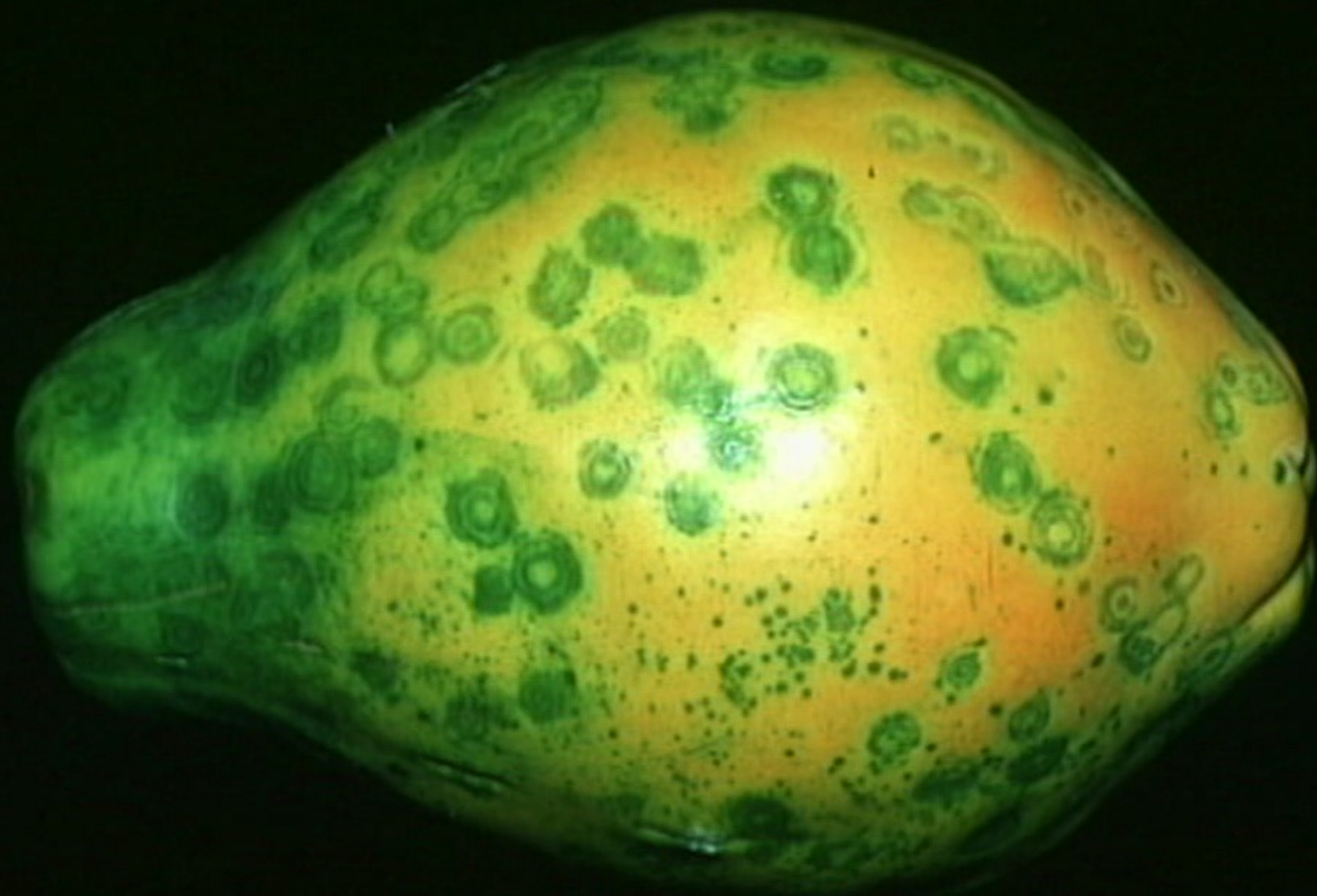


T-DNA
integreerub
taimegenoomi.

↓
Tekib kasvaja
ehk kroonkallus

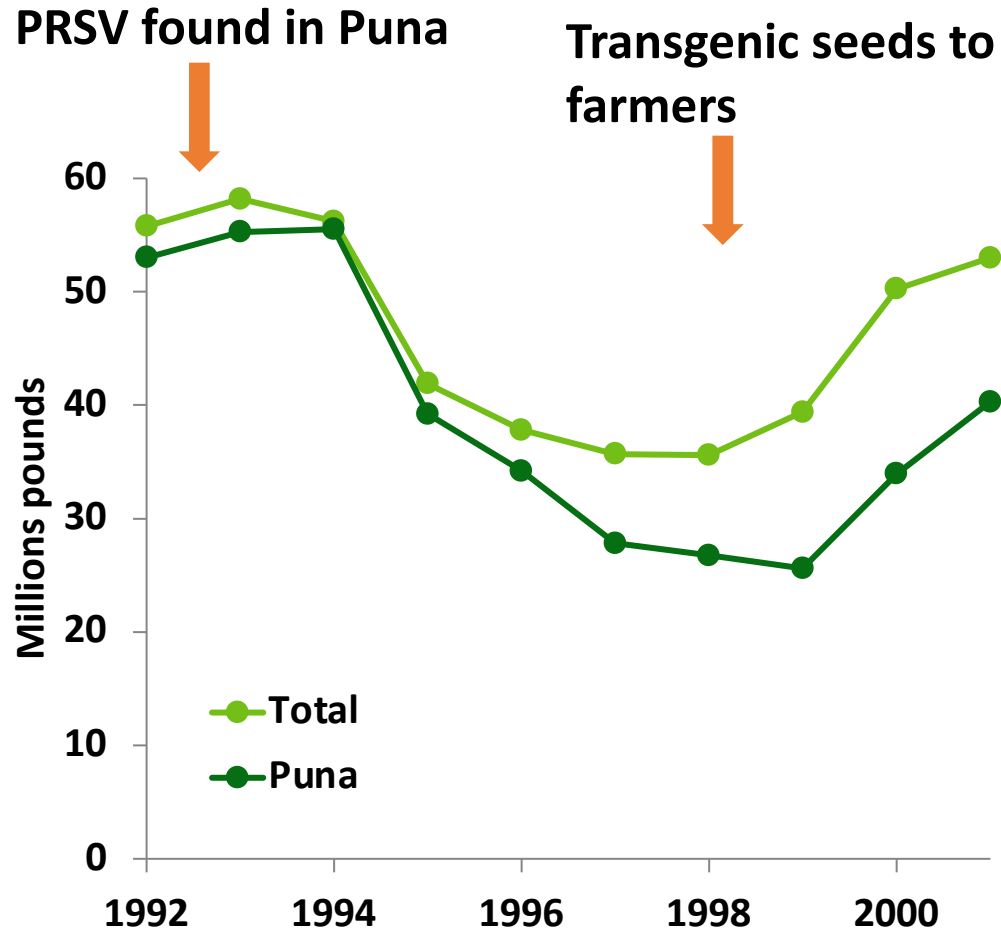






Transgeensed papaiad Havail

'Ring Spot' viiruse suhtes resistentsed papaiad



Dennis Consalves:

“Some people say, ‘I never eat transgenic papaya.’

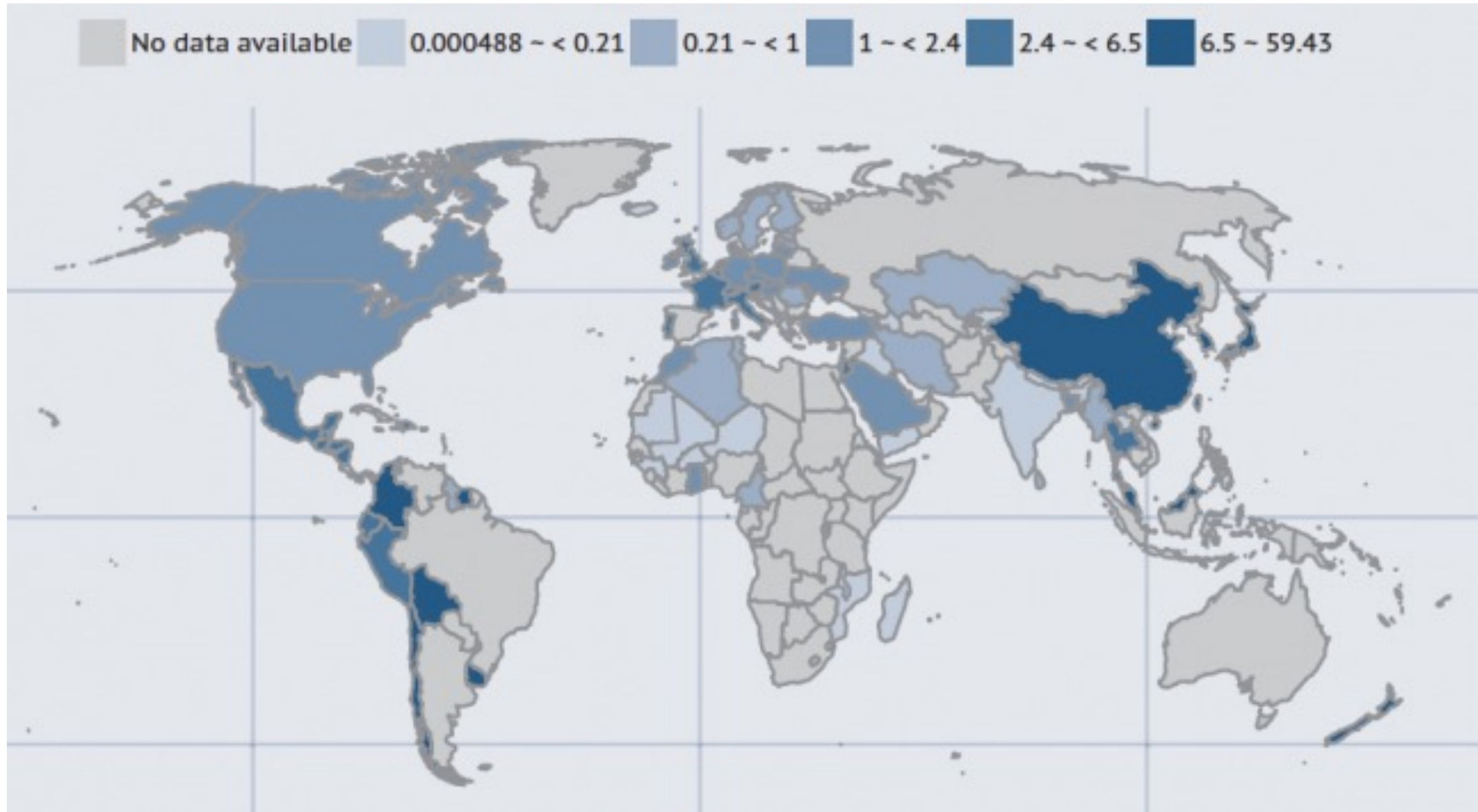
Great. But don't tell me it's not safe!”

Kahjuriresistentsus

Erinevad kahjurid põhjustavad globaalselt igal aastal 15% saagikadu



Globaalne pestitsiidide kasutamine



- (kg/ha) The source is the FAO (2013) – Statistical Yearbook

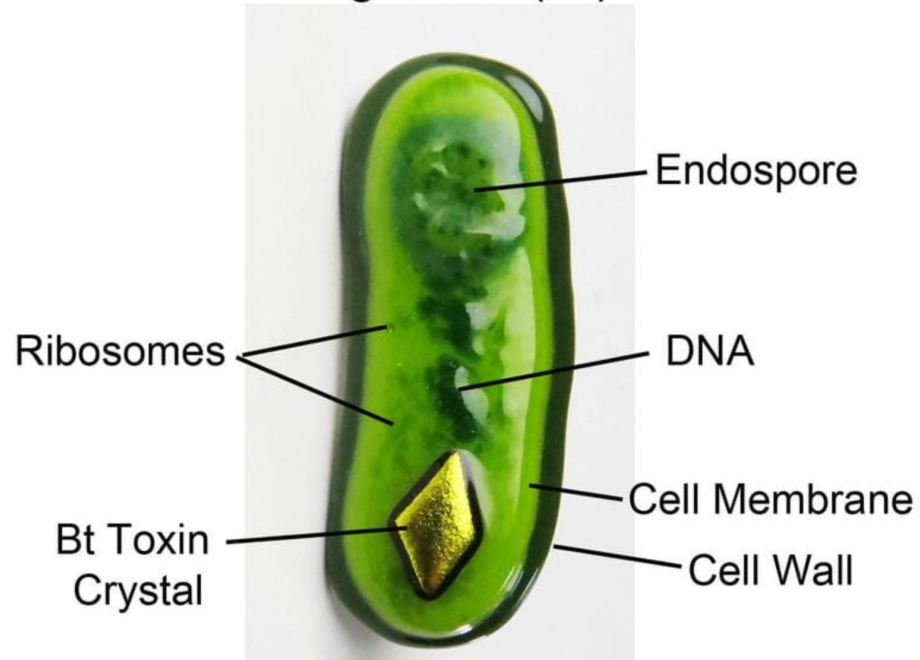
Kahjuritõrje



Arengumaades hukub igal aastal insektitsiidide tõrje tõttu ~ 300 000 inimest

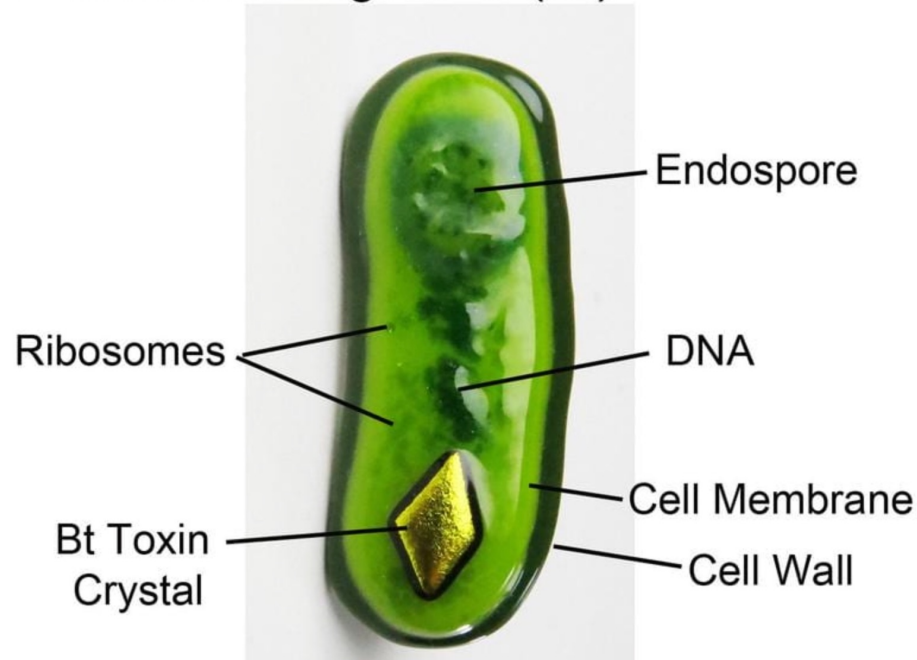
Bacillus thuringiensis on mullabakter,
mis toodab Bt toksiine, mis on
toksilised kahjurputukatele

