Biotech Approaches to Mitigating Pesticide Use in Agriculture

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Source: bio.org

Plant Science: Driving Agricultural Sustainability

to end poverty, protect the planet, and ensure a better world by 2030

- 'Without access to modern farming or machinery, let alone science-based climate and weather data, farmers' livelihoods hinge precariously on a changing environment that they're struggling to understand'-*US Agency for International Development*
- FAO estimates without crop protection global food losses would double.

Pesticides are an Integral Part of our World

Pesticides…

- …keep harmful insects and pests out of homes and businesses
- …remove weeds from yards, gardens
- …prevent diseases from infecting household plants and gardens
- …are found in household cleaning agents

85% of all U.S. households have at least one pesticide in use at their home.

Source: http://ipm.ncsu.edu/safety/factsheets/pestuse.pdf

Types of Pesticides Used in Agriculture

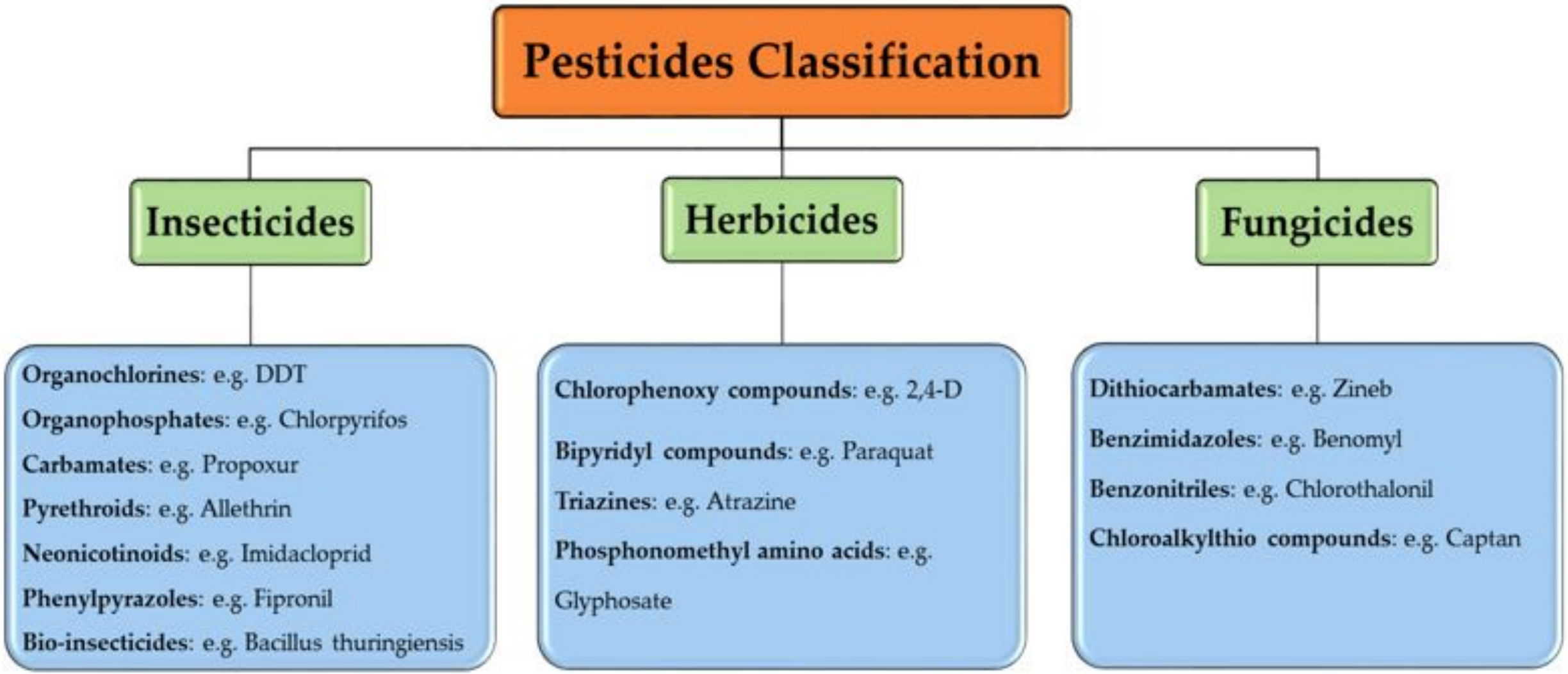
Herbicides – Protect crops against weed competition

