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Understanding GMO

Genetic Engineering: New dimension in the Science

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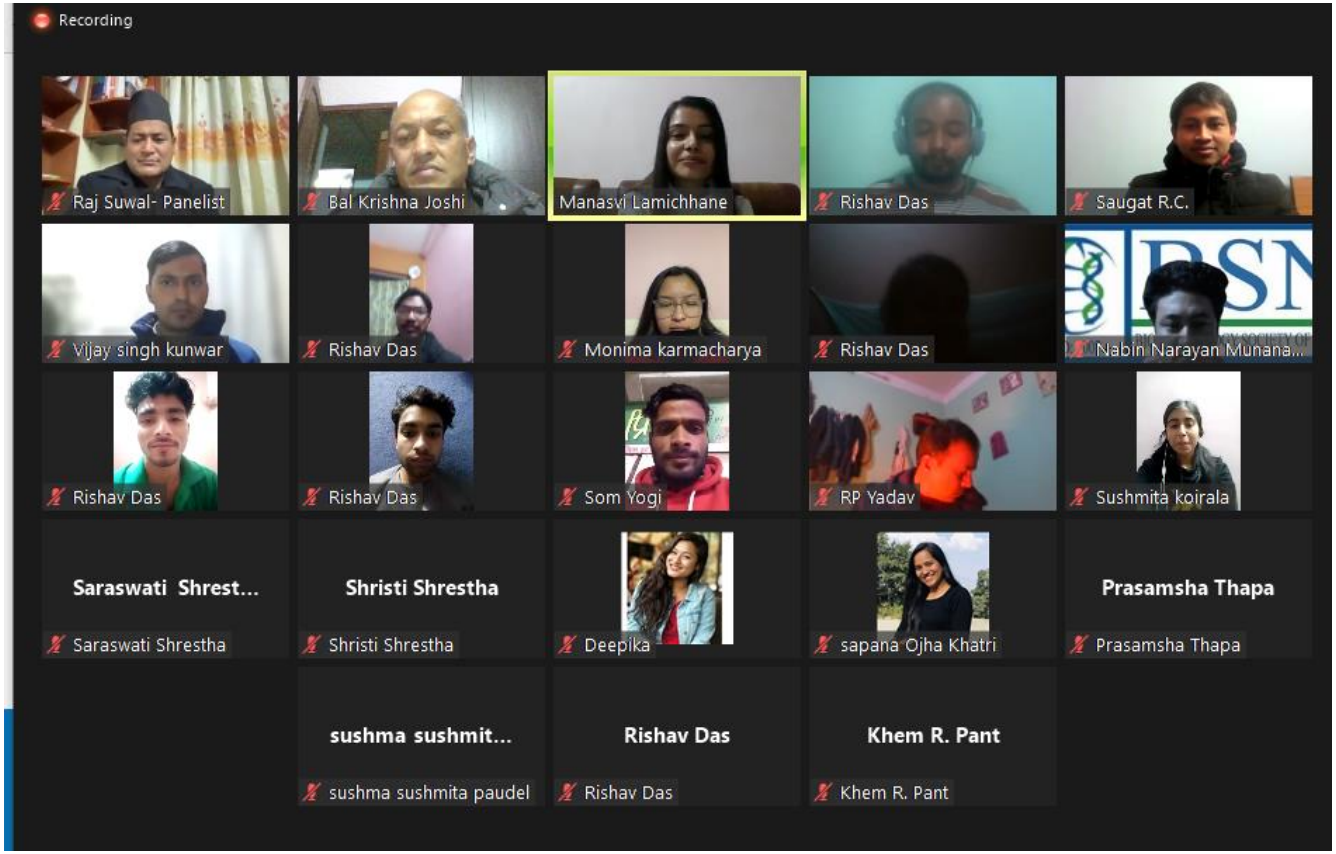
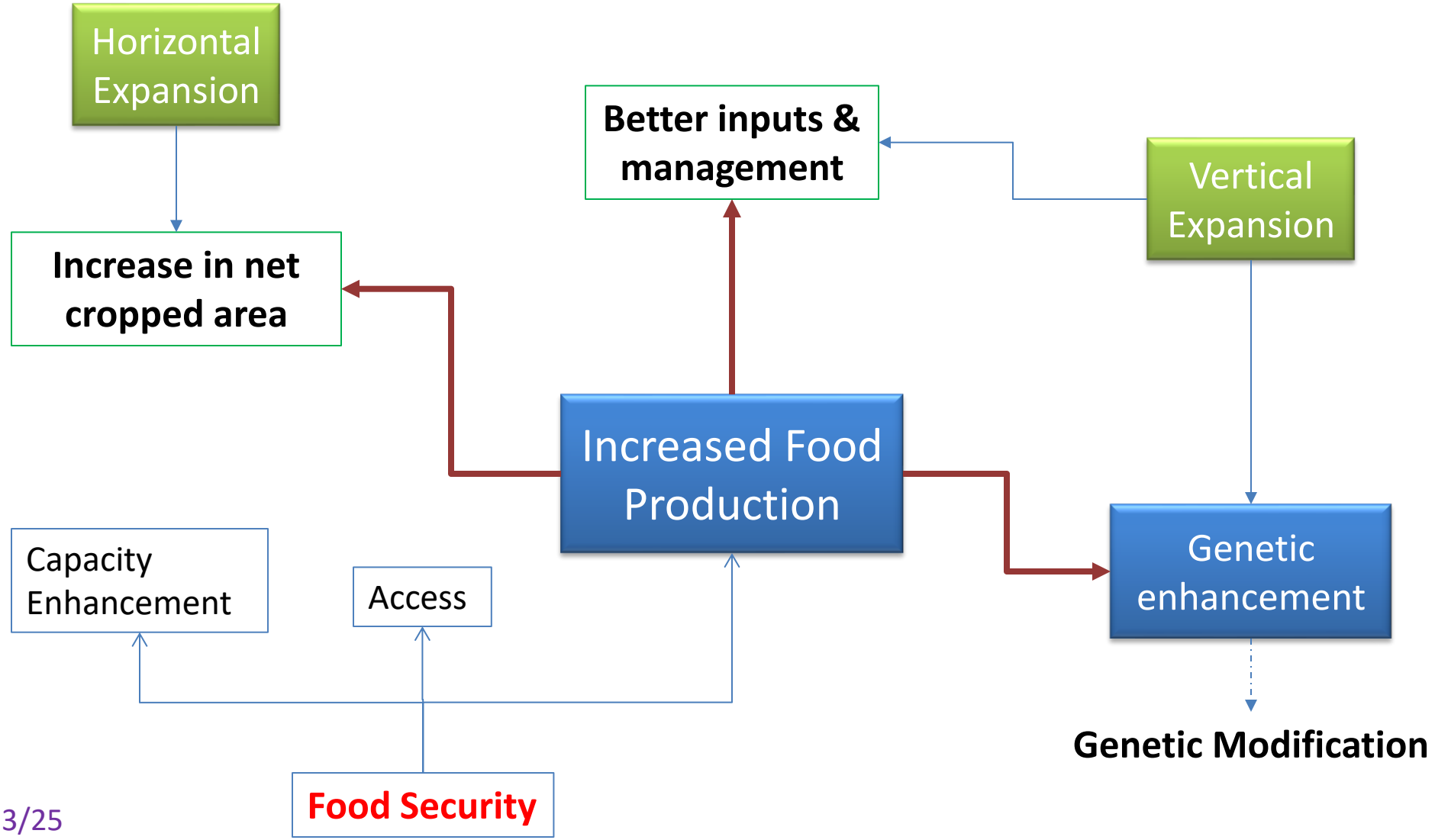
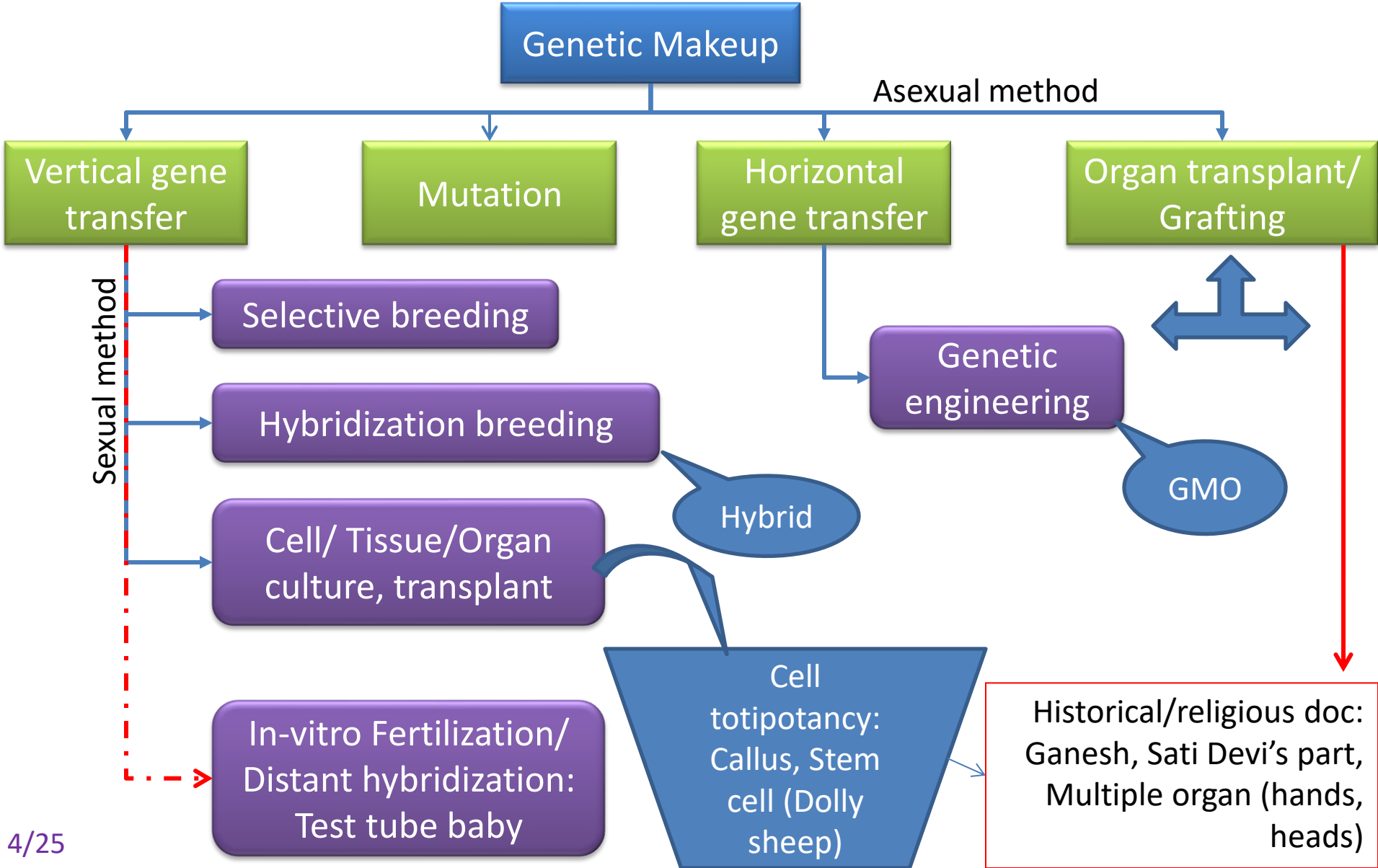
What
How
Why
Where


