An investigation into the economic, health and environmental implications of the increasing use of GM animal feed in Europe

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BACKGROUND

This essay will investigate the direct and indirect global implications of the ever-increasing world production of Genetically Modified (GM) crops that is fuelled by the rising demand for GM animal feed within the EU and elsewhere. Currently, the estimated global area given over to GM crop production is 125 million hectares (GMO Compass, 2009 [http://www.gmo-compass.org/eng/agri_biotechnology/gmo_planting/257.global_gm_planting_2008.html]) and this figure is continuing to rise (now 134 million). In Europe there is a great demand for cheap animal feed and GM animal feeds based on GM soya and maize are increasingly perceived as the cheapest and most readily available. According to the European Feed Manufacturers' Association, 85% of the EU's compound feed production is now labeled to specify that it contains GM or GM-derived material (FSA, 2009 [http://www.food.gov.uk/gmfoods/gm/gmanimal]). Supermarkets are also under pressure to stock more GM-based food, as it is both cheap and readily available. However in Europe, consumer wariness or outright rejection, as well as compulsory GM labelling, act as major obstacles.

The public is being exposed to a large amount of Government spin and pressure because of the 'professed' health, economic and even environmental benefits of GM crops. Purported benefits claimed by the biotechnology (Monsanto, 2009 [http://www.monsanto.com/biotech-gmo/asp/experts.asp]) industry include higher protein content to accelerate animal growth rates and the use of less pesticide to reduce costs. Most, if not all, of the biotech industry's claimed advantages of GM crops can be contested scientifically or economically. During their production, GM crops also threaten the organic agriculture industry by the contamination of organic crops, which makes 'co-existence', the catch-cry of governments and biotech firms, hugely problematic.

GM in the EU: the legal perspective (source: EurActiv.com [http://www.euractiv.com/en/cap/genetically-modified-organisms/article-117498])

GM foods are opposed by a large proportion of EU citizens, and several countries reject them outright. EU Member States insist on more thorough pre-market safety reviews than in the US where they are voluntary, and EU Directives and Regulations have been set up on various issues. Consequently, current EU legislation on GMOs is regarded as the strictest in the World.

EU Directive 2001/18/EC, adopted in 2001, relates to the release of GMOs into the environment. The Directive ensures that all GM food and crops are subject to strict risk assessments before they can be sold, marketed, or planted in the EU.

Meanwhile, Regulation 1830/2003/EC requires the labelling of all foods produced from GMOs if they contain 0.9% or more of GM material, unless GMOs are accidental and technically unavoidable. The threshold for the presence of GMOs not yet authorised in the EU (but which

have received a favourable scientific risk assessment) has been set at 0.5 per cent.
This Regulation also stipulates that GMOs ‘must be traceable throughout the entire production and distribution process, thus making it compulsory to the producers of GM seeds and crops to inform any purchaser of the presence of GMOs and to record to whom and from whom GM products are made available’.

Regulation 1829/2003/EC on GM Food and Feed, introduces a centralised authorisation procedure for GMOs used as food or animal feed.

At the moment, EU labelling is very stringent and any human or animal food containing more than 0.9% GM product must include on its label the phrase "This product contains genetically modified organisms" or "Product produced from GM (name of organism)". However, if an animal product is derived from animals fed GM animal feed, there is no mandatory labeling requirement. Ireland is the first EU member state to adopt a voluntary scheme to provide a GM-free label (GM Free Ireland, 2009 [http://www.gmfreeireland.org/]) for qualifying animal products whose diet (throughout their whole life) respects the same 0.1% threshold for GMO presence. Environmental NGO Friends of the Earth has meanwhile called on the EU to introduce mandatory labeling for meat and dairy products from livestock reared on a GMO-based diet. These recent events will provide greater transparency within the GM animal feed market.

The co-existence of GM and conventional crops is currently under discussion at EU level. Controversial issues here, concern GMO thresholds in organic produce, civil responsibility, thresholds for GMO in seeds and the possibility of setting up GM-free zones.