Insecticides – Reduce crop losses from insect feedings

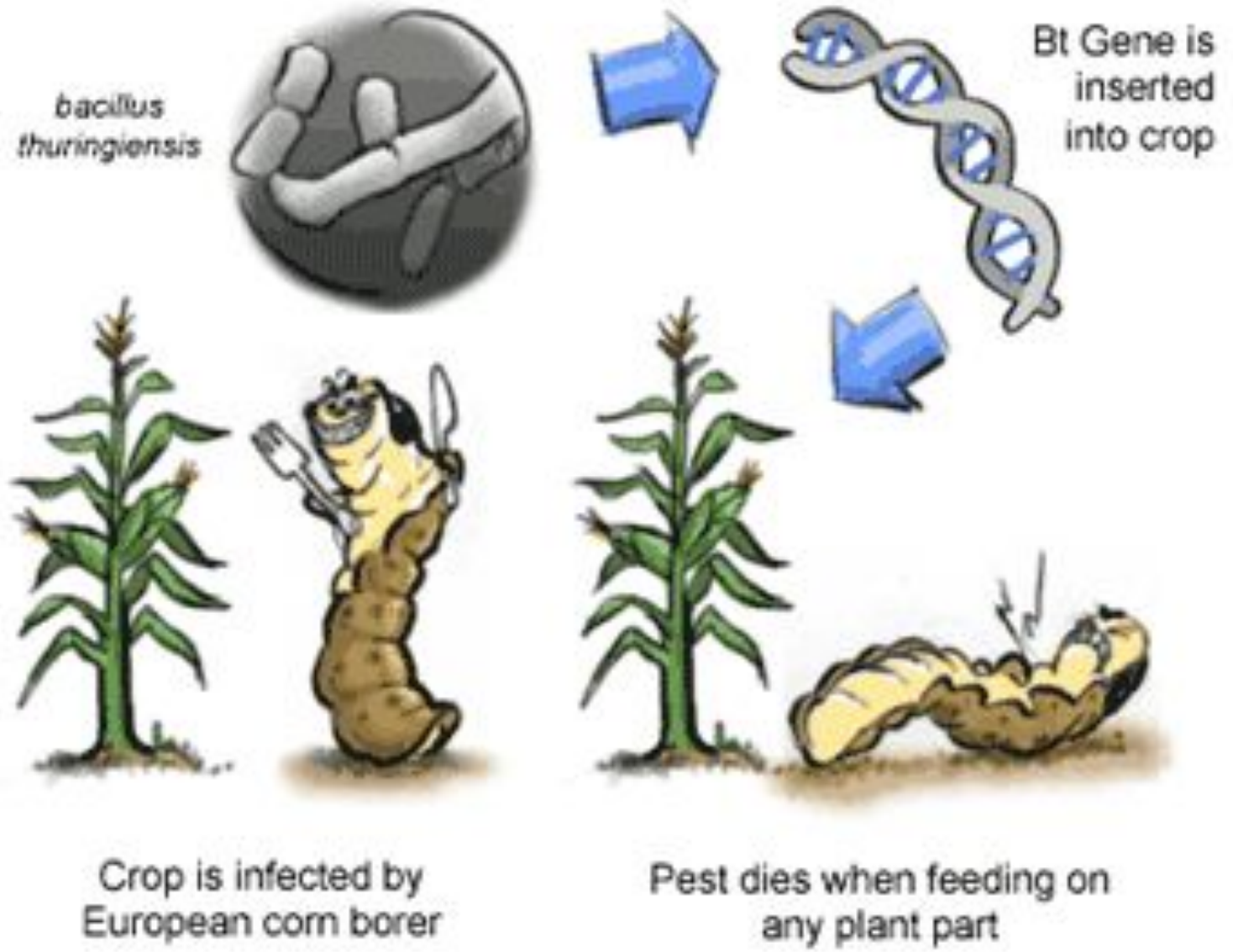
Fungicides – Promote healthy plants and keep them free of diseases