Recording
Raj Suwal- Panelist
Bal Krishna Joshi
Manasvi Lamichhane
Rishav Das
Saugat R.C.
Vijay singh kunwar
Rishav Das
Monima karmacharya
Rishav Das
Nabin Narayan Munana...
Rishav Das
Rishav Das
Som Yogi
RP Yadav
Sushmita koirala
Saraswati Shrest...
Saraswati Shrestha
Shristi Shrestha
Shristi Shrestha
Deepika
sapana Ojha Khatri
Prasamsha Thapa
Prasamsha Thapa
sushma sushmit...
sushma sushmita paudel
Rishav Das
Rishav Das
Khem R. Pant
Khem R. Pant

Food Security = Increase Food Production



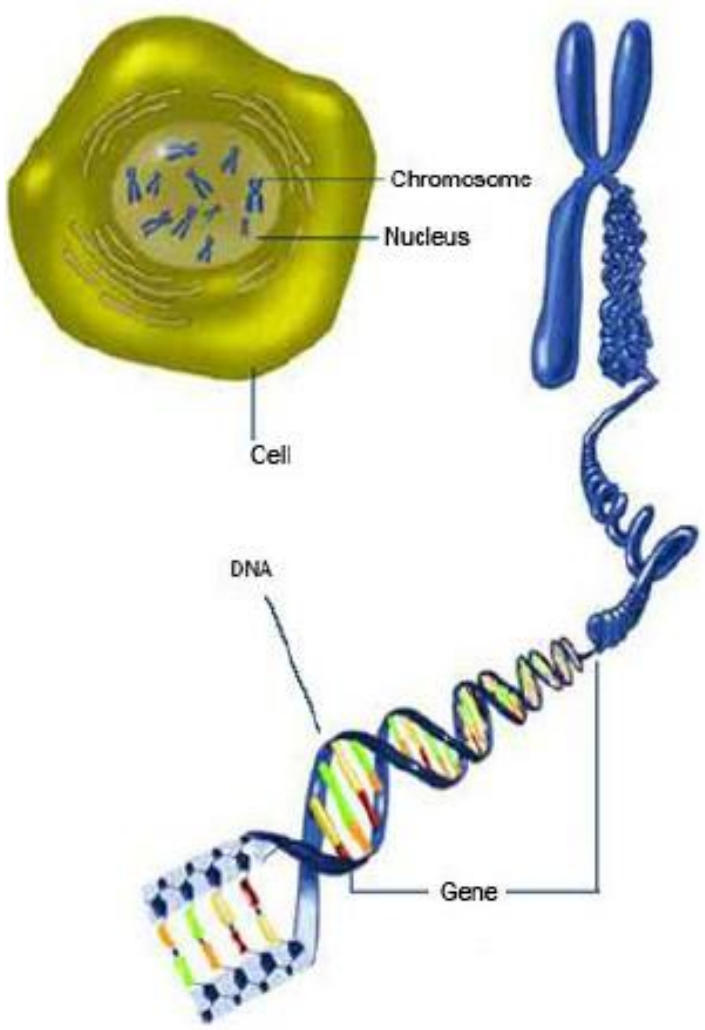
Genetic Modification = Changes in Genetic Makeup



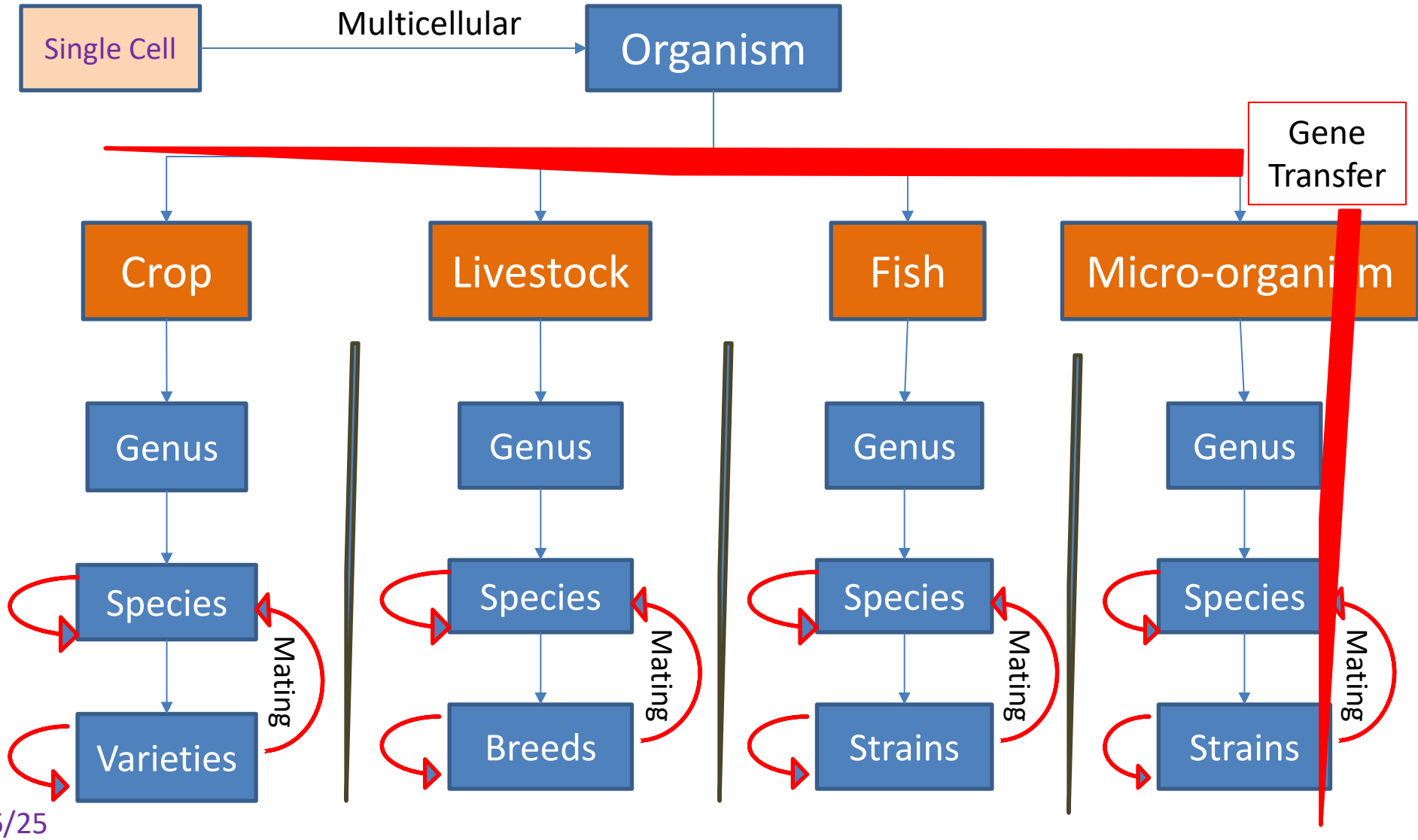
Crop Improvement = Playing with Genes

- Genes are **regions of DNA** controlling a trait or phenotype
- Trait must be inherited (**parent to offspring**)
- Gene x Environment = Trait
- Recombinant = Genotype with different traits
- Gene carrier: Pollen, ovule

