Introduction to Plant Breeding, Seeds and NBTs

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Natural Diversity

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Maize

Potato

Beans

Domestication of Maize and Tomato: Selection of rare mutants

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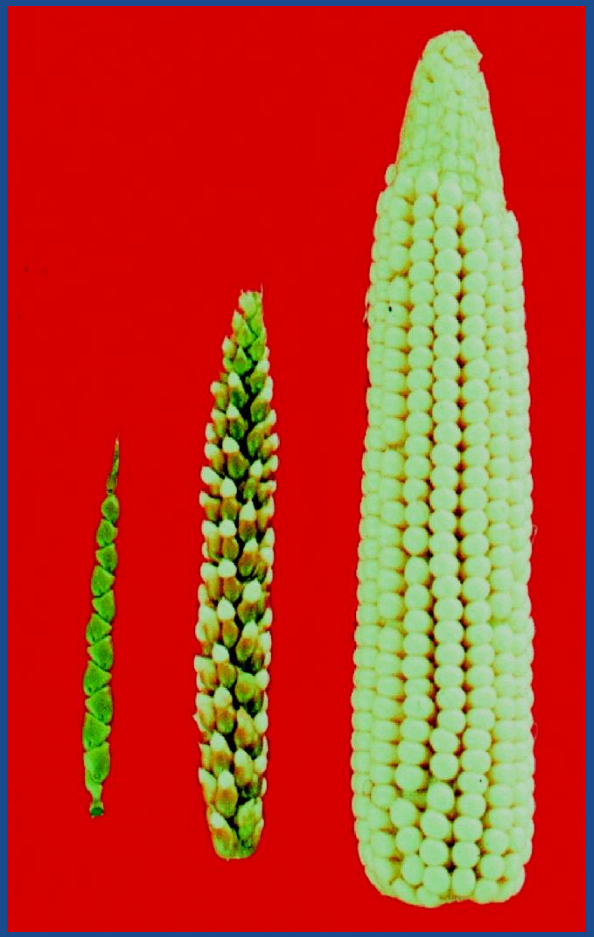

Domesticated crops: Eating Mutants

You eat mutants! Everybody does, every day. Genomes are constantly undergoing variations in DNA code—mutating—with each generation. Every item in the supermarket has been touched by genetic changes, ranging from the minor to the profound. Today's mammoth tomatoes, for example, can weigh as much as 1,000 times the weight of their wild ancestors.

Everything about our food, from size to texture, colour, taste, and nutritional content—plus much, much more—is influenced by plant genes.

Domestication traits:

Initially by random selection

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- Higher germination rates
- Greater germination predictability
- More uniform timing of germination
- Increased size of reproductive organs
- Reduced complexity of reproductive organs
- Reduction of toxicity (humans select against self defense mechanisms)
- Change in biomass allocation (more in fruits, roots, or stems, depending on human preference)
- Change in life cycle (normally from perennial to annual for seed crops, and from annual to biennial for vegetable crops)

