EATING IN THE DARK – AN ETHICAL APPRAISAL OF GENETICALLY MODIFIED FOODS'

by

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“At dinner that night, environmental ministers could not help but look suspiciously at their plates. They had gathered at the St. James Club in downtown Montreal for a sumptuous spread whose contents had been leaked to the Friends of the Earth. When the ministers, negotiators and guests arrived at the club to dine, the activists greeted them, passing out annotated menus:

CREAM OF SWEET POTATO SOUP

A GM herbicide-tolerant U.S. speciality with a touch of special GM corn starch thickener.

ST. JAMES SALAD WITH VINAIGRETTE

Some delicious GM virus-resistant peppers served on a hot bed of herbicide-tolerant lettuce and lightly drizzled with a variety of GM oils, including our popular corn and soy oil. And of course, not forgetting the GM tomatoes.

GRILLED SALMON WITH WHITE WINE CREAM SAUCE

Why not try the fast-growing GM fish variety? Made with cream from GMO fed cattle. Coming soon, specialty GM wines – French or German?

FILET OF BEEF WITH THREE-PEPPER SAUCE

Juicy meat from GMO-fed beef cooked to your own taste.

ENTREES SERVED WITH SEASONAL VEGETABLES AND POTATO

Current selection might include herbicide-resistant cauliflower, broccoli and peas. Not forgetting a range of GM potatoes from around the world.

CHOCOLATE CAKE

Almost certainly includes eggs from GMO-fed chickens. Lecithin likely to follow from GM soybeans.

COLUMBIAN COFFEE, THE BEST IN THE WORLD.

So far not GM and lets keep it that way.”

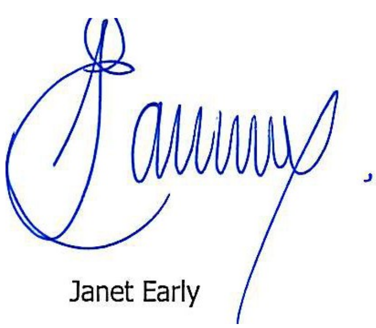
(Extract from '*Dinner at the new gene café*' – Bill Lambrecht; 2001)

DECLARATION OF OWN WORK

I, declare that 'Eating *in the Dark – An Ethical Appraisal of Genetically Modified Foods*' is my own unaided work and that all sources that I have used or quoted have been indicated and acknowledged by complete references.

I, declare that this work has not been submitted to any other University for examination.

Janet Early
Dated: 11 May 2011



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The staff of the Steve Biko Centre for Bioethics.

Janet Early

TERMINOLOGY

Bt: *Bacillus thuringiensis:* a soil living bacteria that produces an endotoxin deadly to insects. The genes encoding this endotoxin are often inserted into genetically modified crops to give those crops a form of insect resistance.

Gene splicing: The creation of a new genetic combination by intentionally interspersing a novel gene sequence into an existing genome usually bacteria.

Genome: The full DNA sequence of an organism.

Germplasm: The genetic material that carriers the inherited characteristics of an organism.

Glyphosphate: A common type of herbicide that inhibits a specific enzyme, EPSP synthase, which plants need to grow. Roundup, produced by Monsanto is probably the most well-known.

GM: *Genetic Modification or Genetic Engineering,* a process through which individual genes from one species of plant or animal are extracted and then inserted into the cell of another species.

GMO: *Genetically Modified Organism*, a plant or animal containing permanently altered genetic material

Terminator genes: A colloquial name for transgenes developed by Delta & Pineland Co., that result in sterile seeds in the second generation. Seeds of the first generation can be planted but the seeds from resulting plants are sterile and produce no crop.

Transgenes: Any gene that has been transformed using genetic modification from one species to another.

Transgenic: An organism that contains one or more genes from a different species.

(**Source:** Fukuda-Parr. S. (2007). '*The gene revolution: gm crops and unequal*

Development').

TABLE OF CONTENTS

TABLE OF CONTENTS (cont)

"It is astonishing to see serious players in agriculture maintaining that one does not have to look before leaping unless one has solid demonstration that a cost effective looking is called for. If someone wishes to impose a risk on me for his benefit, it is his task to demonstrate that the risk is minimally likely to happen. And then the choice is still mine. What part of that is hard to understand?"

S J Dundon (2003)[1]

Chapter One: The Debate

1.1. Introduction:

Traditional breeding works together with nature, slowly and sensitively by serendipity and observation, harnessing rather than overturning natural forces, in contrast genetic engineering works against it, rushing change without consideration or reflection in a way that is at odds with evolutionary time, overturning rather than respecting what it finds (Cook, 2005: 107).[2]

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[1] Dundon. S J. 2003. 'Agricultural ethics and multifunctionality are unavoidable'. *Plant Physio*., 133: 427 -437.

[2] Opponents of GM technology argue that in traditional breeding, each plant is the same or a related species and the mixing or recombination of genetic material occurs between two plants that share a recent evolutionary history with no major disruption in the plant's inner working and most offspring of traditional breeding are normal. In genetic engineering, a well-characterised gene is transferred in a targeted manner without sexual crossing. Part of the problem is that the new gene is not inserted into the plant's cell on its own, but rather as part of a package of genes known as a cassette. Engineers claim however that the genetic instability complained of is not really a health or safety issue for the new foods, but a problem that can and would be sorted out in the laboratory (Pringle, 2003: 60-61).

Domestication of plants and animals, combined with gradual, long term changes in their quality and quantity can be traced as far back as 15 000 year ago[3]. Gradual improvements in agricultural techniques were characterised by step by step selection of better performing and more adaptive genotypes along with intuitive breeding. Mendel's discovery of genetics in the 1860's led to the beginning of applied science and controlled breeding methods. [4] The discovery of the structure and function of DNA exploited the capability of changing organisms by altering their DNA, but it was the discovery of restriction and litigation enzymes in the 1970's that provided a quantum leap in molecular techniques and made possible for the ability of any isolated DNA molecule to be spliced together in large blocks of genes, either from the same or different organism (Parekh and Gregg, 2004: 3-5). [5] From one perspective GM foods are only an incremental change in crop and animal breeding, inevitable after millennia of progress with the potential benefits of gene transfer immense. Viewed from the other side, GM foods are our greatest affront to nature yet - one that is ethically unsupportable and profound (Winston: 2002).

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[3] The first such domestication of the tomato by the Aztec's is understood to have occurred round 500 B.C.