- Genes to be transferred are from **how distantly related species**



Reproductive Barrier: Restriction in Gene Recombination



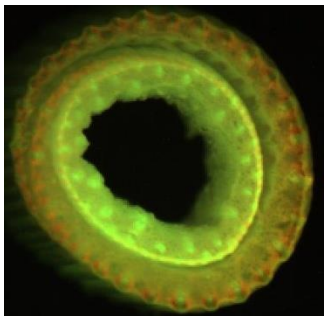
GMO

- Organism with distantly related gene which is **not possible to recombine in natural way and conventional breeding** system
- Using **genetic engineering** (gene slicing and recombination = Recombinant DNA): Creation of new genotype (transgenic crops) by adding distantly related genes (transgenes)
- Transgene must be **inherited**

***Luc* gene from firefly**

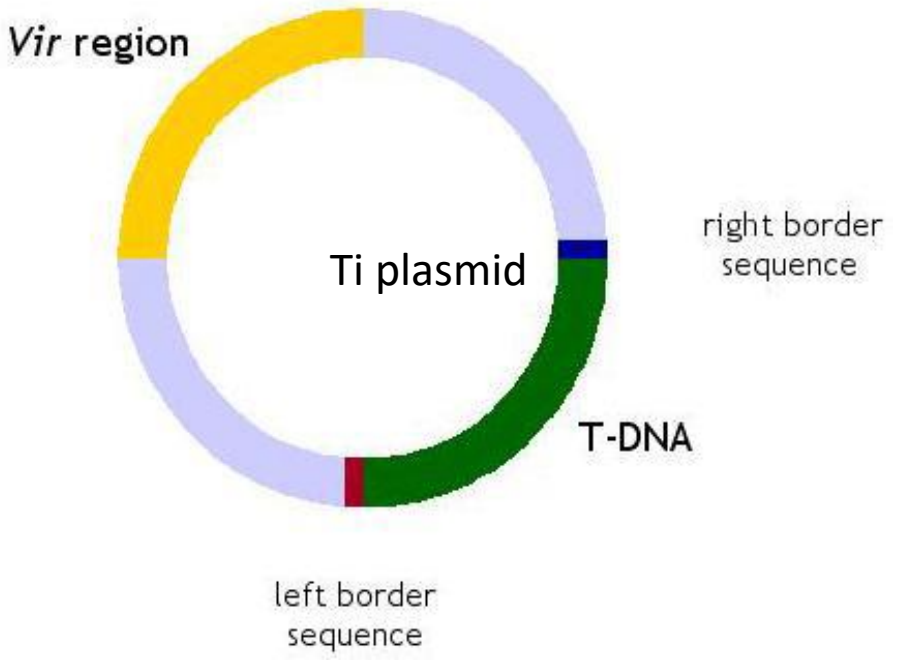
- GMO, LMO, Transgenic organism, Biotech Crops
- Products of GMO = GM Food
- Recombinant DNA technology by Paul Berg in 1972 and awarded Nobel prize
- First GM crop = Tomato in 1994
- Using in medicine since 1976 ?

