Precision Plant Breeding techniques

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Plant Breeding

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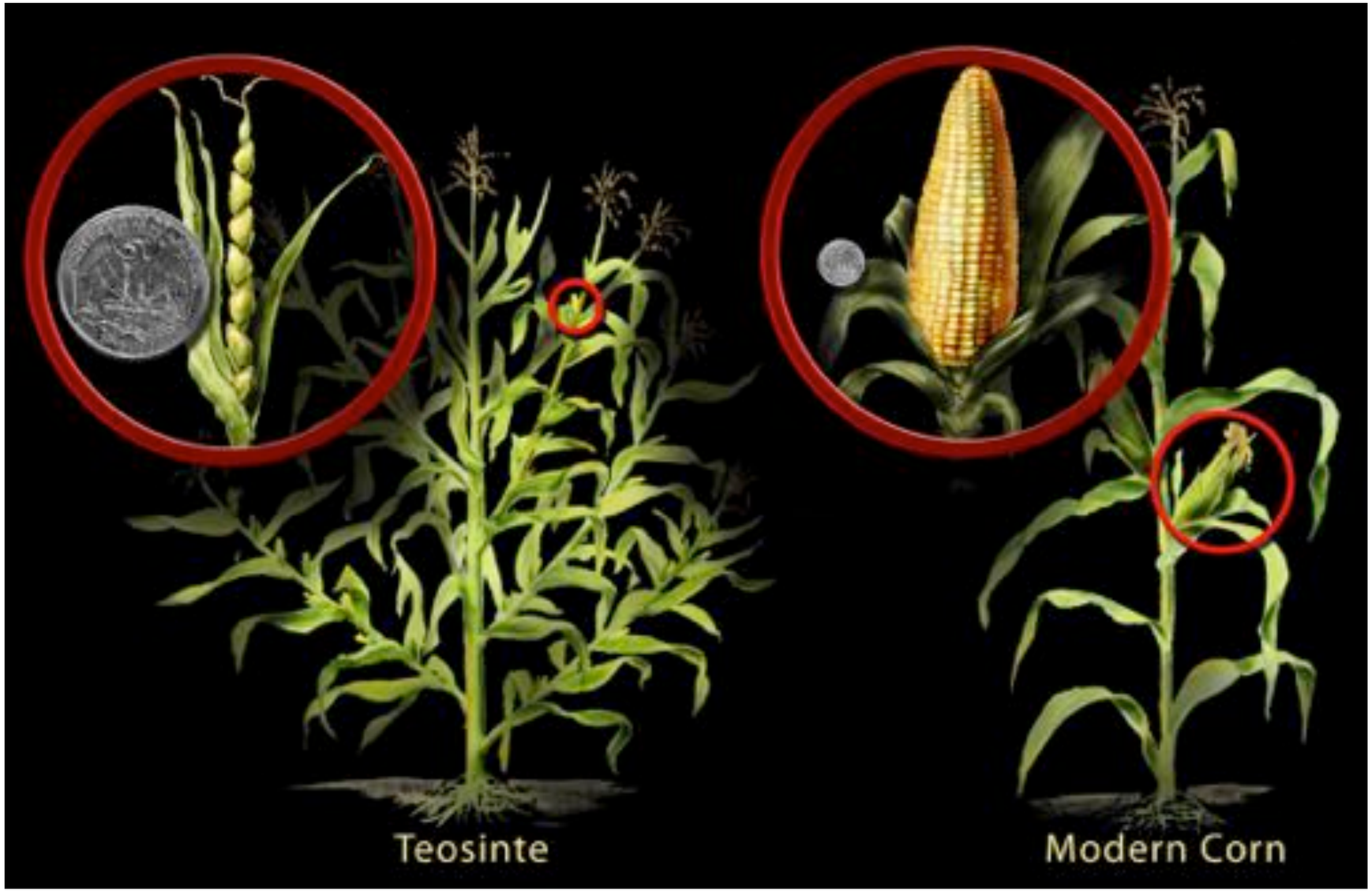
Domestication and breeding for 10,000 yrs



Exploiting genetic variation in crops

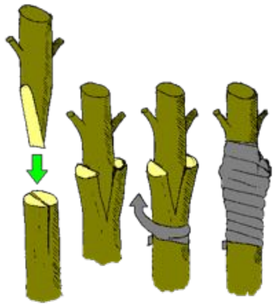
2x more with 2x less

- Breeding combines genetic variation accumulated over millions of years in crops plus crop-wild relatives
- Agriculture needs to feed a growing population with less environmental impact of agriculture: ”2x more with 2x less”
- Plant breeding is an important component
  - Breeding is slow in vegetatively propagated crops
  - Efforts needed for using variation from wild relatives
- **Plant breeding needs innovations**
  - Unproductive to exclude some innovations up front

