New Plant Breeding Techniques
Outline

- IGTC
  - Members & Stakeholders
  - Business Plan
- Transgenesis
- New Plant Breeding Techniques
Encourage policy and commercial practices that support global trade in grain, oilseeds, pulses and derived products
IGTC members & stakeholders

• Membership: all recognized trade associations and other non-governmental representative groups throughout the world representing any segment or multiple segments of the grain, oilseed and other agri-bulk industries => 24 associations & councils

• Corporate Stakeholders: for profit businesses active in the international trade of grain, pulses, oilseeds and derived products.
Main topics:
• Grain as a hazardous product
• Development of a standard for the International Movement of Grain
• Global Low Level Presence Initiative (GLI)
• Cartagena Protocol on Biosafety
• New Plant Breeding Techniques (NPBTS)
Transgenesis

- Process of introducing an exogenous gene (‘transgene’) into a living organism => organism exhibits a new property and transmit that property to its offspring.
- Transgenesis can be facilitated by liposomes, plasmid vectors, viral vectors, pronuclear injection, protoplast fusion, and ballistic DNA injection.
- Concerns: Expensive, time consuming & opposition
Different techniques

- Grafting (on GM rootstock)
- Cisgenesis & intragenesis
- Reverse breeding
- Zinc finger nuclease (ZFN) => ZFN-1, ZFN-2 & ZFN-3
- Oligonucleotide directed mutagenesis (ODM)
- RNA-dependent DNA methylation (RdDM)
- Agro-infiltration (agro-infiltration “sensu-stricto”, agro-inoculation, floral dip)
- Synthetic genomics
## Differentiation in regulation

<table>
<thead>
<tr>
<th>Technique</th>
<th>Country/region=&gt;</th>
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<th>Europe</th>
<th>New Zealand</th>
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Source: van Deynze, 2014
Setting the scene: Literature search

- 200+ publications
- Grafting on GM rootstock (20+ yrs)
- Other techniques: 10+ yrs
- 45% EU; 32% N. Am
- EU highest: cisgenesis / intragenesis; reverse breeding; RdDM; grafting on GM rootstock
- N. Am highest: ZFN-technique; ODM; agro-infiltration
- Majority (81%) by public institutes
- Proof of concept HT & IR traits

Source: JRC, 2011
Setting the scene: Patent search

- 85+ publications – last decade
- 65% US; 26% EU
- 70% private companies; 26% univ/public research inst.
  - EU: 83% private / 17% public
  - US: 68% private / 32% public
- US highest: Grafting on GM rootstocks; ODM & ZFN
- 50 companies: most only 1 patent => high specialisation

Source: JRC, 2011
Setting the scene: Survey plant breeding companies

- All techniques adopted by commercial breeders
- Most used: ODM; cis/intragenesis; agro-infiltration
- Crops at commercial development phases I-III
- Less used: ZFN, RdDM; grafting on GM rootstocks & reverse breeding => mainly applied at research level
- Among first commercial: HT in OSR & Corn; fungal resistance in potatoes; drought tolerance in Corn; Scab resistant apples; Potatoes with reduced amylose content

Source: JRC, 2011
NPBT’s: Drivers

Fairly recent techniques, but:

• NPBT’s are innovative improvements & refinements to existing breeding methods
• Great technical potential => produce genetic variation
• Resulting products in many cases indistinguishable /similar to existing products, produced by traditional breeding techniques
• Enhance efficiency & specificity of breeding => more knowledge & understanding of final product
• Adaptable to large variety of crops (incl. trees & vegetables, by researchers from all sectors (public/private; large/small)

Source: BIAC, 2014
NPBT’s: Constraints for adoption

- Efficiency (low!) => further research needed
- Availability of suitable method for delivery
- Regeneration
- Registration costs
  - Low if classified as non-GMO
  - High if classified as GMO
NPBTs – Products under development

Cisgenics/Intragenics:
Apple scab resistance, potato late blight resistance, drought/cold tolerant maize, fungal resistant papaya, improved forage ryegrass, a variety of vegetable crops

Grafting:
Citrus trees with transgenic rootstock

ZFN (-1/-2/-3):
Improved nutritional quality maize & canola, higher yield tomatoes, diseases resistant wheat, nematode resistance

ODM:
HT OSR and HT Flax
NPBTs – Products under development

- **Countries:** AR, AU, BE, CA, IE, JP, MX, NL, CH, UK, US
- **Crops:** Apple, Canola, Cassava, Cereal grains, Citrus, Flax, Maize, Papaya, Ryegrass, Tomato, Wheat
- **Developers/Users:** SME’s, Academics, Industry
# Interpretation difficult

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<tr>
<th>Techniques</th>
<th>Involves a GM technique?</th>
<th>Produces an intermediate product that is a GMO?</th>
<th>Offspring are GMOs?</th>
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<tr>
<td>Cisgenesis/intragenesis</td>
<td>Yes*(B) / Yes</td>
<td>--</td>
<td>Yes *(B) / Yes</td>
</tr>
<tr>
<td>Reverse Breeding</td>
<td>Yes</td>
<td>Yes</td>
<td>No *(A)</td>
</tr>
<tr>
<td>Agroinfiltration</td>
<td>Yes</td>
<td>Questionable</td>
<td>No</td>
</tr>
<tr>
<td>Grafting (non GM-scion / GM-rootstock)</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>RNA-dependent DNA methylation</td>
<td>No – nucleic acid molecules not inserted into genome</td>
<td>No</td>
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<td>Yes</td>
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<td>Yes</td>
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* Uncertainty about legal interpretation of the definition
A: Offspring of GMO’s => GMO’s? / B: Unclarity on ‘altering’ of genetic material / C: Recombinant nucleic acid molecules if not inserted into genome...

Source: Advisory Committee of Releases in the Environment (ACRE)
Industry positions

⇒ Gov.’s not regulate products differently that are similar or indistinguishable from products of trad. techniques
⇒ Crucial not to hamper NPBT’s without scientific reason by unnecessarily subjecting them to unpredictable and excessive regulatory oversight
⇒ All gov’s encouraged to adopt globally harmonized approach
Codex Alimentarius

Currently the Codex Alimentarius Commission has:

• Est. 1961 by FAO & WHO
• 186 Codex Members - 185 Member Countries and 1 Member Organization (EU)
• 229 Codex Observers - 52 IGOs, 161 NGOs, 16 UN
• Collection of internationally recognized standards, codes of practice, guidelines and other recommendations relating to foods, food production and food safety.
• Main goals: protect health of consumers & ensure fair practices in international food trade.
“Modern Biotechnology” means the application of:

1. In vitro nucleic acid techniques, including recombinant deoxyribonucleic acid (DNA) and direct injection of nucleic acid into cells or organelles, or
2. Fusion of cells beyond the taxonomic family, that overcome natural physiological reproductive or recombinant barriers and that are not techniques used in traditional breeding and selection.
Codex Alimentarius

• Most countries adopted Codex definition on biotech

• Assess which technologies inside scope of that definition;
• Convene ad-hoc biotech task force => guidelines
• Governments to align with Codex & definition => consistent regulations across trading partners.
• Asynchrony in approvals drives innovation out of global food system.
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Source: van Deynze, 2014
NPBTS - Conclusion

- Several new techniques (20+yrs)
- Great potential, but efficiency to be improved
- Products similar/indistinguishable
- Legal certainty needed for industry
- Product that determines safety, not method
- Need for globally harmonized approach
Thank you for your attention