Global Food Regulatory Science Society

GFoRSS is a disciplinary organization of IUFoST

CODEX GUIDANCE ON ASSESSMENT OF FOOD DERIVED FROM BIOTECHNOLOGY

Workshop On Biotechnology and the Future of Food, Ensuring Food Safety, Security and Sustainability

30 September 2024 • W Hotel, Abu Dhabi, UAE

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GM Food Safety Assessment

Introduce the definitions, concepts and principles currently applied for the safety assessment of GM foods – Regulatory Aspects

Introduce internationally agreed texts, guidelines and recommendations required for the safety assessment procedure

Concepts and Principles of GM Food Safety Assessment

https://www.fao.org/4/i0110e/i0110e.pdf

Codex Guidance

- ❑ Codex Guidance on Food Derived from Biotechnology - Hosted by Japan
- ❑ Codex Inter-Governmental Taskforce on Food Derived from Biotechnology 2000-2007
- ❑ **7 Sessions 4 texts**

Codex Guidance

CODEX
CODEX ALIMENTARIUS
1963-2023

- CXG 44-2003 – Principles for the Risk Analysis of Food Derived from Modern Biotechnology
- CXG46 – 2003 - Guideline for the Conduct of Food Safety Assessment of Foods Produced Using **Recombinant-DNA Microorganisms**
- CXG 45-2003 - Guideline for the Conduct of Food Safety Assessment of Foods Derived from **Recombinant-DNA Plants**
- CXG 68-2008 - Guideline for the Conduct of Food Safety Assessment of Foods Derived from **Recombinant-DNA Animals**

Food Derived from Biotechnology

AGRICULTURAL BIOTECHNOLOGY ?

Biotechnology is a broad term used to describe the process of using living things to create or change products — such as harnessing yeasts to brew beer and make bread

Agricultural biotechnology is a natural progression of conventional breeding.

Over time, the spectrum of plant breeding has become increasingly sophisticated, moving from farmers who saved seeds from crop plants that performed the best in the field (selective breeding), to the deliberate crossing

Biotech Applications ….. For Centuries…

- ✓ For centuries plant breeders have cross-bred similar varieties of plants to produce new crops.

- ✓ **Genetic engineering** allows scientists to isolate a specific gene for a particular trait – such as resistance to insect attack – in a plant, bacterium or animal, and transfer it into another plant.

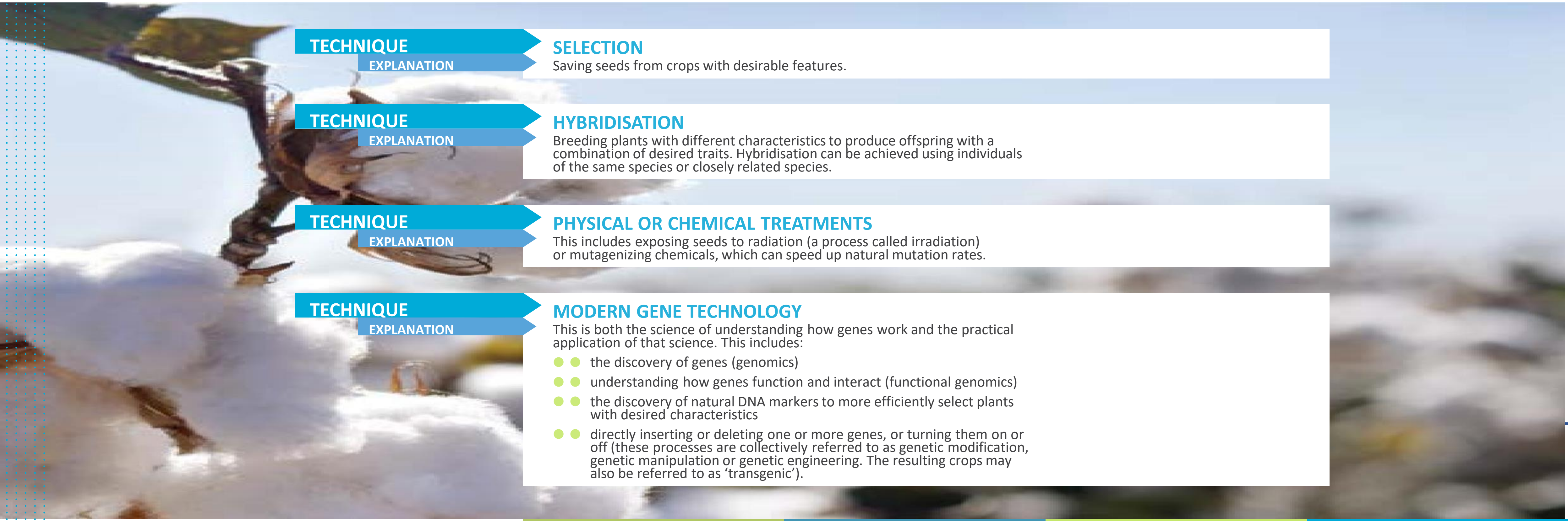
WHAT IS AGRICULTURAL BIOTECHNOLOGY?