Green fluorescent protein from jellyfish

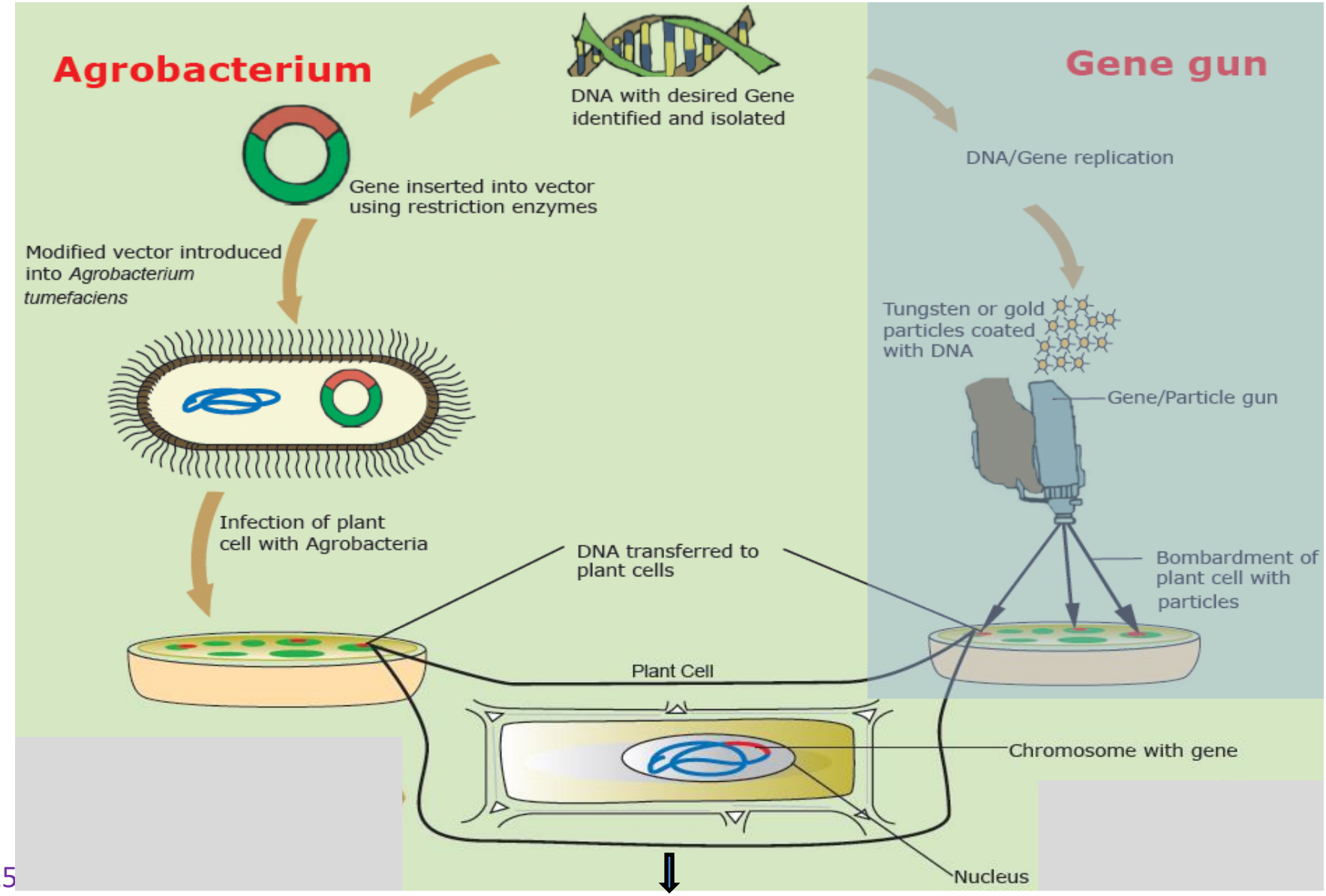


A Natural Genetic Engineer: Agrobacterium tumefaciens

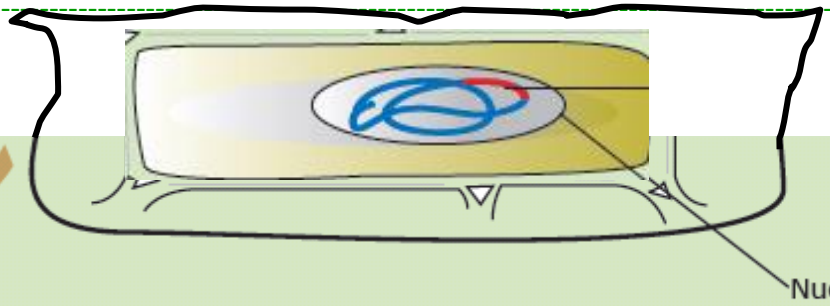
- A gram-negative soil bacterium that is used to transfer DNA into plant cells by a process similar to bacterial conjugation. The transferred DNA (T-DNA) randomly integrates into the plant genome to produce stably transformed plants.
- It transform plants to synthesize food (opines) for itself



General Method for Developing GMO

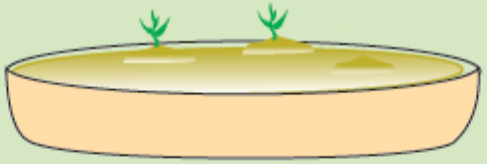


General Method …



Plant cell

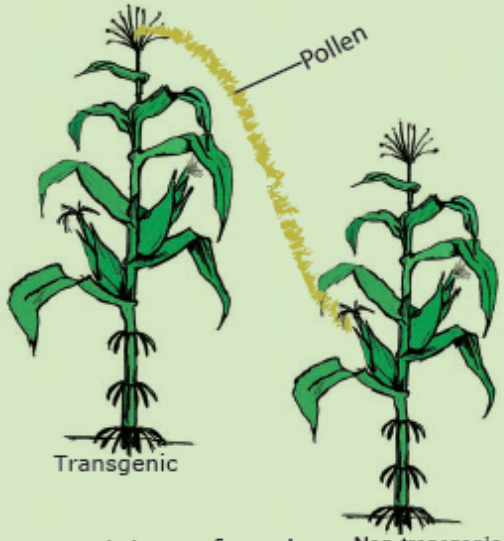
Screening for transformed cells with selectable markers



Cell regeneration to produce transgenic plants

Test the transgenic plant for gene expression in greenhouse and field trials

Or

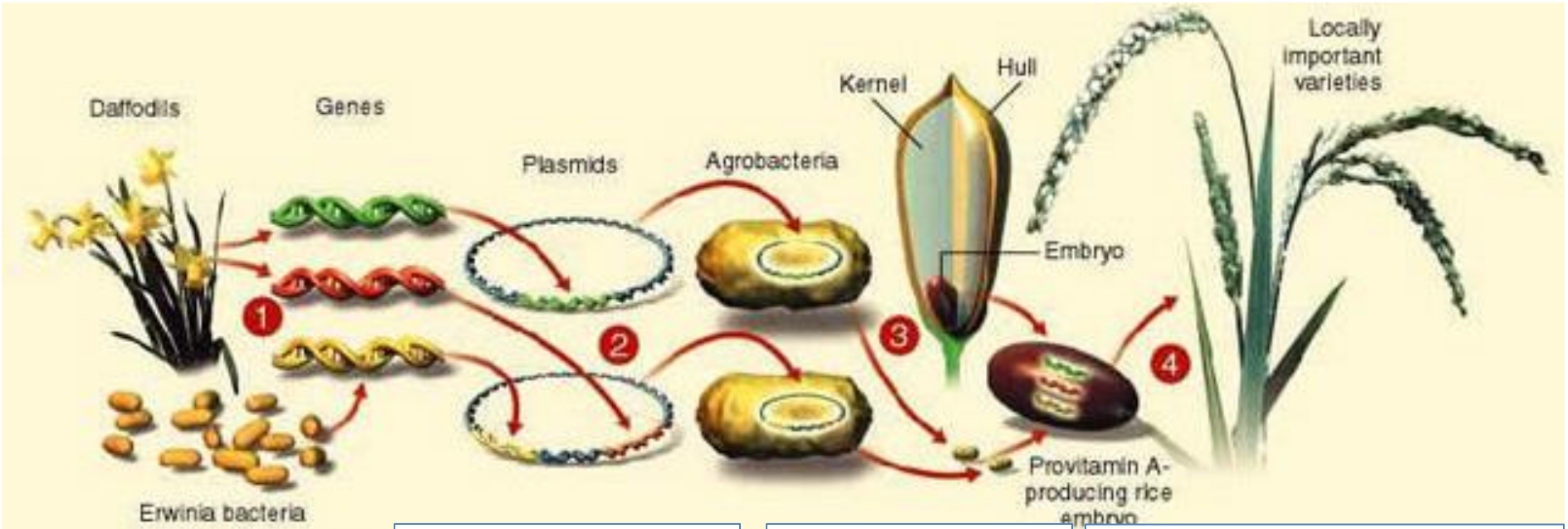


Incoporate new gene into preferred cultivars by conventional breeding

Preferred cutivars with desired gene released for commercialization

Transgenic crop released for commercialization

Transgenic Rice = Golden Rice = GMO



1. The genes that give golden rice its ability to make **beta carotene** in its endosperm (the interior of the kernel) come from **daffodils** and a **bacterium** called Eruinia uredovora

2. These genes along with promoters (segments of DNA that activate genes) are inserted into **plasmids** (small loops of DNA) that occur inside a species of bacterium (Agrobacterium tumefaciens)

3. These agrobacteria are then added to a petridish containing rice embryos. As they also transfer the genes that encode the instructions for making beta carotene

4. The transgenic rice plants must now be crossed with strains of rice that are grown locally and are suited to a particular region's climate and growing conditions

Do you know where biotech crops are grown?