[4] **Gregor Johann Mendel** (July 20, 1822– January 6, 1884) Gregor Mendel's research demonstrated the particular nature of inheritance with his careful breeding experiments with peas. He examined numerous traits including the easily visible characteristics of seed shape, plant height and floral colour and noted that traits seemed to skip a generation in being expressed when plants of different types were crossed. He calculated the mathematics of the inheritance patterns he observed and determined that each trait was dominant or recessive, inherited independently, half from the father and half from the mother plant. These concepts inevitably led Mendel to the conclusion that heredity involved physical particles, which we now know as genes and the chromosomes that carry them (Winston, 2005: 18).

[5] These enzymes can break isolated DNA molecules into fragments that can be reassembled in any desired sequence.

GM foods have changed the debate about the criteria used to determine the acceptability of any agricultural technology by introducing a new question – *Do we need it*? The question posed could equally be moral or ethical rather than just scientific or economic, by asking – *Ought we to do it*? In spite of the ongoing and heated debate, this form of biotechnology will be the primary force that shapes tomorrow's agriculture.[6]

1.2. Language, Science and Ethics:

It is not the details of *how* crops or animals are genetically modified in laboratories which are at issue, but rather *what* crops and animals are modified to do, their potential effects on humanity and the environment (Cook, 2005: 107). Both proponents and opponents of GM foods agree that GM agricultural practices will change the nature of life on Earth. For proponents, GM gene transfers will fight plant pests,[7] lessen environmental damage, combat world

[6] For example, in 2001 South Africa became the first country in the world to permit the commercial production of GM insect-resistance white maize as a staple crop (Gouse, 2007). It is estimated that 14 million farmers planted 134 million hectares (330 million acres) of GM crops in 25 countries in 2009 (ISAAA**:** Press Release of ISAAA *Brief* No. 41-2009 (Feb 2010)**:** Global Status of Commercialized Biotech/GM Crops: 2009.
Available online: http://www.isaaa.org/kc/cropbiotechupdate/specialedition/2010/default.asp. [Accessed 14 May 2010].

[7] For example, scientists have taken the gene code for the insect-killing toxin *Bacillus thuringiensis* (Bt), removed it from the soil-dwelling bacteria and inserted it into plants such as corn. The toxin is then produced as the plant grows and pests that attempt to eat the plant are killed. This method of pest management clearly has innumerable advantages, including activity of the toxin throughout the growing season, specificity for only insects that eat corn and the concomitant reductions in chemical pesticide use and labour costs for spraying. Herbicide-resistant crops are the most widely disseminated form of GM crops, containing various genes that prevent weed-killing herbicides from affecting crops, allowing farmers

hunger, improve nutrition and create tastier fruits and vegetables.[8] For opponents, it will damage wildlife, create new health risks, exploit poor farmers, undermine democracy and disrupt Nature[9] without bringing any benefits (Cook, 2005). There is consensus however that although there is nothing inherently unsafe about GM foods, there are possible hazards posed by the transference of genes between species as an unpredictable operation (Pringle, 2003).

The language of the GM debate is nearly as complex as the science itself and Cook (2005: 2) convincingly argues that many arguments for GM exemplify disturbing trends in the use of contemporary English by powerful organisations and individuals. Language while professing to be rational, honest, informative, democratic and clear is in fact none of these things, but, on the contrary, often

to spray herbicides while crops are in the field, reducing herbicide application from the pre-planting and post-harvest sprays done previously to only one spray while the crop is growing (Winston, 2002: 4-5).

[8] Frost and drought tolerance will expand the growing regions for many crops, while the insertion of nutrient-producing genes will allow food to be used to prevent malnutrition syndromes such as vitamin A, vitamin E and iron deficiencies. The storage life of fruits and vegetables can be increased dramatically through plant biotechnology; fatty acid content of oils can be made healthier and pharmaceutical-producing crops can be grown that will reduce the cost of producing drugs and permit people to be vaccinated simply by eating a vaccine-carrying banana (Winston, 2002). Perhaps the most famous of these gene insertions has been Calgene's '*Flavr Savr'* tomato, where researchers have located the gene that produced the rotting process (polygalacturonase) and simply reversed its DNA sequence by antisensing. The result being modified tomatoes that turn red on the vine, tough enough to be mechanically picked and have a shelf-life of three weeks, allowing adequate time for shipping and selling (Pringle, 2003: 68).

[9] There are concerns that bioengineered genes may move from crops into the wild, borne by wind-blown or bee-carried pollen that then would fertiliser feral plants. It is well known that plants promiscuously exchange genetic material and genes from the current generation of GM crops have already been found in adjoining weeds. There are fears that the proteins expressed in GM foods may harm us, inducing silent cell mutations that could erupt in later cancer epidemics or immediate and fatal allergic reactions in unsuspecting consumers or that GM crops may induce resistance in pest insects, forcing us back into the heavy overuse of synthetic chemical pesticides (Winston, 2002).

illogical, obscure, patronising and one-sided, filled with false analogies, misleading metaphors and impenetrable ambiguities, including key phrases such as '*improved,*'[10] '*friendly and flavour enhanced*,'[11] '*sound science*,'[12] '*Frankenstein foods*'[13] and '*interfering with nature.*' While an analysis of this language use is beyond the scope of this essay, it requires recognition because

[10] Cook (2005: 91-92) argues that the word 'improved' is used routinely to describe GM foods by the multinational companies, for example by Monsanto to "…encourage research to improve rice and related crops…to improve technology and advance science and understanding…to improve agriculture and the environment…to improve subsistence crops…" Cook argues that 'improvement' has no absolute sense, but that it can be understood relative to some value. What needs to be examined is what constitutes improvement from the various perspectives of seed companies, farmers, retailers, cooks, shoppers and consumers; from a general human perspective and for non-human species – animals, birds, insects and plants.

[11] GM fruit and vegetable are presented as flavour enhanced and guaranteed to be of a certain taste. Some strange changes have been proposed to make things more friendly such as a GM onion which can be cut up without tears or strawberries which will ripen at a preset time (i.e. for the first week of Wimbledon). Here the assumption is about what people like than what they need and a judgment on what constitutes good food is a matter of subjective evaluation about which science can have nothing to say and if it does Cook (2005:93) argues it has surely overstepped its mark and strayed.