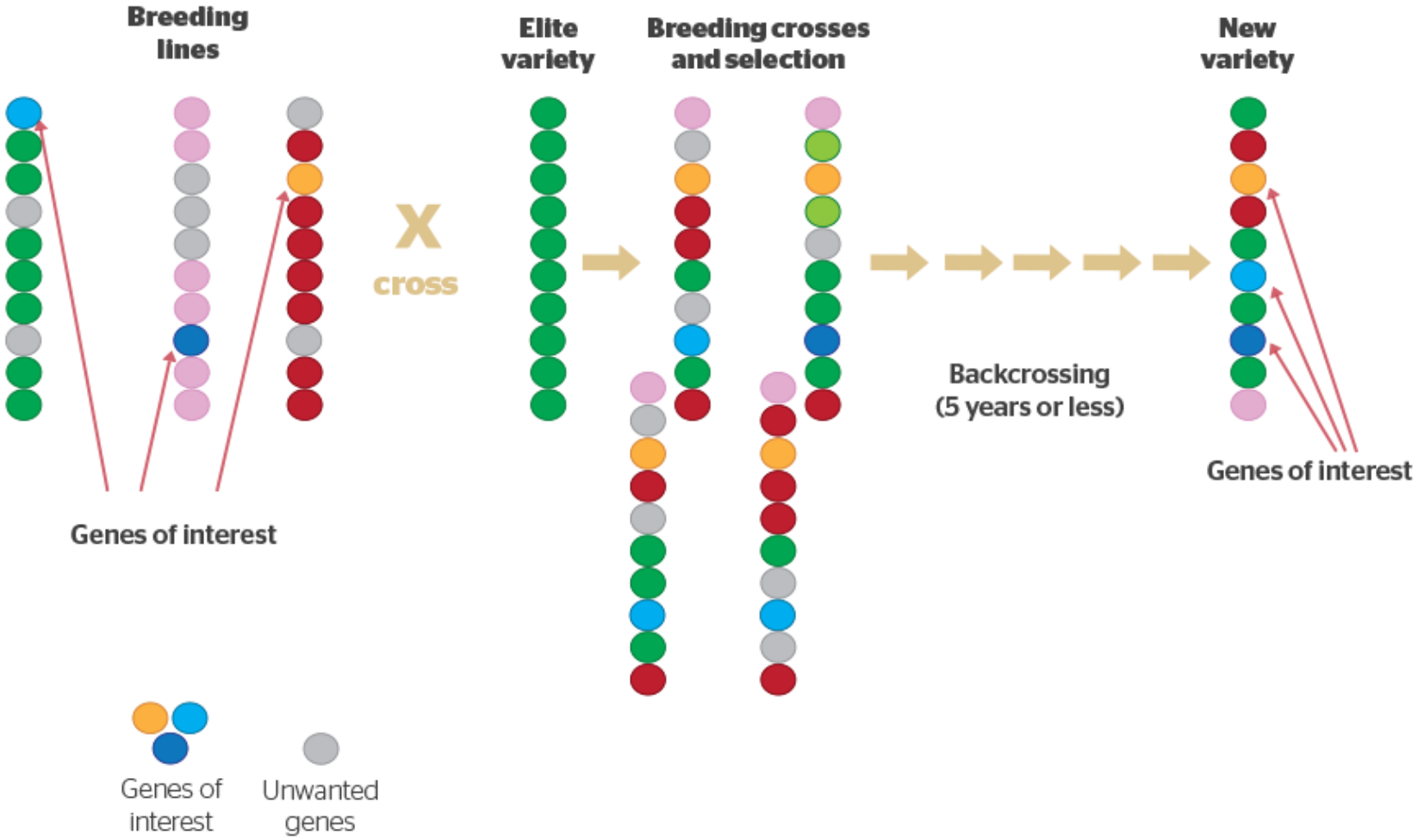
Introduction of genetics (1906)

