Session 11

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Effect of short-term feeding of genetically modified (Bt MON810) maize on weanling pig growth performance, organ weight and histopathology

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Introduction

- GM maize - 2nd most cultivated GM crop worldwide
- Consumer concerns:
  - Health risks
  - Toxicity
  - Allergenicity
  - Transfer of antibiotic resistance
- Bt maize (MON810) – Cry1Ab protein confers resistance to European corn borer
- Cry1Ab protein proven safe in animal trials & no homology to allergenic proteins (EFSA, 2009)

Introduction

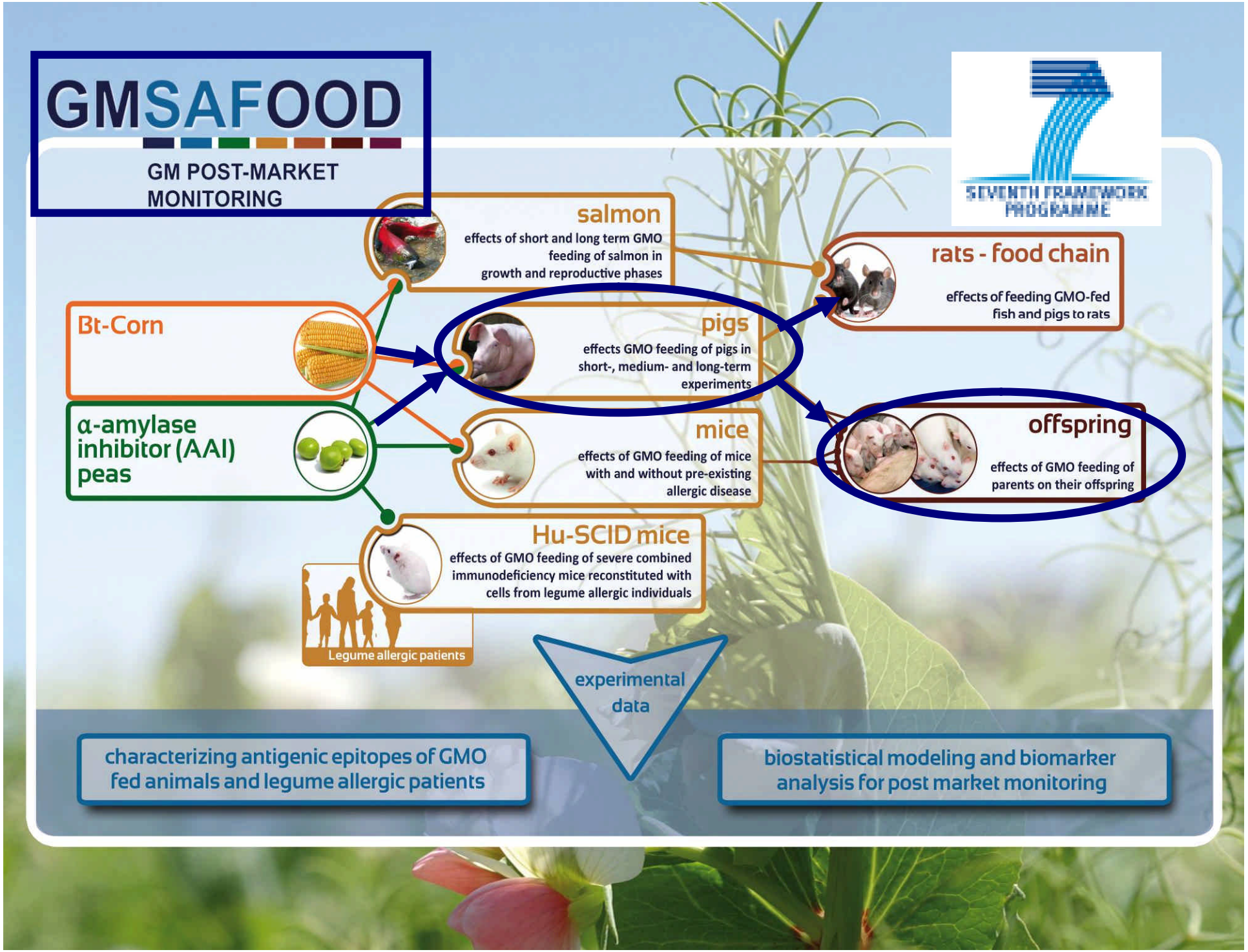
- GMOs – EU authorised after short-term pre-market risk assessment

