

Regulatory and IP Aspects on NBTs (genome editing): Perspective from Industry

ISTA Seminar

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North Hill Group: Services

Biotech Regulatory Affairs

- Securing Regulated Field Trial Permits
- Data Interpretation and Regulatory Science Planning
- Technical Writing and Dossier Submission
- Laboratory Best Practices for Research and Development of Regulated Materials
- Client Representation Before Global Regulatory Authorities

Government & Industry Affairs

- International Trade Policy Development, Strategy and Advocacy
- Resolving Technical Barrier to Trade (TBT) and Sanitary and Phytosanitary (SPS) Issues
- Organizing and Leading Industry Outreach and Awareness Campaigns
- Global Stakeholder Mapping

Market Development & Market Access

- Develop Strategic International Marketing Plans
- Securing Government Grant Funding for Market Research and Promotion
- Designing and Implementing Foreign Market Consumer Research Studies

NHG: 17 Team Members Across 9 Countries

Carlos Almendares

Lead, Central America
Honduras

Fernando Contreras

Country Lead
Mexico

Mary Locke

Chief Technology Officer
United States

Mieko Kasai

Country Lead
Japan

Firoz Amijee

Vice President Global Regulatory
Belgium

Greg Dana

Vice President
United States

Jeffrey Nawn

CEO/Founder
United States

Theresa Sult

Senior Advisor
United States

Hisao Fukuda

Senior Advisor
Japan

Deanna Ayala

Senior Advisor
Canada

Ana Luisa Diaz

Country Lead
Colombia

Kristen Nawn

COO
United States

Walter Quiros

Country Lead
Costa Rica

Huong Bui

Senior Advisor
Vietnam

Christian Foster

Senior Advisor
United States

Gabriel Romero

Country Lead
Philippines

Paulo Paes de Andrade

Country Lead
Brazil



What is Genome Editing?

- Genome editing is a **group of technologies that can change an organism's genetic material (DNA)**
- Genetic material can be added, removed or altered at **specific targeted** locations in the genome
- Several genome editing methods have been developed such as ZFN, TALEN, Meganuclease and CRISPR → **CRISPR 70% of all applications** (JRC, Berlin 2023)
- **CRISPR-Cas9 (Clustered Regularly Interspaced Short Palindromic Repeats and CRISPR-associated protein 9)** has generated most interest because it is **faster, cheaper, more accurate and efficient than other genome editing methods**
- **Edit types called Site Directed Nuclease (SDN) 1, 2 or 3**
 - SDN1: small point mutation in native gene
 - SDN2: insertion of existing engineered DNA template
 - SDN3: insertion of new DNA template including from unrelated species

Genome Editing: Evolving Landscape

- **Policy Pioneers:** select countries in Latin America & Asia take leadership roles
- **New Players:** new companies & innovative products
- **Same Game:** cultivation, export markets, investors, ethics & stewardship
- **Regulatory:** evolving, harmonization vs divergence & opportunity for SMEs



Policy/Regulatory Pioneers: Not the Usual Suspects

Argentina

Australia

Brazil

Canada

Chile

Colombia

England

Guatemala

Honduras

India

Japan

Nicaragua

Nigeria

Kenya

Philippines

USA



Genome Editing: New Companies & Innovative Products

- Plants

Artic Apple: non-browning apple using RNAi

Calyxt: high-oleic soy, high-fiber wheat, non-browning potatoes, improved-quality alfalfa, mildew-resistant wheat

CGIAR: disease resistance in bananas, cassava, corn, potatoes, rice, wheat

Chinese Academy of Science: fungus resistant wheat, high-yield tomatoes, HT corn, non-browning potatoes
vitamin C lettuce, disease resistant bananas

Cibus: sulfonylurea tolerant canola

Corteva: waxy corn, drought resistant corn

GDM: drought resistant soy

Inari: high yield and resource use efficiency soy, corn, wheat

Pairwise: non-pungent mustard green, seedless blackberries, thornless blackberries

Sanatech: high-gaba tomatoes, disease resistant tomatoes

Simplot: non-browning avocados, potatoes

Syngenta: multiple crops including disease resistant tomatoes

Toolgen: drought tolerant chili, disease resistant apples and cabbage

Tropic Bioscience: disease resistant bananas and rice, low caffeine coffee

Ukko: low gluten wheat

Yield10 Bioscience: enhanced omega 3 camelina

- Aquatics

Aquabounty: fast growing tilapia

Regional Fish Company: muscled sea bream, fast growing tiger puffer fish

Seikai National Fisheries Research Institute: docile tuna fish

Sumitomo: disease resistant shrimp

- Livestock

Genus: PRRSV-resistant pig

Recombinetics: poled cattle



Regulatory Reformist: Brave New World

Eager Regulators

- Accessible and progressive regulators interested in how edits were made

Simpler Regulatory Determinations/Exemptions

- Documentation of the genome edit
- Demonstrating absence of rDNA

Rapid Turn Around Times

- Guatemala reviewed and issued notification for product as conventional within 2 days
- Colombia & Honduras issued exempt notifications within couple of months
- Philippines regulations require 30 days review and determination