Heterosis in maize: Effect on yield

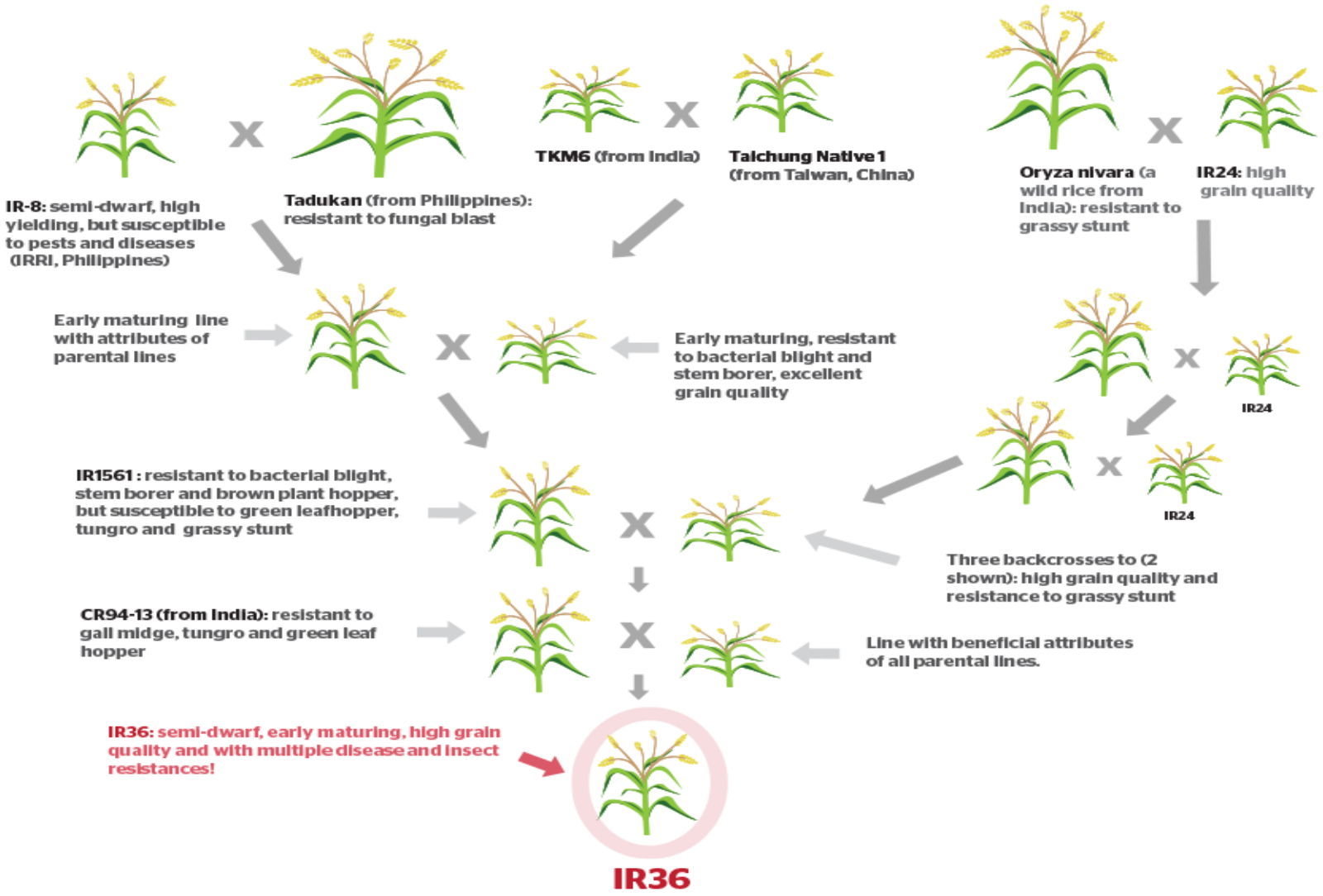
Inbred line 1 F1 F1 Inbred line 2

The growth of commercial ag-biotech.
Pioneer HiBred: 1924 $5000,
1999 sold for $7.7 billion