[12] Cook (2005: 94) argues that this phrase is used frequently in arguments for both sides and is used to imply that in addition to sound science, other science may be unsound. For the pro-GM lobby it is often levelled against the work of those scientists who have recovered negative effects, like Pusztai investigating the decline of the monarch butterfly. It is also levelled by the anti-GM lobby against experiments apparently disproving such effects, for example Cook cites an experiment which claimed to prove that bovine hormone did not survive in pasteurised milk on the grounds that the milk was boiled for 30 minutes instead of 60 minutes. A different but related sense of 'unsound science' is one that has been bought by interested parties, whether government, industry or NGO's. Here the opponents of GM are on strong ground for while those producing pro-GM findings are paid directly or indirectly by governments and companies, those whose finding support the anti GM case have generally not reaped either financial or professional benefits. Indeed a disturbing fact for non-scientists trying to weigh up the evidence is that there are few if any scientists actively campaigning for GM food technology who are not directly or indirectly funded by the biotech industry or pro-GM governments. The phrase therefore is not in itself very sound and when used by scientists can become self-congratulatory and circular – an epithet as Cook argues (2005: 95) awarded by those on one side of a scientific dispute to themselves and denied to their opponents,

perhaps of its sheer quantity and familiarity it passes unchallenged and often unnoticed.

Cook (2008) argues that while opponents are accused of hysteria, hyperbole and lack of scientific rigour, it is the pro-GM arguments that regularly exhibit these qualities. He illustrates this by stating that the same moves in the same arguments are being repeated by the pro-GM lobby – move one is to claim that the argument is only scientific, a matter of quantifying short term effects as a prelude to making policy decisions, without mention of the political, social, or psychological changes in food production while move two is to conduct the argument in distinctly unscientific terms, not by addressing scientific evidence against GM, but by stereotyping the opposition as emotional and ignorant. Cook (2008) concludes that while the pro GM lobby seeks to distract by stereotyping its opponents by associating them in highly emotive language with the worst kind of extremism and disguising their own motives which is still 'profitability' rather than concern for the world's poor- the real arguments both scientific and ethical against GM remain.

Science is concerned with understanding the material world in a process of constant dynamic interaction between theory and evidence, in which theories

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when used by politicians and governments, it is reserved for the scientific evidence which supports its own agenda and policies.

[13] Cook (2005: 96) notes that it is ironically now used far more often by the pro-GM lobby as a shorthand label to refer to and characterise what they see as the irrational, uninformed and media-led resistance to GM and in a sense the phrase has rebounded upon the anti-GM lobby for who used it and is now deployed, quite effectively to brand and dismiss the opposition.

derived from rational consideration of the available facts are tested against further observation and experiment. It is regarded as ethically neutral, disinterested and driven by the search for greater truth and not based on moral or aesthetic evaluation. Only after the results of scientific practice are in the public arena and the developments of its applications are initiated is information truly available for evaluation (Burkhardt, 2002). We tend therefore to judge science by its results or outcomes despite claims to ethical neutrality.

Comstock (2002) sees science as a communal process devoted to the discovery of knowledge and to its open and honest communication. Its success he argues rests on two different kinds of values or ethical responsibilities namely; *epistemological* values which are those by which scientists determine which knowledge claims are better than others and include fecundity, simplicity and elegance and *personal* values which include honesty and responsibility. He sees science as an expression of some of our most cherished values and argues that scientists must in turn act as good stewards of this trust.

Boulter (1997) argues that science has moved from being viewed as an unalloyed public benefit to being regarded with suspicion if not outright distrust, influenced by social, economic and political pressures. This is underscored by the fact that it is equally known that some bad consequences scientists said were unlikely to have occurred have indeed happened.[14] Burkhardt (2002:21) argues

[14] For example: the outbreak of 'mad cow' disease in the UK after it was denied by government scientists; pharmaceutical drugs being withdrawn from the market after passing Food and Drug Administration (FDA) approval in the US and in Japan which experienced scandals of food being mislabelled.

that there is a general consensus among ethical analysts, echoed by scientists and the public alike that science generally has performed ethically in that it has produced knowledge and technologies whose benefits are clear and which outweigh relevant costs and risks. The problem however is that scientists and researchers engaged in agricultural biotechnology have made a bid for the same ethical justifiability and credibility, but that this attempt has been met with less success. A possible reason being that when judged from consequentialist reasoning there is significant uncertainty about the outcomes and whether we can judge them as beneficial or not. [15]

Ethics in contrast seeks justification for actions. It is concerned with what we ought or ought not to do. Focusing on particular GM food products and their context provides the target for judging ethical acceptability. Under such scalar interventions that GM engineering offers, decisions are being made that may irrevocably change the composition of the food supply for millions of people. The fact that most of the affected population have had little or no participation in the decisions affecting their diets and ultimately, their lives and livelihoods is an ethical issue in its own right (Lappé & Bailey, 1999: 108).

[15] Pringle (2003: 189-190) argues that these include for example, whether Bt crops have cut down on pesticide use, did Roundup Ready herbicide crops reduce the overall use of herbicide? The answers though depend on who is doing the measuring and Pringle cites an independent researcher who is of the opinion that overall it would appear that the gains are marginal. Roundup Ready crops have reduced the average number of active chemical ingredients applied per acre but have modestly increased the average use of actual herbicide. Bt corn has had little impact on pesticide use. The real question is whether biotech can be used in a more subtle way to strengthen plant's defence mechanisms and put an end to the pesticide treadmill that occurs when pesticides destroy beneficial insects and at the same time create new, resistant pests requiring even more pesticides.

Ethical principals provide standards for the evaluation of policies or practices and in GM technology asks whether it is right or wrong to carry out a certain genetic modification that may threaten human health or harm the environment. It recognises the fact that it may be scientifically possible to undertake a certain experiment or introduce a new type of crop for commercial planting or animal husbandry but questions whether it would be ethically right to do so. The traditional breakdown of ethical issues in genetic engineering questions the rightness or wrongness of a particular intervention with value judgments about what things count as right or wrong and why (Burkhardt, 2001: 66).

Consequentialist ethics assess actions or practices in terms of their outcomes - good outcomes justify an action and bad outcomes condemn it. Naturally how ‘good’ and ‘bad’ are defined is of course critical. Justification usually takes the form of utilitarianism which is concerned with maximising benefits or achieving a net benefit through actions or policies (Burkhardt, 2002: 20).