Bacillus thuringiensis (Bt)

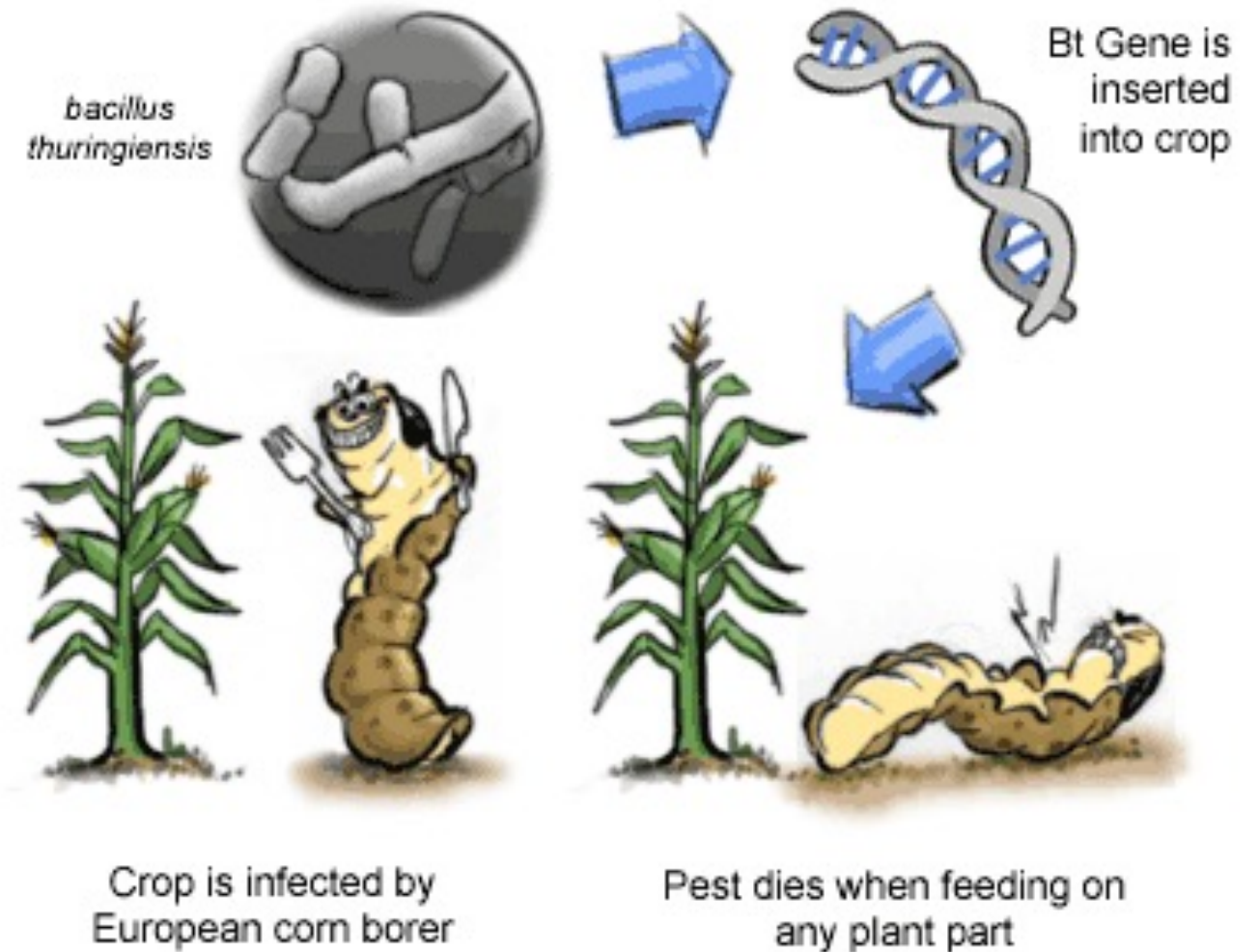


Bacillus thuringiensis on mullabakter, mis toodab Bt toksiine, mis on toksilised kahjurputukatele

Bacillus thuringiensis (Bt)



Bt-toksiin kodeeriva geeni ülekandmisel taime tekib taimes kahjuriresistentsus

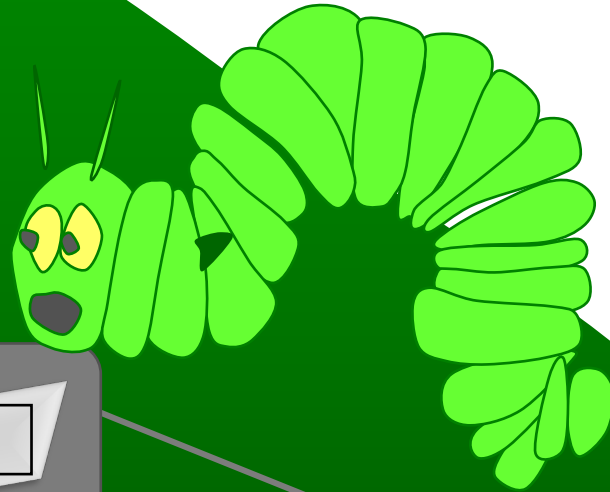


Bt mais ja puuvill olid ühed esimesed GM-taimed, turul alates 1996

Ligi 1/3 GMO taimedest kannavad Bt gene.

ISAAA andmetel on GM taimede kasutamine vähendanud pestitsiidide kasutamist 19%

Taime rakk, mis toodab Bt toksine



ISAAA – International Service for the Acquisition of Agri-biotech Applications

Bt puuvilla võidukäik Indias

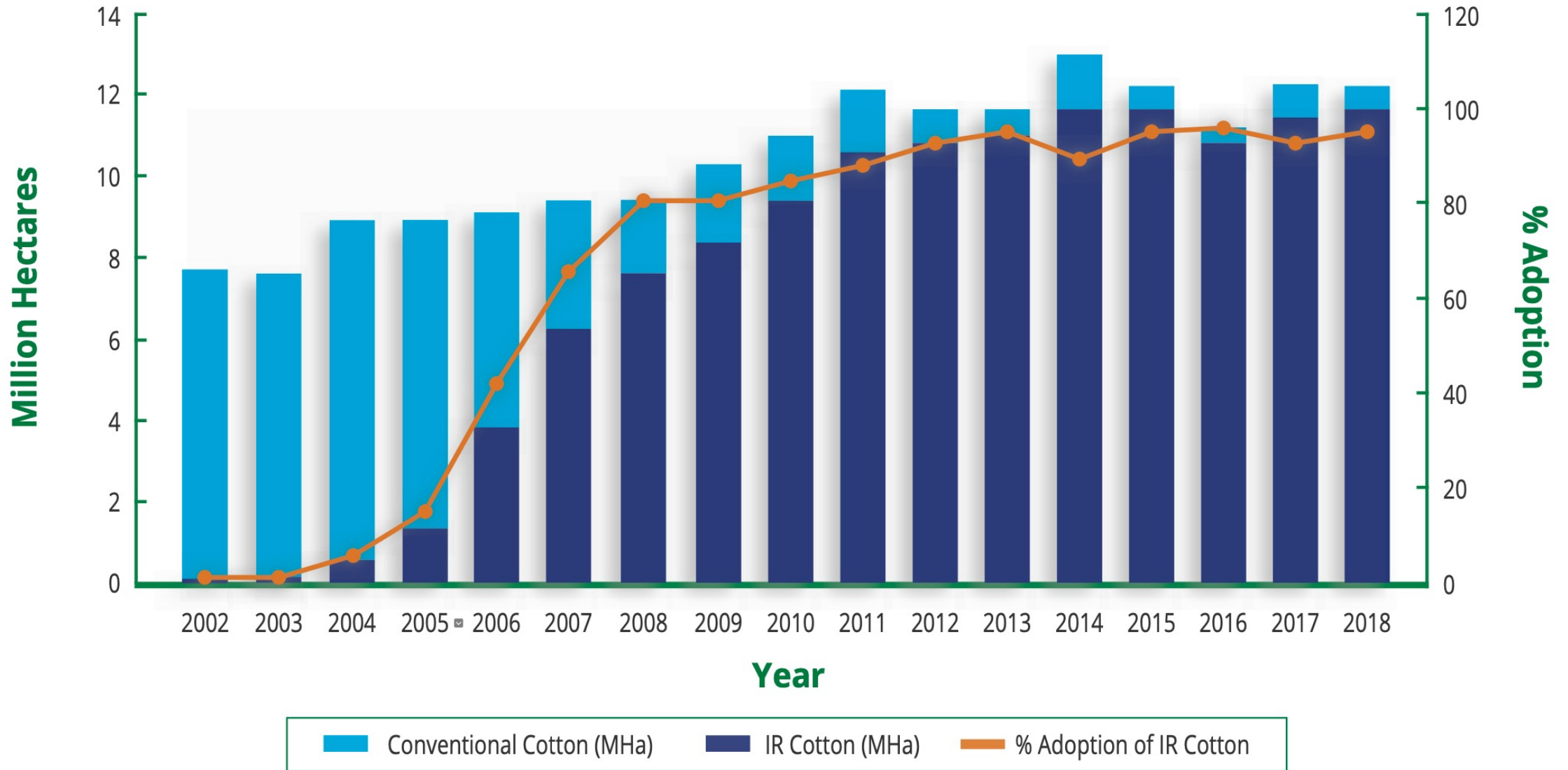
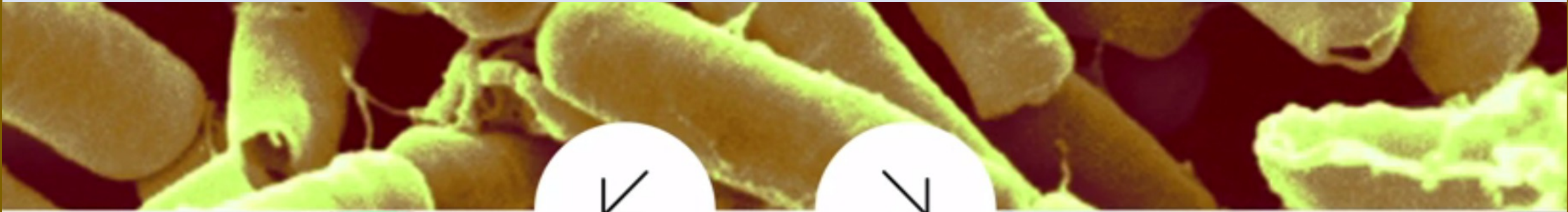


Figure 7. Seventeen Years of Adoption of IR (Bt) Cotton in India, 2002 to 2018

Source: Analyzed and Compiled by South Asia Biotechnology Centre, 2018

Mahetootmises kasutatava praktika ... ja Bt toksiini tootev GM taim



↙
ORGANIC

↘
GENETIC



↓

↓



Bataat on 'looduslik' GMO? Bataat e. maguskartul kujunes kultuur-taimeks peale agrobakteri vahendatud geeniülekanne ca. 8000 a tagasi

291 testitud maguskartuli- e. bataadisorti sisaldas agrobakteri T-DNA-d.

Seega on enamus maguskartuli sorte transgeensed.

The genome of cultivated sweet potato contains *Agrobacterium* T-DNAs with expressed genes: An example of a naturally transgenic food crop

Tina Kyndt^{a,1}, Dora Quispe^{a,b,1}, Hong Zhai^c, Robert Jarret^d, Marc Ghislain^b, Qingchang Liu^c, Godelieve Gheysen^a, and Jan F. Kreuze^{b,2}

^aDepartment of Molecular Biotechnology, Ghent University, 9000 Ghent, Belgium; ^bInternational Potato Center, Lima 12, Peru; ^cBeijing Key Laboratory of Crop Genetic Improvement/Laboratory of Crop Heterosis and Utilization, Ministry of Education, China Agricultural University, Beijing, China, 100193; and ^dPlant Genetic Resources Unit, US Department of Agriculture, Agricultural Research Service, Griffin, GA 30223



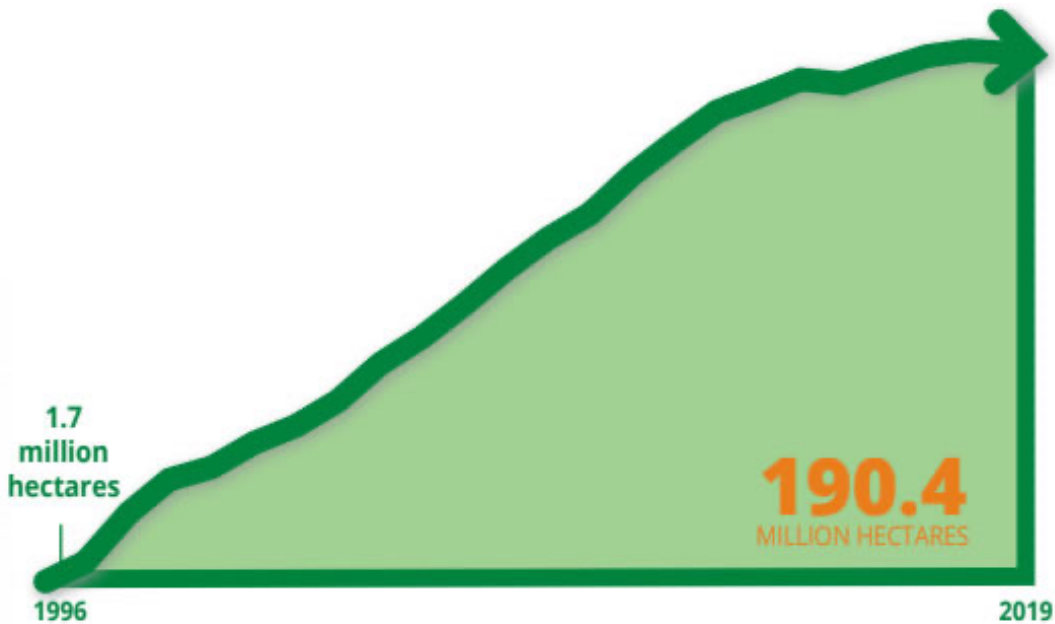


FIGURE 1. GLOBAL AREA OF BIOTECH CROPS, 1996 TO 2019 (MILLION HECTARES).