On the dangers of GMO's, the EU asserts that the scientific community is as yet unable to give a definitive answer. It recognises the only known health risks from GMOs as being food allergies, and increased antibiotic resistance. They also recognise that wildlife can be harmed, and that cross-pollination with other plants may occur.

This essay is divided into two main parts: a geographic evaluation, which explores the details of GM crop production, supply and demand, and a scientific evaluation which investigates the health implications of human consumption of animal products derived from animals fed GM animal feed. Finally the essay examines the environmental effects caused by ever increasing GM crop cultivation, as well as the implications of this on the viability of the human race. Fundamentally, the discussion will question the EU's attitude to GM animal feed and the arguments placed by the World Trade Organisation and agri-business interests that are placing increasing pressure on the EU—and its nearly 500 million strong population—to accept more GM crops and food.

GEOGRAPHIC ASPECTS

Production

1.) Countries with largest GM crop production

Country	Gm crop production (mHa)
USA	62.5
Argentina	21
Brazil	15.8
India	7.6
Canada	7.6

Data source: GMO Compass, 2009 [http://www.gmo-compass.org/eng/agri_biotechnology/gmo_planting/257.global_gm_planting_2008.html]

The countries in table 1 are not the only countries contributing to the GM market; countries such as China, Paraguay and South Africa are cultivating GM crops on an area of over one million hectares (GMO Compass, 2009). On a global scale, GM production is rising fast and there are four cash crops that continue to account for virtually all output: soya (51%), corn (31%), cotton (13%), and canola (5%) (Worldwatch Institute, 2009 [http://www.worldwatch.org/node/5950]). These cash crops are being used in animal feed, but it is specifically GM soya, maize that this essay examines in further detail.

GM soya production has increased rapidly, by 7.2mHa from 2007 to 2008. Table 2 shows the countries cultivating significant amounts of GM soya are predominantly in North and South America (USA, Argentina, Brazil, Canada, Uruguay, Bolivia, Paraguay, Chile and Mexico)(GMO Compass, 2009 [http://www.gmo-compass.org/eng/database/plants/67.soybean.html]). Government policies and export forces are encouraging their production at a fast increasing rate. World GM maize production has increased by 6% up to 37.3 mHa . The foremost countries cultivating GM maize are the USA and Argentina, followed by Canada, South Africa, Uruguay, the Philippines, Chile, Honduras and China (GMO Compass, 2009 [http://www.gmo-compass.org/eng/agri_biotechnology/gmo_planting/257.global_gm_planting_2008.html]).

2.) Production of GM Soya and Maize

CROP	COUNTRY	GM (mHa)	NON-GM (mHa)	Total crop cultivation (mHa)
SOYABEAN	Total	65.8	25.2	91
	USA	26.98	2.35	29.33
	Brazil:	13.975	7.525	21.5
	Argentina:	13.8	0.2	14
MAIZE	Total	37.3	110.7	148
	Argentina	1.495	0.805	2.3
	USA	22.968	5.742	28.71
	China	7	17	24

Data Sources: Nation Master, 2009 [http://www.nationmaster.com/encyclopedia/GM-crops], FSA, 2009 [http://www.food.gov.uk/gmfoods/gm/gmanimal]

Economics and Supply

GM seeds only account for 14% of the total seed market that in 2007 was worth ‘approximately

$50 bn' (Bonny, 2009 [http://www.economia.uniroma2.it/icabr/Public/5/File/Bonny%20Presentation%2018%20June%202009.pdf]). The GM seed market, though small, is a significant part of the seed sector and there is an increasing merging of companies in the seed industry, especially by the top 5 companies, namely Monsanto, BASF, Dow AgroSciences, Pioneer (DuPont), Bayer Crop Sciences, and Syngenta. It is found that on average the private sector and industrialized countries are the greatest investors for research and development expenditure in agro-biotechnology. The total global expenditure was 4400 ($10USD^6$) and industrialized countries represented 96% of global expenditure whilst Less Economically Developed Countries (LEDC's) accounted for a mere 4%. In 2008 the global sales of GM seeds were 7.5 billion USD and out of this technology fees cost 3.5 billion USD (47%)(Bonny, 2009 [http://www.economia.uniroma2.it/icabr/Public/5/File/Bonny%20Presentation%2018%20June%202009.pdf]).