The *Autonomy/ Consent* Ethical paradigm argues that self-determination implies that people have inviolable rights, which establishes the ethical demand that people be given a choice concerning how they want to act and be treated. Burkhardt (2001) argues that it is instructive to note that those who subscribe to the ethics of autonomy/consent demand that action be consented to, even if, on some consequentialist calculation those actions would benefit people. Its application to the issue of GM foods arise in part because of the lack of transparency of the food system to consumers by the lack of mandatory labelling in most jurisdictions but also because of exemptions made to most GM foods at least in the United States from special testing regarding safety. One further concern that impacts on choice is a farmer's decision to plant non-GM crops and the availability of non-GM seeds within the structured seed industry controlled by a small number of large corporations all heavily invested in GM crop technology and monopolising a large portion of the seed market.

Finally the ethics of *Virtue/Tradition* have been offered in the appraisal of agriculture generally and food/agricultural biotechnology in particular. Agrarianism is the philosophy that views agriculture as a way of life reflecting more than a business or an economic sector in society. It sees the traditional farm as a place where real human values and virtues can be practiced, instilled in the next generation and hence preserved. The strongest expression of agrarian rejection of GM technology has come from smaller-sized traditional farm communities who are concerned that GM technology will favour larger farms, make traditional agriculture less competitive and drive small farms out of business. The second version of virtue/tradition ethics is naturalism which simply implies that we should not be engaging in transgenic technology which has the potential to disrupt deep ecological processes by manipulating species (Burkhardt 2001: 78-79).

1.3 <u>Guiding Framework:</u>

There are four main principles that are relevant and that form the basis of this discussion. They are the principle of *general welfare*; the maintenance of people's rights reflected in the *rights of consumers to freedom of choice*; the *principle of justice* that requires that the burdens and benefits of policies and practices be fairly shared among those who are affected by them and finally the *ethical status of the natural* world itself (Nuffield, 1999). Discussions of the ethical dimensions of agricultural biotechnology involve both extrinsic and intrinsic objections. Extrinsic objection focus on the potential harms consequent on the adoption of GMO's, while intrinsic objections allege that the process of making GMO's is objectionable in itself based on the unnaturalness objection with special focus in this discussion on the use of animals in GM foods (Comstock, 2002).

Within this framework, I have chosen certain principles in an attempt to answer '*ought we to do it.'* By focusing on the principle of general welfare I examine the debate surrounding what would amount to an adequate safety assessment of GM foods and its possible ecological risk. The right of consumers to freedom of choice is addressed by exploring both the arguments against and for labelling. Justice then questions whether food security can indeed be improved by using GM technology, whether patents can be judged ethically justifiable and what safeguards need to be in place to manage Bioprospecting and to control Biopiracy. Finally the ethical status of the natural world is raised by attempting to answer whether modern biotechnology could be considered blasphemous from a broad religious stance and whether it is ethically permissible to breach the natural integrity of the species.

The purpose of my research report is to reflect on GM foods as an ethical concern in a balanced manner despite the constant flow of alarm from consumer watchdogs and assurances from the agricultural biotechnological establishment that all is well down on the farm. Attempts have been made to weigh these ethical principles within the broad genetic modified food industry with recognition that the debate remains inconclusive and controversial. My approach is normative and presented in a way to increase dialogue, instigate debate and seek a better understanding, but not necessarily to draw water-tight conclusions. Although limited in scope, it remains an explorative travel through the genetically modified zone without any intention to advocate or oppose and to achieve this I have purposely steered clear of directly involving either the local or international biotechnology industry and their opponents in this debate.

Chapter Two: Welfare, Regulation and Safety Assessment

2.1. Introduction:

The essential purpose of public policy is to protect and promote the welfare of its citizens. A fundamental question of GM foods is whether and how they promise to increase human welfare and whether their introduction may damage human welfare directly, by injuring the consumer or indirectly by damaging other things we value like the diverse wildlife or the environment (Nuffield, 1999). Much current regulatory practice underlies this concern and the need for effective stewardship (Fukuda-Parr, 2007). [16]

The safety assessment of GM foods generally investigates direct health effects (toxicity); tendencies to provoke allergic reaction (allergenicity); specific components thought to have nutritional or toxic properties; the stability of the inserted gene; nutritional effects associated with genetic modification; and any unintended effects which could result from the gene insertion (WHO, 2010).

[16] Parekh (2004: 346) argues that despite thousands of laboratory experiments, field trials and risk assessments conducted inside academic, industrial, and movement laboratories around the world, where GMO's caused no harm to human health or to the environment, the focus now has turned to the scientific, legal and political impacts of deliberate release into the ecosystem. The reasons for the shift are straightforward: the technology has advanced to the stage at which what were only promising laboratory developments are now products waiting for clinical trials and commercialisation. It will become critical for the industrial practice of GMO's to apply technologies derived from cellular and molecular concepts and to create novel products that will be integrated into all sectors of life.

Environmental concerns have focused on the fear that GM herbicide-tolerant crops might encourage farmers to use more broad spectrum herbicides with a negative impact on insect and bird life; genes conferring herbicide tolerance might also migrate from crop plants to their wild relatives resulting in herbicide-tolerant weeds; damage to non-target species by insect-resistance crops and the inadvertent creation of new viruses (Nuffield 1999). [17] Lee and Burrell (2002:518) also consider the harm that non-GM farmers may suffer from migration including the loss of GM-free status, leading to a conflict between organic and GM farming.[18]

From the very beginning, ecosystem changes and harm to human health concerns have been at the heart of the controversies about agricultural biotechnology and have driven political struggles over legislation on procedures for approval of GM foods. It is also cause for scientists to reflect soberly on the

[17] For example, the concern that transgenic crops contain ethically sensitive genes including antibiotic marker genes and promoter sequences derived from viruses. Where some crop varieties will be transformed many times, antibiotic resistance genes may accumulate and it seems sensible to remove them as plant breeders will soon encounter difficulties in locating harmless antibiotic marker genes. Another fear is that antibiotic marker genes will be recruited into humans and domestic animals rendering antibiotics ineffective in curing bacterial infections. Technologies for targeted gene removal incorporating site specific recombinases have been developed and alternative marker genes to ethically sensitive ones exist. The World Health Organisation has judged antibiotic markers genes to be safe. (Bengtsson, 1997: 290).