- Post Market Monitoring
  - Unintended responses may not appear until exposure to a genetically diverse population for a long period of time

efsa
European Food Safety Authority

Objectives

- To identify changes in pig performance and health in response to Bt (MON810) maize consumption
- To use as biomarkers to predict harmful effects of GM maize consumption after product authorization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GM POST-MARKET MONITORING
SEVENTH FRAMEWORK PROGRAMME
salmon
effects of short and long term GMO feeding of salmon in growth and reproductive phases
Bt-Corn
α-amylase inhibitor (AAI) peas
pigs
effects GMO feeding of pigs in short-, medium- and long-term experiments
mice
effects of GMO feeding of mice with and without pre-existing allergic disease
Hu-SCID mice
effects of GMO feeding of severe combined immunodeficiency mice reconstituted with cells from legume allergic individuals
Legume allergic patients
rats - food chain
effects of feeding GMO-fed fish and pigs to rats
offspring
effects of GMO feeding of parents on their offspring
experimental data
characterizing antigenic epitopes of GMO fed animals and legume allergic patients
biostatistical modeling and biomarker analysis for post market monitoring

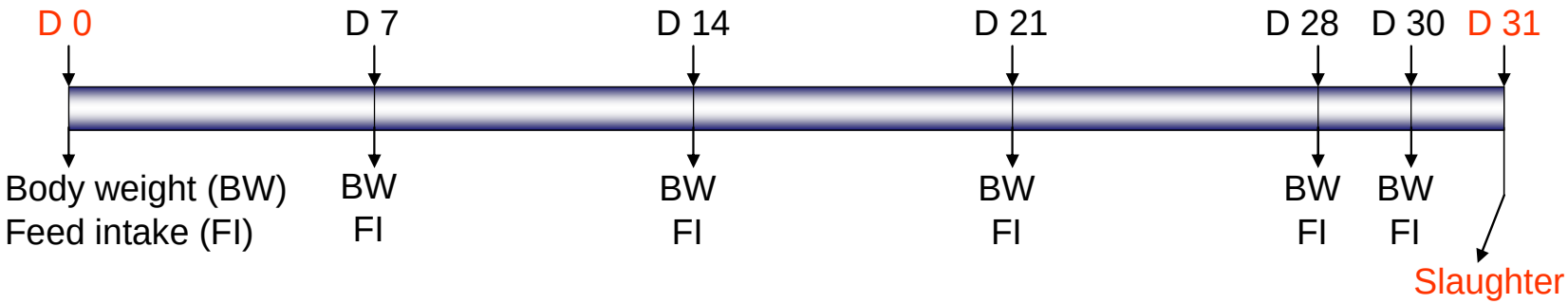
Experimental design

32 male pigs (16/trt) weaned at ~28 days

Non-GM maize

GM maize

~39 % of diet for 31 days



Parameters of interest

- Maize analysis
  - Mycotoxins (aflatoxin, ochratoxin, zearalenone, vomitoxin, T2 toxin, fumonisin)
  - Pesticides (355 active substances)
  - Presence of Cry1Ab protein
  - Proximate composition
  - Amino acid levels
- Dietary analysis
  - Proximate composition
  - Amino acid levels

Parameters of interest

- Growth performance
  - Individual body weights (BW)
  - Average daily gain (ADG)
  - Average daily feed intake (ADFI)
  - Feed conversion efficiency (FCE)
- Organ dysfunction
  - Organ weight at slaughter (heart, kidney, spleen, liver)
  - Blood biochemistry at slaughter (liver and kidney)
  - Histological evidence of organ dysfunction (heart, kidney, spleen, liver, muscle)

Results

Dietary composition

- Maize
  - Pesticide residues below minimum detection limits
  - Mycotoxins below maximum allowable levels
  - *Cry1Ab* gene confirmed in GM maize
- Maize and diets
  - Similar proximate and amino acid composition