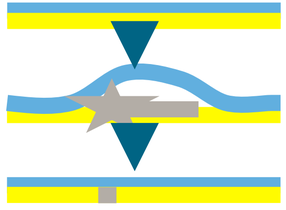
Precision Breeding Techniques

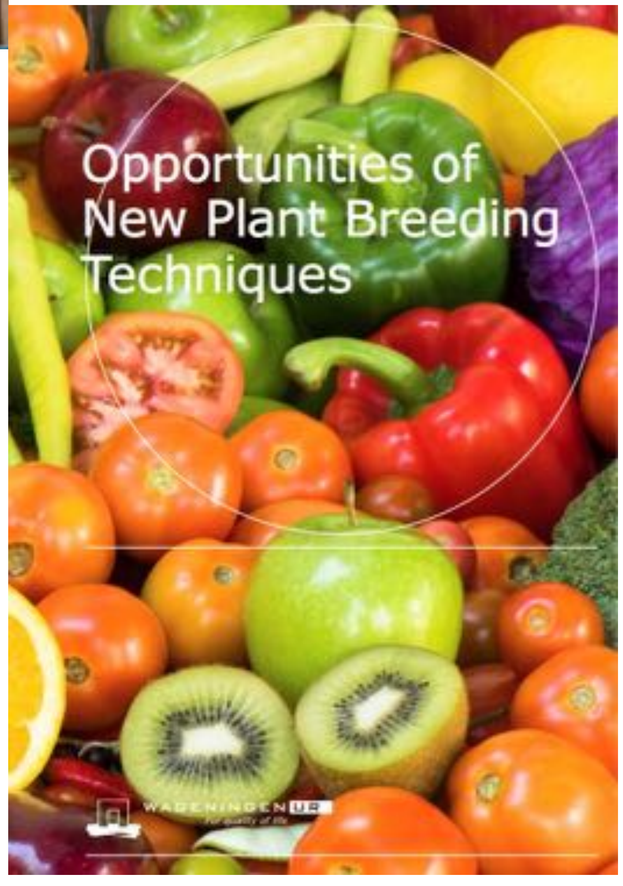
- Normal innovations in Plant Breeding
- Potentially very strong methods to achieve ‘Precision Breeding’ and shorten breeding cycles especially in cross-pollinators and vegetatively propagated crops
  - Potato, apple, banana, cassave, …
- They focus on improving the breeding process

Precision techniques include:



- Marker-assisted selection
- (Classic) mutation breeding
- Somatic cell fusion
- Cisgenesis/Intragenesis
- Reverse breeding
- Agro-inoculation
- **Genome editing**
- Homologous recombination
- **Early flowering**