[18] For example, The Soil Association, the largest organic certification authority in the UK, has set a ‘zero tolerance’ threshold for GM contamination. According to Lee and Burrell (2002), an organic farmer whose crop becomes contaminated by GM material may face financial ruin and be unable to recoup production costs if forced to sell products in competition with non-organic farmers. It seems likely that non-organic farmers might also suffer if consumer anxiety about GMO’s means that there will be a market advantage from being ‘GM free’.

implications for how science is conducted in increasingly commercialised environments.[19]

Over the years, evidence has accumulated, public debates have advanced and consensus has emerged among the scientific establishment[20] that the crops released for commercial production so far are safe for human consumption; that environmental risks should be assessed on a case by case basis and that over the last decade of commercial production no cases of ecosystem consequences

[19] The first example being the '*Pusztai Affair'*. Arpad Pusztai, one of the most respected senior scientists in the Rowett Research Institute was commissioned by the Scottish Office's Agriculture, Environment and Fisheries department to investigate the safety of GM foods. The project was especially significant because at that point (1995) there was not a single peer-reviewed journal publication on the subject. Pusztai's study focused on the effects of modifying potatoes by the addition of a lectin gene called GNA. The gene was known to affect the digestive systems of insects but his work was to investigate if the modified potatoes were '*substantially equivalent*' to parent potatoes and to conduct rat-feeding trials to check the effect on mammals. Preliminary results showed totally unexpected and worrying changes in the size and weight of the rat's body organs – liver and heart sizes were getting smaller and so was the brain, with addition indications that immunity was also weakened. Once the results were published in the *Lancet*, the floodgates were released on a smear campaign targeting Pusztai and his research despite the fact that his methodology had been rigorously reviewed and passed by the Biotechnology and Biological Sciences Research Council. The second example is the '*Chapela and Quist Affair,'* here two researchers at the University of California published an article in the premier *Nature* journal reporting that native corn in the Oaxaca region of Mexico had been contaminated by GM variety. It also argued that the GM DNA was randomly fragmented in the genome of the maize. Both claims were explosive and potentially devastating for the GM biotech industry. Within hours of publication, a massive smear campaign got under way with the most virulent personal attacks on the researcher's integrity. In 2002, *Nature* took the unprecedented step of withdrawing the paper citing severe criticism. What is interesting to note is that *Nature Publishing Group* openly integrates its interests with companies such as Novartis and if to prove the point, *Nature* ran a special 'Insight' issue six weeks later, into food and the future, sponsored by Syngenta containing several pro-GM and anti-organic pieces. (Dubhashi, 2004: 158-160).

[20] Including institutions such as the American Academy of Science, the Third World Academy of Science, the Royal Society, the Nuffield Council of Bioethics and the Food and Agricultural Organisation of the UN (FAO).

have been experienced. Opposition groups[21] argue that these conclusions are not based on sufficient analysis and that the technology has been prematurely released. Driving this position is a fundamental distrust of not only the official scientific establishment and industry lobbies but also of government scientists and regulators.

2.2. <u>The Safety Assessment of GM Food:</u>

Some of the strongest rhetoric about GM foods has been directed at the final food product. No adverse consequences have yet been found from eating GM food, but the notion of '*Frankenfoods'* have nevertheless taken hold, becoming what Winston (2002:117) states 'a rallying cry for protest' against what critics view as a terribly dangerous disturbance of our food supply. The propaganda on both sides has repeatedly invoked science to support or criticise safety testing. Proponents argue that the science is clear and accessible and that in the absence of any proven negative impact there is no justification to ban or limit GM foods. Opponents argue that tests for allergens and toxins check only known but not unknown elements and that the potential for harm rather than actual case histories should be sufficient to at least delay GM acceptance.

GM food safety and environmental risk analysis rests on the general principle of risk analysis defined by the '*Codex Alimentarius Commission'* (Codex).[22] Gao (2004: 315) argues that the safety assessment of GM food should include a

[21] This would include Friends of the Earth, Greenpeace, the Erosion, Technology and Conservation Group, Third World Network, Christian Aid and consumer groups such as Consumer Unity and Trust Society of India.

comparison between the food derived from modern biotechnology and its conventional counterpart focusing on differences and similarities. If a new or altered hazard (nutritional or other) is identified by the safety assessment, the risk associated with it should be characterised to determine its relevance. This is commonly known as the concept of *substantial equivalence* which embodies the idea that existing organisms used in food or as a source can be used as the basis for comparison when assessing the safety of human consumption of food or food components that has been modified or is new. [23] This is the accepted US regulatory and a WHO standard.

Although the US and EU policies address the same types of GM product, regulation is strikingly different – US policy is relatively permissive based on the concept of '*substantial equivalence'* or the '*product-based'* approach*,* while EU policy is relatively restrictive, based on the adoption of the '*precautionary principle'* or '*process-based'* approach which shifts the burden of proof from the government regulatory agency to the applicant (Ramjoué, 2007:420).

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[22] The Codex was established in 1963 to jointly implement the Food and Agriculture Organisation of the United Nations (FAO) /WHO Foods Standard Program. Codex is an intergovernmental statutory body, with the purpose to protect the health of consumers, to ensure fair practices in food trade and to promote coordination of all food standards work. According to Codex, definition risk analysis has three components: risk assessment, risk management and communication of risk.

[23] In 1996 an FAO/WHO consultation endorsed its application in the safety assessment of GM foods, but recognised that substantial equivalence is not a safety assessment *per se,* but instead it recognises that although demonstrating absolute safety is an impractical goal, it is possible to show that a GM product is no less safe than a conventional food product.

This Ramjoué remarks reflects policymakers collective ideas, norms or beliefs that then influence and condition policy outcomes. The first fundamental difference is the '*competitiveness versus environmental and health protection' outcome*, with the US policy of GM food being devised against the backdrop of the larger goal of achieving and maintaining economic growth and international competitiveness. In contrast the EU emphasises the need to strike a balance between '*competitiveness through and protection from biotechnology'*, the latter goal prevailing in the case of GM food where policy may hinder economic competitiveness for the sake of upholding strong environmental and health protective measures.

The second fundamental difference lies in the US and EU's perception of the capacity of science to deal with uncertainty and by extension in how potential risks connected with GM foods are defined and addressed. The US bases its food policy on the so-called '*sound science*' principle characterised by a strong and unwavering faith in science's capacity to furnish unequivocal information and establish clear answers, supposing that science and scientific expertise can and do deliver the incontestable evidence necessary to make sound policy decisions (Ramjoué 2007:430)[24].

