West Africa Animal Ag Workshop

Perspectives on the Regulation of Novel GM Insects

John McLean

July 2018

Forward-Looking Statements

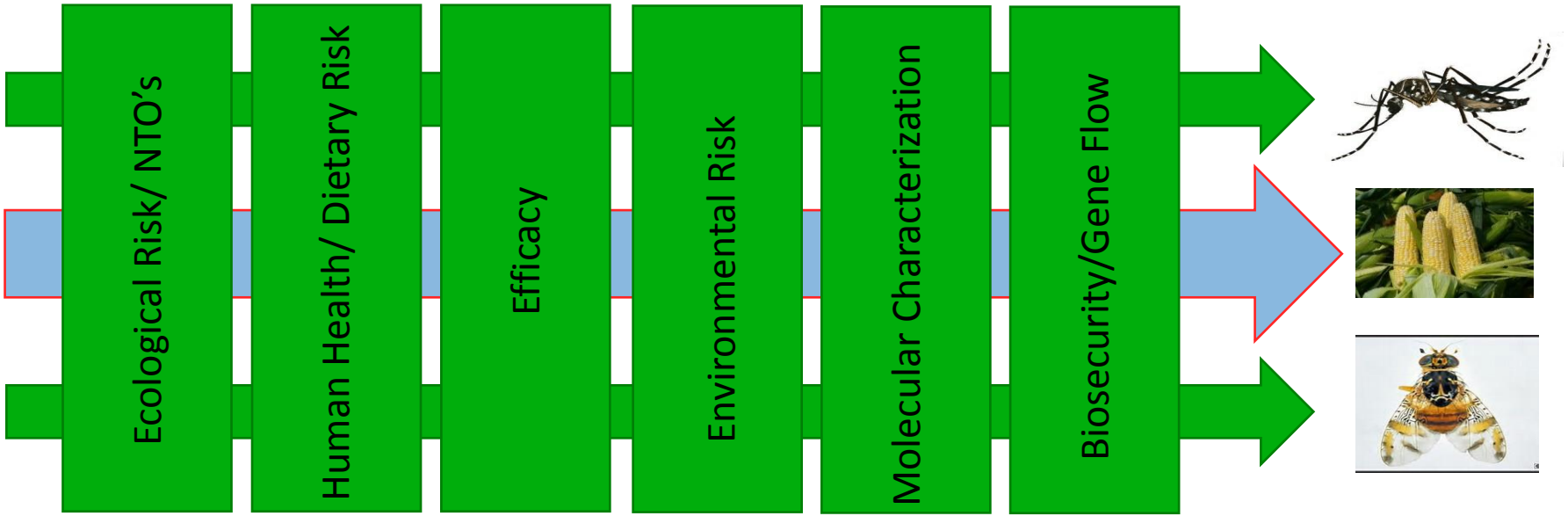
Safe Harbor Statement

Some of the statements made in this presentation are forward-looking statements that involve a number of risks and uncertainties and are made pursuant to the Safe harbor Provisions of the Private Securities Litigation Reform Act of 1995. These forward-looking statements are based upon Intrexon's current expectations and projections about future events and generally relate to Intrexon's plans, objectives and expectations for the development of Intrexon's business and discussion of anticipated clinical trials and future collaborations. Although management believes that the plans and objectives reflected in or suggested by these forward-looking statements are reasonable, all forward-looking statements involve risks and uncertainties and actual future results may be materially different from the plans, objectives and expectations expressed in this presentation. These risks and uncertainties include, but are not limited to, (i) Intrexon's current and future subsidiaries, collaborations and joint ventures; (ii) Intrexon's ability to successfully enter new markets or develop additional products, whether with its collaborators or independently; (iii) actual or anticipated variations in Intrexon's operating results; (iv) actual or anticipated fluctuations in Intrexon's competitors' or its collaborators' operating results or changes in their respective growth rates; (v) Intrexon's cash position; (vi) market conditions in Intrexon's industry; (vii) the volatility of Intrexon's stock price; (viii) Intrexon's ability, and the ability of its collaborators, to protect Intrexon's intellectual property and other proprietary rights and technologies; (ix) Intrexon's ability, and the ability of its collaborators, to adapt to changes in laws or regulations and policies; (x) the outcomes of pending and future litigation; (xi) the rate and degree of market acceptance of any products developed by Intrexon, its subsidiaries, collaborations or joint ventures; (xii) Intrexon's ability to retain and recruit key personnel; (xiii) Intrexon's expectations related to the use of proceeds from its public offerings and other financing efforts; and (xiv) Intrexon's estimates regarding expenses, future revenue, capital requirements and needs for additional financing. For a discussion of other risks and uncertainties, and other important factors, any of which could cause Intrexon's actual results to differ from those contained in the forward-looking statements, see the section entitled "Risk Factors" in Intrexon's Annual Report on Form 10-K and subsequent reports filed with the Securities and Exchange Commission. All information in this presentation is as of the date of the release, and Intrexon undertakes no duty to update this information unless required by law.