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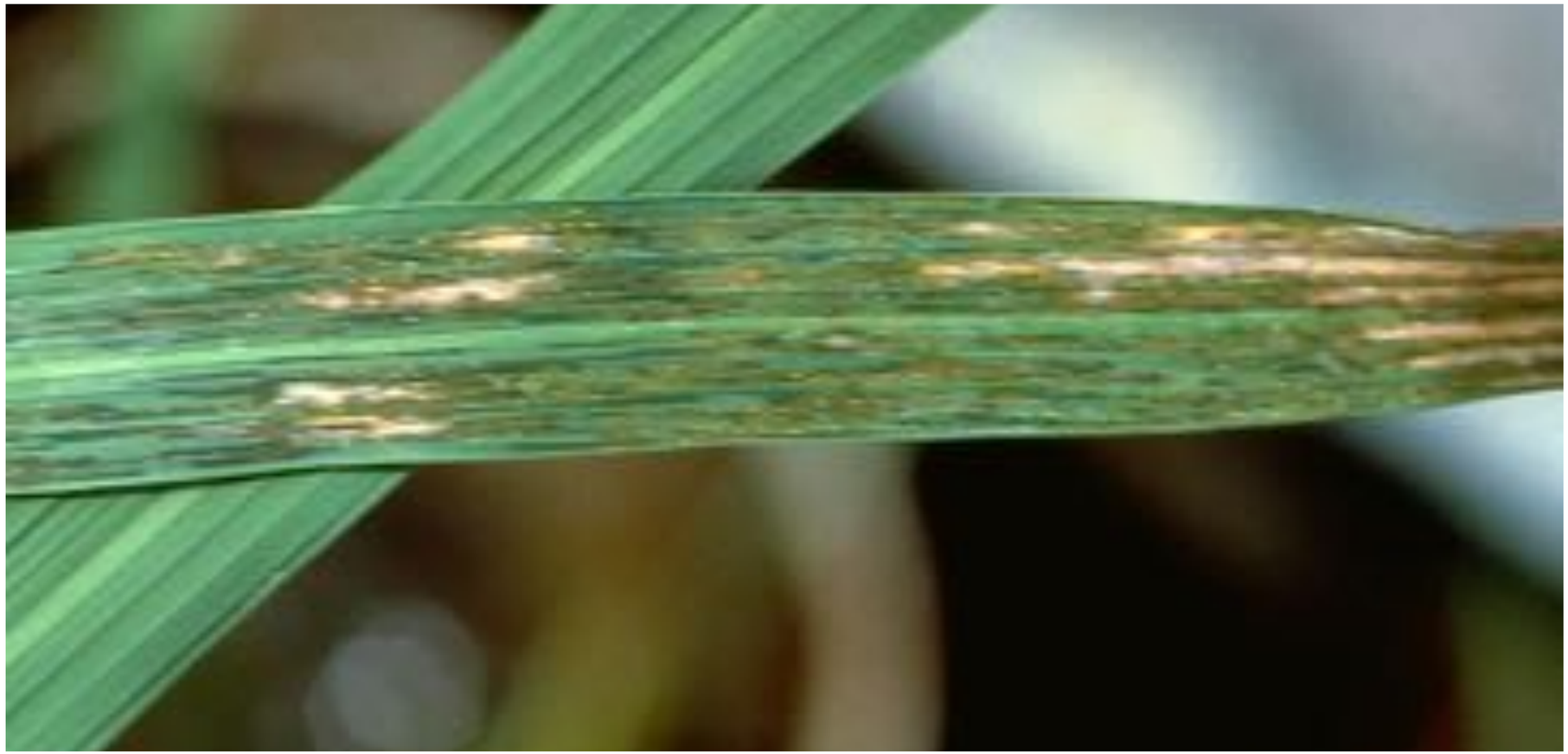
Product: improved plants

1. Plant which contains
   - combinations of e.g. resistance genes

2. Plant which contains
   - (small) modifications of its own DNA

3. Plant which contains
   - no modifications of its own DNA

Bacterial blight (Xanthomonas) in rice



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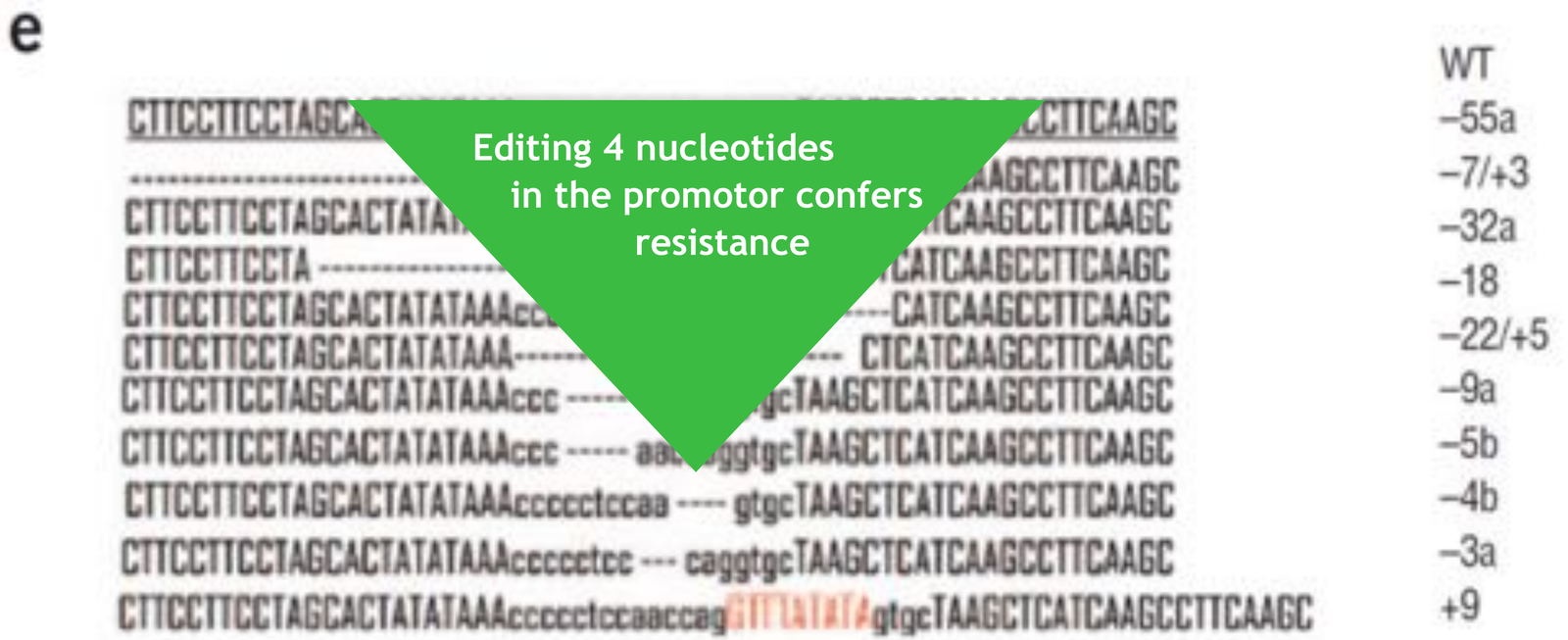
T.W. Mew - IRRI, Los Baños (PH)