Source: ISAAA, 2019

Põllumajanduslikus kasutuses (FAO andmed)

Maismaast	38 %	ca. 5 miljardit ha
Karjamaadena	2/3	
põldudena	1/3	ca 1,65 miljardit ha

ISAAA andmed, 2019 kasvatati GM taimi
190,4 milj ha

*ISAAA – International Service for the
Acquisition of Agri-biotech
Applications*

Globaalne põllumaa	1650 milj. ha
GM põllumaa 2019	190 milj. ha
GM põllumaa all	11,5 %

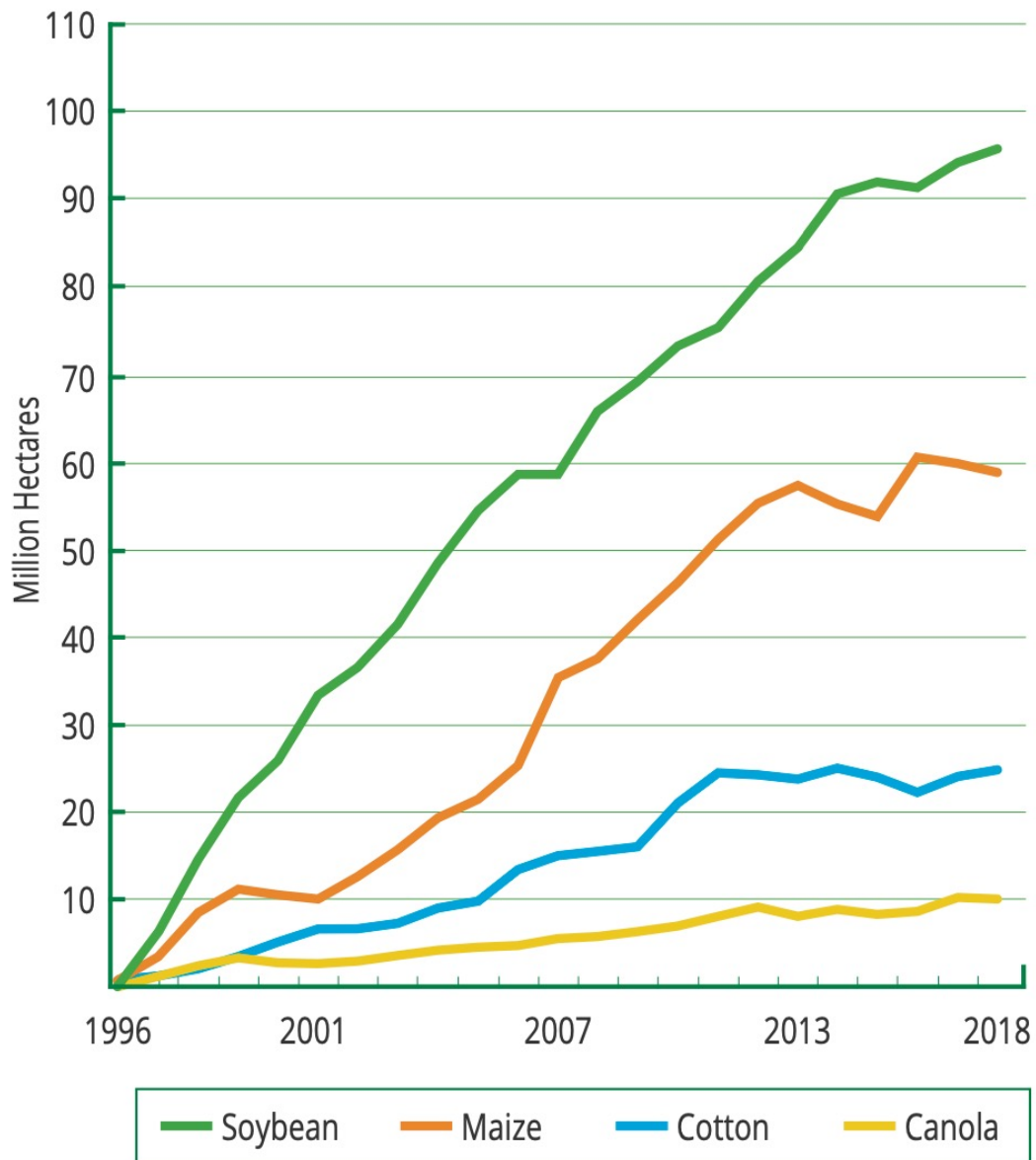


Figure 16. Global Area of Biotech Crops, 1996 to 2018: by Crop (Million Hectares)

Source: ISAAA, 2018

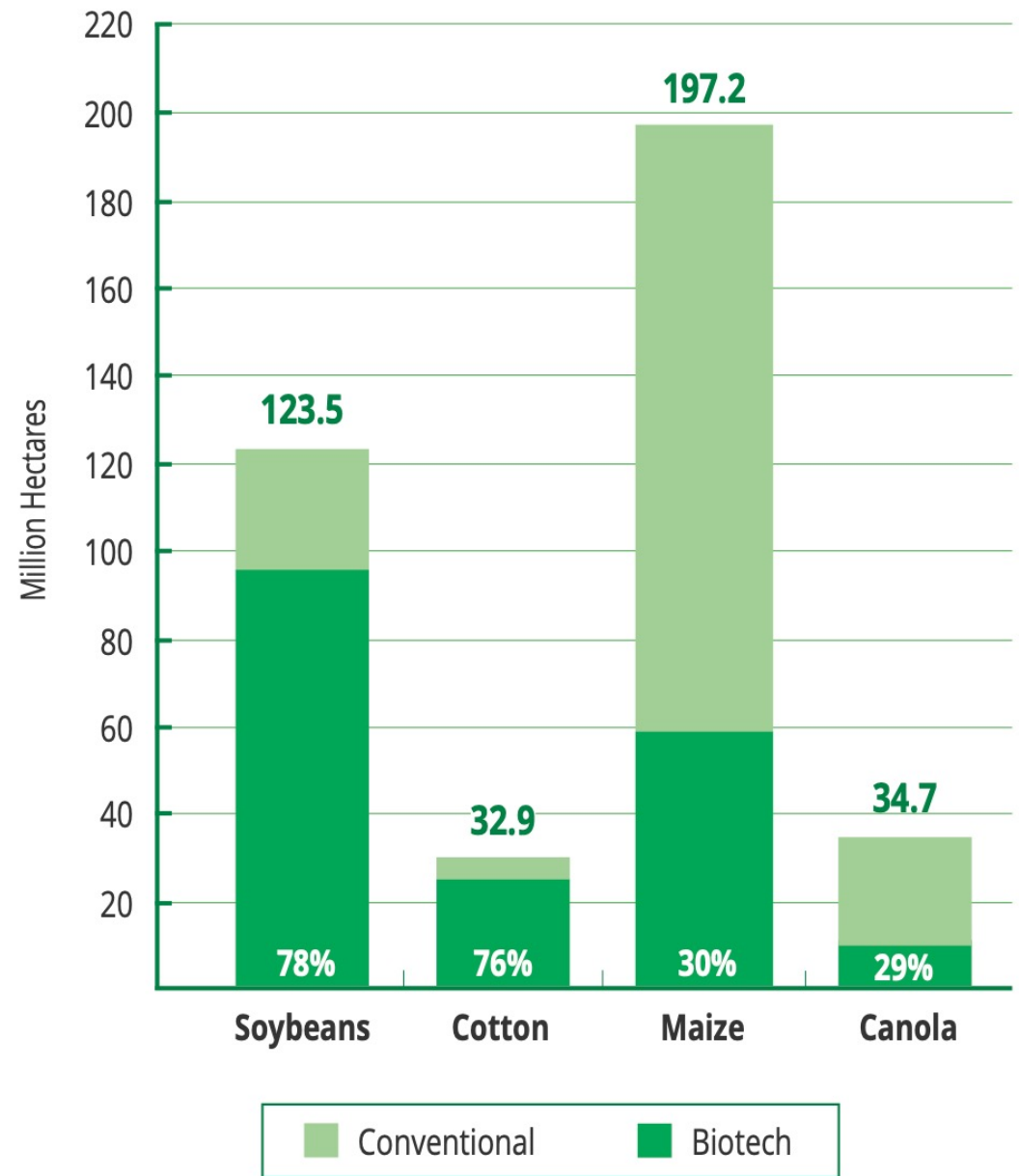
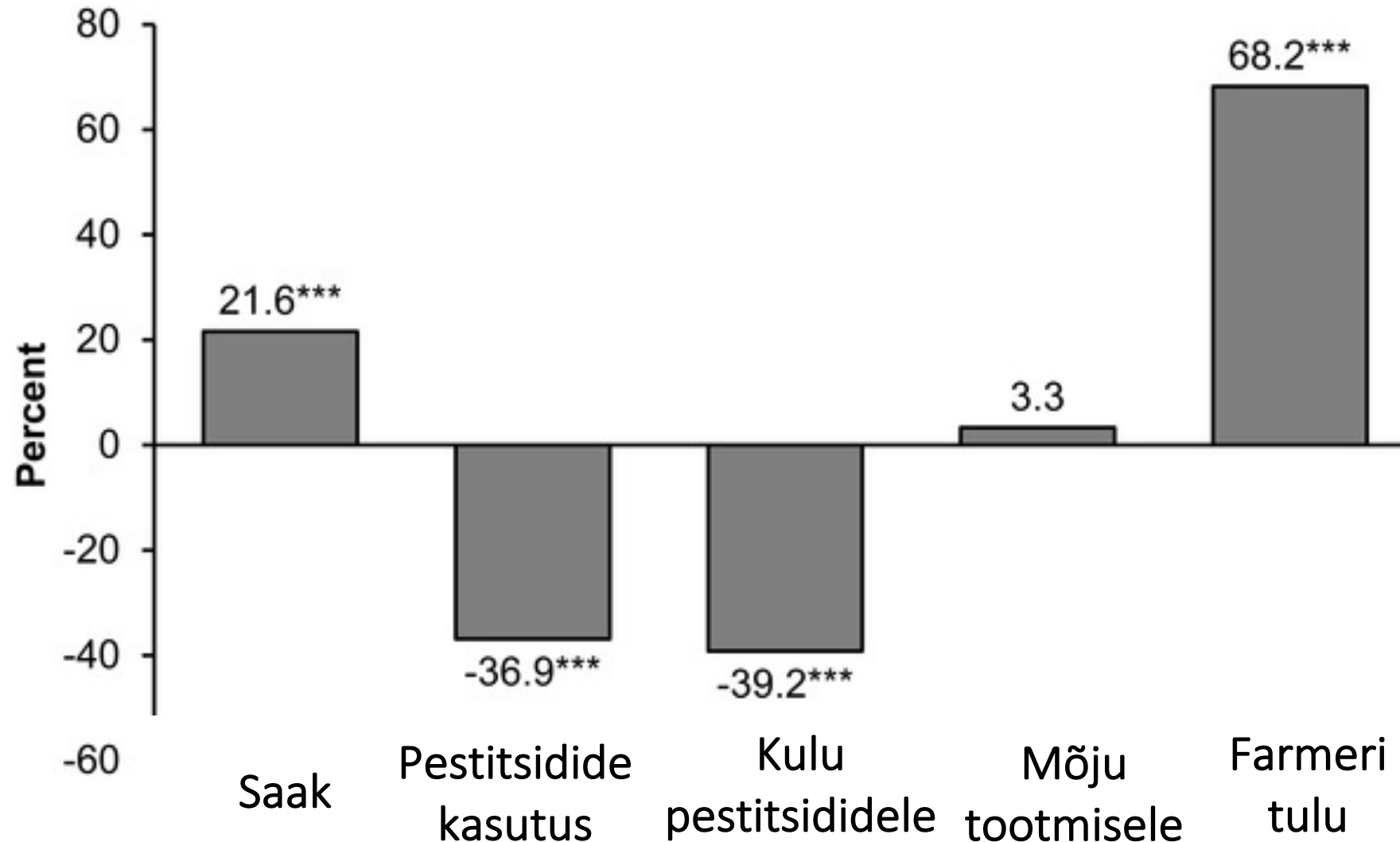


Figure 17. Global Adoption Rates (%) for Principal Biotech Crops, 2018 (Million Hectares)



