

Current Trend And Future Prospects For GM Food

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Global challenges to food security

Population growth

- Increased demand for food
- Increased demand on water & land resources

Static or declining arable land

- Urbanization, industrialization, soil erosion, rising sea levels, preservation

Climate change

- Rising temperatures
- Changing precipitation patterns
- Rising seawater levels

Adoption of GM crops

- **100-fold increase from 1996 to 2014**
- **1.7 to 181.5 M Hectares**
- **Fastest adopted technology ever in Agriculture**

R and herbicide tolerant maize

- Insect resistant maize
 - Corn borer, earworms and armyworms
 - Rootworm control
- Herbicide tolerant maize
 - Glyphosate
 - 2,4-D
- Output traits
 - High amylase maize
- Stacked traits in maize



Herbicide tolerant soybean

- Herbicide Tolerant Soybeans
 - Glyphosate and glufosinate
- Modified fatty acid composition
 - Increased oleic acid content
- Future traits
 - Disease resistance, drought and salt tolerance, quality traits



Help mitigate effect of climate change



- 1996-2012, reduction in pesticide by 497 million kg, saving of 8.7%;
- 18.5% reduction in environmental impact quotient (EIQ)



▣ CO₂ savings of 26.7 billion kg = removing 11.8 M cars off the road

Source: Brookes and Barfoot, 2014

Status of New Biotech Products Approved in the USA 2014/15



- Arctic Apple: USDA grants approval of non-browning arctic apple in February 2015



- Innate Potato – Simplot's GM potato with low level acrylamide and bruise resistance approved in late 2014.



- HarvXtra™ - Low lignin alfalfa stacked with herbicide tolerance.

New Technologies for Genetic Modification of Crop Plants

- **Genomics**
- **RNAi – gene silencing technologies**
- **Zinc Finger Nucleases (ZFNs)**
- **Talen – transcription activator – like effector nucleases**
- **CRISPR/Cas technology – genome editing applications**

What further developments can be expected in the area of GM food?

Future GM organisms are likely to include plants with improved resistance against plant disease or drought, crops with increased nutrient levels, fish species with enhanced growth characteristics. For non-food use, they may include plants or animals producing pharmaceutically important proteins such as new vaccines.

Drought and Salinity Tolerance

Syngenta Trehalose example.

Nutrition

Modified oils

Micronutrients Beta Caratene

Increased iron and zinc

Heavy metal sequestering

Genetic engineering of stress tolerance genes in crops

- Goal: Develop crop plants that can withstand a finite period without water, be grow with less water or use water more efficiently
 - Transcription factors
 - Zinc finger/Leucine zipper (TFs that turn on stress related genes)
 - Functional proteins
 - Stabilization of plant molecules during stress (RNA)
 - Osmotic-protectants (cell membrane integrity)
 - Metabolic pathways
 - Regulation of plant sugars (plant hormones)
 - Genome editing (ZFN, TALENS and CRISPR technologies)
 - Down regulation of certain signaling pathways

Aflatoxin

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Removal of allergens

CRISPR

Peanut example

Nanotechnology/