More than 30 countries have planted biotech crops since 1996. See where they were grown in 2019.

17 MILLION
small, resource-poor farmers and their families totaling >65 million people benefited from biotech crops in 2019

USA
is the largest producer of biotech crops in the world, planting 37.6% of global biotech crop area

Biotech canola's adoption rate in Canada reached **95%**

SPAIN
is the leading country planting biotech maize in Europe

More than **6 MILLION**
farmers in India planted 11.9 million hectares of Bt cotton in 2019

Portugal
Spain
Canada
USA
Mexico
Honduras
Costa Rica
Colombia
Brazil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Nigeria
Sudan
Ethiopia
Malawi
South Africa
Eswatini
Pakistan
India
Myanmar
Bangladesh
China
Vietnam
Philippines
Indonesia
Australia

10 countries
in Latin America planted biotech crops in 2019

BRAZIL
is the top developing country in the world planting biotech crops

MALAWI, ETHIOPIA, & NIGERIA
planted Bt cotton for the first time in 2019

2.7 Billion
hectares of biotech crops planted since 1996

Soybeans, Maize, Cotton, Canola, Sugar beets, Alfalfa, Papaya, Squash, Potato, Apples, Eggplant, Sugarcane, Pineapple, Safflower

For more information on biotech crops, visit
www.isaaa.org

Source: ISAAA. 2019. Global Status of Commercialized Biotech/GM Crops in 2019. *ISAAA Brief* No. 55. ISAAA: Ithaca, NY.

GLOBAL STATUS OF COMMERCIALIZED BIOTECH/GM CROPS: 2018

Biotech Crops Continue to Help Meet the Challenges of Increased Population and Climate Change

191.7 MILLION HECTARES BIOTECH CROPS

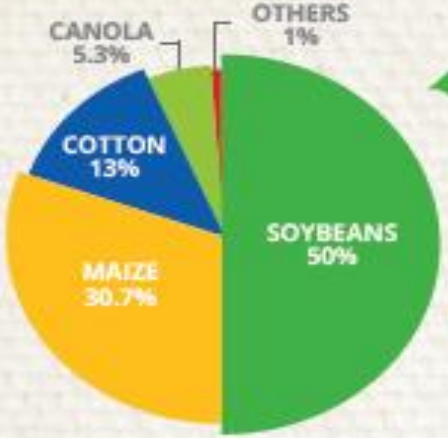
IN **26** COUNTRIES PLANTED BY **17** MILLION FARMERS

FASTEST ADOPTED CROP TECHNOLOGY IN RECENT TIMES

70 COUNTRIES ADOPTED BIOTECH CROPS SINCE 1996, THE FIRST YEAR OF COMMERCIAL PLANTING

BIOTECH CROP AREA INCREASED ~113-FOLD
ACCUMULATED AREA IS 2.5 BILLION HECTARES

MAJOR BIOTECH CROPS



SOYBEANS

HIGHEST ADOPTION WORLDWIDE
50% OF BIOTECH CROP AREA

OTHER BIOTECH CROPS GROWN IN 2018:

NUMBER OF COUNTRIES GROWING MAJOR BIOTECH CROPS IN 2018

4,349 APPROVALS FOR 387 BIOTECH EVENTS FOR 27 CROPS SINCE 1992 INCLUDING CARNATION, ROSE, AND PETUNIA

INDONESIA

PLANTED **BIOTECH SUGARCANE** FOR THE FIRST TIME IN 2018

MAIZE

MOST NUMBER OF APPROVED EVENTS
137 EVENTS IN 35 COUNTRIES

USA

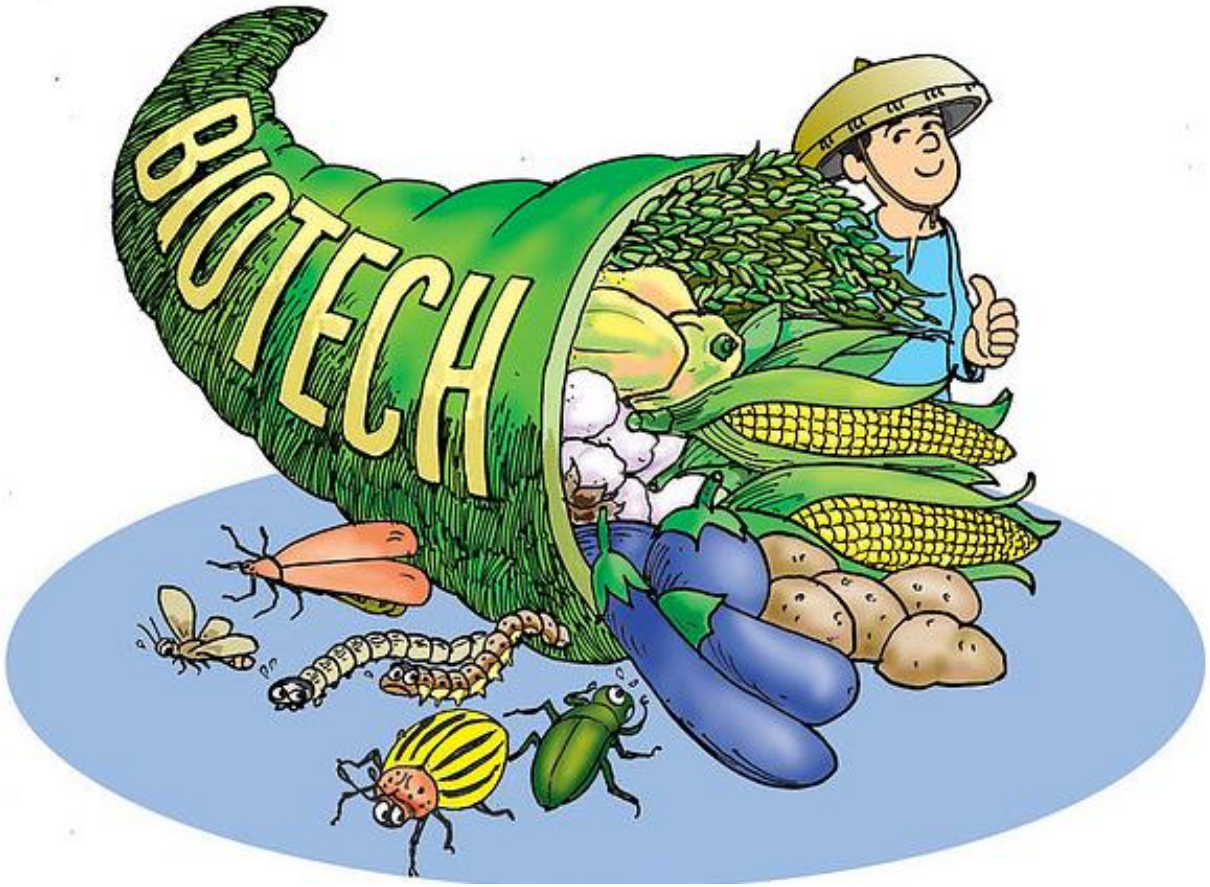
MOST NUMBER OF GM EVENTS
544 APPROVED EVENTS