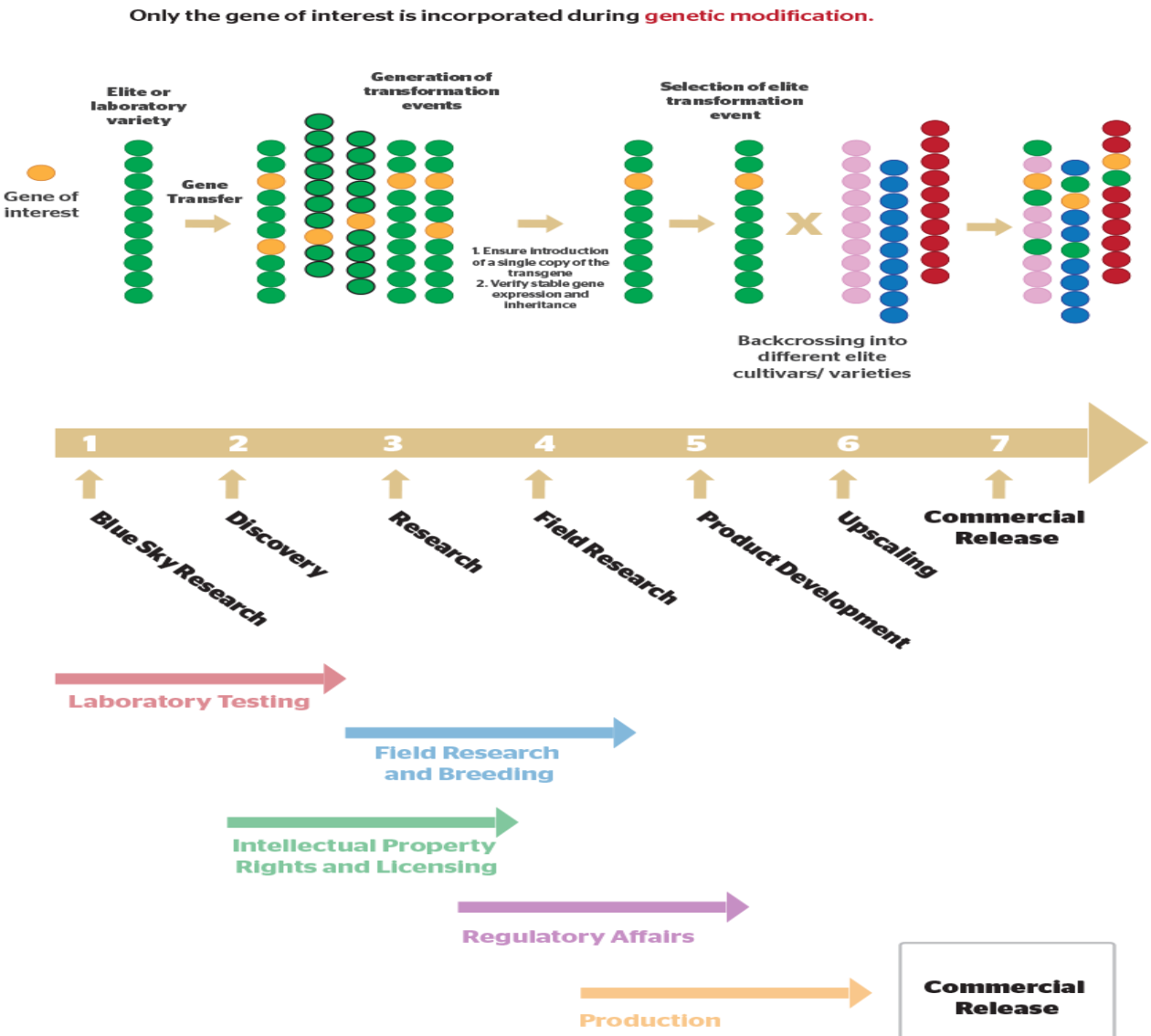
Conventional Plant Breeding



How to develop a new crop variety by conventional breeding: IR36 rice



Genetic modification and plant breeding



The first commercial GM crop products 1994

Flavr Savr tomatoes Calgene

Tomato puree Zeneca

Area of GM Crops: M Hectares

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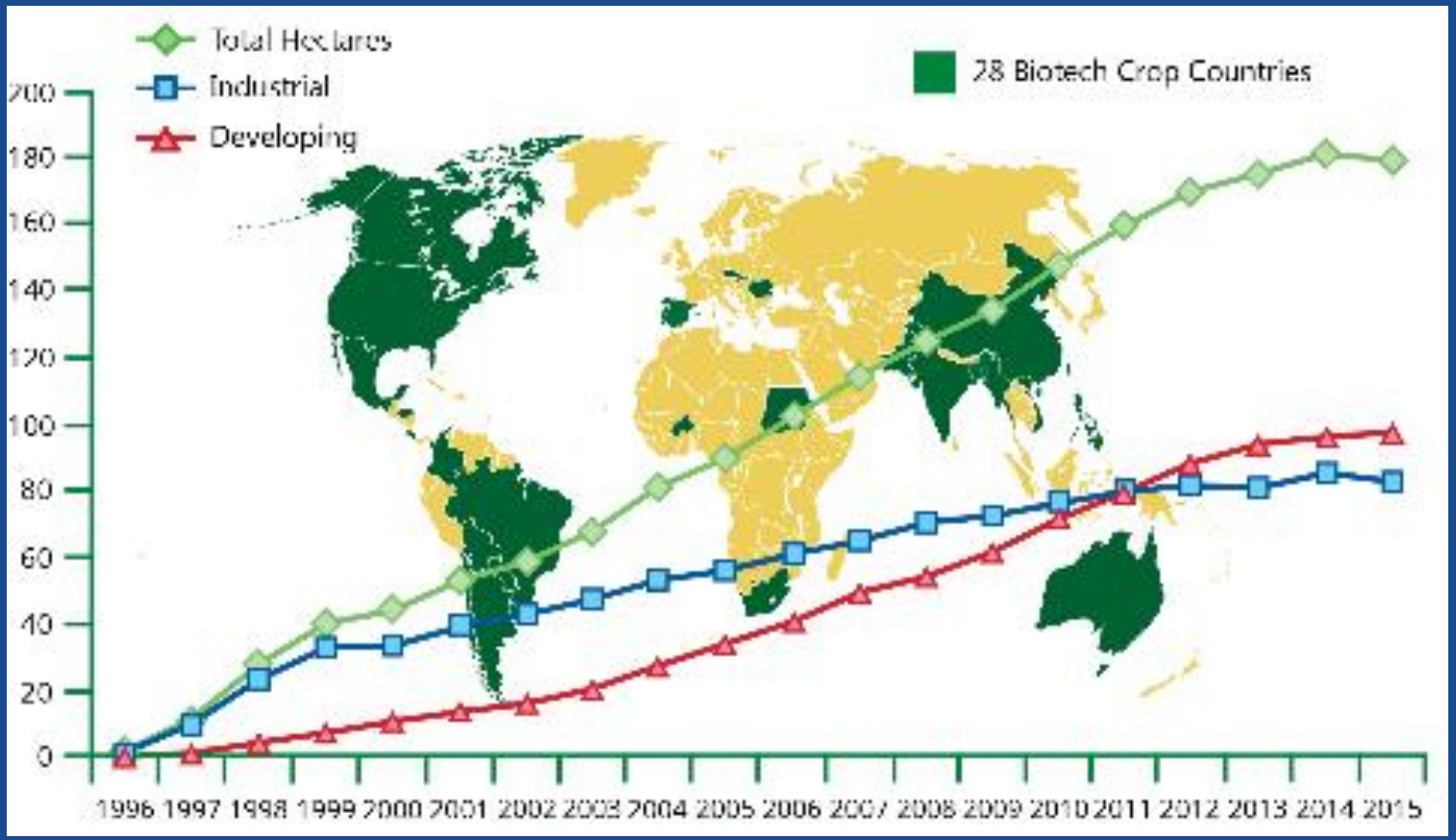

•Of the 28 countries planting biotech crops in 2015, it is notable that 20 were developing and 8 were industrial countries

•2015 makes biotech crops the fastest adopted crop technology in the history of modern agriculture.

Predictions

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"The breeder's dream is, of course, of an agency which would enable him to produce at will a particular kind of mutation uncontaminated by others which would merely be a nuisance to him…."

"There is as yet no indication from genetics of how, or even whether, this could be done…
The dream of directed mutation as a tool in stock and crop improvement is still very much a dream"

Mather, 1960

The genome sequences of all major crops are now available

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https://phytozome.jgi.doe.gov/pz/portal.html

Genomes aid exploitation of new breeding technologies:

- Directed mutation
- Cisgenic
- Reverse breeding (deconstruct F_1 hybrids)
- Agro-infection
- Epigenetics
- Grafting on GM rootstocks
- Homologous recombination
- Zinc finger/designer nucleases
- Minichromosomes
- Etc, etc…….