Usage

Animal feed accounts for a huge proportion of the world's harvest, with estimates ranging from one third to nearly 50% (Goodland, 1999), and 90% of the world's soya is used to feed animals (Brown, 1999). It is not widely recognised that GM crops are used in animal feed or that millions of tons of GM crops have been fed to farm animals for more than a decade (Monsanto, 2009 [http://www.monsanto.com/monsanto_today/for_the_record/food_safety.asp#one]). Within the EU, 150 million tonnes of feed materials are processed into 150 million tonnes of compound feed. The European Feed Manufacturers' Association states that 85% of the EU's compound feed production is now labeled to specify that it contains GM or GM-derived material (FSA, 2009 [http://www.food.gov.uk/gmfoods/gm/gmanimal]). Every year the EU produces, 6 billion broilers, 370 million laying hens, 260 million pigs, 90 million bovines and 100 million sheep & goats. This essentially provides EU-citizens with 130 million hectoliters of milk, 45 million tonnes of meat and 6 million tonnes of eggs (FEFAC, 2009 [http://www.fefac.org/file.pdf?FileID=22194&CacheMode=Fresh]) and a large proportion of these animal products come from GM fed animals.

SCIENTIFIC ASPECTS

Health

A vast majority of conventionally produced animal products are derived from animals fed on GM animal feed (FSA, 2009 [http://www.food.gov.uk/gmfoods/gm/gmanimal]). Documented health risks result from the direct consumption of GM foods or by consuming products from animals fed on GM crops (Smith, 2007 [http://www.seedsofdeception.com/Public/GeneticRoulette/index.cfm]) and this therefore poses contentious issues for human welfare. Known adverse health effects caused by GM foods or constituents include; jeopardized immune function (Green, 1990 [http://ajph.aphapublications.org/cgi/reprint/80/7/848?maxtoshow=&hits=10&RESULTFORMAT=&author1=green&andorexacttitle=and&andorexacttitleabs=and&fulltext=+Bacillus+thuringiensis&andorexactfulltext=and&searchid=1&FIRSTINDEX=0&resourcetype=HWCIT]), early death (Bucchini and Goldman, 2002 [http://www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Reports/Food_and_Biotechnology/hhs_biotech_snapshot.pdf]), reduced fertility (Oliveri, 2006) and allergic reactions (Ordlee, 1996).

GM animal feed has negative implications for human health because of Vertical gene flow and Horizontal gene transfer. A controversial issue portends to evidence that vertical gene flow is occurring in the guts of the animals fed GM foods and this is in turn resulting in horizontal gene flow. Studies have proven that GM animal feed does affect animal products and 'Questions regarding the digestive fate of DNA and protein from transgenic grain have been raised in regard to human consumption and trade of animal products (e.g., meat, milk, and eggs) from farm animals fed transgenic crops.'(Jennings, 2003 [http://ps.fass.org/cgi/content/abstract/82/3/371]).
3.) A Table of research supporting the notion that transgene flow occurs horizontally or vertically following the consumption of GM animal feed.