GM-taimede kasutamise mõju – 114 uuringut koondav metaanalüüs

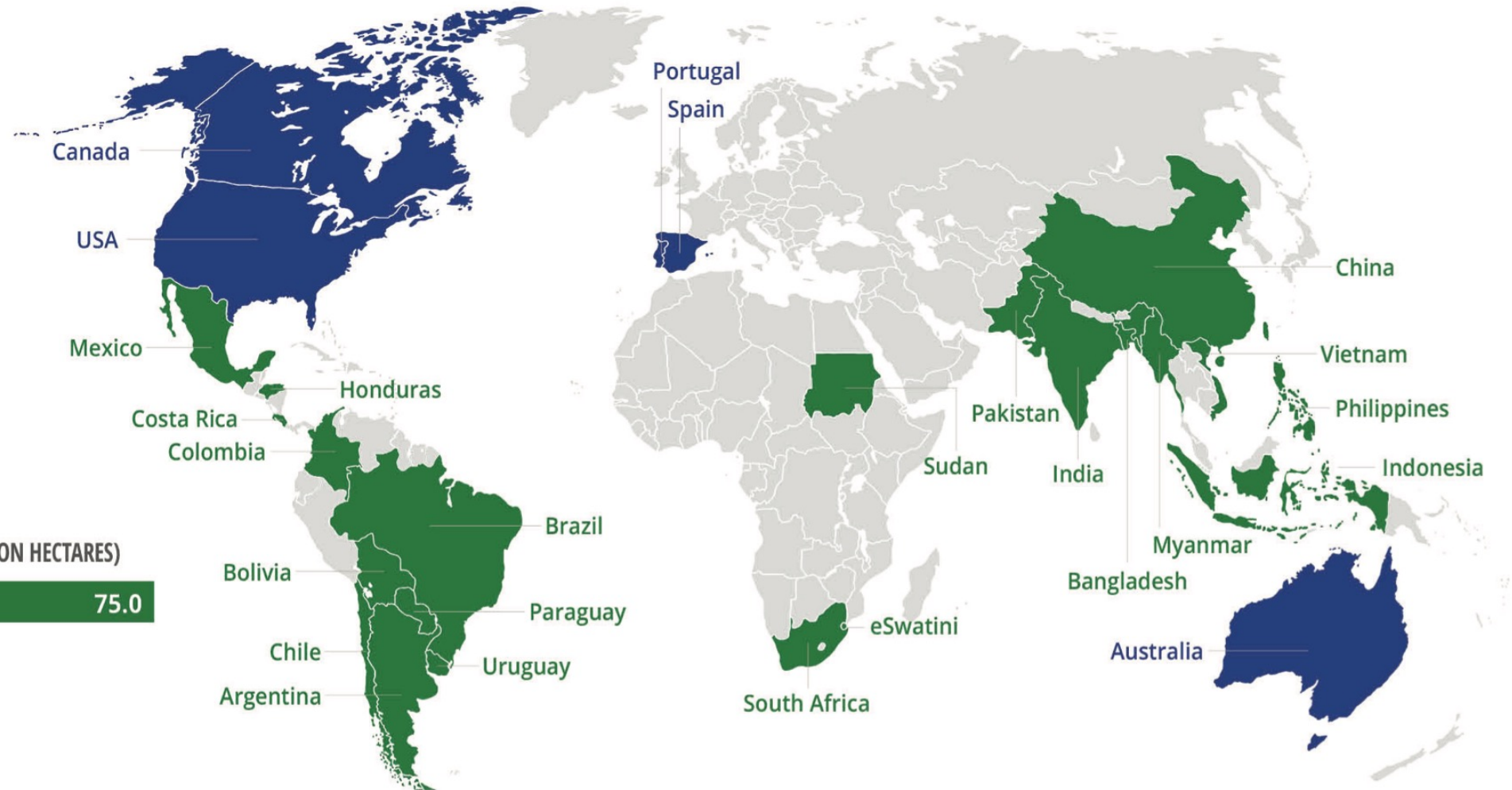
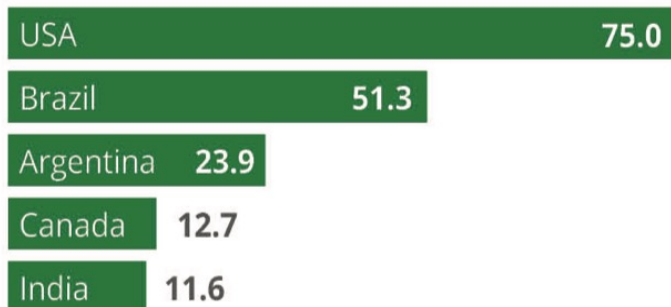


Where are Biotech Crops Grown in the World?

26 countries planted 191.7 million hectares of biotech crops in 2018, the 23rd year of global commercialization of biotech crops



TOP 5 COUNTRIES GROWING BIOTECH CROPS IN 2018 (MILLION HECTARES)





BIOTECH CROPS

PROVIDE A BETTER ENVIRONMENT



less pesticide applications



saved **671 MILLION KG** active ingredients of pesticides in 1996-2016

48.5 MILLION KGS IN 2016 ALONE from being released to the environment



www.isaaa.org

#ISAAAReport2017
#GMCrops2017



BIOTECH CROPS

MITIGATE CLIMATE CHANGE

REDUCE GREENHOUSE GASES



REDUCED USE
OF FOSSIL-BASED
FUELS

FEWER HERBICIDE &
INSECTICIDE APPLICATIONS



REDUCED
**FUEL
USE**

REDUCED CO2 EMISSIONS
EQUIVALENT TO TAKING

16.7 MILLION CARS
OFF THE ROAD FOR 1 YEAR



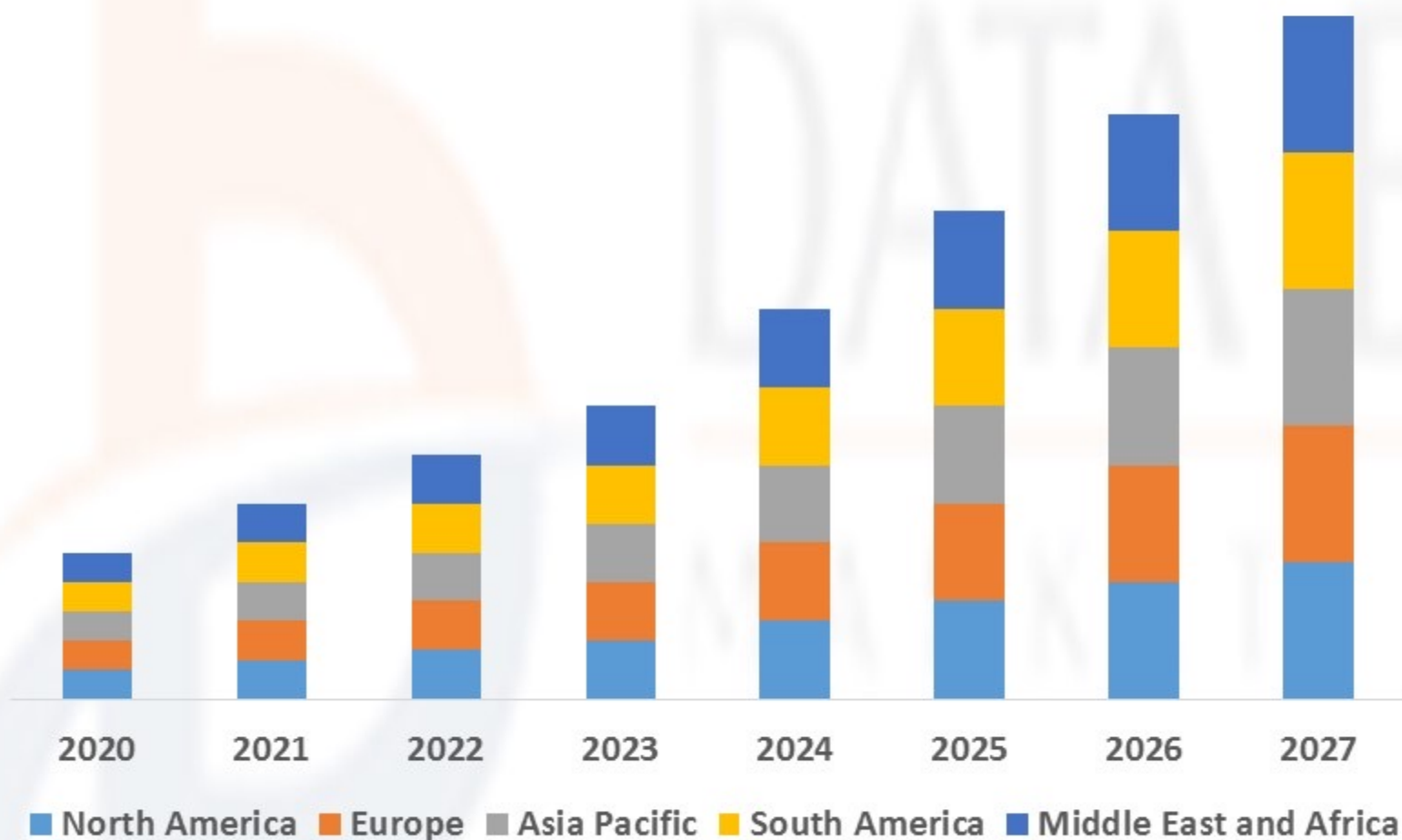
www.isaaa.org

#ISAAAReport2017
#GMCrops2017



Global Non-GMO Food Market is Expected to Account for USD 8.0 Billion by 2027

Global Non-GMO Food Market,
By Regions, 2020 to 2027



DATA BRIDGE MARKET
RESEARCH

PINK
SALT

Fine

HIMALANIA[®]
Fine Pink Salt



Net Wt: 10oz (285g)

GM-tehnoloogia on
taimearetuse võtte,
mis on ohutu

GM-taimed on
ohutud

http://ec.europa.eu/research/biosociety/pdf/a_decade_of_eu-funded_gmo_research.pdf



EUROPEAN COMMISSION / European Research Area / Food, Agriculture & Fisheries & Biotechnology

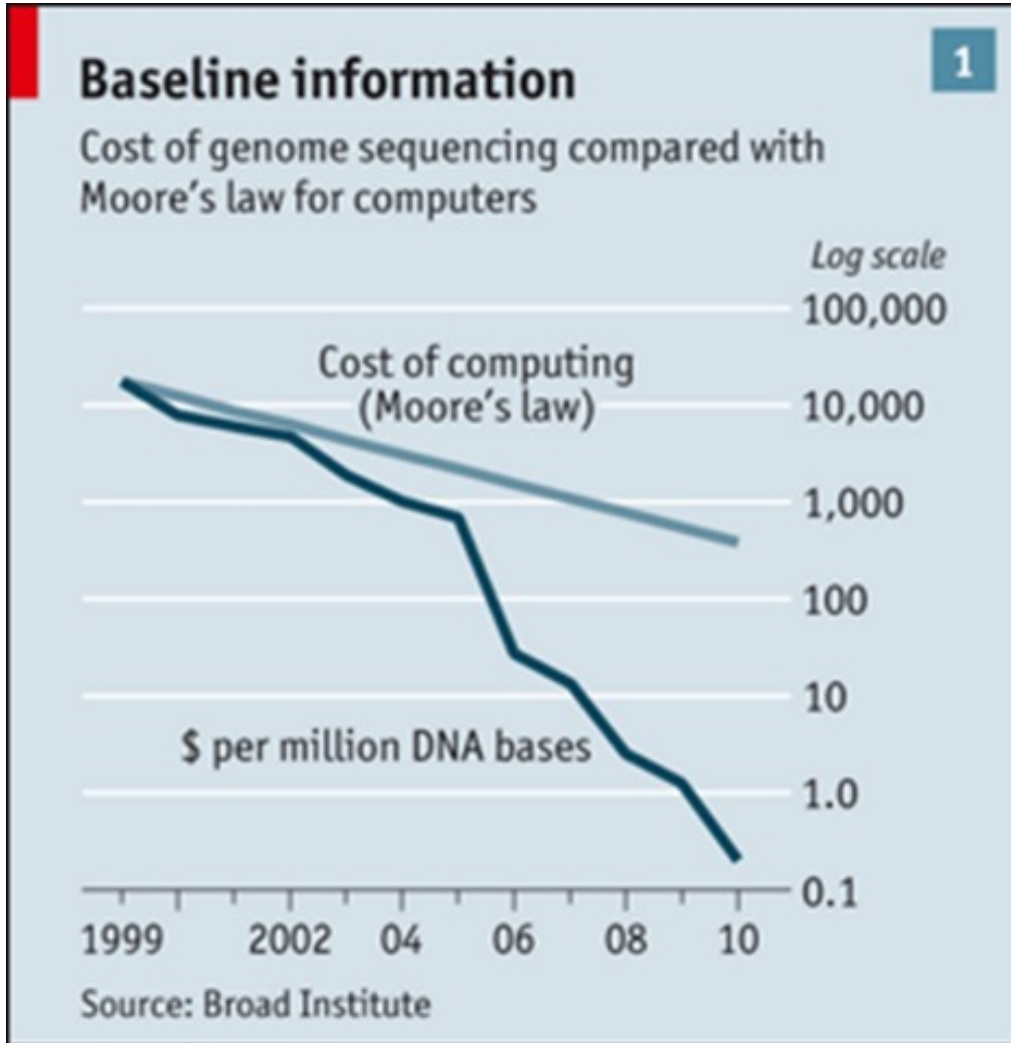


A decade of
EU-funded
GMO research

(2001 - 2010)

Kust on tulnud areng?

DNA sekveneerimine ja süntees



Talk by prof. Detlef Weigel – A Mutation is A Mutation is A Mutation



Kõik taimed siin põllul on mutandid ja kõik nad on üksteisest erinevad

FOTO: Meelika Sander-Sõrmus

Mutatsioonide tekkimise sagedus: $\sim 10^{-8} \text{ bp}^{-1} \text{ generatsioon}^{-1}$

Nisu genoom: $\sim 20 \text{ Gb} \rightarrow \sim 200 \text{ mutatsiooni ühes generatsioonis}$

1 g nisu = 20 seemet

1 ha nisu \rightarrow 10 t nisu $\rightarrow 2 \times 10^8 \text{ tera ha}^{-1}$

4×10^{10} mutatsiooni 1 ha nisu saagis

Kust on tulnud areng?