Biotechnology is a broad term used to describe the process of using living things to create or change products — such as harnessing yeasts to brew beer and make bread

Agricultural biotechnology is a natural progression of conventional breeding.

Over time, the spectrum of plant breeding has become increasingly sophisticated, moving from farmers who saved seeds from crop plants that performed the best in the field (selective breeding), to the deliberate crossing of different varieties from the same or closely related species (hybridisation), to gene selection through mutagenesis, to modern agricultural biotechnology.

All available breeding techniques remain important to the modern plant breeder — agricultural biotechnology is the latest tool available to speed up and make more accurate the development of new and improved crop plants.



TECHNIQUE — **SELECTION**

EXPLANATION — Saving seeds from crops with desirable features.

TECHNIQUE — **HYBRIDISATION**

EXPLANATION — Breeding plants with different characteristics to produce offspring with a combination of desired traits. Hybridisation can be achieved using individuals of the same species or closely related species.

TECHNIQUE — **PHYSICAL OR CHEMICAL TREATMENTS**

EXPLANATION — This includes exposing seeds to radiation (a process called irradiation) or mutagenizing chemicals, which can speed up natural mutation rates.

TECHNIQUE — **MODERN GENE TECHNOLOGY**

EXPLANATION — This is both the science of understanding how genes work and the practical application of that science. This includes:

- the discovery of genes (genomics)
- understanding how genes function and interact (functional genomics)
- the discovery of natural DNA markers to more efficiently select plants with desired characteristics
- directly inserting or deleting one or more genes, or turning them on or off (these processes are collectively referred to as genetic modification, genetic manipulation or genetic engineering. The resulting crops may also be referred to as 'transgenic').

Definition of Biotechnology

Definition: modern biotechnology

❑The application of:

- **in vitro nucleic acid techniques**, including r-DNA and direct injection of nucleic acid into cells or organelles, or
- fusion of cells beyond the taxonomic family, to overcome natural physiological reproductive or recombinant barriers and **using techniques not used in traditional breeding and selection**

(Cartegena Protocol on Biosafety)

Modern Biotech …. Safety Standards

Modern biotechnology

Broadens the scope of genetic changes

*Should not result in foods **that are less safe** than those produced by conventional techniques (OECD, 1993)*

↓

A new or different standard of safety is not required

***Previously established principles** for assessing food safety still apply*

International Efforts : Safety Assessment

- Concerted efforts made internationally
- Key international consultations addressing the safety assessment of GM foods:
  - FAO/WHO, ILSI, OECD, CAC, etc.
- Countries may differ in **statutory and non-statutory** approaches to regulating GM foods
- But Guidance to Assess ….. Consistent

Consensus Was Achieved … OECD and Codex

Key considerations

- International discussions between OECD countries, and within the United Nations FAO/WHO expert consultations, have resulted in a consensus on the specific safety issues that **should be considered when evaluating a novel food**

General Principles

General principles

- The following are used internationally in safety assessment of r-DNA foods:
  - **conventional foods are generally considered to be safe**, if provided prepared and handled
  - **novel foods,** including r-DNA foods, are required to undergo **mandatory pre-market safety assessment in some jurisdictions** (e.g. Japan, Canada, Australia and New Zealand, UK, EU)
  - an **explicitly cautious approach** is applied to foods, such as r-DNA foods, with no history of safe use

GM Food Safety Assessment

General principles (cont.)

