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New Genetics, Food, and Agriculture: Scientific Discoveries - Societal Dilemmas

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2003

Overview

- Context
- Scope of study
- Findings
- Future perspectives
- Further information

Context

Scientific discoveries

1866 Gregor Mendel shows how traits are inherited

1953 Watson and Crick discover DNA double helix

1983 First inter-specific gene transfer in plants using Agrobacterium

2000 Human genome map completed

2003 60 m ha genetically modified crops grown in 16 countries

Scope of study

Identify issues in areas related to new genetics

- Applications in food and agriculture
- Implications for food safety and human health
- Implications for biodiversity and environment
- Regulatory issues
- Effects on emerging economies

Scope of study

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50 individual reviews; published 2000-2003

A – V: Australia to the Vatican

- 25 International agencies
- 18 National academies, governments
- 7 Other academic reviews

Scope of study

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Five key questions on GM Foods / LMOs

1. Who needs them?
2. Are they safe to eat?
3. Will they affect the environment?
4. Is there adequate regulation?
5. Will they affect trade?

Scope of study

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Assess state of the science today

- Areas of convergence
- Areas of divergence
- Gaps in knowledge

Findings

Future food needs

Who needs GM foods?

Findings

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Future food needs

Continuing demand for more, cheaper, and /or better quality food

- relative importance of above factors varies

Need to produce more food, with less land / less water while avoiding environmental damage

Emerging economies need more food, feed, milk and meat

Findings

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Future food needs: Contributions of new genetics

Current applications increasing efficiency of agriculture

Smarter breeding through molecular markers (e.g. high quality wheat varieties)

New vaccines for livestock diseases (e.g. foot and mouth, rabies in Europe)

Findings

Future food needs: Contributions of new genetics

Biological control of plant pests and diseases

Rapid propagation of clean planting material
(e.g. flowers, vegetables, bananas)

Findings

Future food needs: Contributions of new genetics

Transgenic plant varieties (GM crops) offer new possibilities

- 2002 first generation products grown on 58 M ha, in 16 countries
- four crops: cotton, maize, soybean, rapeseed
- two traits: insect resistance / herbicide tolerance

Findings

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Future food needs: Contributions of new genetics

Future products will address more complex characteristics, for example:

- improving nutritional content
- enhancing environmental traits (e.g. drought resistance)

New scientific discoveries will identify genes that control other traits in plants

Findings

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Food safety

Are GM foods safe to eat?

Findings

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Food safety: Scientific convergence

Currently available GM foods are safe to eat

- millions of meals eaten, no documented ill effects

Broad international agreement on safety assessment methods (CODEX)

- assess risks or allergens, toxins, etc.

Current/future products must be assessed on case-by-case basis to ensure pre-market safety

Findings

Food safety: Scientific divergence

Post-market monitoring difficult, due to diversity of populations and diets

Debate as to whether post-market surveillance is scientifically possible

More complex products of the future may require whole food analysis, using new methods

Findings

Food safety: Gaps in knowledge

Long-term effects of GM foods—and of most other foods—is unknown

Unintended effects possible, through plant breeding and gene technology

Improved methods needed for assessing changes in food content in future products

Pharmaceutical / industrial plant products must be kept out of the food chain

Findings

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Environmental effects

Will genetically modified organisms affect the environment?

Findings

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Environmental effects: Scientific convergence

Agriculture affects the environment

New genetics may increase / decrease threats

Case-by-case analysis of risks / benefits required for specific application, in a specific environment

Need to assess both *direct effects* and *indirect effects* (from changing agricultural practices)

Findings

Environmental effects: Scientific convergence

Risk assessment of plants: *Direct effects*

Need to monitor any increased potential for

- gene flow
- weediness / invasive species
- unintended effects
- effects on ecosystem function

Findings

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Environmental effects: Scientific convergence

Risk assessment of plants: *Indirect effects*

Changing agricultural practices will alter:

- pesticide use and pest management
- herbicide use and weed control
- cultivation practices
- land use

Findings

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Environmental effects: Scientific divergence

Significance of gene flow:

- Does it happen? Does it matter?
- Centres of diversity issues

Effects on non-target species

- laboratory studies need to be verified by field studies (e.g. Monarch butterflies / Bt corn)

