# *Economic impacts of biosafety regulations on APEC economies*

**Kym Anderson** and **Lee Ann Jackson**

**World Bank**
**Washington DC**
kanderson@worldbank.org

**WTO Secretariat**
**Geneva**
Leeann.Jackson@wto.org

## *The issue*

- First-generation GM crop varieties promised direct economic benefits to biotech and seed firms and to adopting farmers, and lower food, feed and fibre prices
- Second-generation GM crops (e.g. Golden Rice) promise also direct benefits to food consumers
  - especially poor households in developing countries in the case of micronutrient-enhanced GM crop varieties
- However, there may be risks associated with transgenic crops, which has given rise to strict biosafety regulations that inhibit adoption of GM varieties in many countries

## *Are the benefits worth taking the risks?*

- Requires :
  - empirical analysis of recent and prospective economic benefits net of any higher costs to farmers;
  - Identifying and valuing any externalities (positive as well as negative) on the production and consumption sides of the market, and their probabilities of occurrence; and
  - weighing total social benefits (including positive externalities, discounted according to their likelihood of not occurring) against total social costs (including negative externalities, again discounted according to their likelihood of not occurring), in present value terms
- Our analysis contributes to the first of those steps

## *GM adoption: reasons for restraint*

- Many individual farmers, if left unconstrained, would adopt GM crop varieties once they are clearly more profitable than non-GM alternatives
- But there are demands to constrain adoption:
  - environmentalists' concerns
  - non-GM food producers and consumers' concerns
    - fear of losing due to identity preservation costs
  - farm profitability is also affected by market access, which depends on foreign consumer attitudes and policies affecting imports from GM-adopting countries
    - fear that, once GM adoption is allowed, the nation's or region's GM-free status will be lost forever

## *Welfare effects of GM adoption cannot be determined a priori*

- Even if new farm technology is cost-saving, price of GM crops may be low if there are import restrictions or strong consumer aversion abroad
  - True even if domestic consumers have no aversion to GM varieties, in cases where export-dependence is high
- Hence the need for empirical analysis to estimate the net gain to each national economy
  - against which to compare any perceived costs (discounted according to their likelihood of not occurring)

## *Modeling approach*

- We use the economy-wide GTAP model of the global economy, modifying it to separate the markets for GM and non-GM crop varieties
- We ignore the biotech and seed industries' gains, and simply assume potentially profitable GM seeds become available for farmers to purchase and grow
  - thereby underestimating the gross gain to biotechnology-producing countries
- We ignore any producer or consumer externalities (positive or negative) and the value consumers place on their right to know if their food contains GMOs

# GTAP modeling of GM attributes

- For first-generation GM varieties, we assume a farm productivity shock for a portion of the crop area (around half for food crops)
  - ignoring gains to the environment and to farmer health where the GM variety involves less pesticide
- For second-generation GM varieties, we assume unskilled labor in poor countries becomes more productive
  - ignoring their potential to lower farm costs, and also their non-pecuniary benefits (people living longer and healthier lives)

==> our calculated gross benefits, which also exclude net gains to biotech firms, are lower-bound estimates (but also need to subtract value of any negative externalities to get net social benefits)

# Productivity shock assumptions

- Farm total factor productivity (TFP) shocks from first-generation GM crop varieties, relative to traditional varieties, in GM-adopting countries:
  - 7.5% TFP increase in GM coarse grains
  - 6% TFP increase in GM oilseeds
  - 5% greater TFP in non-golden GM rice and wheat
  - 0% greater TFP in golden rice (although evidence suggests this may well be positive rather than zero)
- Unskilled labour productivity shock from GM golden rice in adopting countries:
  - 0.5% increase

## *Basis of golden rice assumption*

- It has more beta-carotine, which is needed for provitamin A production that reduces blindness, morbidity and mortality
- Philippines case study (Zimmerman/Qaim 2004): first-strain golden rice could reduce number of DALYs lost due to provitamin A deficiency by up to 47%
  - That is equivalent to an increase in unskilled labor productivity in that country of 0.53%
    - and the latest strain of golden rice (Paine et al., April '05) is many times more effective than that first strain

## *First-generation scenarios*

- 1: Distribution of global welfare gains from ***GM corn, soybean and canola*** adoption in US, Canada and Argentina:
  - (a) if there had been no EU moratorium, versus
    (b) in the presence of an EU moratorium
- 2: Effects if EU were instead to adopt
  - to estimate the cost they are bearing to avoid GMOs
- 3: Effects if the whole world adopted
  - to get a sense of the technology's global potential for those crops (to compare later with ***rice and wheat***)

## *Global welfare effects of GM corn and oilseeds with & without EU moratorium*

| Welfare of ($billion pa): | NA & ARG | EU15 | Asia + ANZ | **World** |
|---|---|---|---|---|
| 1. NA & ARG adopt: *(a) no moratoria* | 1.4 | 0.3 | 0.45 | **2.3** |
| *(b) EU moratorium* | 0.9 | -3.1 | 0.50 | **-1.2** |
| 2. NA, ARG & EU adopt | 1.3 | 0.4 | 0.47 | **2.4** |
| 3. All countries adopt | 1.2 | 0.6 | 1.05 | **4.0** |

## *First-generation scenarios (cont.)*

- 4: Distribution of global welfare gains from ***GM corn, soybean, canola, rice and wheat*** adoption in US, Canada and Argentina plus China and India:
  - (a) if there had been no EU moratorium, versus (b) in the presence of an EU moratorium
- 5: Effects if the whole world adopted