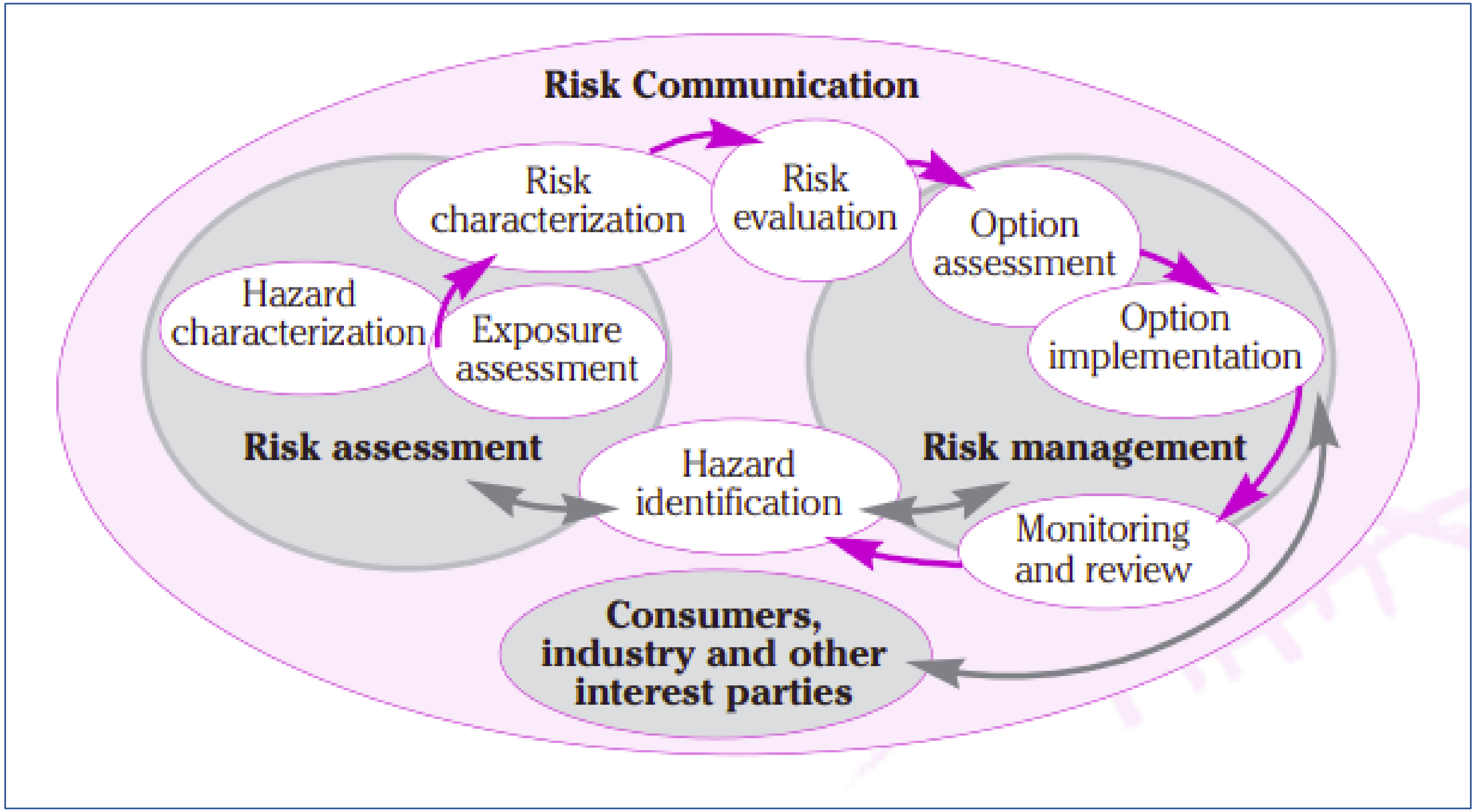
- Safety assessments of r-DNA foods are undertaken according to key principles:
  - 1. Safety assessments use **scientific, risk-based methods.**
  - 2. Safety **assessments are conducted on a case-by-case basis**.
  - 3. Both **intended and unintended** effects of **genetic modification** are considered.
  - 4. Where appropriate, comparisons are made with conventionally produced foods.
- Decisions with respect to safety are **based on the totality of the evidence**

Risk Analysis Paradigm Provides Structure

Robust Food Decisions

GM Food Safety Assessment

Risk Analysis Framework



Traditional Risk Assessment Approaches had to be adapted

Usually applied to a discrete chemical entity

- e.g. new food additive

- ❑ Established studies used to identify and characterise hazard
  - e.g. animal toxicity studies, *in vitro* studies, metabolism, epidemiological studies

