Feeding Bt (MON810) maize to pigs; Outcomes of the GMSAFOOD project

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Teagasc
Agriculture and Food Development Authority

The Irish Agriculture and Food Development Authority

Outline

- GM Feed
  - Definition
  - Ireland's stance
  - Authorisation of GM food in Europe
  - Concerns with GM
- GMSAFOOD Project
  - Background
  - Teagasc involvement
  - Results of pig trials
  - Conclusions

What is a GM feed?

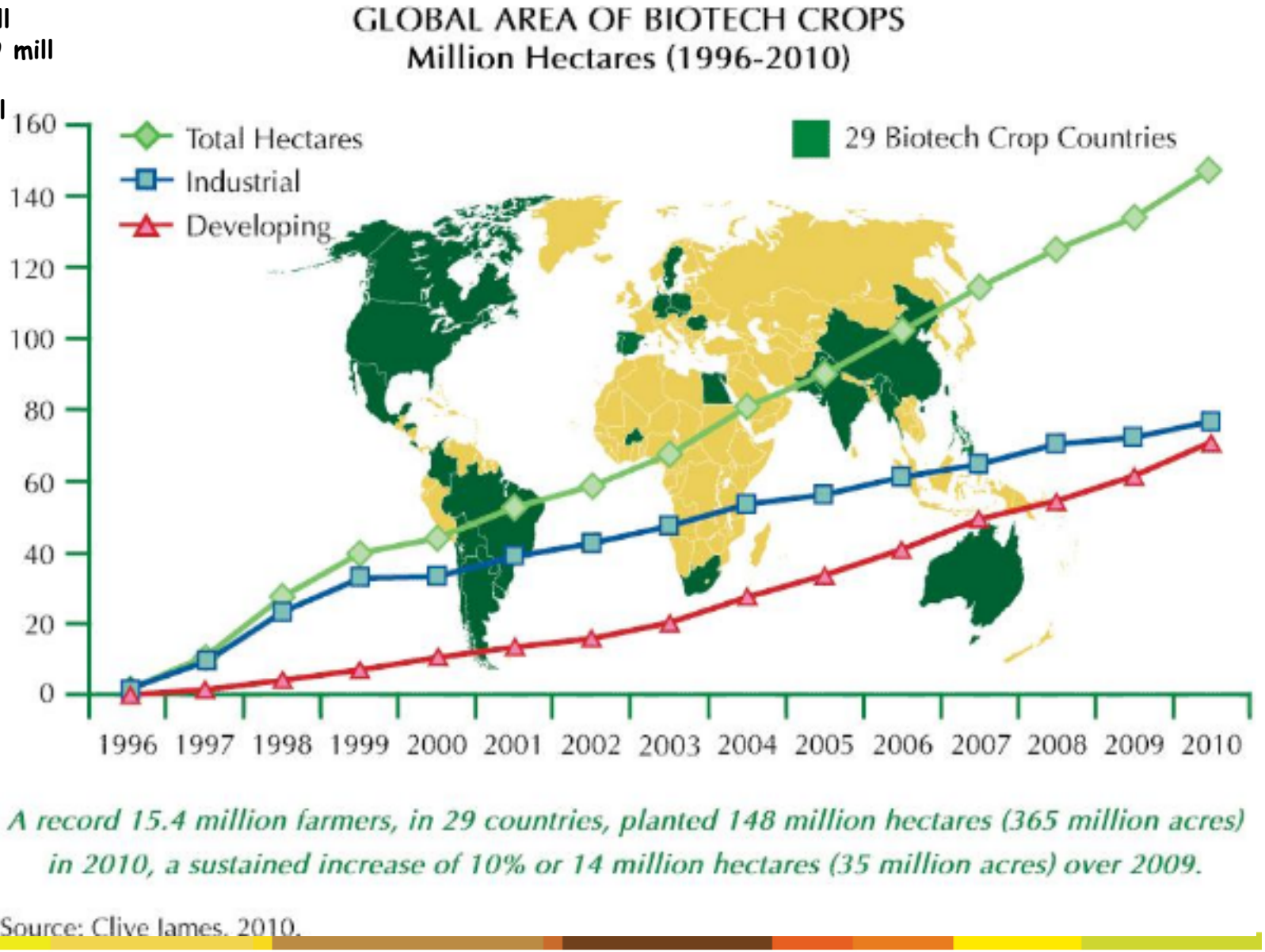
- GMO are organisms in which the genetic material (DNA) has been altered in a way that does not occur naturally *(WHO, 2002)*

- Transfer of desirable characteristics to living cells

- 0.9% established as the baseline for the 'presence of GMO'

- Call for tolerance of 0.1% unauthorized GMO in animal feed

1. **USA - 66.8 mill**
2. **Brazil - 25.4 mill**
3. **Argentina – 22.9 mill**
4. **India – 9.4 mill**
5. **Canada – 8.9 mill**



A record 15.4 million farmers, in 29 countries, planted 148 million hectares (365 million acres) in 2010, a sustained increase of 10% or 14 million hectares (35 million acres) over 2009.