- CRISPR/Cas9 tehnoloogia

Genetic scissors: a tool for rewriting the code of life



© Johan Jarnestad/The Royal Swedish Academy of Sciences

The Nobel Prize in Chemistry 2020



© Nobel Prize Outreach. Photo:
Bernhard Ludewig

**Emmanuelle
Charpentier**

Prize share: 1/2



© Nobel Prize Outreach. Photo:
Brittany Hosea-Small

Jennifer A. Doudna

Prize share: 1/2



Neli revolutsiooni taimearetuses







Jennifer Doudna



Selektiivne aretus	Mutatsiooniline aretus	Transgeenne aretus	Täppisaretus
Tuhandeid aastaid	Alates 1920st	Alates 1980st	Alates 2010st
Soovitud geenid kanduvad üle koos paljude teiste geenidega	Soovitus mutatsioonidega kaasneb tuhandeid teisi mutatsioone mis on vaja ristata välja	Toimub ainult soovitud geeni ülekanne, aga see seondub genoomi juhuslikult	Võimalik viia sisse paljusid erinevaid mutatsioone potentsiaalselt kõigis kultuurtaimedes
Vaja korduva ristamisi et vabaneda soovimatutest geenidest	Vaja korduva ristamisi et vabaneda soovimatutest geenidest	Täpne tunnuse ülekanne aga seondumine genoomis juhuslik	Täpne, kiire ja ei jäta mingeid jälgi

EFSA JOURNAL

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Scientific Report |  Open Access |   

Overview of EFSA and European national authorities' scientific opinions on the risk assessment of plants developed through New Genomic Techniques

European Food Safety Authority (EFSA)  Konstantinos Paraskevopoulos, Silvia Federici

First published: 29 April 2021 | <https://doi.org/10.2903/j.efsa.2021.6314>



[Volume 19, Issue 4](#)

April 2021

e06314



References



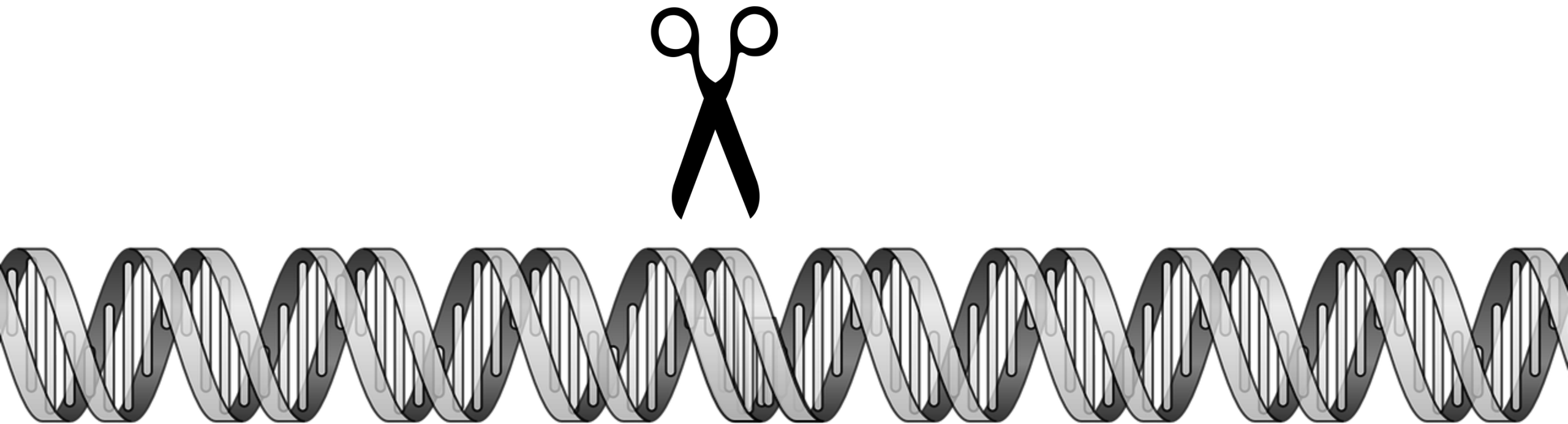
Related

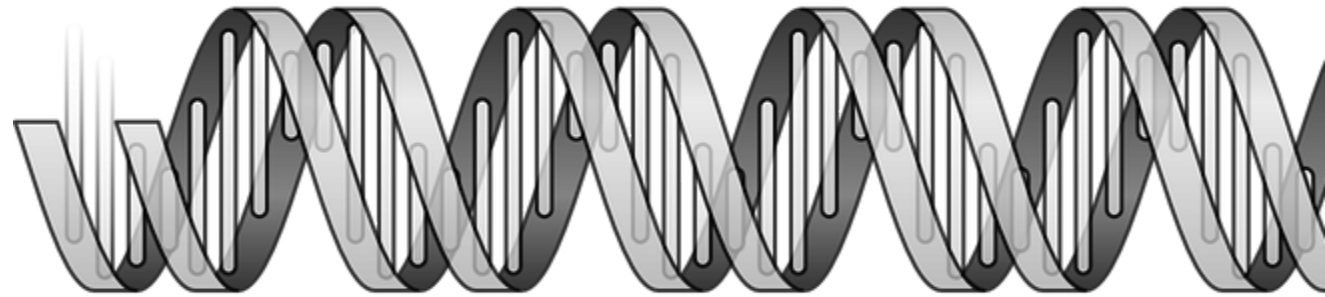
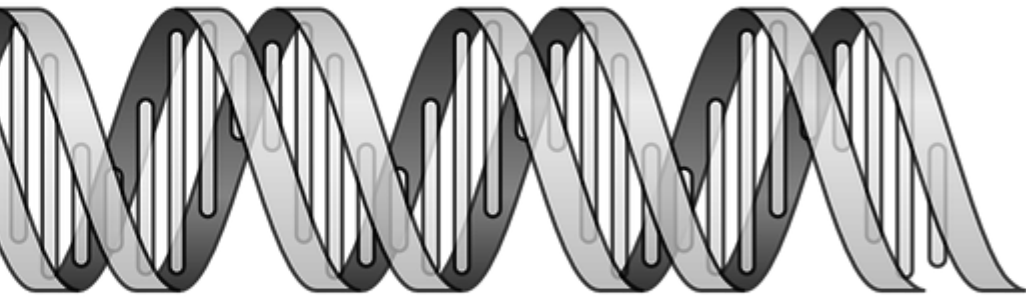
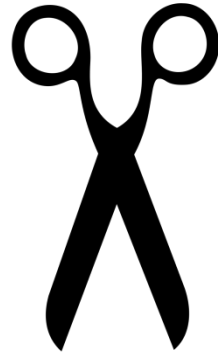


Information

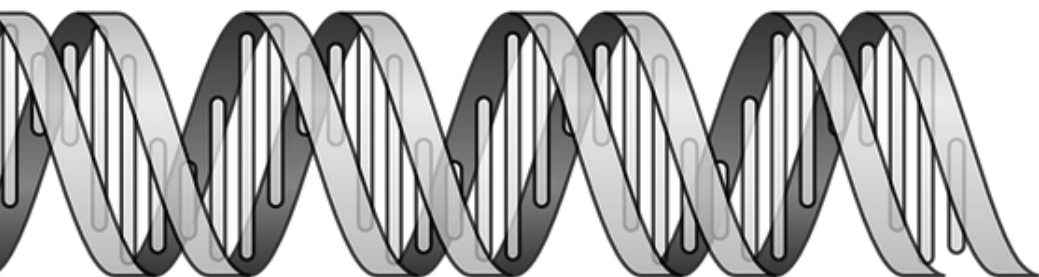
Recommended

- EFSA järeldus: Ei tuvastatud spetsiifilise ohte, mis võivad tekkida kasutades täppisaretusvõtteid.
- Täppisaretusvõtted on oluliselt täpsem võrreldes tavaaretusega.

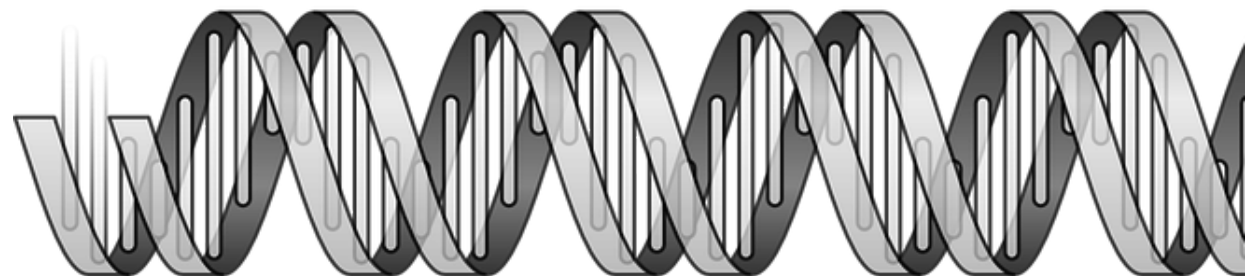
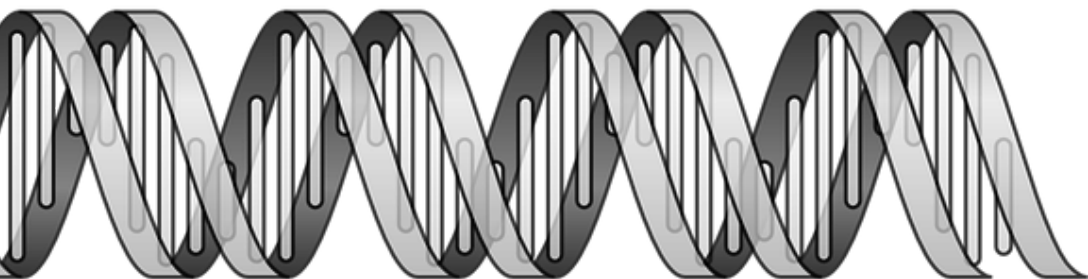
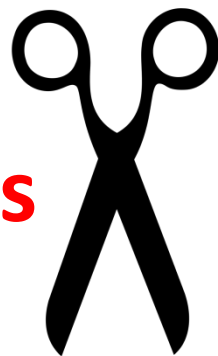