Self Determination

- New era in Australia (OGTR)



Regulatory Traditionalist: Opportunities for Improvement

China

- Ministry of Agriculture and Rural Affairs/MARA: local developers vs others
- Guidelines published to risk assess and regulate as GMOs

European Union

- ECJ ruling (25 July 2018) on mutagenesis: random (GMO exempt) vs targeted (GMO)
- European Commission regulatory proposal expected in July 2023

Korea

- All products regulated under LMO Act with GMO label requirements
- Possibly some streamlining with pre-submission reviews

Mexico

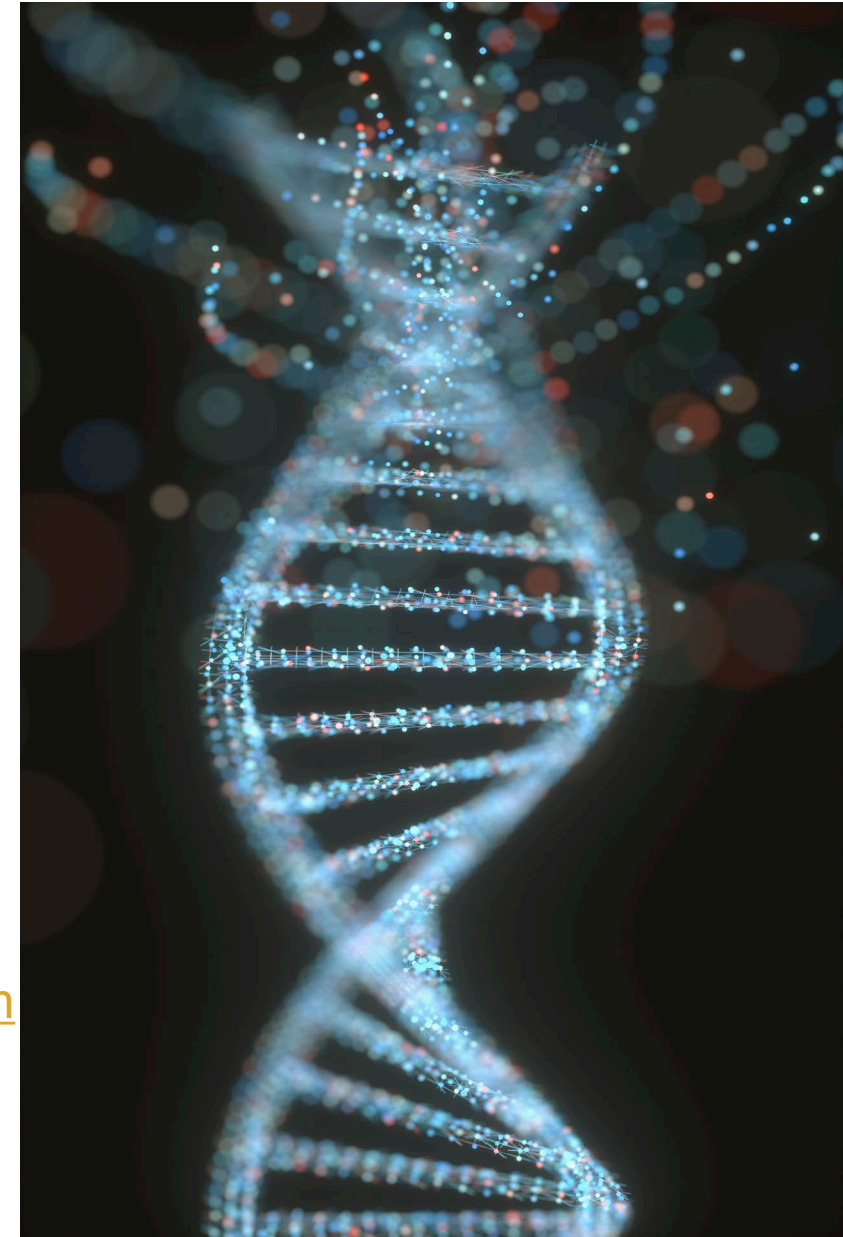
- Department of Agriculture/SENASICA: no genome editing policy formulation yet
- Department of Health/COFEPRIS: uninterested



IP Aspects: Complex

IP developments (CRISPR)

- Initial research activity and publications starting 2007
- Broad Institute, MIT, Harvard, University of California et al lead on IP filings (Doudna/Charpentier, Nobel Prize 2020)
- ***Science (2015)*** - CRISPR Makes the Cut, Breakthrough Technology of the Year!
- Attracting investor funding for research, innovation, start-ups
- High patenting activity - *Technology Landscape Study (2018)*: www.maxval.com
 - CRISPR-Cas9 patent filings → 10000+ (4800 are unique)
 - Vector/delivery → 1121
 - Guide RNA/Nuclease → 600
 - Detection/assays → 668
 - Plants → 461
- **Patent challenges and legal uncertainty → FTO?**
- Corteva's "open innovation": www.openinnovation.corteva.com
- Broad's "inclusive innovation": www.broadinstitute.org