Regulatory Overview: Technology and Risk Assessment Elements

	Mosquito	Ag Pest	Plant Biotech
Technology			
GMO	★	★	★
Biopesticide	★	★	★
Biocontrol Agent	★	★	
Disease Vector/ Human Health	★		
Plant Pest		★	★
Risk Assessment			
Human Risk	★	★	★
Environmental Risk	★	★	★
NTO Risk	★	★	★
Biocontainment/ Gene Flow	★	★	★
GMO Risk	★	★	★

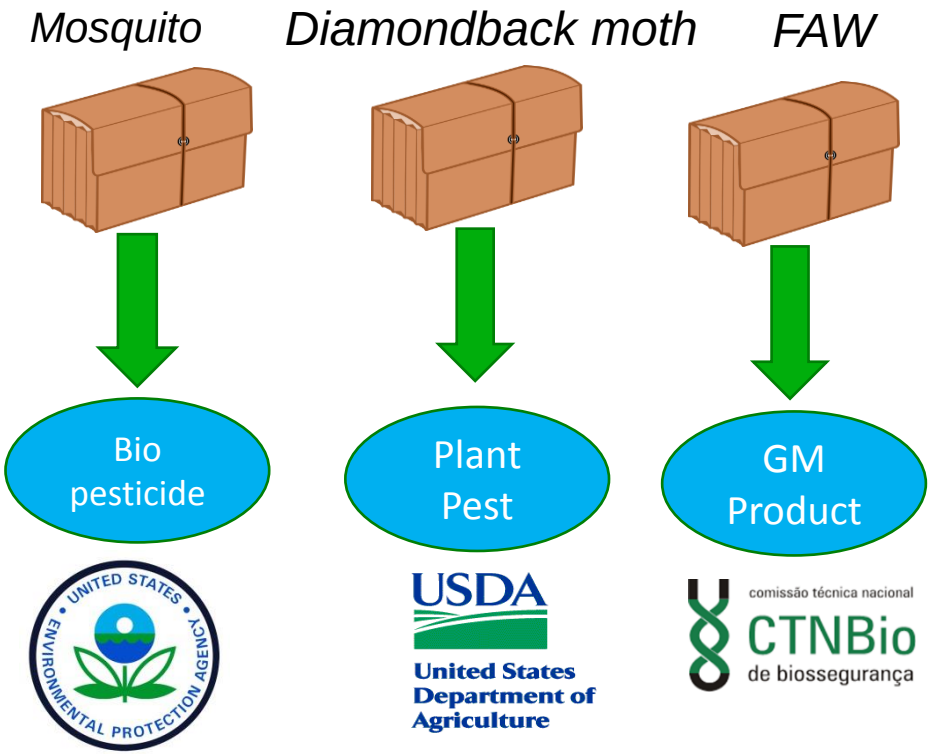
Regulatory/ Risk Assessment Paradigm
An Overview



- Regulatory jurisdiction and oversight may differ, but problem formulation and core scientific risk assessments related to human health and environmental safety are very similar.