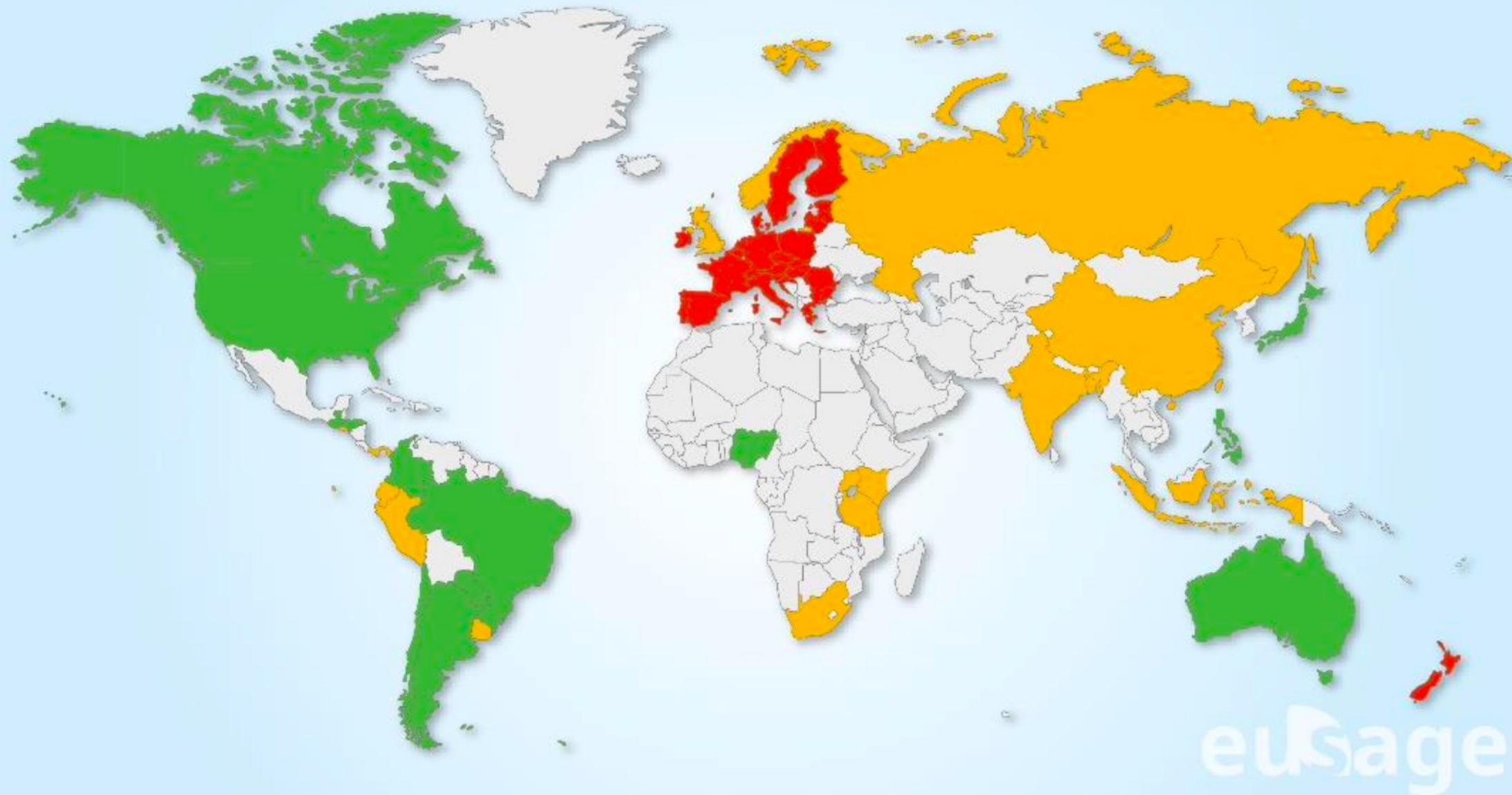
Mutagenees
Ei ole GMO



CRISPR/CAS, Täppisaretus
Euroopa Liidus GMO

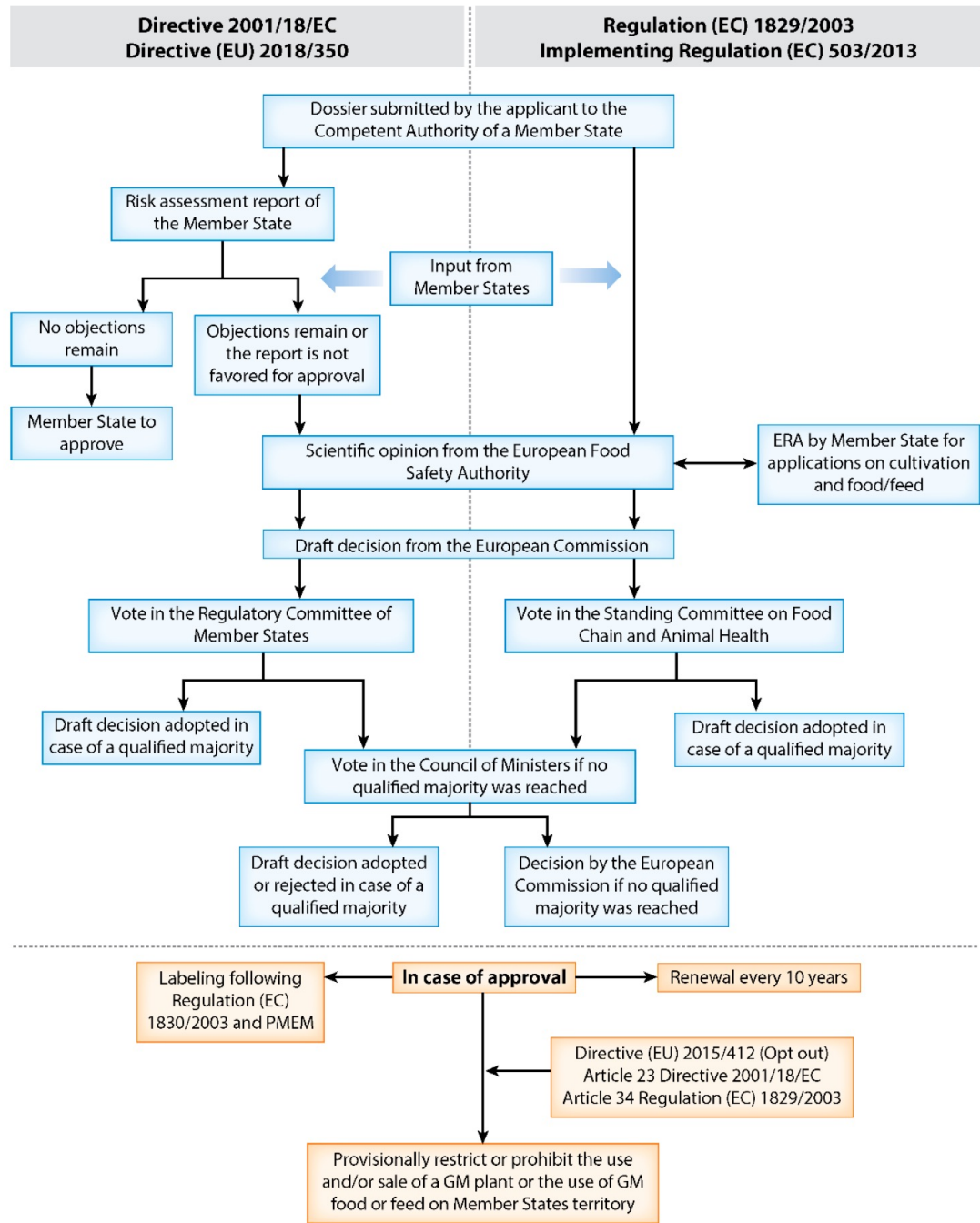


Genoomide editeermine ja geneetiline modifitseerimine



eusage



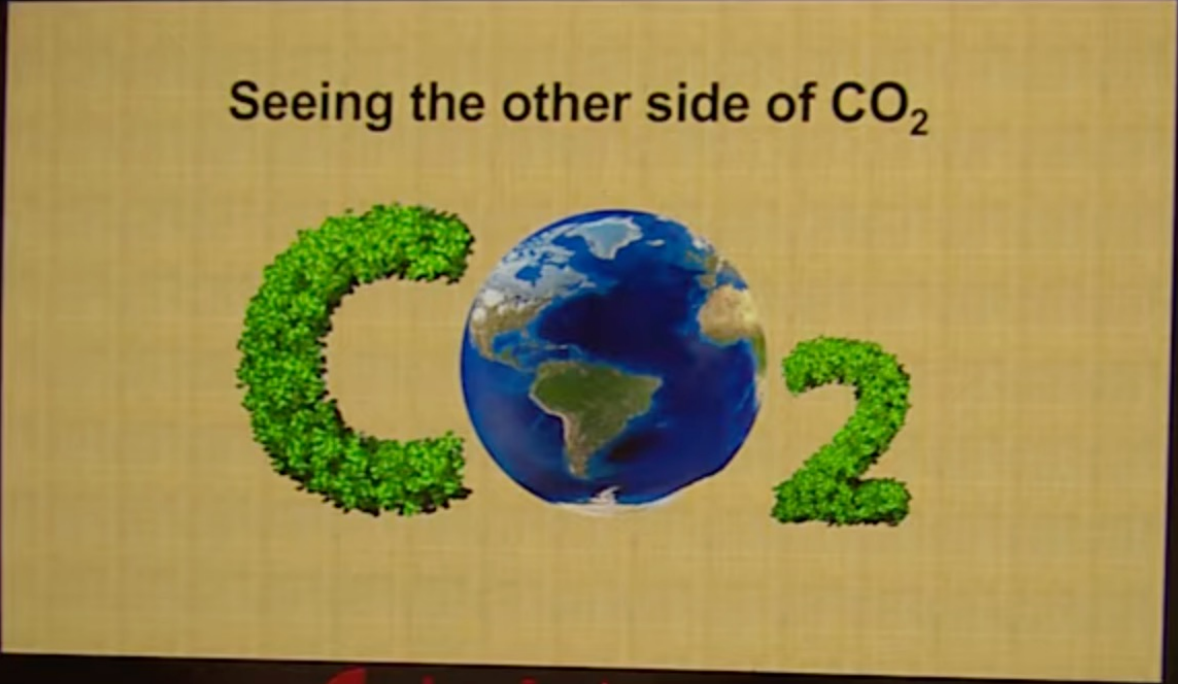




Joanne Chory – Salk
Instituut, San Diego



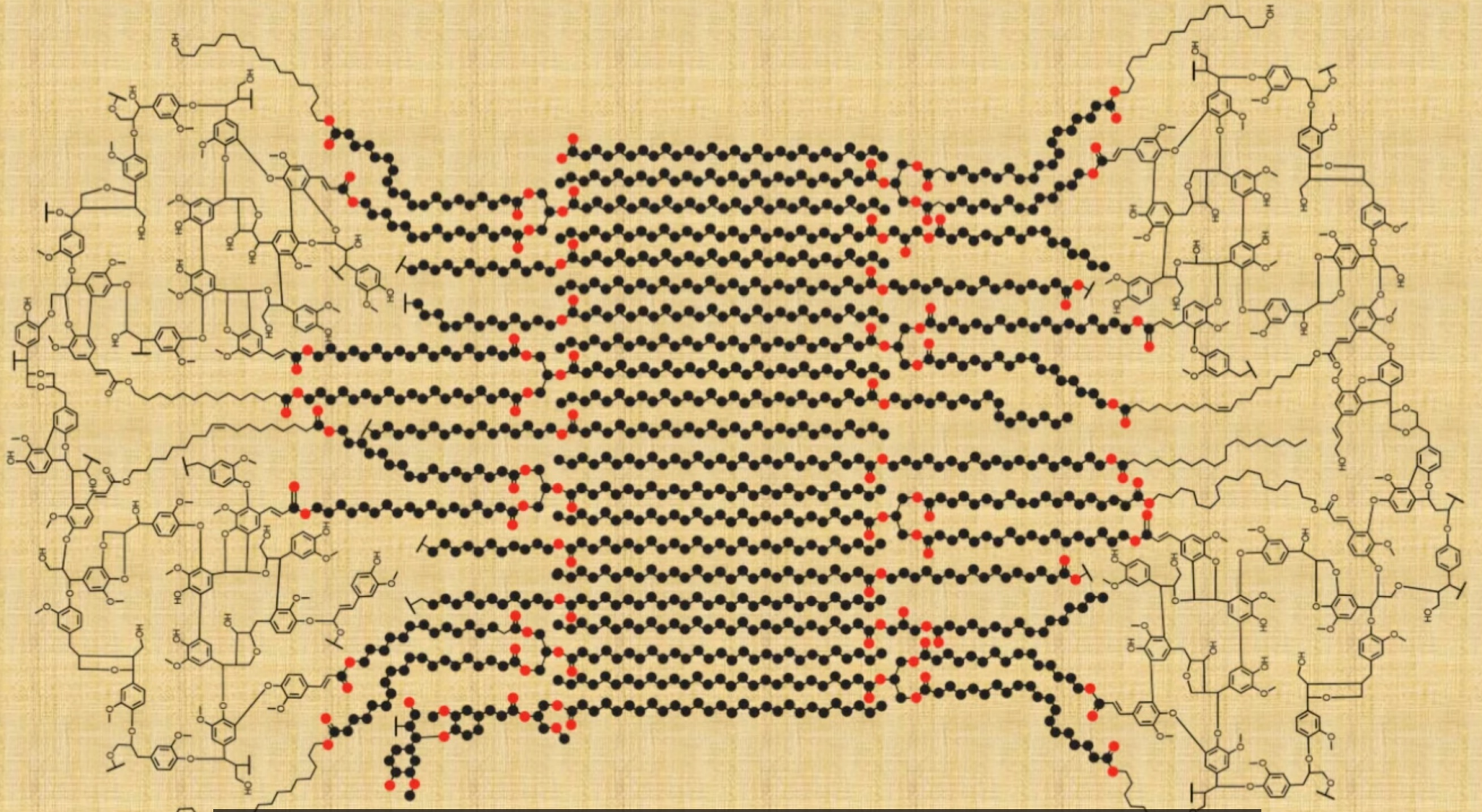
Joanne Chory



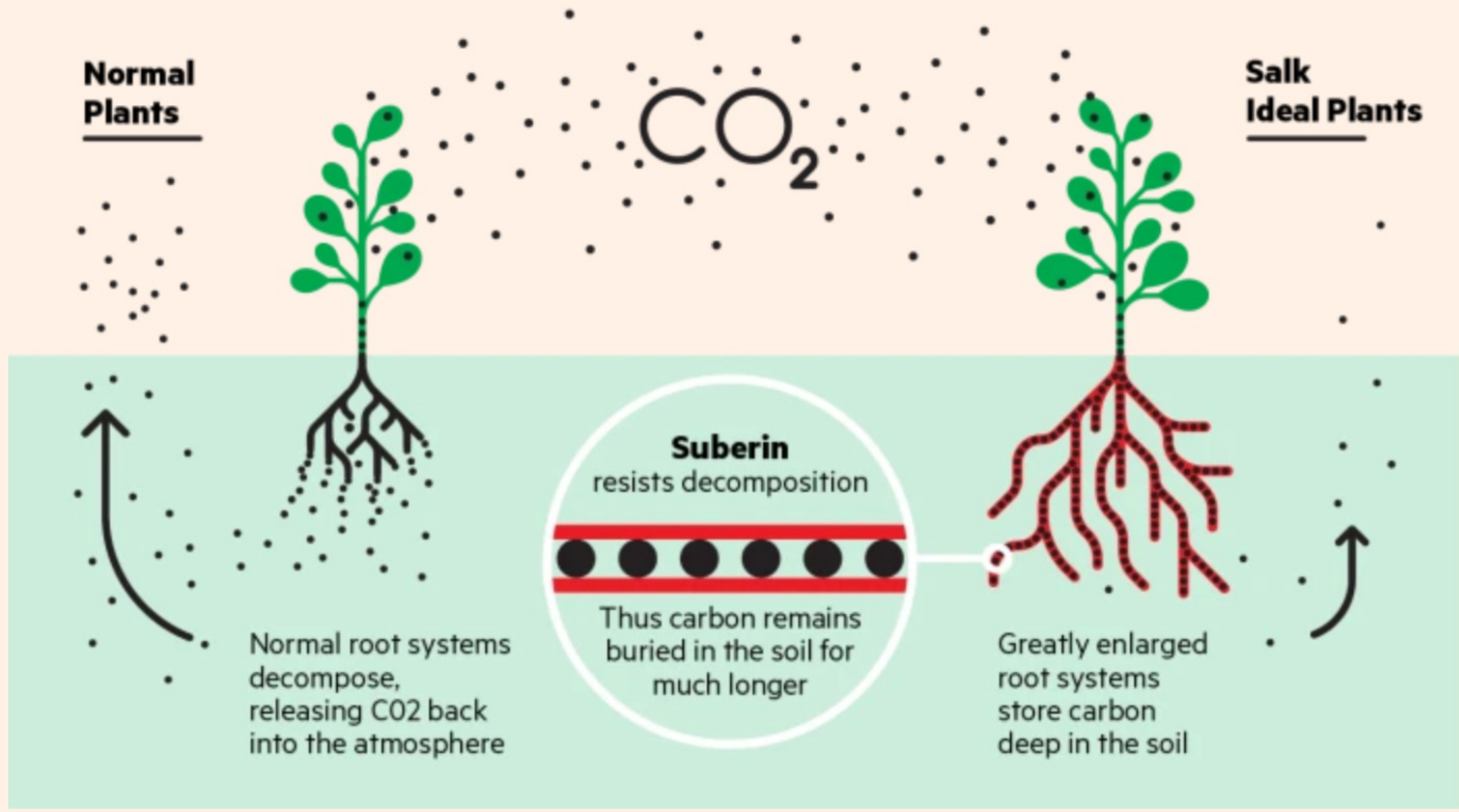
TED



Suberin: A Natural Carbon-Storage Device



How the ideal plant works

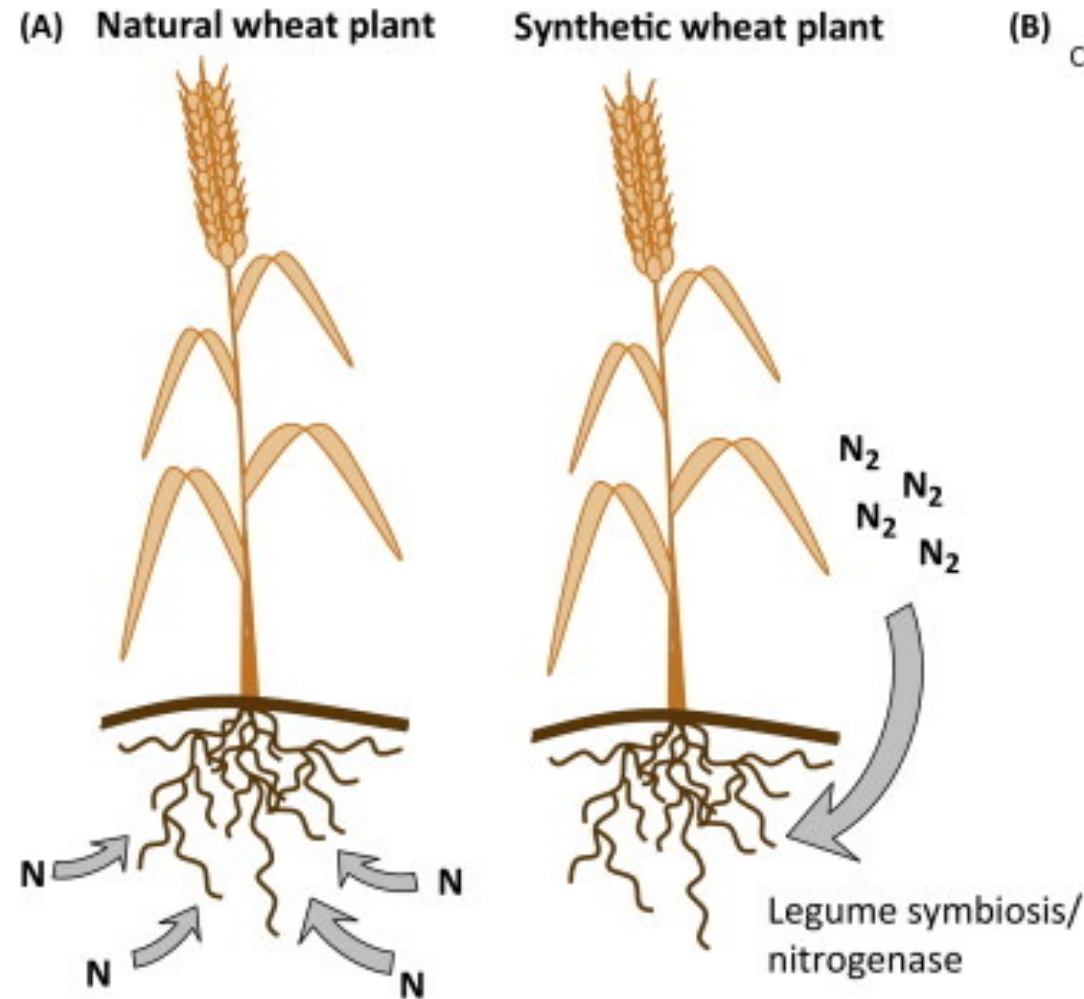


Joanne Chory is using plants to save the planet

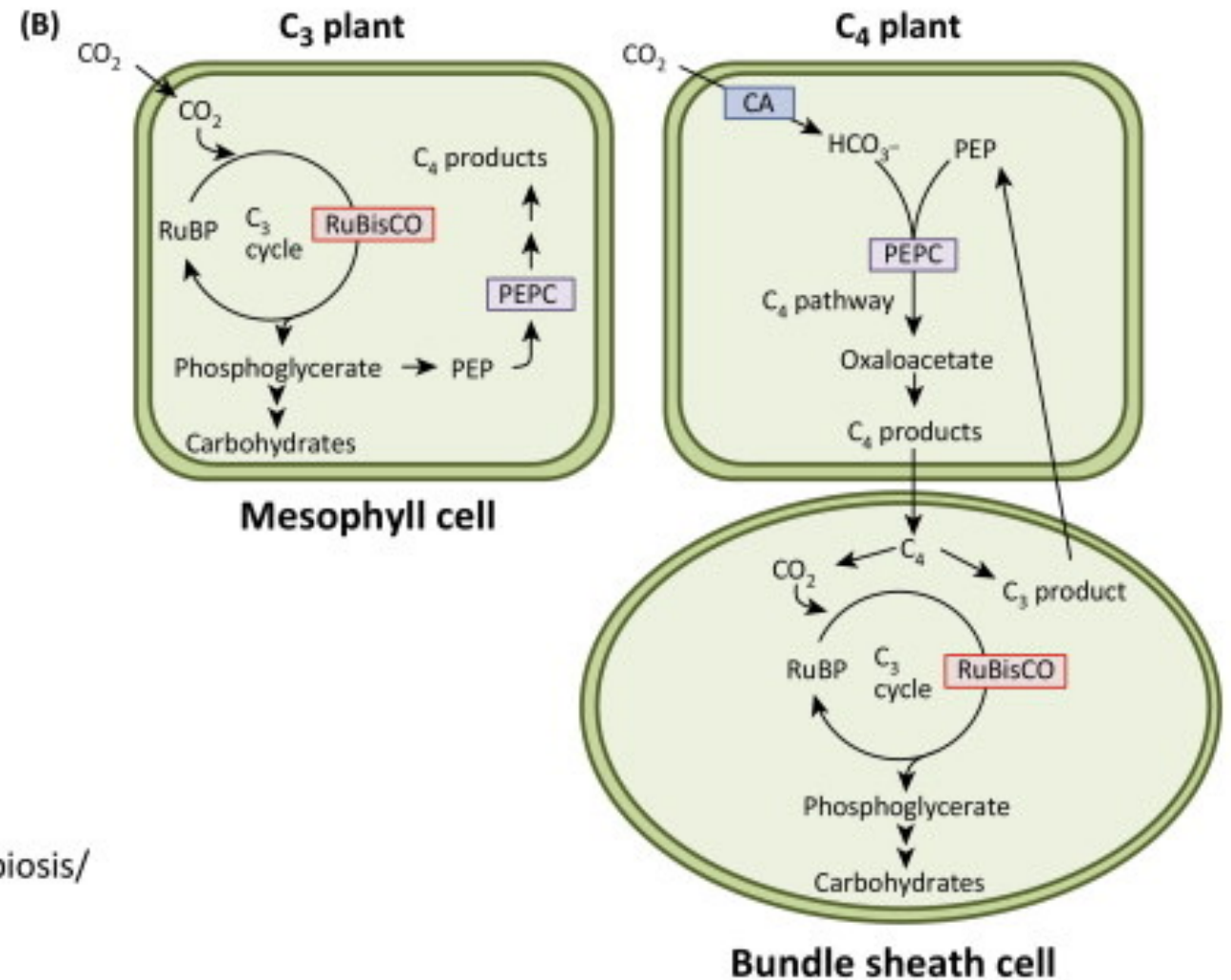


Taimede sünteetilise bioloogia 'suured projektid'

N₂ fikseerivad teraviljad



C₄ fotosünteesiga teraviljad



INARI™

SEEDesign™ platform.

Satisfying demand. Enriching the environment.

PRODUCTIVITY GOALS

UP TO

+20%

YIELD IN CORN AND SOY

Compared to historical
yield improvements of ~1% per year

WATER USAGE GOALS

-40%

WATER NEEDED FOR CORN

Equivalent to approximately 2.1 years of US
total water consumption from domestic
and public supply

CLIMATE CHANGE GOALS

-40%

NITROGEN NEEDED FOR CORN

Equalling a reduction of half a metric ton of
CO2 per acre of corn



The background of the image is a dark, top-down view of several petri dishes containing various bacterial cultures. The cultures exhibit a wide range of colors and textures, including white, yellow, orange, brown, and grey. Some dishes show dense, confluent growth, while others have more sparse or patterned colonies. The lighting is dramatic, highlighting the textures of the bacterial growth against the dark background.