## *Welfare effects of 1st generation GM rice, wheat, corn and oilseeds adoption*

| Welfare of ($billion p.a.): | NA & ARG | EU15 | China and India | Other devel-oping | **World** |
|---|---|---|---|---|---|
| 4. NA, ARG, Ch, In, & Sth. Africa adopt: *(a) no moratoria* | 1.5 | 0.4 | 1.5 | **1.0** | **4.3** |
| *(b) EU moratorium* | 1.0 | -4.7 | 1.5 | 1.3 | **-0.9** |
| 5. All countries adopt | 1.4 | 0.8 | 1.6 | **3.5** | **7.5** (cf 4.0) |

## *2nd generation scenarios*

- Comparator: 1st generation ***GM corn, soybean and canola*** adoption in US, Canada, Argentina
- 6. Effects if Developing Asia were also to adopt Golden Rice
  - (a) if there are no moratoria, versus
    (b) in the presence of a moratorium by EU, Japan and Korea

# *Welfare effects of golden rice (0.5%)*

| Welfare of ($billion p.a.): | China | India | Other Dev. Asia | Ja+Ko | EU15 | WORLD |
|---|---|---|---|---|---|---|
| 1. NA+ARG adopt GM corn & oilseed | 0.1 | 0.0 | 0.0 | 0.3 | 0.3 | **2.3** |
| 6. Dev. Asia also adopts golden rice: *(a) No moratoria* | 1.8 | 0.6 | 1.0 | 0.6 | 0.6 | **6.4** |
| *(b) EU, Ja+Ko adopt moratorium* | 1.9 | 0.6 | 1.0 | -1.8 | -2.9 | **1.0** |

# *Conclusion from GM food/feed sims.*

- Second-generation Golden Rice benefits to Asia's developing countries could be substantial, even when farm cost savings and non-pecuniary health benefits are ignored (not to mention potential gains from nutrient-enriched wheat, & gains to non-Asian DCs)
  - True even if EU, Japan and Korea were to ban imports of those crops from GM-adopting countries
- Same is true for Sub-Saharan Africa

## *So why has adoption not happened?*

- Current GM attitudes and policy in EU are slowing investment in development of new GM food/feed varieties by biotech firms and IARCs, esp. second-generation GM foods
- Fear by developing countries of loss of market access abroad? (seems unwarranted)
- Fear of domestic consumers not accepting GM food? (seems unlikely in developing countries, especially among the poor)

## *So why has adoption not happened?*

- Government authorities in DCs are not yet convinced GM food is safe enough for consumers?
  - Yet Americans have been eating it for a decade now
- To give national R&D providers a chance to catch up with multinational biotech firms so that gains to GM technology provision (not included in above analysis) stays within the developing country?
  - May be an issue in China, but has had the opposite effect in India where national biotech firms cannot afford the up-front cost of & delays in meeting regulators' demands

# What about GM cotton?

- GM cotton has been adopted mainly by the US, Australia, China and South Africa
  - In Aust, GM cottonseed was deemed safe for consumers in 1996 (but no other GM foods since)
- India recently began adopting GM cotton
- What are the national econ. welfare effects of:
  - (a) GM cotton adoption by early adopters to 2001
  - (b) China completing its adoption and all but Sub-Saharan Africa also adopting
  - (c) Sub-Saharan Africa also adopting?

# Welfare effects of Bt cotton adoption

| Welfare of ($billion pa): | US, Au and SA | China | SE Asia | Sth. Asia | Other Sub-S. Africa | WORLD |
|---|---|---|---|---|---|---|
| (a) Just US, Au, SA and Ch adopt as of 2001 | 0.35 | 0.16 | 0.04 | 0.01 | **-0.02** | **0.7** |
| (b) Then all *except* SSAfrica also adopt | 0.41 | 0.27 | 0.10 | 0.97 | **-0.04** | **2.8** |
| (c) Then Sub-Saharan Africa also adopts | 0.39 | 0.26 | 0.10 | 0.98 | **0.15** | **3.1** (cf 7.5) |

## *Welfare effects of GM cotton vs removal globally of all cotton subsidies and tariffs*

| Welfare of ($billion pa): | US, Au and SA | China | SE Asia | Sth. Asia | Other Sub-S. Africa | WORLD |
|---|---|---|---|---|---|---|
| Global GM cotton adoption | 0.39 | 0.26 | 0.10 | 0.98 | **0.15** | **3.1** |
| Global removal of cotton subsidies and cotton tariffs | 0.57 | 0.05 | -0.08 | -0.10 | **0.15** | **0.3** |
| Global removal of all subsidies and tariffs | 4.6 | 3.1 | 6.5 | 2.6 | **-0.0** | **81.8** |

## *Effects of GM cotton adoption globally on net incomes of cotton farmers (%)*

| | US | Aust & Sth. Africa | China & SE Asia | South Asia | Other Sub-S. Africa | WORLD |
|---|---|---|---|---|---|---|
| *Without* SSAfrica adopting | -3 | -3 | -3 | -3 | **-12** | **-4** |
| *With* SSAfrica adopting | -4 | -7 | -3 | -4 | **6** | **-4** |

# *Some background papers:*

- Anderson, K. and L.A. Jackson, "Some Implications of GM Food Technology Policies for Sub-Saharan Africa", *Journal of African Economies* 14(3): 385-410, September 2005
- Anderson, K. and L.A. Jackson, "GM Crop Technology and Trade Restraints: Economic Implications for Australia and New Zealand", *Australian Journal of Agricultural and Resource Economics* 49(3): 263-81, September 2005
- Anderson, K., L.A. Jackson and C.P. Nielsen, "GM Rice Adoption: Implications for Welfare and Poverty Alleviation", *Journal of Economic Integration* 20(4), December 2005
- Anderson, K., E. Valenzuela and L.A. Jackson, "GM Cotton Adoption, Cotton Subsidy and Tariff Removal, and Developing Country Welfare", mimeo, World Bank, Washington DC, January 2006