Vertical or Horizontal Gene Flow	**Experimental model**	**Study conclusion**	**Reference**
V	Cows	In lactating Dairy cows Single-copy genes were only detected in the solid phase of rumen and duodenal digesta. In contrast, fragments of the rubisco gene were detected in the majority of samples analyzed in both the liquid and solid phases of ruminal and duodenal digesta, milk, and feces, but rarely in blood.	(Phipps, Deaville and Maddison, 2003)
V	Calves	In calves fed insect-resistant genetically modified maize Bt11 or non-genetically modified isoline maize for 90 days, trace amounts of Cry1Ab protein were detected in the gastrointestinal (GI) contents. These results suggested that only a trace amount of Cry1Ab protein survived passage through the GI tract but was not transferred to liver, spleen, kidney, lymph nodes or muscles.	(Chowdhury, 2003)
V	Humans	The only published human feeding study carried out on GM foods showed that, in three out of seven participants, genes transferred into the DNA of gut bacteria from GM soy. Herbicide tolerant bacterial gene sequences, the CaMV promoter and a petunia plant, which are all part of the Round up Ready soybean cassette, were confirmed as present in the bacteria using PCR analysis.	(Netherwood, 2004)
H	Chicks	In chicks fed GM corn, antibiotic resistant marker genes were found in their stomachs.	(Chambers, 2000)
H	Chickens	The gene fragments from feed were found in muscle, liver, spleen, and kidney tissues in chickens.	(Einspanier, 2001)
H	Pigs	In pigs fed GM and non-GM corn, Transgene and gene fragments were detected in the lower gastrointestinal tract (rectal and cecal).	(Chowdhury, 2003)
H	Sheep	The transgene for a Bt corn line (the full length of the coding portion for cry1AB) was found in sheep rumen.	(Duggan, 2003)
H	Humans	When humans were fed rabbit meat, fragments of rabbit DNA were found in the bloodstream.	(Forsman, 2003)

The scientists at the FDA's centre for Veterinary Medicine (CVM) have stated that every GM food requires testing before approval for public consumption. The CVM's director shows concern that residues of plant constituents or toxicants in meat and milk products may pose human food safety concerns (Gerald, 1992 [http://www.biointegrity.org/FDAdocs/08/view1.html]). However, Monsanto, one of the largest biotech companies in the world, announce on their website that "There is no need for, or value in testing the safety of GM foods in humans."(Monsanto, 2009 [http://www.monsanto.com/monsanto_today/for_the_record/food_safety.asp])

There is evidence to suggest that GM crops result in the build up of environmental toxins or the concentration of toxins in the produce of GM-fed animals. Toxicologist Gilles Eric-Seralini proposes that there are unknown levels of nutrients and toxins in many GM crops because there are new pesticide residues and possibilities of accumulation of residues because of the pesticide tolerance of GM crops. These may promote toxic effects on humans, animals and offspring, however tests for these residues are not generally done (Smith, 2007 [http://www.seedsofdeception.com/Public/GeneticRoulette/index.cfm]). Gilles Eric-Seralini also called for labeling of animal products from GM fed animals because pesticide residues associated (with) GMO's may bioaccumulation in the food chain, especially Roundup residues and adjuvants, and because animals may have metabolic disorders when they eat GMOs (Gilles Eric-Seralini). It is of great concern that mortality rates in cattle have increased in line with consumption of GMOs both in the United States [http://www.thecattlesite.com/articles/1641/dairy-cow-mortality-a-growing-problem] and in the UK [http://209.85.129.132/search?q=cache:votOueso_XoJ:www.sac.ac.uk/news/currentnews/09n61calves+uk+death+rate+in+cows&cd=9&hl=en&ct=clnk&gl=uk&client=firefox-a].

The health risks are not confined to the consumer; in source regions where GM crops are grown there are negative health implications for the communities who grow them. This was demonstrated in 2003 when Filipinos in at least five villages fell sick due to a nearby GM cornfield that was pollinating. Additionally, GM crops are clearly linked to allergic reactions, and one example of this is the hundreds of labourers in India who report allergic reactions from handling GM cotton [http://infochangeindia.org/200902147609/Agriculture/Features/Genetic-roulette.html]. At this moment in time there is no adequate regulatory framework, and industry studies are not competent to identify most of the unpredicted side effects of GM crops. Therefore public health is currently being jeopardised and we need to increase effectiveness of GM traceability.