ESWATINI

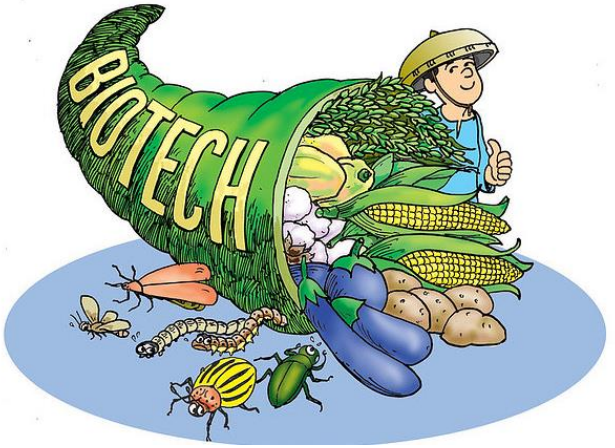
PLANTED **BIOTECH COTTON** FOR THE FIRST TIME IN 2018

Thank you all

- Nabin Munakarmi
- NBS



Merits



- Possible to engineer living organism
- New genotype to new areas
- Resistance genes better than pesticides
- Drought and heat tolerance genes in the context of climate changes
- Can save and grow seeds over generations by farmers
- Accelerate the conventional plant breeding (fast track)
- Higher yield with better nutrient composition and cost/ time efficient

Demerits

- Much concern on agro-biotech crops not in medicinal, industrial and environmental biotech organisms
- May be allergen protein in GM Food: Creating new allergens
- Potential to develop antibiotic resistance bacteria (due to use of antibiotic resistance gene in genetic engineering
  - Restriction on use of resistance genes to common antibiotics
- Fear of the unknown
  - Many nations and interest groups oppose transgenic crops
  - Intellectual properties issues generally limits deployment of transgenic crops to a small number of large AgBiotech companies

Environmental and Ecological Risk

- Escape of transgenes in the wild (creating super weeds or contaminating natural gene pools)
- Resistance development in insect pests to Bt
- Effects on non-target organism (Bt corn pollen with beneficial insects)
- Mono crop in large areas
- Genetic erosion
- New form and new products

Commercialized Biotech Traits

- Herbicide tolerance (glyphosate) – 63%
- Insect resistance (Bt) – 15%
- Herbicide tolerance stacked with insect resistance – 22%
- Everything else (< 1%)
  - Virus resistance
  - Delayed ripening…


Application of Genetic Engineering

GMOs

Agriculture

Transfer of important genes for increased yield with resistance to diseases, insect pests and environmental stresses

Medicine

Vaccines and drug production: Vaccines for pox, rabies, insulin, growth hormone, antibiotics, etc

Industry

Production of useful compounds (ethanol, lactic acid, etc), Production of antibiotics and enzymes (Penicillin, streptomycin, proteases, lipase, etc)

Environment

Biocontrol of disease and insect pests, Efficient sewage treatment, detoxification of wastes

Noticeable Cases

- Bt crops: No need of pesticides
- Glyphosate resistance crops: Use of herbicides
- SunUp and Rainbow Papaya: Resistant to PRSV (Papaya Ring Spot Virus)
  - Coat protein sequence of PSRV was transformed into papaya embryos
  - Resistance was heritable