BIOTECH

Wall Street wins signal the start of a synthetic biology revolution

By James Thorne & Marina Temkin

June 7, 2021 [View comments \(2\)](#)

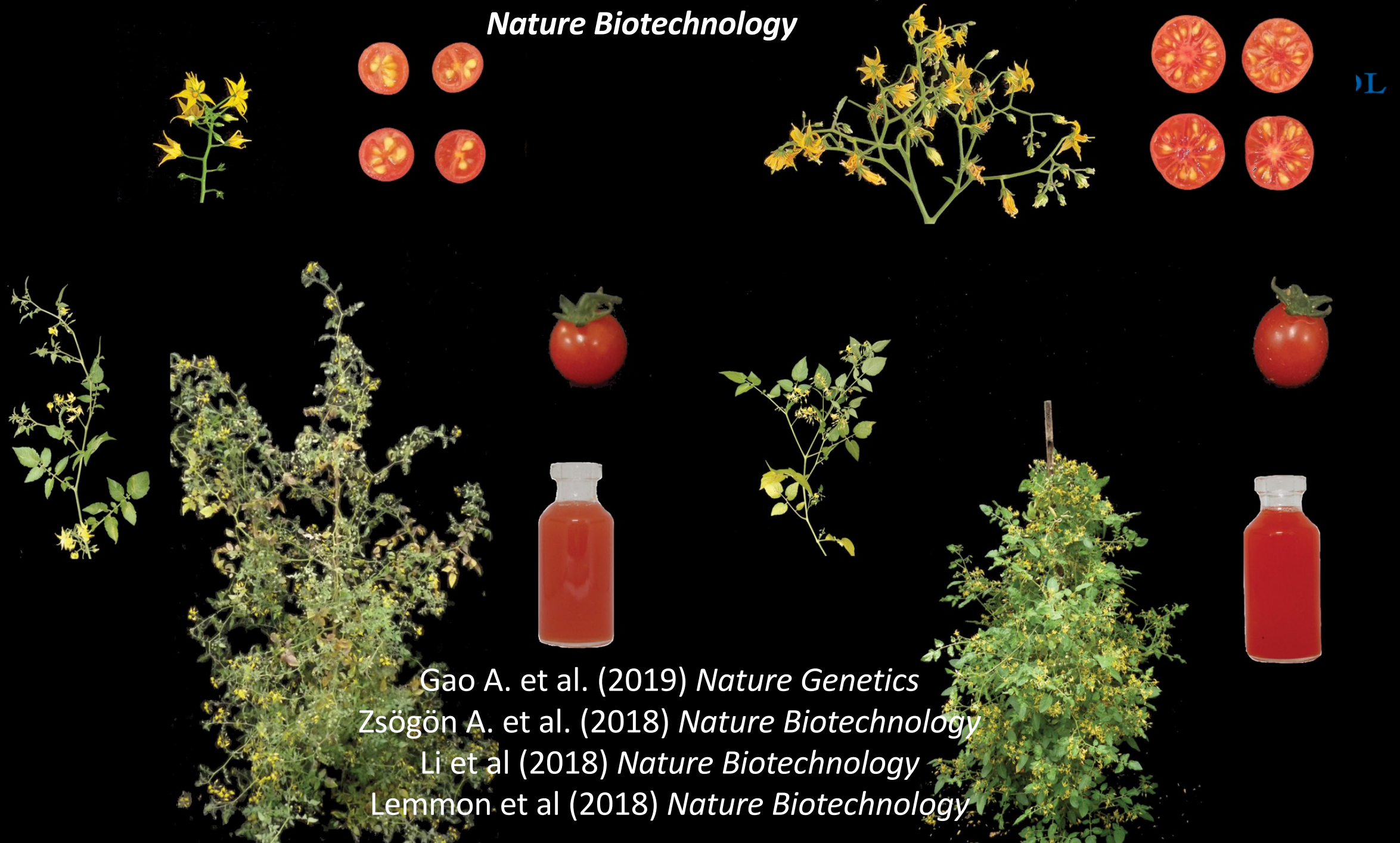
<https://pitchbook.com/news/articles/wall-street-wins-signal-the-start-of-a-synthetic-biology-revolution>

Biology by design.

Biology is the most advanced manufacturing technology on the planet. We program cells to make everything from food to materials to therapeutics.

The Boston-based company's patience recently paid off: Last month, Ginkgo landed a blank-check deal that **valued the company at \$15 billion**, more than triple what it was worth last year, according to PitchBook data. Its rival [Zymergen](#) also took a platform-first approach to biomanufacturing and rode it to an IPO in April at a roughly \$3 billion valuation.

Nature Biotechnology



Gao A. et al. (2019) *Nature Genetics*

Zsögön A. et al. (2018) *Nature Biotechnology*

Li et al (2018) *Nature Biotechnology*

Lemmon et al (2018) *Nature Biotechnology*

Finally! A way to return flavor to bland tomatoes

COOL

Scientists have discovered a rare gene that could help "make tomatoes great again"... or at least taste less bland.