[24] In the case of agricultural biotechnology, this principle has led to regulators perceived certainty that GM foods do not pose significant risks and that a narrow definition of risks connected to GM foods is acceptable. It supposes that GM foods pose no significant risk until proven otherwise by consumers or by a demonstrated impact on the environment, making a relatively permissible GM food policy possible.

Clark and Lehman (2001), conclude that the widespread commercial adoption of GM technology has not been preceded by a rigorous and scientifically defensible assessment of benefits or harms for consumers or primary producers, for the Third World, for biodiversity or for the environment and calls substantial equivalence '*argument by analogy*' in that if crop X is chemically similar to crop Y and X has not caused any obvious harm to humans or animals that consume it, then Y must also be safe. In their opinion there is no independent, peer-reviewed, scientific evidence of safety to anything. The use of this measure as the primary determinant of acceptability and presumed safety is a commercially approved, political/regulatory decision that is not based on any requirement for scientific evidence of safety.

Millstone *et al*., (1999) as cited in Pouteau (2000:274) argue that comparison tests carried out on GM and non-GM foods are in terms of *substantial equivalence* usually limited to a restricted set of criteria, including chemical and nutritional evaluation with a set of selected substances and superficial animal testing. Because GM food toxicity cannot be predicted from its chemical composition this measure is misguided and should be abandoned in favour of one that includes biological, toxicological and immunological tests rather than merely chemical ones.

Pouteau (2000: 274-275) argues that other informed scientific objections point to the context in which the concept of *substantial equivalence* was adopted, namely preconceived claims in favour of genetic engineering, the obliteration of the distinction between genetic engineering and conventional breeding and the failure to take existing scientific evidence pointing to hazards into account such as incidental residues resulting from the use of chemicals (pesticides or veterinary drugs) during food production or the possible emergence of food borne pathogens and secondary unintended effects so that safety assessments focus almost exclusively on intended effects aimed at by genetic modification. Therefore in the US the potential risks posed by GM foods are defined in terms of their specific characteristics and immediate impacts on human health and the environment. This definition is relatively narrow, specific, direct and short-term (Ramjoué, 2007:431).

The EU also abides by the sound science principle but introduces an important caveat by also basing its GM food on the *precautionary principle*, which states that lack of scientific information and certainly shall not stop measures from being taken to prevent potential hazards, thereby viewing the area of GM foods as one of scientific uncertainty and assuming that GM products may be hazardous until proven safe.[25] The idea behind this is that sound science as a principle alone may not always suffice and that scientific certainty may not always be achievable. Potential risks include both indirect and delayed effects in addition to

[25] A series of food and health-related shock events that coincided with the development and marketing of biotechnology and that cemented great public distrust of European regulatory institutions included Bovine Spongiform Encephalopathy (BSE) although the probable causes of BSE are completely unrelated to genetic engineering and GM foods. The anti-GM food coalition was able to effectively utilise this mood to push for increasing restrictive food policies.

direct or immediate effects on the environment, for example the impact on biodiversity. Gao (2004: 332 fn), argues that the standard of applying the *precautionary principle* in GMO safety assessment is controversial as it was developed to prevent harm from hazardous environmental practices and not to serve as a food safety standard. Its application could create an impossible burden of proof for food products and ingredients and could do more harm than good through substituting an alternative with a greater risk or through the economic costs associated with rejection of adequately safe foods.

The blanket adoption of the *precautionary principle* risks an imbalance between the avoidance of harm and the achievement of a positive good, because some interpretations of this principle require an absolute priority to the first goal before we attend to the second (Nuffield, 1999:8-9). Its application therefore raises familiar problems as with any simple welfare based principle, namely how to define the conditions under which the avoidance of harm should take priority over the attempts to do good. Common sense suggests that the development of GM foods that substantially reduce hunger or improve nutrition in the developing world would justify running the risk of modest damage to the interest of well-off consumers or the environment. Critics however argue that GM foods only bring benefits to the producer, not to the consumer and that any risk of harm cannot be justified. The *precautionary principle* they argue should be best interpreted not as part of a cost/benefit calculation but as a principle governing how we should engage in such calculations. At times it could be treated as a rule of thumb that regulators should adopt a wary attitude to new technology and sometimes as a reminder that if the harm anticipated is very great, we should be attentive to very small risks of it occurring.

Nuffield (1999) concludes that a precautionary approach to so novel a technology is justified, but that when it concerns very small risks to the inhabitants of developing countries to inhibit research and development that could benefit the inhabitants of the poorer world, its prohibition would lead to an inappropriate embargo on the introduction of new technology. The only sensible interpretation of the precautionary approach is comparative, that is: to select the course of the action or inaction with least overall risk that should be proportional to the chosen level of protection; non-discriminatory in application; consistent with similar measures already taken; based on the examination of the potential benefits and costs of action or lack of action (including where feasible and appropriate, an economic cost/benefit analysis; subject to review in the light of new scientific data and capable of assigning responsibility for producing the scientific evidence necessary for a more comprehensive risk assessment (European Commission 2000: 6).[26]

Pouteau (2000) recommends inclusion of *substantial equivalence* as the first level of food safety evaluation. It would then be succeeded by her concept of

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[26] Cited in: 'The use of genetically modified crops in developing countries'.' 2003. Nuffield Council on Bioethics. Available online: ***http://www.nuffieldbioethics.org/go/ourwork/gmcrops/page_218.html***. [Accessed: 19 June 2010].

‘*qualitative or non-substantial equivalence’*- a concept which includes country of origin, methods of production, modes of harvest, methods of conservation and methods of processing. Some of these can be analytical, but most in her opinion would escape detection by the *substantial equivalence* screen. She then advocates that products be evaluated for their ethical equivalence, which would include ethical criteria for environmental sustainability, socio-economic acceptance, effects on wealth allocation and socio-cultural effects which would include effects on freedom, respect for individual identity and respect for religious and philosophical beliefs. This process of evaluation, as is often true of many normative ethical benchmarks, may be criticised as being so demanding, non-quantitative and vague that the scientific community and general society may resist accepting. König *et al*. (2010) argues that this ideal is supported by the European Commission (2003) who mandate that a ‘*quality of life’* criteria also be included with consideration of issues such as animal welfare, equity impacts, environmental impacts, aesthetics, ethics, and cultural and community identity in risk assessment with the aim to maximise health and qualify of life rather than just to minimise risk.