Pesticides can be organic or synthetic

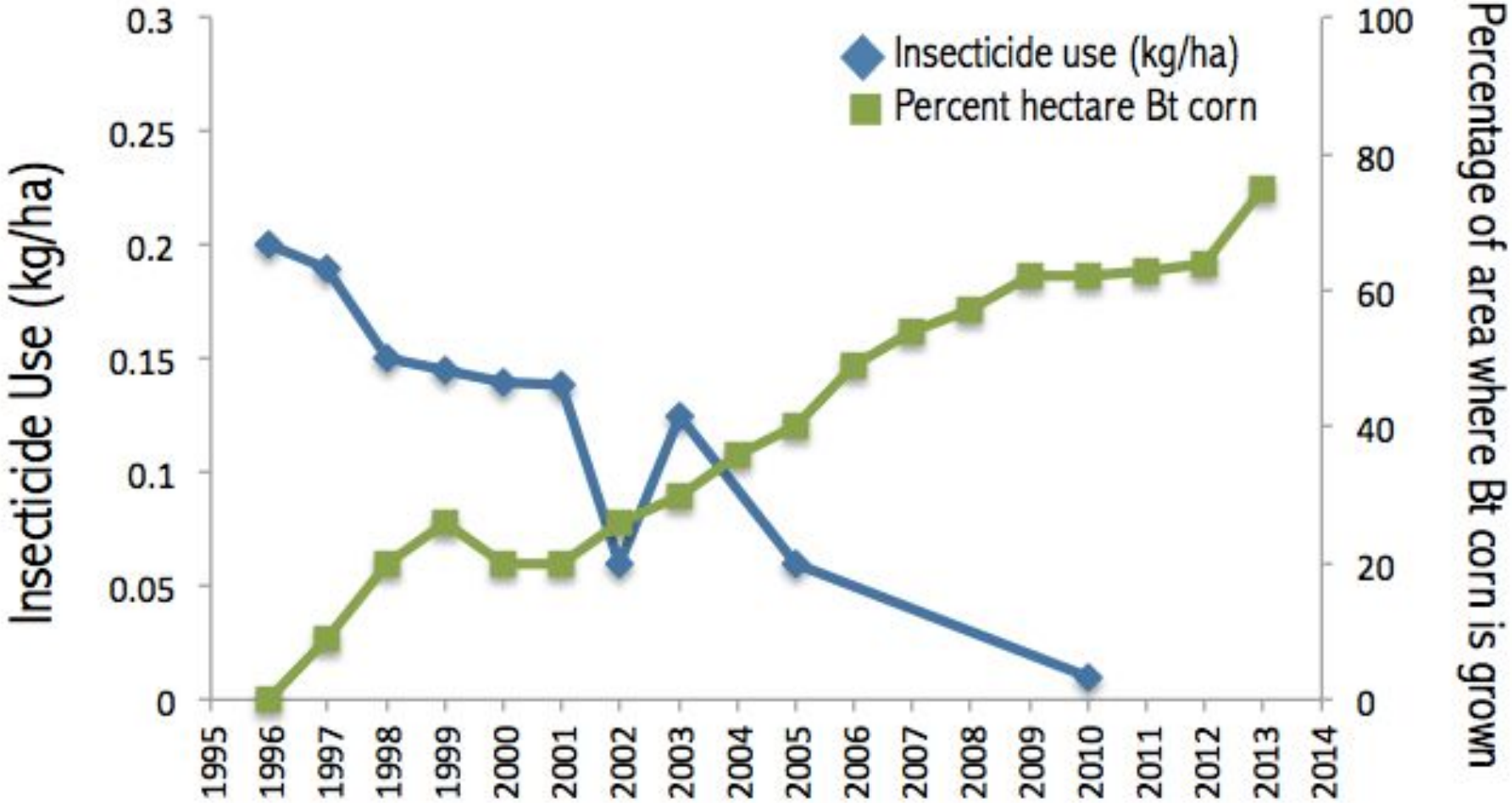
Source: http://ipm.ncsu.edu/safety/factsheets/pestuse.pdf