<https://www.dw.com/en/finally-a-way-to-return-flavor-to-bland-tomatoes/a-48732899>



Esimene CRISPR vili Jaapani turule – GABA rikas tomat

15.09.2021



- GABA on näidatud stressi vähendav ja und parandav toime
- Tomatis vähendatud GABA lagundavat ensüümi
- Jaapanis ei ole reguleeritud kui GMO, sest samasugune muudatus võis tekkida ka looduslikult



Learning to Love G.M.O.s

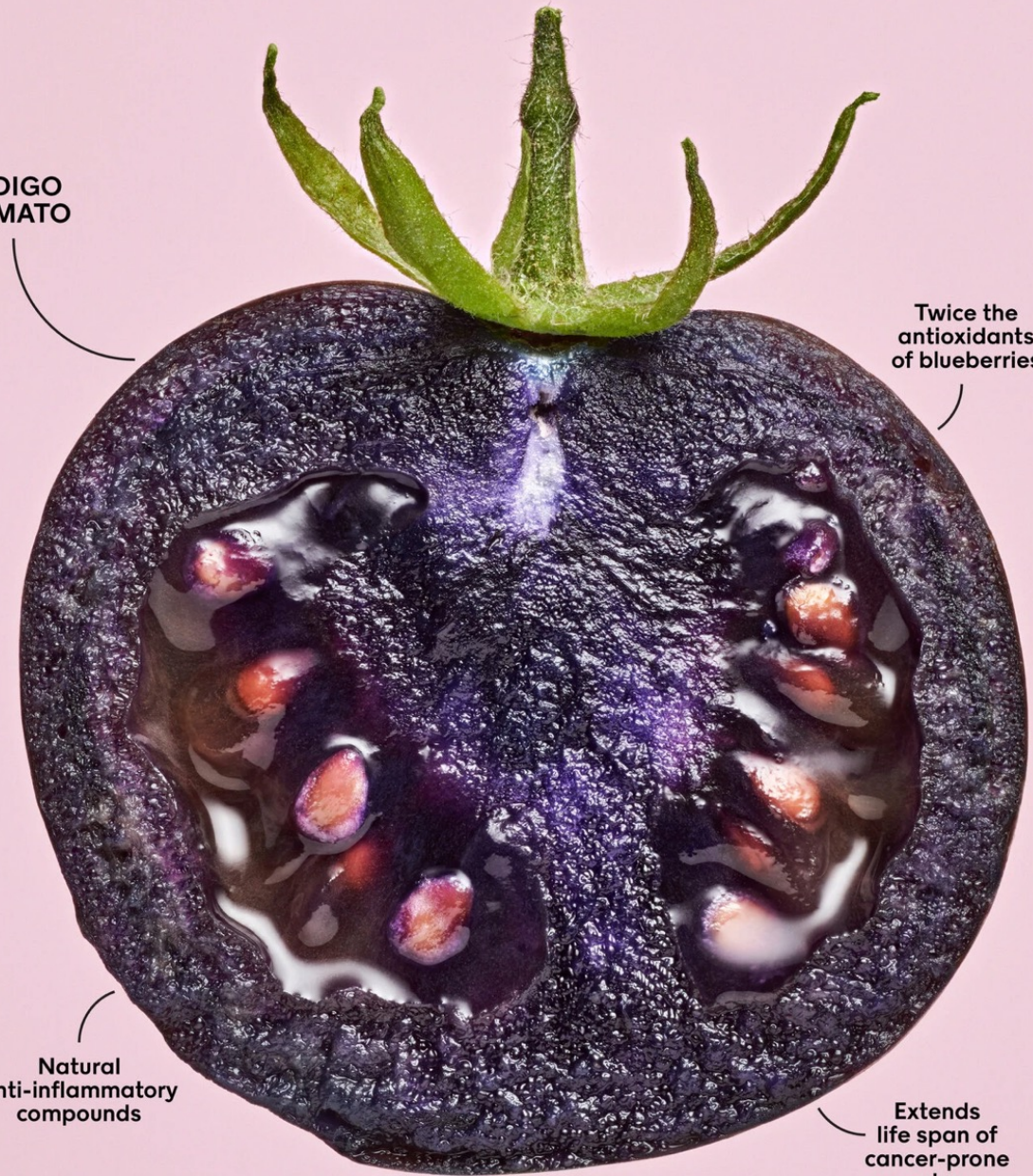
Overblown fears have turned the public against genetically modified food. But the potential benefits have never been greater.

INDIGO TOMATO

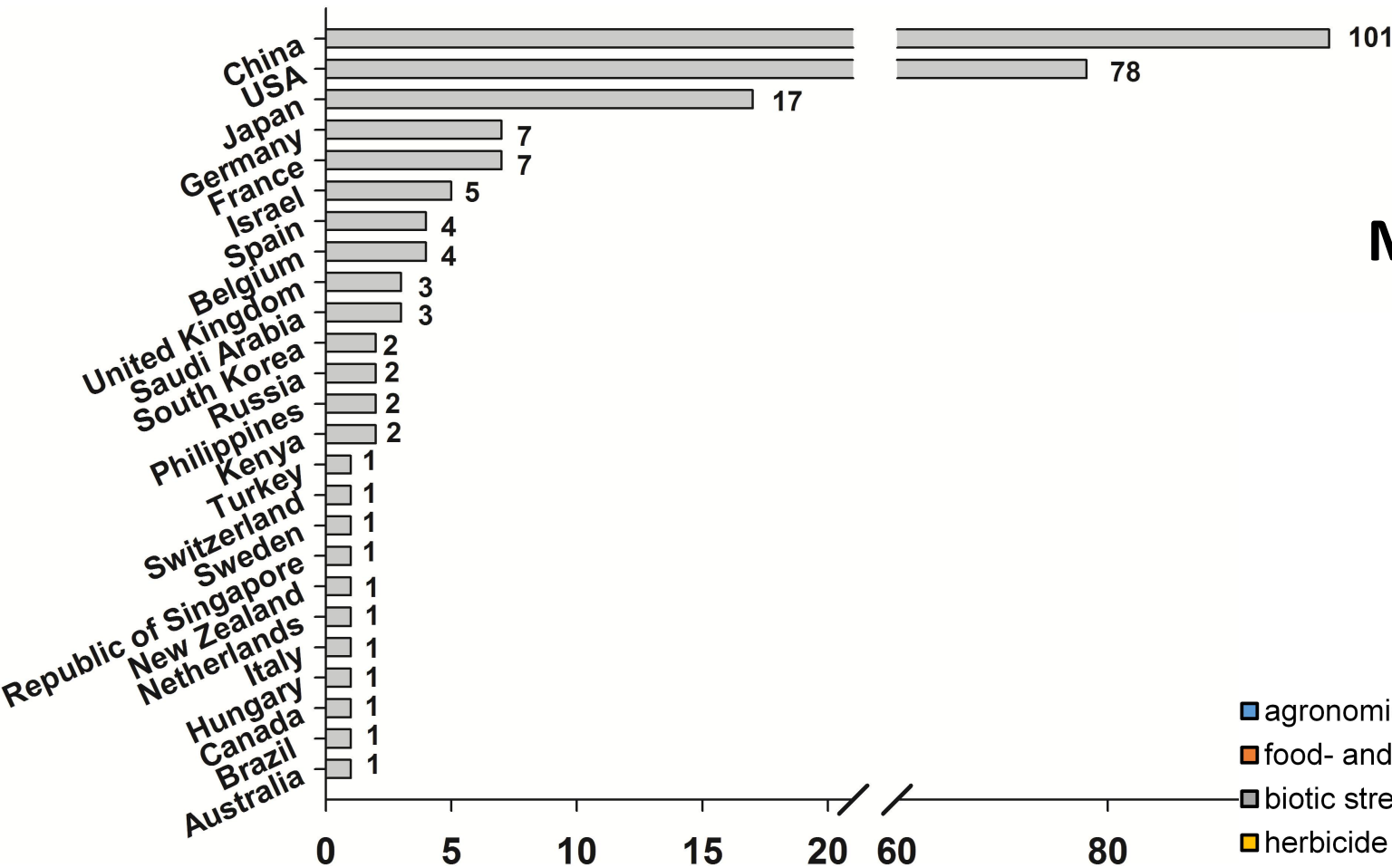
Twice the antioxidants of blueberries

Natural anti-inflammatory compounds

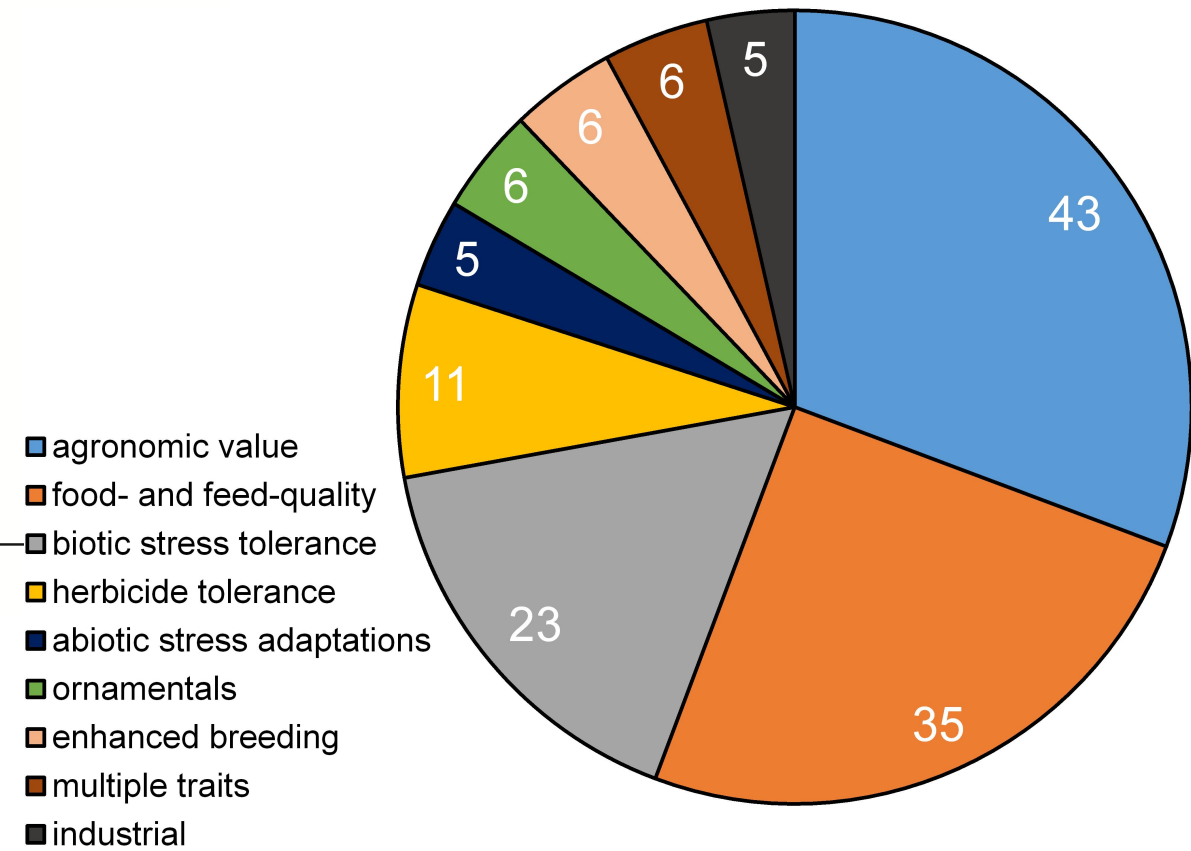
Extends life span of cancer-prone mice



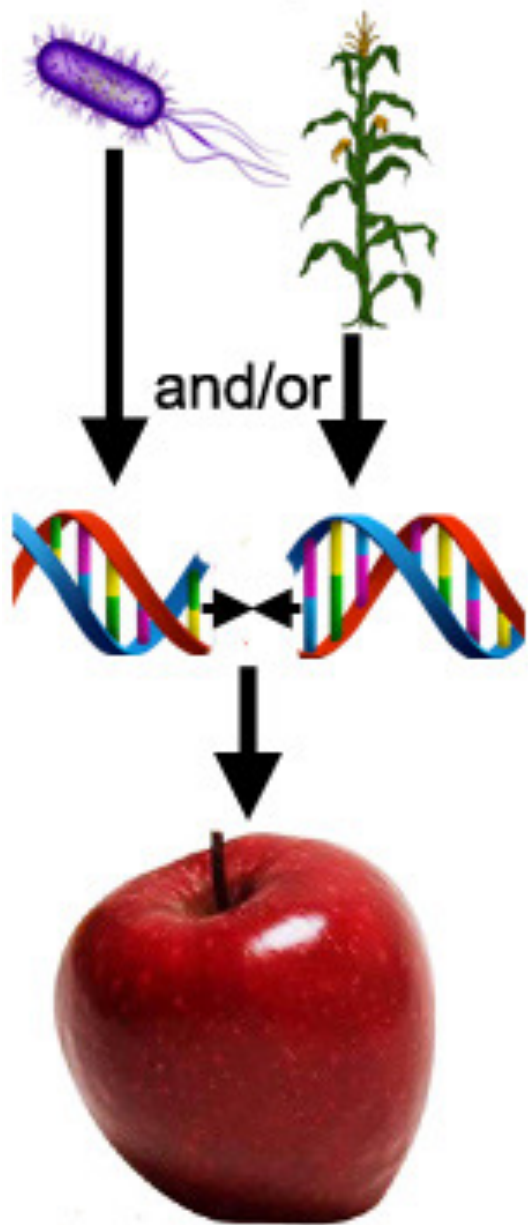
Turule orienteeritud CRISPR arenduste arv



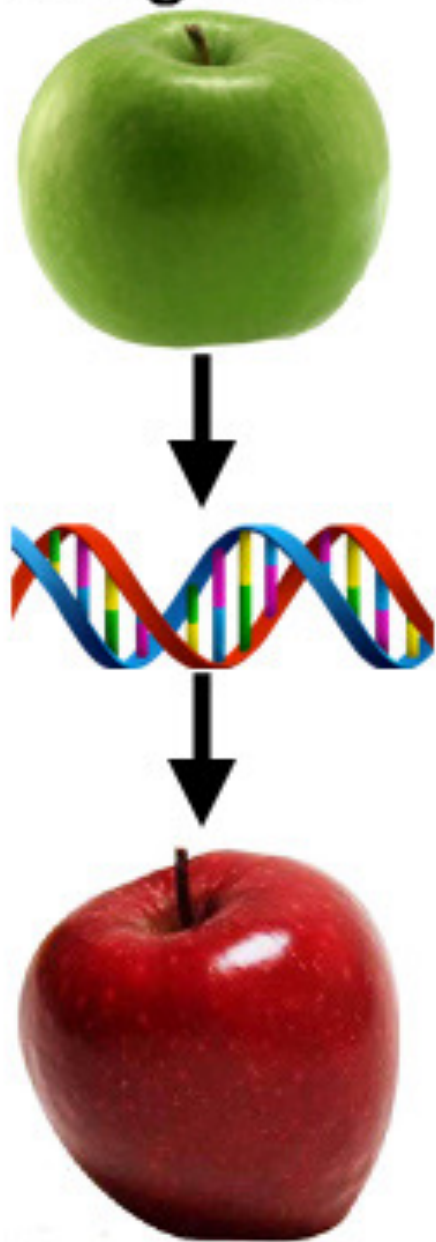
Mis tunnuseid püütakse parandada



Transgenic



Cisgenic



Intragenic