Xoo resistance through genome editing



Genome editing

- ✓ Technically easy
- ✓ New genetic variation at target gene
- ✓ Enables exploiting genomics

Li et al. *Nature Biotechnology* 30 (2012), pp. 390–392

Scab (Venturia) in apple

- Apple scab is major disease in apple
- Common culture: 20 sprays/season

Apple scab resistance

5 generations, 50 years conventional breeding

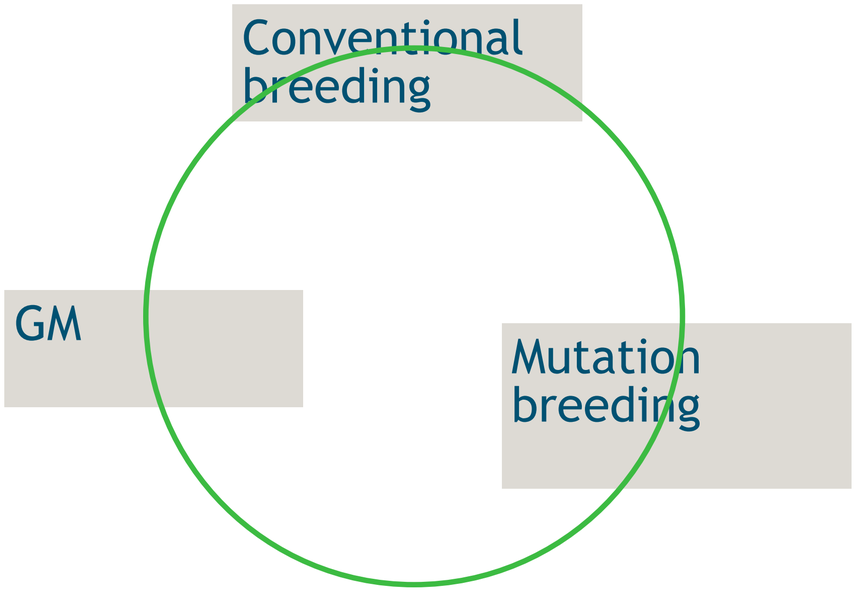
5 generations, 15 years using early flowering

Early flowering

- ✓ Natural gene from a crossable species
- ✓ Identical to conventional breeding
- ✓ Decades earlier

Precision Breeding Techniques

- Enable durable, effective and fast breeding



Societal debate on GM crops

Mixture of concerns

- Consequentialism/Utilitarianism
  - Weighing pro's and cons, risks and opportunities
- Deontological ethics
  - Intrinsic value of life (e.g. in organic farming)
  - No role as Creator
- Freedom to choice
  - Symmetry
  - Thresholds, labelling

Societal debate and dialogue on NPBT

- Technological innovation:
  - Concerns about hazards
  - Agro-ecological framing is missing
  - Power issues linked to patents
- Costs of forsaking technologial developments in agriculture
  - Health
  - Environment
  - Economy

Take home messages

- NPBT expand the breeders' toolbox
- Enable faster and precise breeding
- Enable exploiting genomics information, also in small and underutilized crops
- Contribute to meeting the challenges of agriculture in the 21th century
- Unwise to exclude technology up front

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