Source: Clive James, 2010.

Ireland's Position on GM Crops

- No cultivation of GM crops currently

- Only EU authorized GM crops can be imported & used in animal production and for food

- Import large amounts of GM crops

(2005-2007; >3.4 million tonne imported into Ireland)

EU Authorisation of GM feed

- Based on EU regulation on genetically modified food and feed (829/2003)

- Application is made to member states
  - Studies to show GM food is not dangerous to health or the environment
  - Nutritionally equivalent to conventional counterpart
  - Proposal for post-market monitoring

- Application forwarded to EFSA (6 mts to make decision)
- EFSA opinion submitted to the EC and member states
- EC and member states produce a draft of decision
- Submitted to 'Standing Committee on the Food Chain and Animal Health'
- Decision different to EC – European Council of Ministers (90 days)
- Process can take up to 33 months

Concerns with GM

- Perceived risk to health
- Development of toxicities and allergies
- Transfer of antibiotic resistance

- Environmental concerns
  - Gene transfer to indigenous plants
  - Reduced biodiversity
  - Influence on non-target species

- Unintended responses may not appear until;
  - Genetically diverse population
  - Long period of time

GMSAFOOD

GM POST-MARKET MONITORING

salmon
effects of short and long term feeding of AAI peas & Bt-corn to salmon in growth and reproductive phases

Bt-Corn

α-amylase inhibitor (AAI) peas

pigs
effects on pigs of feeding AAI peas & Bt-corn in short-term, medium-term and long-term experiments

mice
effects on adult mice, development of mice and on mice with pre-existing allergic disease

Hu-SCID mice
effects of feeding of AAI peas to human-severe combined immunodeficiency model

Legume allergic patients

rats - food chain
effects of feeding AAI pea & Bt-corn-fed fish and pork to rats

offspring
untoward effects in offspring of AAI pea & Bt-corn -fed parents

experimental data

characterizing antigenic epitopes in GM-fed animals vs plant-allergic humans

biostatistical modeling of GM biomarkers for PMM

Bt (MON810) maize

- Bt maize (MON810) – confers resistance to the European corn borer

- Cry1Ab protein has been found to demonstrate antibacterial activity *in-vitro* *(Yudina et al., 2007)*

- To date, Cry1Ab protein has been proven safe in animal trials & no homology to any allergenic proteins (*EFSA, 2009*)