IP Aspects: Considerations

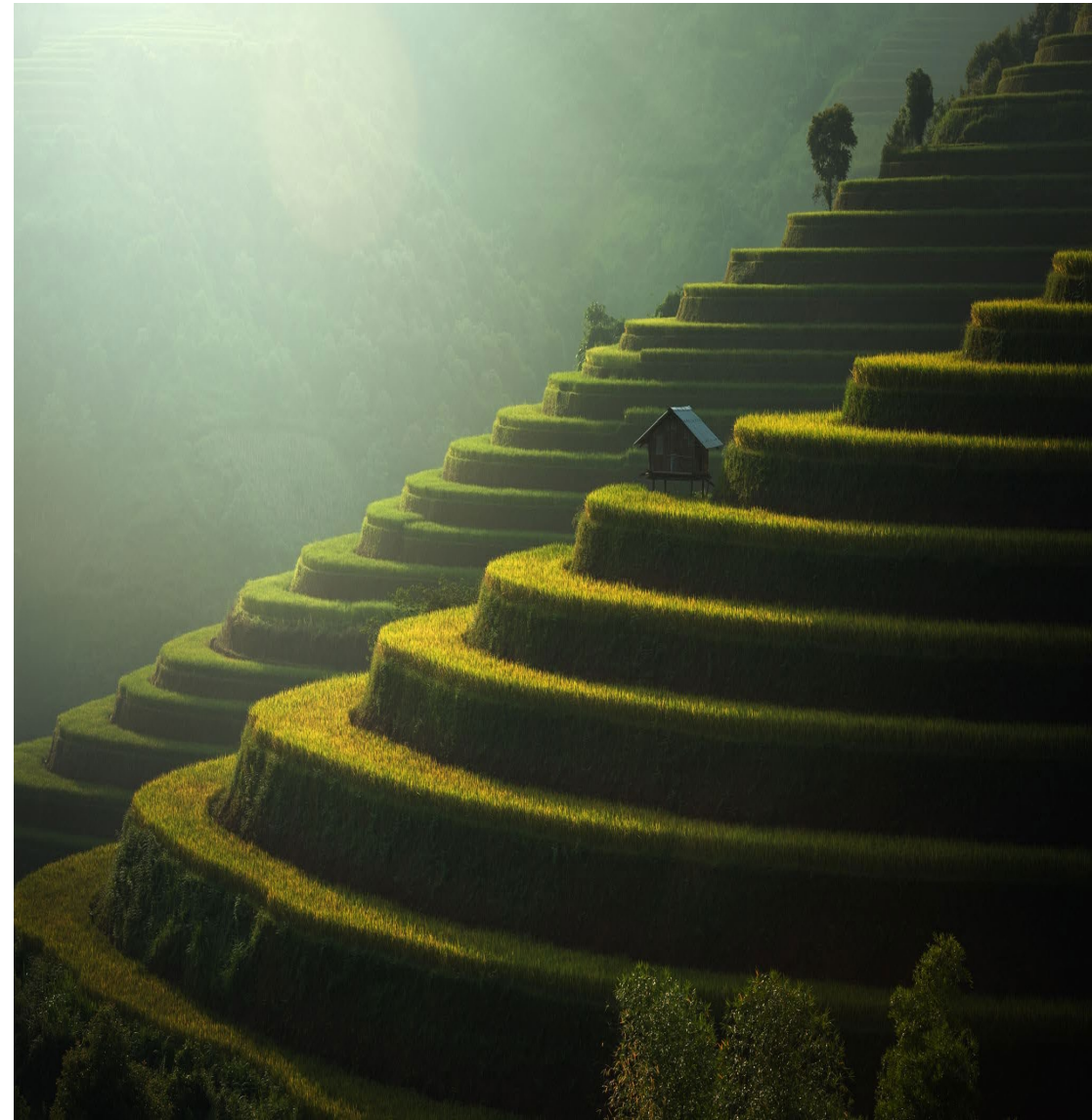
Ag plant/crop

- Access to technology via research exemptions
- Licensing partnerships for commercial use (stewardship)
- Plant breeders' rights and exemptions
- Plant variety protection and EDVs
- Plant patents
- Trait utility patents
- Country/Regional differences
- Timing of IP filings and regulatory disclosures
- Seek legal guidance early!



Genome Editing (NBTs): Evolving Landscape

- **New Opportunities**
- **Regulatory Coordination**
- **IP Considerations**
- **Delivery and Acceptance?**





NORTH HILL GROUP