Crop technology landscape c. 2000
GMO new technology

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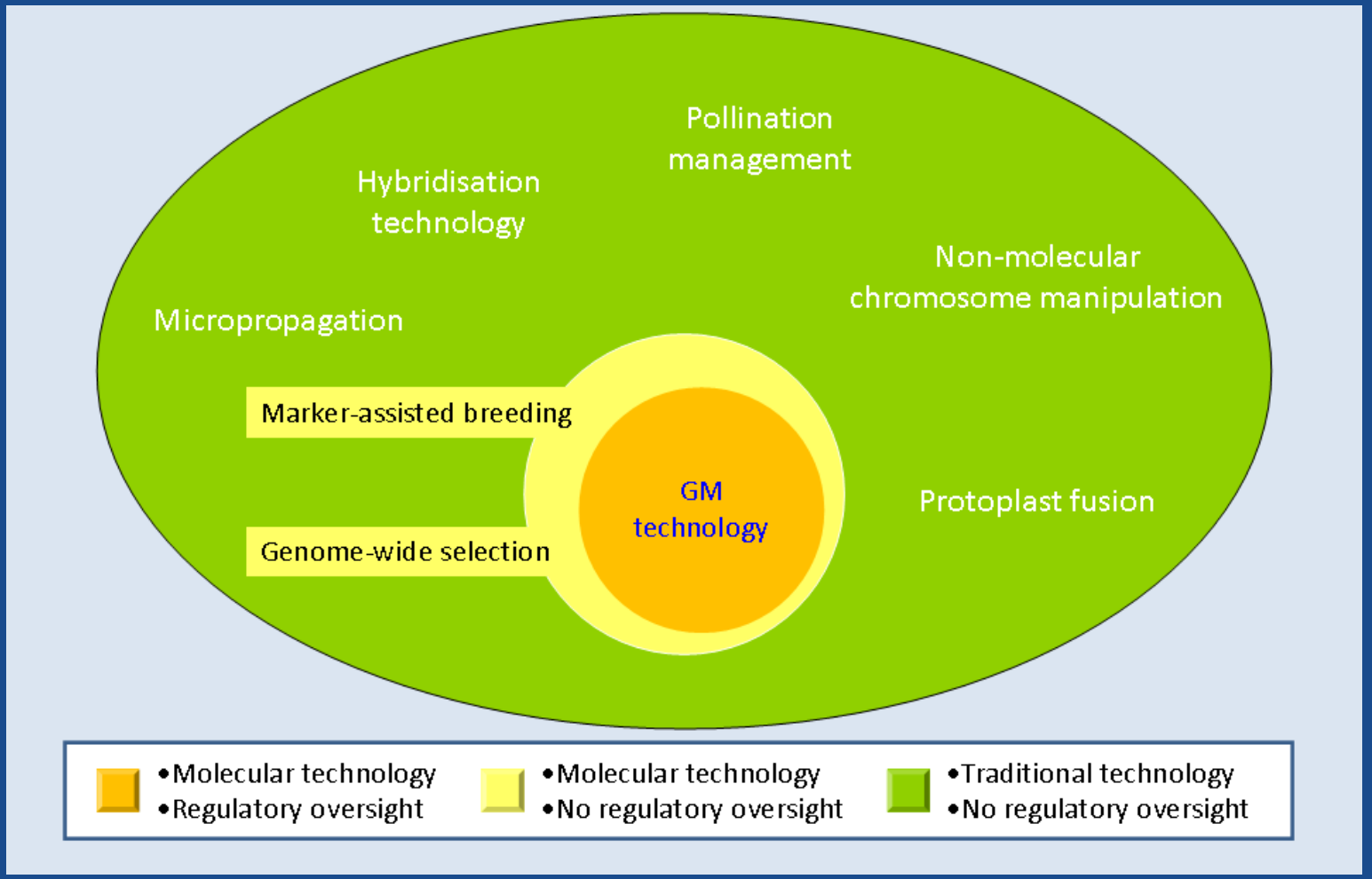