Short-term feeding of Bt (MON810) maize to pigs

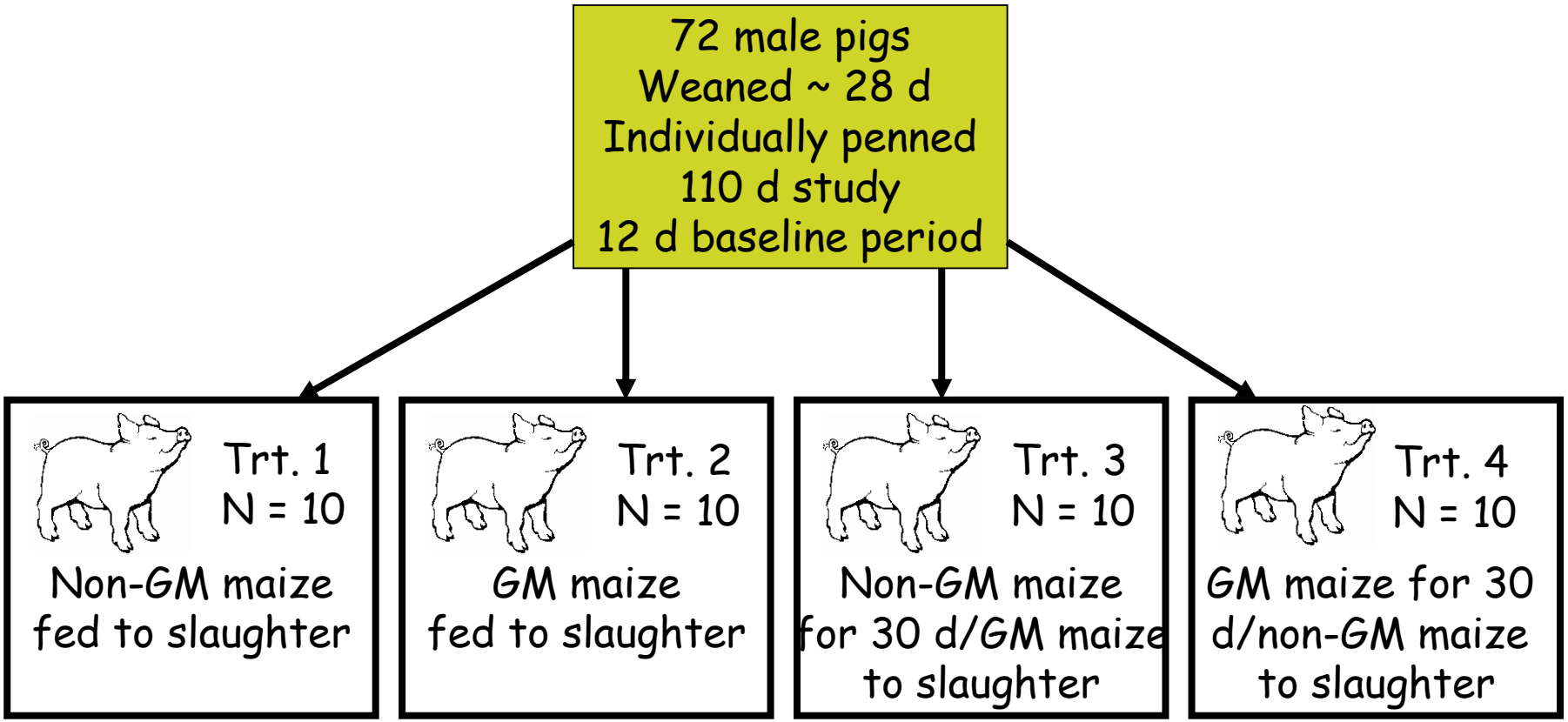
32 male piglets
weaned at ~28 days

Non-GM maize
(~39% of diet)

GM maize
(~39% of diet)

- Penned individually in 4 similar rooms (8 pigs/room)
- 31 day experiment (n = 10)

Medium-term feeding of Bt (MON810) maize to pigs



- Growth performance
- Organ structure and function
- Intestinal histology
- Intestinal microbial populations
- Tracking of Bt toxin

Results

1. Growth Performance

Short-term study

Overall	Non-GM	GM	SE	P-value
ADG, g/d	576	620	18.2	0.11
ADFI, g/d	697	770	22.9	0.03*
FCE	1.22	1.24	0.015	0.28
d 30 BW, kg	24.7	26.0	0.56	0.11

* P < 0.05

Walsh *et al.*, 2011

Medium-term study

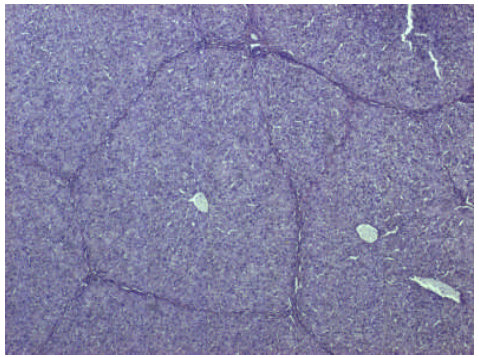
Overall	Non-GM	GM	Non-GM /GM	GM/ Non-GM	SE	P-value
ADG, g/d	920	905	961	933	18.3	0.16
ADFI, g/d	1806	1773	1908	1817	45.5	0.18
FCE	1.96	1.96	1.98	1.95	25.9	0.86
d 105 BW, kg	106.7	105.8	111.8	108.6	1.88	0.11

2. Organ Function

Short-term study

	Non-GM	GM	SE	P-value
Kidneys, g	145.2	161.0	4.52	0.06†
Spleen, g	47.5	54.3	2.71	0.14
Liver, g	690.0	665.3	17.98	0.38
Heart, g	133.3	142.2	3.96	0.18