Changing chemical use in broad-scale agriculture

- pesticide use – Bt cotton (40% less)
- herbicide use – soybean (no till agriculture)

Findings

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Environmental effects: Scientific divergence

Long-term ecological effects

Post-release monitoring of ecological effects

Need common agreement on scientific methodologies for assessing risks and benefits of new gene technologies

Findings

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Environmental effects: Gaps in knowledge

- Need to compare effects of new gene technologies against present practices and/or other options for land use
- Lack of base-line ecological data for comparisons
- Need international standards for assessment of risks / benefits
- Look for new ways to share landscape amongst multiple users, based on scientific data


MATT
GM CROPS THREAT
'They now have carrots that can be deployed within 45 minutes'

Findings

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Regulations

Are regulations adequate?

Findings

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Regulations: Scientific convergence

Science based, transparent, participatory regulatory system desirable

Product and/or process approach used

International / regional harmonization of data, methods and standards required

Regulatory systems must be supported by research to continually improve assessments, as new products emerge

Findings

Regulations: Scientific divergence

Extent of regulations needs to be proportionate to risk

Regulatory costs, complexity and uncertainty are barriers to entry for:

- developing countries
- small companies
- public institutions

Findings

Regulations: Gaps in knowledge

Need internationally agreed standards for environmental assessments of risks and benefits, which are comparable to food safety standards

Findings

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Emerging economics

What are the implications of new genetics in emerging economies?

Findings

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Emerging economies

Wider use of currently available technologies would benefit agriculture in many countries

- tissue culture propagation of planting material
- marker-assisted plant breeding
- new vaccines and diagnostics for diseases of crops, livestock and fish

Findings

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Emerging economies

Common constraints to use of gene technology include

- policy for the rural sector
- capacity to manage new technologies
- regulatory framework
- investments – public and private
- delivery systems
- trade implications

Findings

Emerging economies

Current / future options for use of new gene technology in agriculture

- Need to be targeted at local priorities;
- Compare gene technology option with other possible solutions.

- Need international/regional harmonization on science-based standards for trade in GM foods and commodities

Findings

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Emerging economies

Some promising early applications:

- Bt cotton in China – grown by 5 million farmers
- Bt cotton and maize in South Africa
- New diagnostics for fish diseases in Thailand

Future perspectives

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Where do we go from here?

Future perspectives

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Scientific community

Could play a greater role in public discussion of issues and by generating new knowledge

Need agreement between science and society as to what are the critical gaps in knowledge

Pursue additional, well-targeted research to resolve some of the issues

Future perspectives

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Policy makers

Trade implications are increasingly important:

- affect policy in emerging economies for local food production and export market access
- need science-based standards for trade in new products of gene technology
- informative food labeling may enable more choices by individuals and societies

Future perspectives

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Future choices

Science may inform, but does not determine, choices by individuals / societies

Ethics and values affect choices; these differ between and within societies

Important that science enables societies and individuals to exercise choices in life

Next steps

Further information

ICSU Synthesis Report June 2003

"New Genetics, Food and Agriculture: Scientific Discoveries-Societal Dilemmas"

Annotated Bibliography and full documents available via the Internet and on CD-ROM

www.icsu.org

UK Farm Scale Evaluations

The study compared weed management strategies for conventional and HT maize, sugar beets and oilseed rape

The FSE report

- showed a 36 % reduction in herbicide use on HT fields
- Did not compare the costs of the weed control programs
- Yields were not measured
- No assessment on the more important indicators of biodiversity such as species and genetic diversity

An evaluation of the suitability of HT crops in the UK will depend on a balance between benefits and costs

↓

Good management of glyphosate spray will protect better natural habitats than any herbicide used with conventional crops

Inefficient Agriculture Requires More Land

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NCFAP study: GM sugar beet yields are 5 % higher
Cost of weed control are 56 % lower

Strategic decision: maximizing food production on existing farmland

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21,000 acres could be dedicate to natural reserves, providing greater biodiversity

No-till agriculture leads to decreased energy inputs, lower soil erosion and much healthier soils with respect to structure, microbes, invertebrate species, and soil organic matter