- ❑ Can derive “safe” levels of exposure (intake)

- ❑ Risk of adverse health effect and its impact determined

Traditional Risk Assessment Approaches had to be adapted

Traditional risk assessment not specifically designed to apply to whole foods

Whole foods not like chemicals:

- complex mixtures of compounds
- not always fully characterised
- difficulties with using traditional toxicity testing in animals

The Comparative Approach

- ❑ Modified approach **used for GM foods** (and other whole foods)

- ❑ The safety of a GM food is assessed **by comparison to its conventional counterpart** having a history of safe use:
  - identification of **new or altered** hazards relative to the conventional counterpart
  - **new or altered hazards** subject to further assessment to determine any impact on food safety

Comparative Approach

Goal of the Assessment

To determine whether the GM food is comparable to the conventional counterpart food in terms of its safety

if yes, the GM food can be said to have all the benefits and risks normally associated with the conventional food.

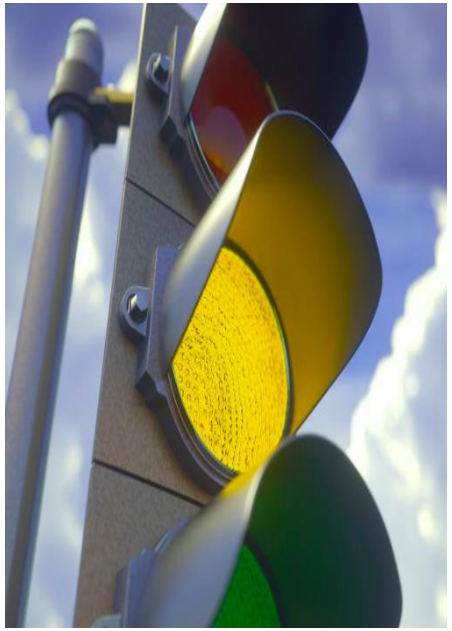
Risk Analysis: GM Food Safety Assessment

1. Hazard identification

- ❑The objective is to identify the potential for **adverse effects that r-DNA** foods may pose for human health
- ❑Use a **modified hazard identification** scheme referred to as a **safety assessment** to identify whether a hazard is present in the whole food

Risk Analysis: GM Food Safety Assessment

2. Hazard characterization



Safety assessments conducted on a case-by-case basis

- ❑Applied **to a food commodity**, for the food and **food products derived from that modified commodity**
  - e.g. corn (kernels, corn flour, corn syrup, oil); canola (oil); cotton (oil and linters)
- ❑Foods derived from a commodity (e.g. soybeans) that have been modified with **different traits** are assessed separately
- ❑**Any subsequent use of modern biotechnology** requires a separate safety assessment

Risk Analysis: GM Food Safety Assessment

3. Exposure assessment

Consideration is given to both **intended and unintended effects**. Safety considerations apply to all aspects of the r-DNA food. Conducted in two phases:

1. **Identification of similarities and differences**

- ❑traditional vs novel sources of donor DNA/genes
- ❑molecular characterization – new genes, proteins, genetic stability
- ❑compositional analysis

2. **Identified differences are subjected to further scrutiny**

- ❑toxicity/allergenicity of any new protein
- ❑safety of any transferred antibiotic resistance genes
- ❑safety, nutritional impact and pattern of any compositional changes

Risk Analysis: GM Food Safety Assessment

4. Risk characterization

- ❑Comparisons are made with conventionally produced foods
- ❑r-DNA food variety compared with conventional counterpart food **with history of safe use**
- ❑Comparison used to identify differences in levels of **naturally occurring allergens, toxins, nutrients and antinutrients**, or the ability to promote typical growth or well-being
- ❑Significant differences (r-DNA vs conventional) **assessed for biological significance** and potential adverse health effects

To Summarize : Overall Safety Considerations….

Safety considerations

1. Description of the host organism that has been modified, including information **on nutrient composition**, known antinutrients, toxicants and allergenic potential, and any significant changes in these that may result from normal processing.

2. A description of the donor organism, including **any known associated toxicity and allergenicity, and the introduced gene(s).**

3. **Molecular characterization of the genetic modification**, including a description of the modification process and **the stability of the introduced trait.**

4. Identification of the **gene products, including a description of the characteristics of the inserted gene.**

To Summarize : Overall Safety Considerations….Continued

Safety considerations (cont.)