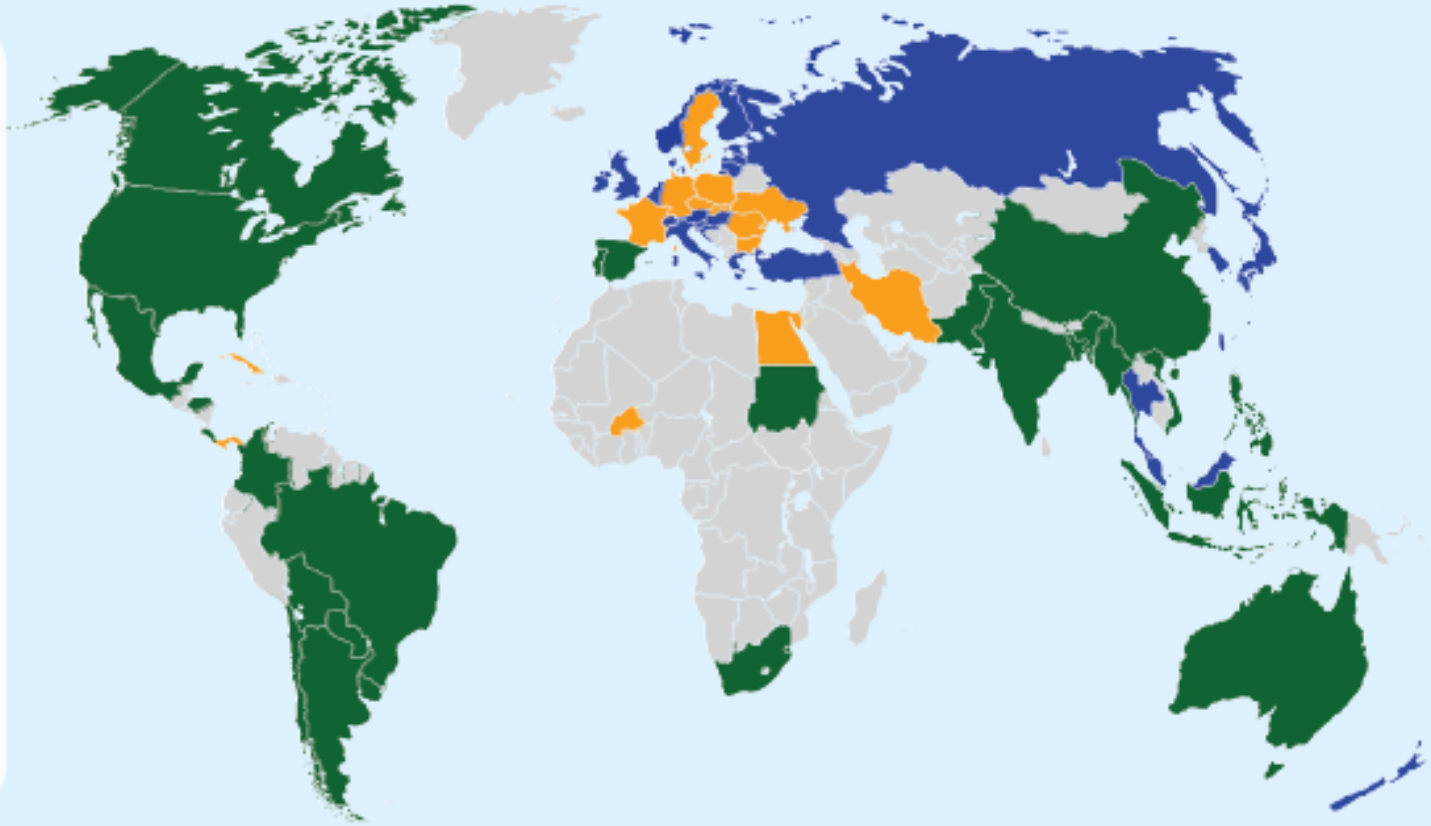
- Aesthetic changes in ornamental crops

  Flower color: Blue rose

23 Years of Biotech Crops in the World

Since the first year of commercial planting of biotech crops in 1996, more than 70 countries from all over the world have either planted or imported biotech crops.

- The 6 founder biotech crop countries in 1996 are **USA, China, Argentina, Canada, Australia,** and **Mexico.**
- **Up to 17 million farmers** planted biotech crops in 2018, 95% is from developing countries.
- **26 countries** planted **191.7 million hectares** of biotech crops in 2018, a ~113-fold increase from 1.7 million hectares in 1996.
- In 2018, **26 countries planted** and **44 imported** biotech crops.



Countries planting biotech crops in 2018
(USA, Brazil, Argentina, Canada, India, Paraguay, China, Pakistan, South Africa, Uruguay, Bolivia, Australia, Philippines, Myanmar, Sudan, Mexico, Spain, Colombia, Vietnam, Honduras, Chile, Portugal, Bangladesh, Costa Rica, Indonesia, and eSwatini)

Countries not planting, but importing biotech crops
(Austria, Belgium, Croatia, Cyprus, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Malaysia, Malta, Netherlands, New Zealand, Norway, Russian Federation, Singapore, Slovenia, South Korea, Switzerland, Taiwan, Thailand, Turkey, and United Kingdom)

Countries that stopped planting, currently importing biotech crops
(Bulgaria, Burkina Faso, Czech Republic, Cuba, Egypt, France, Germany, Iran, Panama, Poland, Romania, Slovakia, Sweden, and Ukraine)

For more information on biotech crops, visit
www.isaaa.org

ISAAA

- ISAAA. 2018. Global Status of Commercialized Biotech/GM Crops in 2018. *ISAAA Brief* No. 54. ISAAA: Ithaca, NY.
- ISAAA GMO Approval Database (http://www.isaaa.org/gmapprovaldatabase/default.asp).

GMO: Status in Nepal

- Not possible to develop GMO in Nepal under existing conditions (manpower and facilities)
- Poor implementation of existing policy, act and regulation
- GMO testing lab in SQCC since 2005: No GMO
- GMO testing training in NARC in 2006: No GMO (Maize and soybean)
- No GM Maize in Nepal (Am J Agric Food Chem 2008)
- No study on Food and Livestock

- GMO not grown in Nepal but may have GM food consumed (Mainly imported oil: Soybean, Canola, Rapeseed)
- Only Japanese soybean milk powder labeled in Kathmandu

National Policies on GMO

- National Agricultural Policy 2061
- National Seed Policy 2056
- Seed Regulation 2069 BS
- Agro-biodiversity Policy 2073
- Seed Vision 2025
- National Biosafety Framework 2007
- Biosafety Guidelines 2005
- National Biosafety Framework 2007
- Biotechnology Policy 2006

- Regulation
- Research on GMO, develop infrastructure and guidelines
- Risk assessment before approval for consumption
- Registration of GMO only after biosafety report (risk assessment)
- Marketing of only registered variety

GMO in General

- All GMOs are not equally harmful
  - Screening and evaluation of biotech traits and biotech crops
  - Introgression of biotech traits to number of other normal varieties to cultivate in diverse areas
- All GMOs have positive and negative aspects, like other science based technology
- Genetic engineering: New dimension in science
- Need of maximum use of science for country development
- Is possible to trade genes with international value?
- Apply beyond the scope of conventional plant breeding
- People will eat GM food rather than dying hungry
- Trend of biotechnology in Research, Education, Investment, Concern increasing in the country

Way Forward: GMO

- Research in confined areas (Science based judgment)
- GMO as parents and integration of GMO in normal breeding
- Risk assessment. All GMO are not equally harmful

- Awareness
- Labeling
- Testing

- Regulatory framework for research, import and use of GMOs (science based and cost/time effective regulatory systems)
- Variety release process

For Further Information

- www.isaaa.org (crop biotech update)
- http://gmoanswers.com/
- http://www.greenpeace.org/international/en/
- https://www.nongmoproject.org/
- http://www.britannica.com/EBchecked/topic/897705/genetically-modified-organism-GMO
- http://www.fao.org/
- http://www.geneticliteracyproject.org/
- AgBioForum, AGRICOLA, BIOSIS Previews, Biological Abstracts, CAB International (CABI), etc

Acknowledgements

- Nabin Munakarmi
- NBS

Thank you all