Growth Performance

	Non-GM	GM	SE	P-value
Final BW (kg)	24.7	26.0	0.56	0.11
ADG (g/d)	576	620	18.2	0.11
ADFI (g/d)	697	770	22.9	0.03
FCE (F:G)	1.22	1.24	0.015	0.28

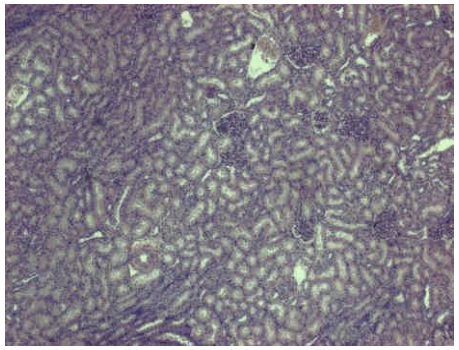
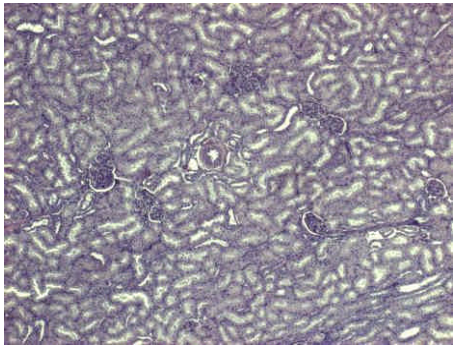
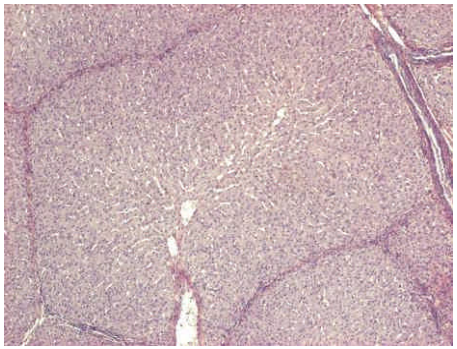
Organ Weights*

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

*Final body weight used as a covariate in the statistical model

Organ Histopathology

- No evidence of organ dysfunction
- No differences detected between treatments

	Non-GM	GM
Kidney:		
Liver:		

Histology of pig organs H&E stained (40x)

Blood biochemistry

	Non-GM	GM	SE	P-value
Total Protein, g/L	55.1	57.9	1.08	0.12
Kidney Function				
Creatinine, μmol/L	109.5	103.0	3.74	0.27
Urea, mmol/L	5.9	5.3	0.51	0.45
Liver Function				
Alanine aminotransferase, U/L	41.1	44.8	3.57	0.49
Aspartate aminotransferase, U/L	54.7	56.3	2.96	0.74
Gamma glutamyl transferase, U/L	43.6	38.1	7.63	0.64

Summary

- ADFI increased in pigs fed GM maize but no significant effects on ADG, FCE or final BW
- Maize and diets of similar composition
- No significant effects on organ weights – kidneys tended to be heavier in GM maize fed pigs
- No differences detected in organ histopathology
- Blood biochemistry parameters within normal limits and not significantly different between treatments

Implications

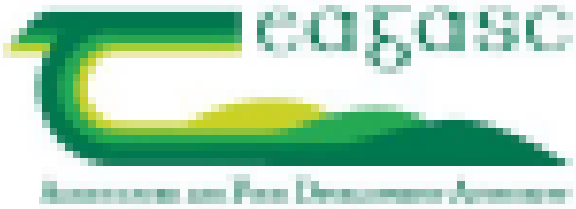
- No observed adverse effects on the health and growth performance parameters measured
- No suitable biomarkers for post-market monitoring identified to date
- Consumer assurance as to the safety of GM feed ingredients

Ongoing & Future Work

- Medium & long-term effects of feeding Bt (MON810) maize to pigs & their progeny
- Transfer of transgenic proteins & genes to tissues and gut microbiota
- Short-term effects of feeding αAI peas to pigs

Acknowledgements

- Funding from EU Commission 7th Framework Programme
- Walsh Fellowship funding by Teagasc



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