Pesticides Classification
Insecticides
Herbicides
Fungicides
Organochlorines: e.g. DDT
Organophosphates: e.g. Chlorpyrifos
Carbamates: e.g. Propoxur
Pyrethroids: e.g. Allethrin
Neonicotinoids: e.g. Imidacloprid
Phenylpyrazoles: e.g. Fipronil
Bio-insecticides: e.g. Bacillus thuringiensis
Chlorophenoxy compounds: e.g. 2,4-D
Bipyridyl compounds: e.g. Paraquat
Triazines: e.g. Atrazine
Phosphonomethyl amino acids: e.g. Glyphosate
Dithiocarbamates: e.g. Zineb
Benzimidazoles: e.g. Benomyl
Benzonitriles: e.g. Chlorothalonil
Chloroalkylthio compounds: e.g. Captan

Organic insecticide engineered in crops



Bt corn uptake and insecticide use in U.S. corn fields



Adapted from Malakof D. and Stokstad E. Pesticide Planet. Science Magazine. 16 August 2013.

Herbicides Eliminate Weeds That Compete With a Crop for Light, Moisture and Nutrients

Globally, farmers lose 30 to 40 percent of their crops because of pests and diseases. Without crop protection chemistry, these losses could easily double.

Source: FAO http://www.fao.org/docrep/014/i2215e/i2215e.pdf

Glyphosate is the Most Thoroughly Evaluated Herbicide in the World

- Works by stopping an enzyme that exists in plants – not humans or animals
- Approved by regulatory agencies in over 160 countries globally
- Is categorized in U.S. EPA's most favorable category (IV) for acute toxicity
- Breaks down in the soil into naturally occurring elements such as carbon dioxide and phosphate

Source: Williams, G.M., Kroes,,R., and Munro,I.C. 2000

Roundup Ready® Transgenic Plants

EPSP synthase → Glyphosate → 5-*enol*pyruvyl shikimate-3-phosphate (EPSP) → Amino acids → Protein synthesis → Plant growth

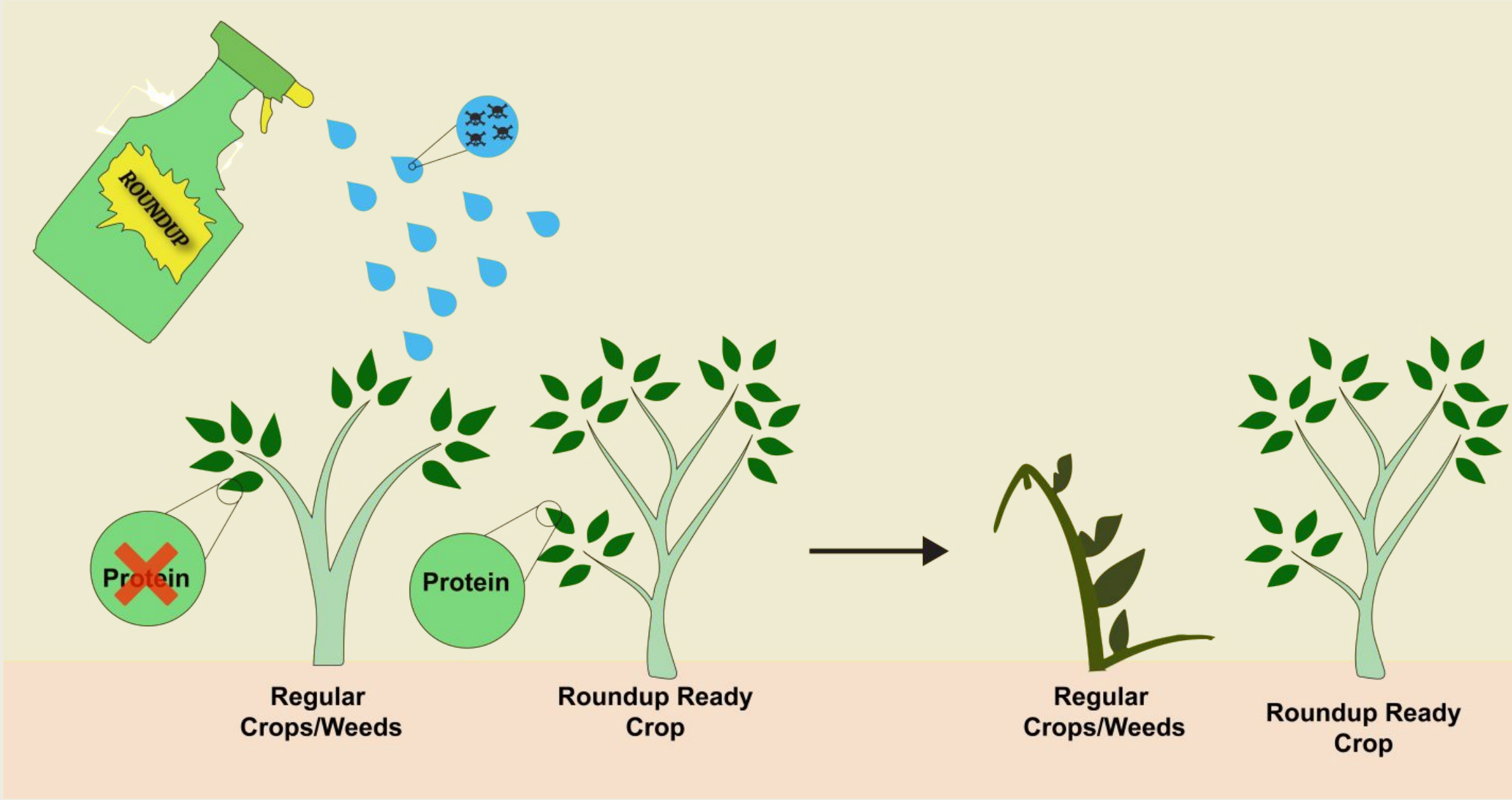
EPSP synthase from Agrobacterium resistant to Glyphosate