Example: Regulatory Oversight in US and Brazil

- Depending on countries and biosafety legislation, regulatory oversight and jurisdiction may either be based on technology (GM vs conventional) or nature of product (biopesticide, vector control, public health application)



Overview: Regulation of GM Insects

- Conceptually analogous to framework for GM plants
  - Focus on safety of constituent proteins
  - Adapt to differences in behavior and characteristics of regulated organism

- Focus on key data to characterize:
  - Human safety
  - Ecological safety
  - Environmental safety
  - Efficacy

Regulatory Data Summary for GM Insects

- Human safety
  - Protein tox
  - Bioinformatic assessment
  - Molecular characterization
  - Allergenicity/ Digestibility of proteins
  - Residues of constituent proteins in grain

- Ecological/ Environmental safety
  - Protein persistence and degradation
  - Insect persistence
  - Biocontainment
  - NTO assessment ie avian, predator feeding studies

- Socio-economic considerations
  - Global import approvals not required (GM pest control product vs GM article in commerce)

SLI Regulatory Assessment Summary

- >14 Years of Studies – Biosafety Profile for SLI Technology

Characteristics	SLI
Free of toxic or allergenic components	✓
Safe for predators *(Two oral exposure studies available)*	✓
Fully susceptible to insecticides	✓
Species-specific insect control	✓
Ability to monitor and assess efficacy	✓
Ability to confine & contain/management of off-target impacts	✓
De minimis protein exposures to humans/NTOs	✓
Genetically and phenotypically stable	✓
Efficacious control of target pests demonstrated	✓

Global Regulatory Progress for SLI Insects

Import & contained trials approved

- Austria
- France
- Greece
- Guatemala
- Israel
- Singapore
- Thailand
- Vietnam
- India
- Morocco
- Australia
- USA

Environmental release approved

- Brazil
- Cayman
- Malaysia
- USA
- Panama

comissão técnica nacional de biossegurança CTNBio

FDA U.S Food and Drug Administration

Current outdoor release

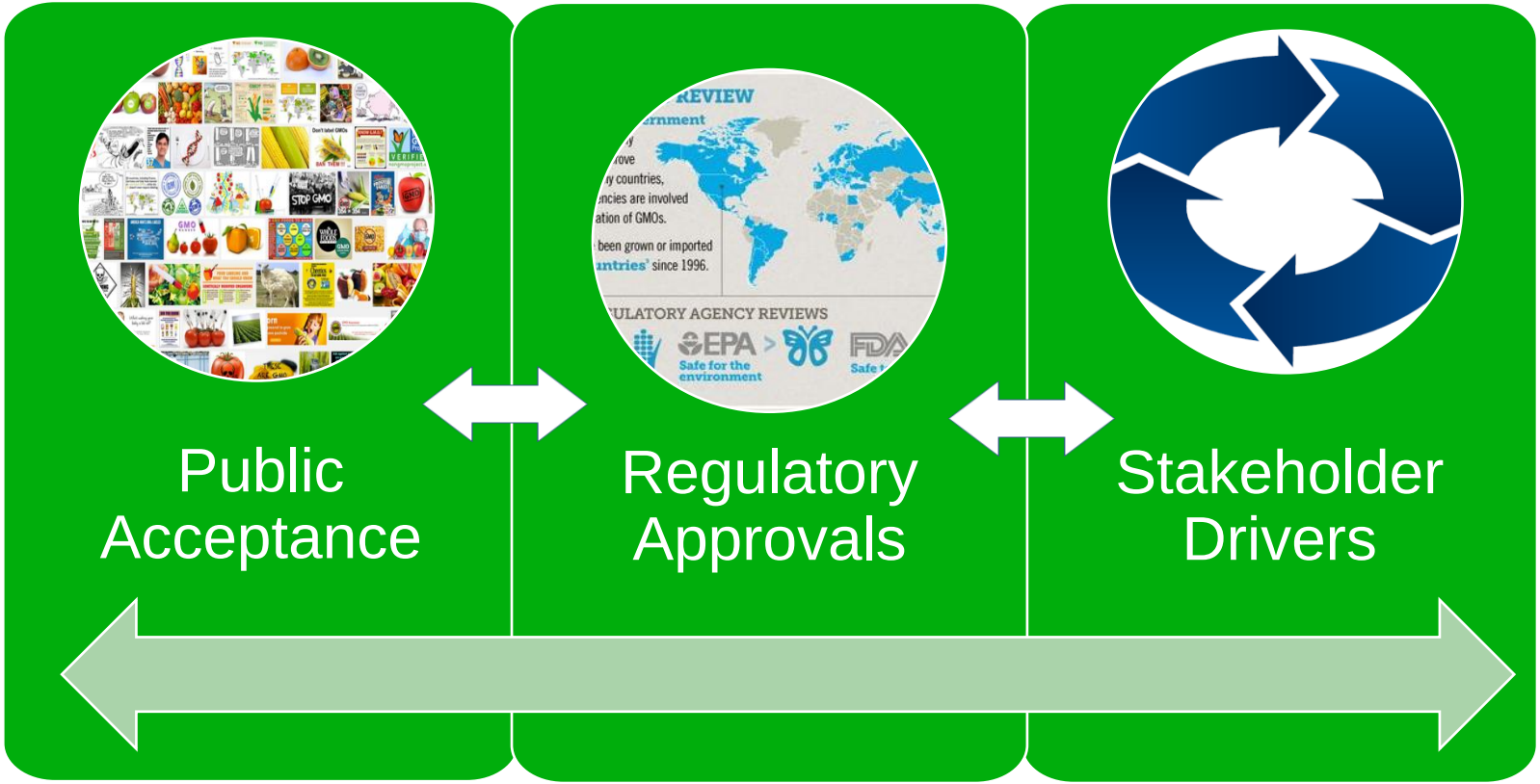
Multiple ongoing
- USDA - DBM
- Dutch - EU standard