Environment

There is a huge environmental impact from the growth of GM crops for animal feed and human consumption. The production of GM crops is causing soil degradation, effecting water sources, and encouraging pollution through overuse of pesticides. Monsanto claim, "This technology is helping farmers throughout the world produce higher yield, while reducing pesticide use and soil erosion,"(Monsanto, 2009 [http://www.monsanto.com/biotech-gmo/asp/country.asp?cname=a%20global%20conversation%20with%20growers]). However, the UN's International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) report (2008) [http://www.agassessment.org/reports/IAASTD/EN/Agriculture%20at%20a%20Crossroads_Global%20Summary%20for%20Decision%20Makers%20(English).pdf] suggests that GM crops do not consistently improve yields, they do not consistently decrease pesticide inputs and the

excessive use of Roundup and Liberty Herbicides on GM crops amplifies the hazards of using GM crops. The accelerated emergence of herbicide resistant weeds has resulted in the increasing use of even more toxic varieties of herbicides. This results in more chemicals entering and polluting water systems, which can be extremely dangerous when water systems are not regulated or monitored, and further biomagnifications in wildlife. South, North and Central Americas are main producers of GM crops for animal feed because they produce most of the world's GM Soya. Essential ecosystems, that are places of important biodiversity, are being felled to supply EU pigs with GM animal feed and the average consumer knows nothing about it. Both savannah and forests (Amazonian rainforest) are being destroyed. GM seeds contaminate the genes of non-GM crops and plants; this results in a loss of biodiversity and threatens organic standards. There are not only detrimental impacts for plants, but also for wildlife.

There are internal impacts for the countries involved in GM crop production. This is demonstrated in Brazil where GM crop production is fuelling the expansion of agricultural land, this results in huge transportation infrastructure that obliterate extensive areas of natural habitats. Deforestation, soil degradation, pesticide and genetic contamination in Brazil is directly stimulated by soybean production and soybean profits have warranted the expansion or creation of three railway lines, eight industrial waterways and a widespread system of roads to transport produce. In turn, the infrastructure has drawn private investment in logging, mining, ranching and other sectors that relentlessly undermine the area's biodiversity, something that has been omitted in any impact assessment studies (Fearnside, 2001). The recent expansion of GM soybean production in Brazil, Argentina, Paraguay and Bolivia signify a potent threat to biodiversity as GM soybean cause more damage to the environment than other crops. This is a result of unsustainable production techniques and because they are export orientated and this entails immense transportation infrastructure projects that make huge areas economically viable for other environmentally damaging extractive activities.

The rapid proliferation of soybean production absorbs government funds from sectors such as education, health, and 'low tech' sustainable agro ecological methods. The subsequent socio-economic consequences incorporate the concentration of land and income, the migration of rural populations to urban areas and thus compounding the concentration of the poor. Also, food security in these countries is also jeopardized as land previously under grain, dairy or fruits production has been converted to soybean for exports. While these countries continue to response to demand from the globalised economy, the associated ecological and social impacts of soybean production will continue (Fearnside, 2001).

ANALYSIS / DISCUSSION

The use of GM animal feed within the EU is widespread and the World Trade Organisation (WTO) is placing increasing pressure on the EU to accept more GM products.

In 2006 a WTO panel of judges ruled [http://trade.ec.europa.eu/doclib/docs/2006/november/tradoc_129465.pdf] (see page 24 of the PDF) that through its moratorium on the approval of GMOs between June 1999 and August 2003, the EU was in violation of its obligations under the 'Sanitary and Phytosanitary Agreement (SPS), including its obligation to undertake and complete approval procedures without 'undue delays'. Furthermore, the nine national safeguard measures introduced by

Austria, Greece, France, Germany, Italy and Luxemburg, since they were not based on a risk assessment, were deemed inconsistent with the SPS Agreement. As a result, the EU Commission must complete its approval for all outstanding GMO applications: 24 in all. Now it is only a matter of time, unless objecting Member States force the EU Commission to pay the hundreds of millions of Euros in annual fines for non-compliance with this ruling. The EU is already paying the equivalent of $150 million annually to maintain its non-acceptance of US hormone-fed beef, due to 'unfair restraint of trade'. As pointed out by GlobalResearch.ca [http://www.globalresearch.ca/index.php?context=va&aid=2202], the Centre for Research on Globalisation: "*It represents a major, dangerous wedge into largely GMO-free EU agriculture, permitting powerful agribusiness multinationals such as Monsanto, Dow Chemicals or Du Pont to overrun national or regional efforts to halt the march of GMO. For this reason, it is potentially the most damaging decision in the history of world trade agreements*".