Corn

Soybean

Cotton

Canola


ROUNDUP
Protein
Protein
Regular
Crops/Weeds
Roundup Ready
Crop
Regular
Crops/Weeds
Roundup Ready
Crop

3 Big Ways GMOs SUPPORT THE ENVIRONMENT

In the past 20+ years, the positive effect on the environment from GMO crops and the traits they express has been nothing short of extraordinary.

GMOs foster sustainable farming practices

Conservation tillage reduced CO_2 emissions by **50.7 billion pounds** in 2018

That's like taking **13.6 million cars off the road for a year.**[1]

GMOs let us grow more food on less land

96 million tons additional crop yield in 2018

conserving **59.7 million acres of land.**[1]

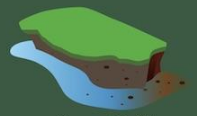
GMOs build healthy soil

LESS TILLING =

More Beneficial Insects

Increased Organic Material

Better Moisture Retention



Less Soil Erosion

[1] https://pgeconomics.co.uk/pdf/globalimpactfinalreportJuly2020.pdf

gmo answers

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
Nigeria
Brazil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Sudan
Pakistan
Ethiopia
India
Malawi
Myanmar
Bangladesh
China
Vietnam
Philippines
Indonesia
South Africa
Eswatini
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