USDA

National Institute for Public Health and the Environment
Ministry of Health, Welfare and Sport

intrexon

Regulatory Drivers



Stakeholder Engagement: Acceptance

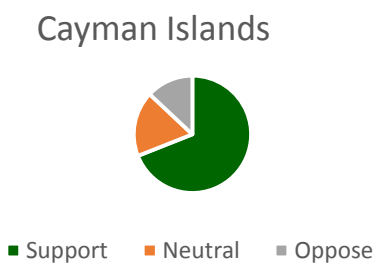
Demand Drivers	‘Greener’ Solutions	Stakeholder Acceptance
• Race to increase trait durability • Preservation and sustainability of widely adopted traits • Opportunity to mitigate or maintain current IRM requirements without addition of onerous, untenable measures	• Significantly reduced environmental footprint • Reduce off target NTO impacts • Opportunity to curb increasing use of chemistries to manage hard to control and resistant insects	• Market access: will not be subject to import approvals or other GMO barriers to trade • *De minimis* exposures and risks to consumers • Supplement current crop production input methods

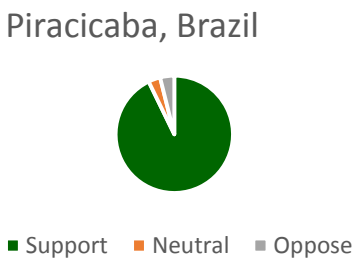
Stakeholder Engagement across the Value Chain

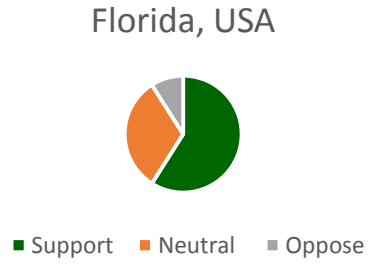
Public Engagement—Example: Mosquitoes

Fundamental component of release program:

- Robust public engagement plan
- Stakeholder mapping
- Adopt culturally appropriate methods
- Train staff
- Train partnering public heath/vector control agents
- 6-8 week intensive campaign before release
- Ongoing engagement throughout project
- Channels for 2 way communication – listen and respond







In Closing…Summary and Learnings

- Global regulatory systems evolving for the evaluation of novel GM animal products
- Most countries have shown a keen ability to adapt to a novel technology utilizing existing authorities and guidelines
- Common risk assessment principles apply across GM organisms released into the environment, including insects
- Harmonization of regulatory requirements and transportability of data will be necessary to ensure timely regulatory approvals
- Proactive engagement and communication with regulators, the public and value chain stakeholders critical to regulatory process and subsequent introduction
- Risk-benefit aspects (public health, resistance development) need to be consistently considered in regulatory decision-making and timing


intrexon