Industry Utilization, Waxy Corn and More

CRISPR-CAS: Representing Abundant Potential for Agriculture

Wendy Srnic, Research Director, DuPont Pioneer
“We put a great emphasis in managing our grain on a much more micro level – so looking not on a field by field basis but more on an acre by acre and even in some cases on a sub-acre level.”

- DuPont Customer

Only DuPont can collaborate with growers acre by acre to answer these demands. Everything we do is about solving one problem – a complex problem that has grown and changed with the needs of our growing world –

CROP PRODUCTIVITY
### CRISPR-Cas is DuPont Pioneer’s Preferred Gene Editing Tool

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<td><strong>Time Efficiency</strong></td>
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<td><strong>Quality</strong></td>
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<td><strong>Cost Efficiency</strong></td>
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<td><strong>Technical Flexibility</strong></td>
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Rated on a scale of 1 – 5, with 5 being excellent.
Next Generation Waxy Corn

No. 2 Yellow Dent Corn
- Functional waxy gene
- Translucent appearance
- Feed / ethanol / food

| Starch    | 75% Amylopectin | 25% Amylose |

Waxy Corn
- Non-functional in waxy
- Candlewax-like appearance
- Food / industrial

| Starch    | >97% Amylopectin |
Waxy Cornstarch in Everyday Consumer Products

Essential functions in **food industry** to improve uniformity, stability, and texture in various food products

Binding qualities for the **paper-making** process

Additional applications in the, **corrugating**, **textile** and **adhesive** industries
The US Waxy Market

U.S. Waxy Corn Market
~ 400,000 to 500,000 acres

- Cargill Cedar Rapids, IA
- Cargill Hammond, IN
- Tate & Lyle W. Lafayette, IN
- Ingredion Kansas City, MO
- Ingredion Indianapolis, IN
Edited variety development can be very efficient
Discovery to commercial product: The ‘invention’ is only the start...

Critical scale is required:
- Industry Leading Germplasm
- R&D Scale:
  - molecular tool kit
  - genome knowledge
  - laboratory, transformation, greenhouse
  - field characterization (many environs.!!)
  - demo & launch
- Commercial Seed Production Capability
- Commercial Route to Market
- End user/identity preservation system
Considerations for Regulatory Policies

**Appropriate, science-based regulatory oversight** for plants developed with CRISPR-Cas advanced plant breeding, consistent with plants developed through other plant breeding methods

- Gene edited plants are indistinguishable from plants that could be produced with conventional breeding tools and have a long history of safe use.
- It is the characteristics of the plant, not the production method, that determines its safety.

- Protecting health and the environment while promoting innovation
- Science-based, accommodate new evidence and learning
- Cost effective and commensurate with the risk
- Transparent, consistently applied and enforced
- Globally harmonized
Global regulatory policies for gene edited products are in development

Current status is related to whether or how the products of genome editing fit the scope of the existing GMO legislation in a given country

The status of familiarity with genome editing and the status of deliberations on the appropriate regulatory regime vary significantly among countries

Countries with available processes or regulatory precedents:

- U.S.
- Canada
- Argentina
- Chile
- Israel
- Several EU Member States
DuPont Pioneer and Broad Institute of MIT and Harvard Join Forces to Enable Democratic Access to CRISPR Licensing in Agriculture

CAMBRIDGE, Mass. and JOHNSTON, Iowa, Oct. 18, 2017 /PRNewswire/ -- DuPont Pioneer and the Broad Institute of MIT and Harvard announced today that they have reached an agreement to jointly provide non-exclusive licenses to foundational CRISPR-Cas9 intellectual property under their respective control for use in commercial agricultural research and product development. These two major CRISPR-Cas9 license holders are coming together with the shared goal of enabling all entities wanting to apply the technology for agricultural applications with a full range of CRISPR-Cas9 tools. Such foundational intellectual property (IP) for CRISPR-Cas9 technology will be freely available to universities and nonprofit organizations for academic research. Pioneer is a business unit of the Agriculture Division of DowDuPont™.
CRISPR-Cas\textsuperscript{1} Advanced Plant Breeding Guiding Principles\textsuperscript{2}

- **CRISPR-Cas is one of many tools** DuPont uses to deliver improved products and value to customers.
- **Safety and product stewardship are foundational** to all DuPont product offerings.
- DuPont products developed using **CRISPR-Cas advanced plant breeding** only include genetic material from the target plant/crop.
- DuPont is committed to **open, transparent and timely communications** about its use of CRISPR-Cas.
- DuPont is committed to the **responsible development and application** of CRISPR-Cas to help ensure consumer confidence.

- DuPont supports appropriate, science-based regulatory oversight for plants developed with CRISPR-Cas advanced plant breeding, consistent with plants developed through other plant breeding methods.
- DuPont intends to enable others wanting to develop agricultural products using CRISPR-Cas through access to intellectual property (IP), technology capabilities, infrastructure and scientific expertise.
- DuPont will engage those with diverse viewpoints to inform its decision-making process for products developed with CRISPR-Cas advanced plant breeding.

\textsuperscript{1}“CRISPR-Cas” is derived from naturally occurring “CRISPR” found in many bacteria that protect themselves against bacteriophage. DuPont has used CRISPR for many years to improve dairy product manufacturing and to make food safe and last longer.

\textsuperscript{2}These principles refer to the DuPont use of “CRISPR-Cas” as a plant breeding technique. If CRISPR-Cas is used to more efficiently develop GMOs, DuPont will follow all applicable GMO regulations and the DuPont Biotechnology Guiding Principles. See more here.
CIMMYT & DuPont Pioneer Public-Private Partnership

Sugarcane Mosaic Virus (SCMV)

Maize chlorotic mottle viruses (MCMV)
new to Africa, more severe than SCMV

Maize Lethal Necrosis Disease
Pioneer Will Deploy Advanced Breeding Broadly

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<th>DISEASE RESISTANCE</th>
<th>YIELD &amp; YIELD STABILITY</th>
<th>DROUGHT TOLERANCE</th>
<th>OUTPUT TRAITS</th>
<th>MATURITY</th>
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Products, benefits and concepts described herein will not be offered for sale or distribution until completion of field testing and applicable regulatory reviews.
Vast Potential for Wide Array of Applications

Developing solutions to the toughest agricultural challenges
Where Ideas Become Reality

DuPont Pioneer believes that the global scientific community can do truly innovative work when we collaborate. Join us and other thought leaders from around the world to advance the development of groundbreaking, sustainable agricultural solutions.

READ MORE
Listening to Full Range of Stakeholders

CRISPRCas.pioneer.com