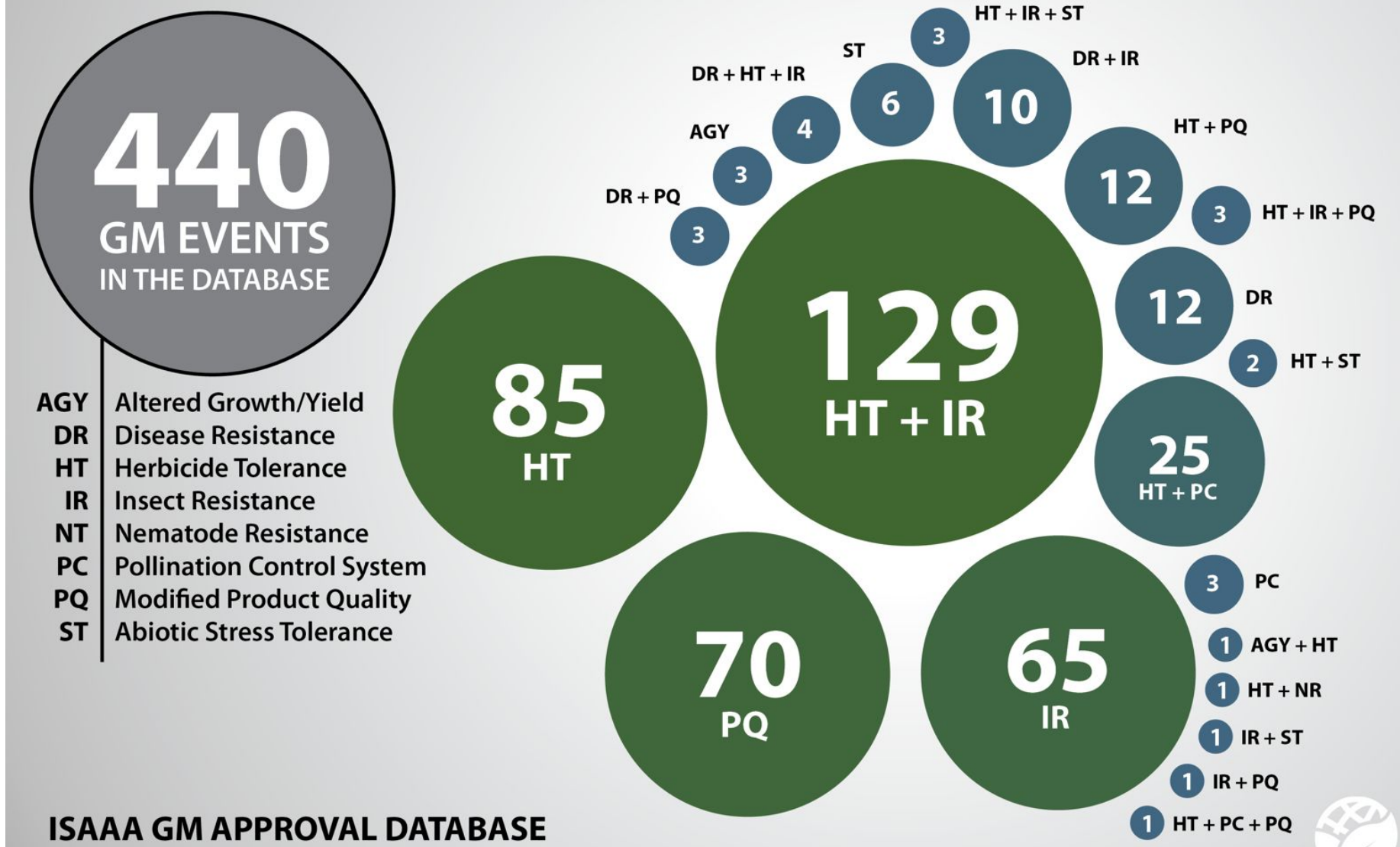
- Soybeans
- Maize
- Cotton
- Canola
- Sugar beets
- Alfalfa
- Papaya
- Squash
- Potato
- Apples
- Eggplant
- Sugarcane
- Pineapple
- Safflower

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

ISAAA

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

Approved Transgenic Plant Events by Trait, 1992-2023



ISAAA GM APPROVAL DATABASE

Visit **www.isaaa.org/gmapprovaldatabase/**

Data from 1992 to September 2023

ISAAA Inc.

BIOTECH CROPS PROMOTE JUDICIOUS APPLICATION OF PESTICIDES

ENVIRONMENTAL IMPACT 1996-2020 (24 YEARS)

ISAAA Inc.