5. Evaluation of the safety of expected **new substances in the food**, including an evaluation of any toxins produced directly by the modification.
6. Assessment of the new food's **potential allergenicity**.
7. Evaluation of the **unintended effects on food composition, including**:
    a. assessment of the changes in the **concentration of nutrients or naturally occurring toxicants**
    b. identification of **antinutrient compounds** that are significantly altered in novel foods
    c. evaluation of the safety of compounds that show a **significantly altered concentration**

GM Food Safety Assessment

Key initiatives: to identify and address future needs

OECD task force for safety of novel foods and feeds

- **consensus documents** that provide guidance on critical parameters (e.g. key nutrients) of food safety and nutrition for each food crop
- **documents for those products that have already been approved, as well as for commodities that are likely to be approved in the future**
- http://www.oecd.org/document/63/0,2340,en_2649_34391_1905919_1_1_1_1,00.html

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Anchor: Codex - GM Food Safety Assessment

Codex guideline

Codex guideline for foods derived from recombinant DNA plants

- The safety assessment of a food derived from a recombinant-DNA plant follows a stepwise process of addressing relevant factors including:
  - description of the r-DNA plant
  - description of host plant and its use as food
  - description of donor organism(s)
  - description of the genetic modification(s)
  - characterization of the genetic modification(s)

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GM Food Safety Assessment

Codex guideline (cont.)

- ❑ Safety assessment expressed substances (non-nucleic acid substances): assessment of potential toxicity and assessment of possible allergenicity (proteins)
  - compositional analyses of key components
  - evaluation of metabolites
  - food processing
  - nutritional modification
  - other considerations (e.g. marker genes)

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Example of Application

MENU

Guidelines for the Safety Assessment of Novel Foods

Food Directorate

Health Products and Food Branch

Health Canada

June, 2006

Updated: July 2022

Table of contents

GFORSS | GLOBAL FOOD REGULATORY

Example of Application

MENU

Canada.ca > Health > Food and nutrition - Canada.ca > About novel and genetically-modified (GM) foods

Completed safety assessments of novel foods including genetically modified (GM) foods

Overview | Safety of genetically modified foods | Labelling of genetically modified foods

Completed safety assessments | Requesting a novelty determination | Transparency Initiative

Table of completed novel food safety assessments

Decision date (yyyy/mm/dd)	Product	Proponent
2024/08/14	Insect resistant maize – MON 95275	Bayer CropScience Inc.
2024/07/18	Sourvisiae®	Mascoma LLC (a Lallemand company)
2024/07/18	Insect Resistant and Herbicide Tolerant Maize – DP-51291-2	Pioneer Hi-Bred Canada Company
2024/06/19	Insect-resistant and herbicide-tolerant DP910521 maize	Pioneer Hi-Bred Canada Company
2024/02/20	Short Stature Maize MON 94804	Bayer CropScience Inc.
2024/01/31	β-Lactoglobulin protein from yeast strain Komagataella phaffii yRMK-66	Remilk
2024/01/16	Arctic® apple event PG451	Okanagan Specialty Fruits Inc.
2023/12/29	Herbicide tolerant sugar beet – KWS20-1	Bayer CropScience Inc.
2023/09/27	Herbicide tolerant (HT4) soybean – MON 94313	Bayer CropScience Inc.

GM Food Safety Assessment – Capacity Building

- FAO capacity building project to assist countries in implementing international standards related to the risk analysis of products derived from biotechnology
- http://www.fao.org/ag/agn/agns/biotechnology_en.asp

Challenges: Ability to Address This Globally

- ❑ Regions most impacted by climate change / food insecurity are the least equipped for Safety Assessment

- ❑ Unequipped food regulatory authorities:
  - Assessment.
  - Management.
  - Communication.

Some of the limitations for all Food Competent Authorities

- Ability to conduct some of the toxicity studies:
  - Including whole food feeding studies (relevance ? Feasibility)
- Ability to predict allergenic potential and associated risk management measures
- Ability to assess exposure – Need to rely on existing data:
  - Occurrence and
  - Food consumption studies.

Food Derived from Biotech .... Future

- ❑Need an Enabling Environment : Food Regulatory Decisions

- ❑Accepted Guidance on Safety Assessment and Acceptance of Products – Market Access and Consumer Acceptance

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