† P < 0.10



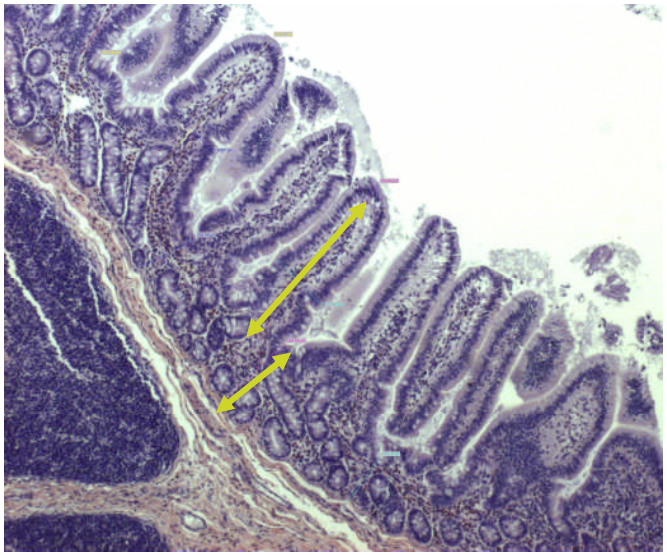
No histopathological indicators of organ dysfunction

No changes in blood biochemistry indicative of organ damage

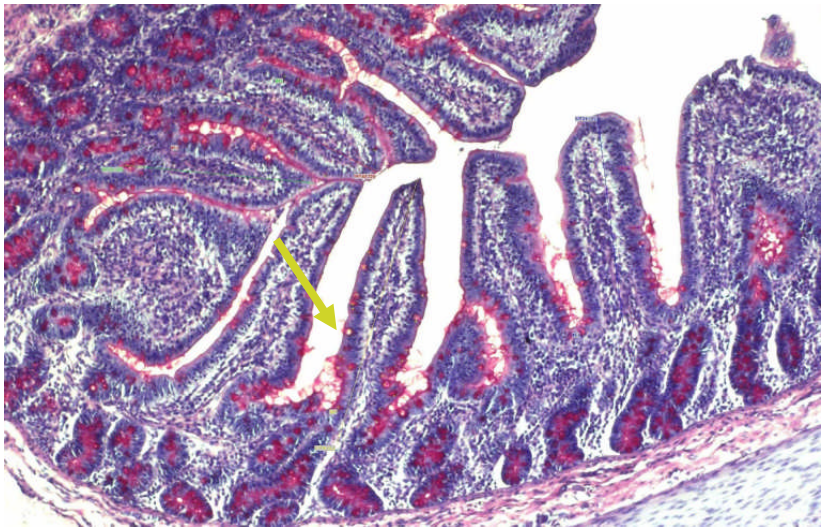
Medium-term study

- No change in organ weight, structure or function following feeding GM maize to pigs

3. Intestinal Structure

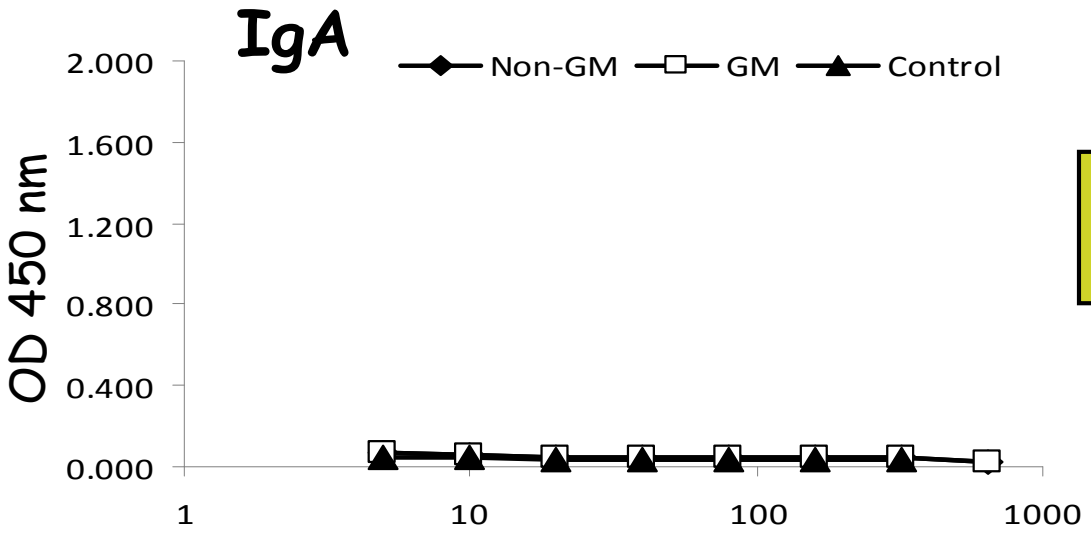


No effect of short- or medium-term feeding of GM maize on villus height or crypt depth in the duodenum, jejunum or ileum