WIDESPREAD USE OF GM INSECT RESISTANT & HERBICIDE TOLERANT SEED TECHNOLOGY REDUCED PESTICIDE APPLICATION BY

748.6 MILLION KG ACTIVE INGREDIENT

ENVIRONMENTAL IMPACT QUOTIENT IMPROVED BY

17.3% BETWEEN 1996-2020

INSECT RESISTANT COTTON

339 MILLION KG AI SAVINGS

45% REDUCED ENVIRONMENTAL IMPACT

GM MAIZE

30% REDUCED ENVIRONMENTAL IMPACT

GM/HT SOYBEANS

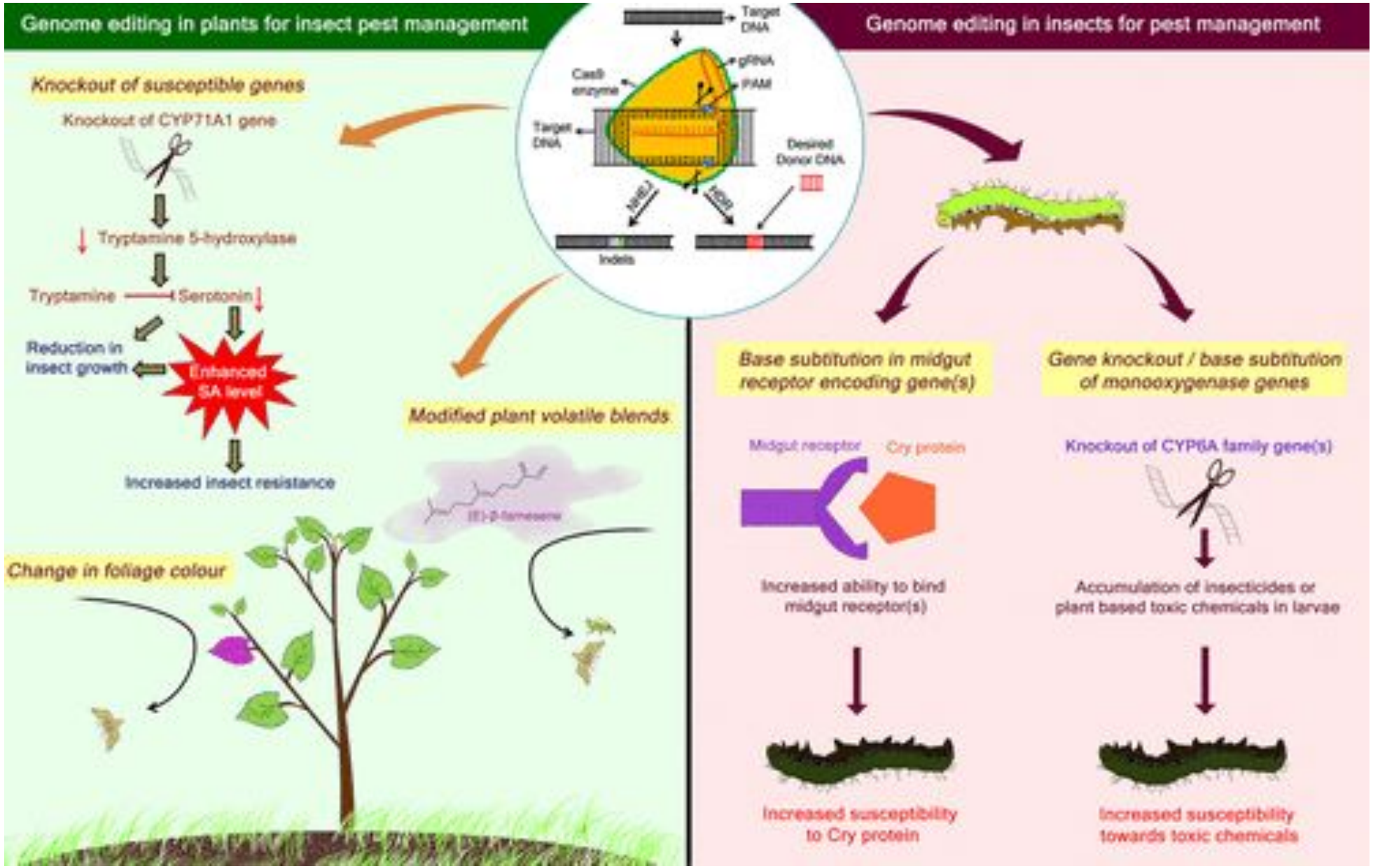
26% REDUCED ENVIRONMENTAL IMPACT

SOURCE: GRAHAM BROOKES, 2022

Focus on Philippines Stacked (IR and HT) maize

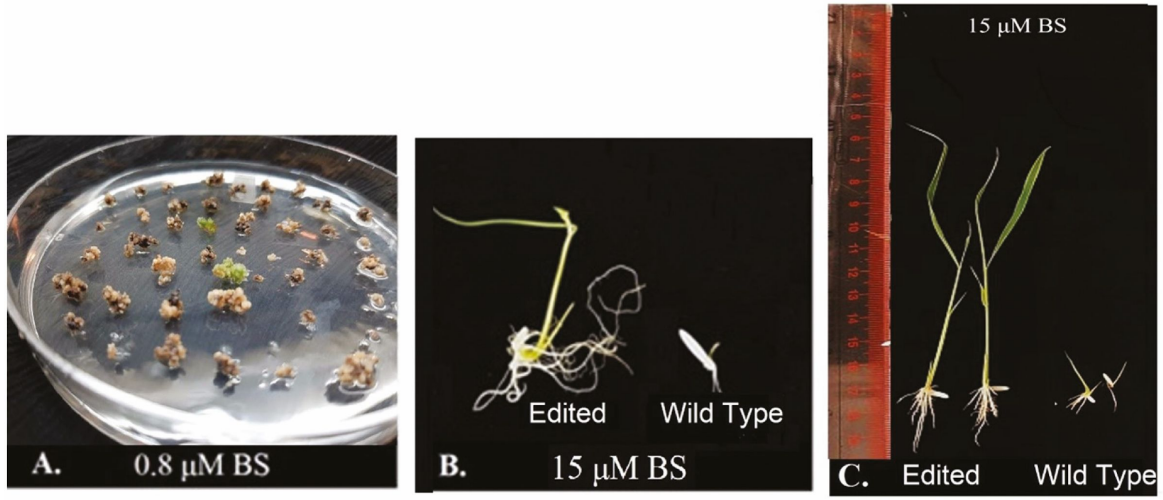