Biotech companies aim to control the seed industry through the use of GM varieties. They are driven by business and profit, and not with benefiting the global population. Therefore it gives cause for concern that it is business that is gaining increasing power over the global supply of staple foods. The European Commission acknowledges that the indirect environmental or human health effects or GM plant induced imbalance in the animal interactions with the ecosystem is still largely an unexplored area.

According to GMO Compass [http://www.gmo-compass.org/eng/news/stories/286.gmo_labelling_animal_products_discussion_continues.html], consumer groups and politicians have repeatedly criticised the fact that there is no requirement in the EU for labelling of foodstuffs produced from GM-fed animals. Whilst it is easy to concur with the simple fact that the animals themselves have not been genetically modified, the fate of the GM material is clearly of great importance in a thorough risk assessment. The European Food Safety Authority (EFSA) [http://www.efsa.europa.eu/EFSA/Statement/gmo_EFSA_statement_DNA_proteins_gastroint.pdf] has published its own findings in this area, and has concluded that: "*a large number of experimental studies demonstrate that neither fragments of the transgenic DNA nor the proteins derived from GM plants are detectable in tissues, fluids, or edible products of farm animals such as broiler poultry, quail, cattle or pigs*". However, studies have been carried out which prove otherwise [http://www.ncbi.nlm.nih.gov/pubmed/16373205]. The levels of toxins that inevitably accumulate within GM-fed animals are also cause for great concern, but this safety aspect was not addressed in the July 2007 statement by EFSA.

The strength of public feeling on the GM animal produce issue was made clear with the submission, in February 2007, of a million signature petition delivered to the EU Commissioner for Health. This was organised by Greenpeace, and demanded the mandatory labeling of milk, meat, eggs and other food products derived from GMO fed animals. The Commissioner promised to revisit the issue, but, so far, EU citizens are still waiting.

The IAASTD report [http://www.agassessment.org/reports/IAASTD/EN/Agriculture%20at%20a%20Crossroads_Global%20Summary%20for%20Decision%20Makers%20(English).pdf] examined the global implications of GM crops and considered them extremely unsustainable, but this has been ignored. There is no adequate scientific basis for claims that GM foods are safe and it is likely that vertical and horizontal gene flow is occurring in animals that are fed on GM feed. Biotech companies are trying to hide the reality of how much GM animal feed is actually entering the food supply, which indicates that there is much more than initially anticipated.

With the threat of many more GMOs being accepted into Europe, and ever-increasing evidence of harm to human and animal health, and to the environment, it is vital that EU citizens have the means to make informed choices through the labeling of all GM foods, including produce from animals fed on GM animal feed.

Conclusion

This study suggests that there is a deficiency in acceptable research on the environmental and human health consequences of indirectly consumed GM in animal products, and proposes that this problem is being ignored or manipulated by governments due to their vested interests in agri-business and associated areas. There is increasing pressure on Europe to relax its stance on GM crop growing, especially from the World Trade Organisation. Through not enforcing the labelling of animal products as animals fed on GM, the EU is denying the public its right to make an informed decision. Essentially, the environmental carnage that the GM animal feed industry is responsible for will only stop when Governments and the agribusiness sector are impeded in their economic benefits.

Public opposition to GM animal feed products would be realised within the EU if these animal products were labelled and the consumer could exercise its purchasing power. The average consumer is not well informed and does not realise the implications of these animal products. Therefore, it is necessary that all GM fed animal products are labelled as such to provide the European population with a choice to consume GM or not.

An amending regulation to the EU laws on novel foods is currently under consideration int he European Parliament. If turned into law, the amendment would make labelling of animal products fed GM feed compulsory. It will be voted for by the European Parliament's Committee on Environment, Public Health and Food Safety on 4 May 2010. The full text of the proposed amendment can be found at: http://www.europarl.europa.eu/sides/getDoc.do?type=TA&language=EN&reference=P6-TA-2009-0171, while Article 8(7) of the proposed amending regulation contains the specific labelling requirement for products derived from animals fed GM feed.

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