No change in the number of goblet cells/villus in the duodenum, jejunum and ileum in response to feeding GM maize

4. Immune Response



No antibodies specific to the Bt toxin detected

Non-GM

GM

- Elevated Th1 cytokine profile (inflammatory) in non-GM maize pigs
- Non-GM maize-fed pigs may be exposed to more endotoxins
- GM maize-fed pigs may be protected from developing an inflammatory response due to the genetic modification in the maize

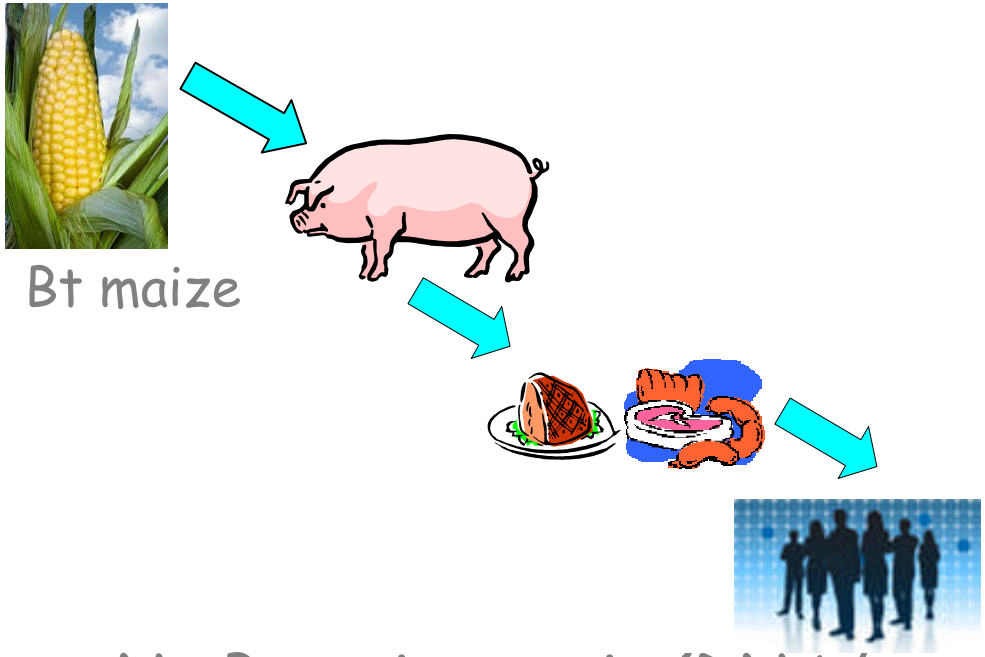
(Walsh et al., 2011: PLoS ONE)

5. Intestinal microbiology

Short-term study

- Changes in the prevalence of a small number of bacteria
- These bacteria were present in very low numbers
- Changes not likely to be detrimental to the pig
- Source of maize or differences in cultivars or ingredients could potentially lead to similar subtle changes
- Further work is being carried out in Moorepark

6. Fate of Bt toxin inside the pig



Bt maize

Genetic fingerprinting
-Bt gene
ELISA
-Bt protein

- No Bt maize toxin (DNA/protein) was found in the blood, heart, liver, kidney, spleen or muscle of pigs fed GM maize

- Bt toxin did not migrate from the digestive tract into other organs

- Bt toxin is broken down as it progresses through the GIT

Conclusions

- GMSAFOOD project is still ongoing – due for completion in March 2012
- Bt maize has shown no adverse effects on;
  - Growth performance
  - Intestinal health
  - Organ structure & function
- Bacteria in the digestive tract appear to tolerate Bt toxin
- Bt toxin does not migrate from the digestive tract & is broken down as it processes through the tract
- Bt maize may offer protection against an inflammatory response observed following non-GM maize consumption

Implications

- Feeding Bt maize resulted in no unintended effects when fed to pigs

- Can offer assurance to regulators, farmers and consumers as to the safety of Bt maize

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GM POST-MARKET MONITORING

SEVENTH FRAMEWOR PROGRAMME