Ecological risk is a function of exposure (environmental dose) and effect (toxicological response). König *et al*. (2010:10) states that assessing environment and ecological impacts requires, where process analysis with respect to identification of potential positive or negative environmental hazards, their characterisation, distribution and exposure.[27] Beringer (1999) argues that the two difficulties in the environmental risk management of GM foods are their possible long term effects and their unpredictability. The Ervin Report (2000) concludes that if biotechnology is to achieve its full potential and avoid environmental catastrophe increased investment in public (in contrast to private) research and development is required with the aim to ensure that the neglected environmental aspects of transgenic crops receive adequate attention and lead to a comprehensive monitoring system and by implication that environmental scientists, their data and their perspectives are included in the debate and the regulatory process.

Claims in favour of GM crops often include environmental benefits for agriculture like the reduction in the need for agri-chemicals and promotion of sustainable agriculture. These statements Porteau (2000: 281) argues are based on a reductive view of sustainability as a global environmental assessment is usually missing.[28] Every single environmental nuisance she argues (2000: 282) is

[27] Zimdahl (2006: 158) argues that a frequent objection is that the release of a transgenic organism into the environment is especially dangerous because the organism cannot be recalled. Plant escape via seed movement, pollen transfer or intentional or unintentional human intervention is inevitable. Once an organism has escaped, given nature's complexity, one cannot predict what will happen. Will ecological diversity be affected? Will the organism be more ecologically fit and become a serious pest or will it die due to lack of fitness?

[28] Current engineered pest resistance relies on vulnerable monogenic mechanisms that would rapidly result in the selection of resistant pests and would therefore need to be replaced in the short term. Herbicide resistance she argues is prone to similar drawbacks. Emergence of weeds resistant to herbicide through out breeding and gene dispersal would impose the replacement of both the transgenic crops carrying the herbicide resistance gene and the herbicide itself. Instead of sustainability these approaches would rather promote transient, disposable pest management systems with short lived ephemeral crop varieties and

addressed independently from the others but no comprehensive vision is applied to see the impacts at different levels. Indeed the possibly detrimental consequences of combining several foreign genes in gene genomes are overlooked. In seeking the one ideal system to solve any problem, the reshaping of the genetic make-up of crops is intrinsically aimed at uniformity. She continues by stating that the difficulty with environmental claims favouring GM crops is that they are based on the assumption that efficient agriculture is necessarily detrimental to the environment and that biotechnology combined with sustainable farming is our best hope for the future. This she states holds true only for intensive agriculture.[29] She concludes that more effort and funding needs to be allocated to the research and development of alternatives (like organic farming) rather than to a technology that aims to compensate for what she terms "nuisance generated by intensive agriculture."

Concluding then, I would argue that the degree of severity of safety assessment chosen to be applied to GM technology is politically influenced and given context by the content of legislation or regulation developed and promulgated. While it can be successfully argued that no clear negative impacts have to date been found, this technology is too novel in my opinion to justify the test of *substantial equivalence* without at least the inclusion of biological, toxicological and immunological tests alongside comparable chemical assessments. Equally

herbicides or pesticides.

[29] This results in a decline in carbon and nitrogen content of soil, in nitrogen leaching into rivers and natural water systems, in natural water wastage, in increased susceptibility to devastating diseases and in intensive resort to pesticide treatments to compensate for lack of genetic diversity and adequate operations.

concerning though is that the strict application of the *precautionary principle* risks imposing a blanket ban on GM technology which could inevitably result as argued by the Nuffield Council on Bioethics, in an imbalance between the avoidance of harm and the achievement of a positive good. I would advocate and support what Pouteau demands is the inclusion of a normative ethical benchmark which would naturally comprise factors such as environmental sustainability, effects on wealth allocation and socio-economic acceptance while allowing a comparative precautionary approach as a principle governing how we should engage in such calculations and then selecting the course of action or inaction with least overall risk.

<u>Chapter Three:</u> **<u>Labelling</u>**

3.1. <u>Consumer Sovereignty:</u>

The special circumstances of GM foods provide a basis for reasserting consumer rights to sovereignty in their food choices. These reasons include emotional reactions against transformed or otherwise “unnatural” foodstuffs, religious objections to the trans-species movement of genes and wishes to support the right livelihood of those food producers who choose non-technology based methods of production (Lappé & Bailey, 1999: 116). In the context of GM food the focus lies in individual autonomy and more specifically on consumer autonomy (Siipi *et al*., 2008: 355). The question about labelling of GM foods should therefore not be simplistically reduced to a question of food safety, but that it should be acknowledged that consumers hold a number of fundamental values and views and respecting them speaks in favour of labelling. Beekman (2008: 62) defines this as the '*notion of ethical traceability*' or the ability to trace and map ethical aspects of the food chain by means of recorded identifications. The interest is not in the conditions of being an autonomous person but on the conditions of autonomous choices as consumer sovereignty.

Consumer choice raises issues of rights and of welfare. Considered as a matter of welfare, a balance is to be struck between the cost to producers on offering the choice and the cost to consumers of foregoing it. Considered as a matter of rights, the balance to be struck is that between the expectation of commercial firms that they will be able to operate in a predictable environment and the right of the consumer to choose what to consume. In a sense it is undeniable that consumers have an absolute right to choose what to consume, but the right to choose presents difficulties when it imposes costs on others and therefore diminishes their right to choose. To enforce a consumer's right to know by requiring specific labelling imposes costs that initially fall on the producer but that then may be passed onto the consumer in the form of higher prices or absorbed in lower returns or lower wages for their employees. There is no consensus to date on how substantial the costs of labelling GM ingredients might be or on whom they should fall, suggesting that the imposition of labelling requirements on producers is less straight forward than many suggest.

A further question is the extent to which the right to choose implies duties on producers over and above the duty to label. The right not to consume GM foods has little meaning when there are no non-GM foods to be consumed in their place or no way of knowing which is which. The core of the integrity objection is the view that genetically modified foods through their construction and production interfere and impede the ability of the individual or group in question to exercise food choices consistent with their deeply held beliefs and to express and create themselves freely through such choices. As opponents cannot abstain from eating, Pascalev argues (2003: 589) they are then left without any choice or recourse thereby violating their individual right to exit and becoming a subject of a coercive asymmetrical arrangement. The labelling of GM food, even if mandatory, may provide information in terms of values and needs, but their utility ends there if there are insufficient GM free foods on the market.