Van den Eede, 2013

Crop technology landscape 2014
Rise of the new technologies

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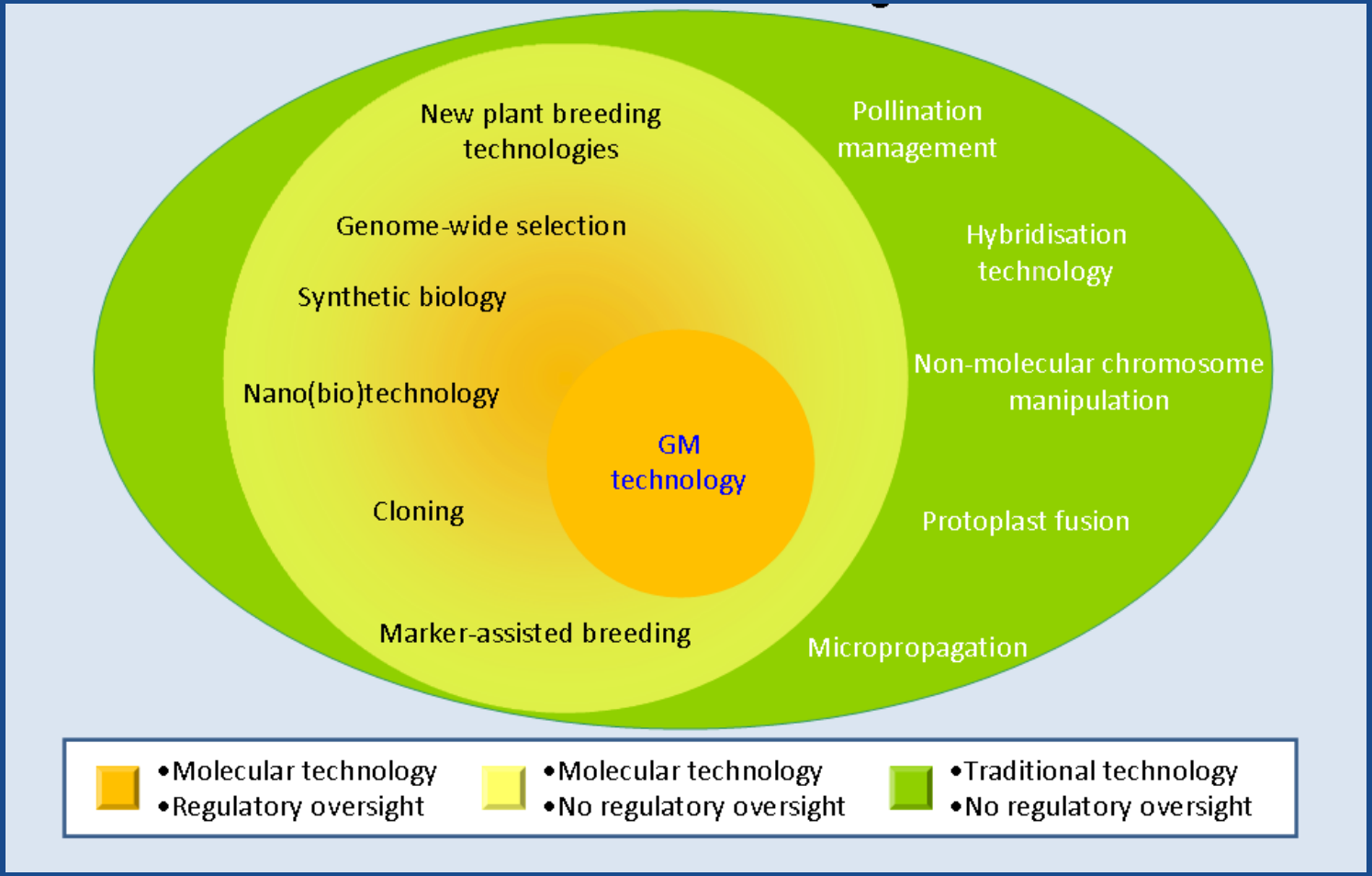

Van den Eede, 2013