Issue	Impact
Introduction	IR 2002, HT and stack 2006
% of crop using technology (2020)	HT only 0.1% stack 24.4%
Yield impact	+23.3%
Average farm income gain ($/ha)	150
Average return on investment - $/ha extra income per extra $1 spent on seed	2.65
Total farm income gain $ million(2002-2020)	1,089
Production impact 2002-2020 (million tonnes)	0.47

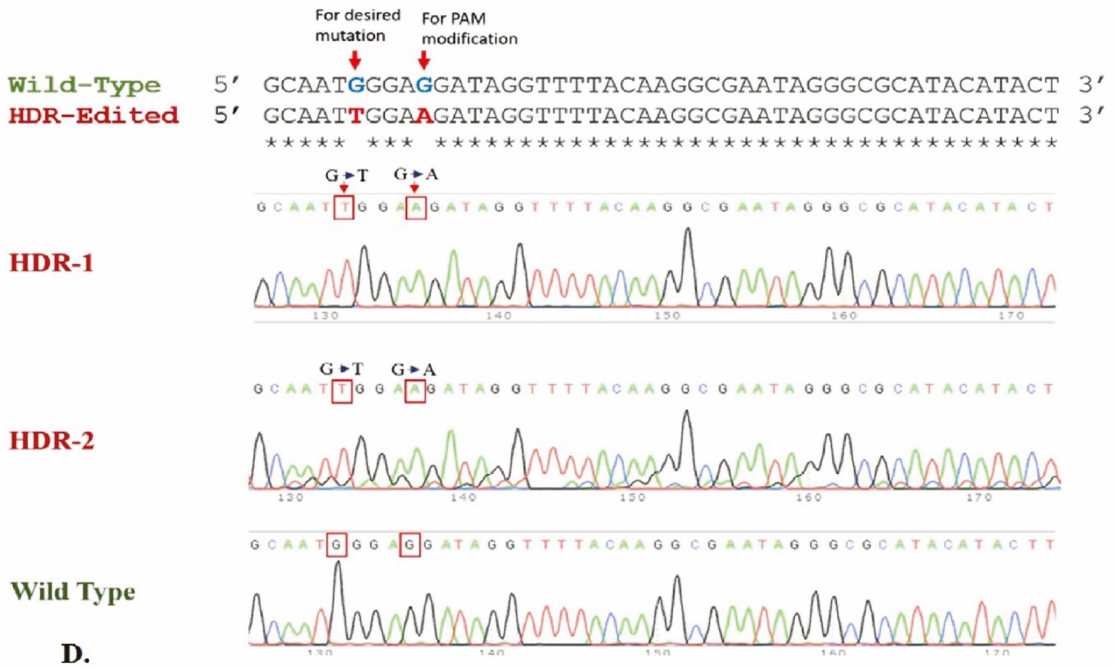
Gene Editing for Insect Resistance in crops



Tyagi et al. 2020

Gene Editing for Herbicide tolerance in rice





Zafar et al. 2023

THANK YOU!