3.2. <u>Arguments in Favour of Labelling</u>:

Aside from arguments which underscore scientific uncertainty and explicit political strategy, Klintman (2002: 76) identifies two other arguments in favour of labelling. Firstly he states that *the argument about democratic rationality* refers to the intrinsic value of transparency which encompasses the disembeddedness or alienation of modern industrial food production from ordinary people's supervision and monitoring. He remarks that it has taken a technological revolution of the magnitude of genetic engineering before the disembeddedness was perceived as democratically unsatisfactory.

A second argument is based on the *diversification of consumer rationalities* involving both ethical and religious concerns. Until quite recently, individuals were able to see and ask whether food products involved ingredients or processes which were in conflict with their ethical and religious concerns, but new GM processes, if not labelled make things much less visible. Darby *et al*. (1973) conceptualise the visibility aspects by distinguishing between '*search'* goods (for which price and direct looks reveal everything), '*experience'* goods (for which consumption and eating will reveal their characteristics) and '*credence*' goods, which are impossible to evaluate even when using or eating them. The ethical or religious aspects are connected to credence aspects, not least when concerns relate to food processing and their potential to violate both ethical and religious dietary law.

Vegetarians, for example, have always been able to select vegetables at search or experience levels, but with the introduction of GM foods, if not separated by a mandatory label all foods end up at the level of uncertainty. Clearly ingesting animal DNA by eating for example fish genes that have been inserted into tomatoes would be ethically untenable for vegetarians. This claim can be furthered by stating that there is no ethical difference between genes that are actually brought from animals to vegetables and gene information that has been brought from animals to vegetables and holds that the separation of the two processes to be not only ethically insensitive but also scientifically untenable. [30]

In my opinion, a labelling policy that does not sincerely take into account the ethical and religious concerns of this growing segment of the population will not induce individuals to ignore their beliefs and purchase plant-animal recombinant foods. Instead such a policy will cause them to restrict their food purchases even more stringently, and to promote reverse labelling, both of which are likely to impact negatively on the market share of genetically engineered foods. On the other hand, if plant-animal recombinants are labelled as containing animal genetic information, individuals whose dietary guidelines proscribe such foods will be able to avoid them in a product-specific manner, thereby minimising the impact on the market and avoiding designating reverse-labelled non-genetically engineered foods as a premium product. Thus, operationally and economically, adequate labelling is likely to be the most effective way to deal with this issue. A positive labelling regime requires that products containing material from GE crops must be labelled as such while a negative labelling regime permits labelling of products that do not contain material from GM foods[31].

[30] Fagan (2000) states that it is scientifically untenable to claim as the biotechnology industry and regulatory agencies wish to do that the rabbit hexokinase gene is no longer a rabbit gene once it is introduced into a tomato plant. He argues that no matter how many generations the rabbit hexokinase gene is propagated in tomatoes, the gene still corresponds in information content to the rabbit gene. It may not be rabbit material, but it is still rabbit information.

[31] Zepeda (2001) and Heslop (2006) remark that effective labelling hinges on the existence of four factors, namely standards, testing, certification and enforcement. If a GM-label provides no useful information,

Botha and Viljoen (2009) studying voluntary GM labelling in South Africa argue that unregulated GM labelling is not a viable alternative to a regulated approach in terms of consumer protection. In their study which aimed to detect and qualify the GM content in food products specifically labelled to indicate an absence of genetic modification, [32] it was found that 31% had GM content above 1.0% and 20% GM content above 5.0%, with product batches differing up to 40% in terms of GM content. They conclude that in the absence of specific regulations on labelling, there appears to be not only an inconsistent application of the definition of 'GM free,' but also a lack of sufficient internal controls to ensure that the product complies with the GM label. [33]

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there are serious questions about its value. They argue that there is significant evidence that the validity of such labelling will be expensive to ensure and monitor, requiring extensive and ongoing standards development, product testing and the streaming of crops from producers to consumers.

[32] Products labeled 'GMO free,' 'non-GM' and 'organic'. Although there are no definitions for GM labeling in the South African context, the common interpretation for 'organic' and 'GMO free' imply zero genetic modification. The problem, as Botha & Viljoen (2009: 1063) argue is that in the absence of specific regulations, companies may apply existing standards taken from other countries, for example in the EU 'organic' may contain up to 0.9% adventitious genetic modification whereas in the US it may contain up to 5.0% genetic modification. Discerning consumers in South Africa may have a different expectation of GM content, especially since 'organic', 'non-GM' or 'GMO-free' labels are not being qualified on the label.

[33] Botha and Viljoen (2009) maintain that the argument against mandatory GM food labeling for consumer preference in South Africa is that it could, according to the Department of Science and Technology, result in a negative perception of technology. This they argue incorrectly suggests that ignorance and acceptance are synonymous and implies that knowledge of genetic modification would result in rejection of GM food by consumers. It is also argued that GM labeling is not feasible for poor developing countries as it would increase the cost of food unnecessarily. Ironically, it is accepted practice to label food products in terms of additives and colourants, even though these do not pose a health risk as well as '*life style'* choice such as Halaal, Kosher or Vegetarian without any consideration of cost.

3.3. <u>Arguments Against Labelling:</u>

Klintman (2002: 74) then identifies two arguments against GM labelling requirements. The first, the *irrelevance* argument claims that food labelling would be confusing, misleading and irrelevant. Opponents to labelling see it as unproductive and diminishing in terms of consumer choice and could falsely imply that GM food is less safe than conventional foods and conversely that a label claim of GMO-free would falsely imply that such food is safer or nutritionally better than GMO containing foods.

The second argument is what Klintman (2002) refers to as the *economic irrationality of consumers* which contends that a requirement for labelling would significantly increase costs, both for producers and consumers. He argues that the cost of labelling is far more than just ink and sticker and consumers wishing to avoid GM entirely will have to pay more for the privilege. Product information as a consumer service is seen as neither necessarily benign nor beneficial with the potential to expand from rationality to morality when the poor are brought into the picture. Indeed McHughen (2000) argues that the poor who must buy at the bottom of the market regardless of their personal opinions would now be required to pay a disproportionately higher share of the increased cost to the benefit of no-one especially themselves. He argues that whatever your position, GM labels fail to provide their intended *raison d'être*, being informed choice.

3.4. <u>The Way Forward</u>?

Markie (2008:103) is critical of proponents of the autonomy argument which suggests we can establish the obligatory nature of mandatory GE labels without wrestling with the risks and safety or carefully detailing and weighing the conflicting interest of various stakeholders. He states that the autonomy argument firstly appeals to consumer autonomy by supporting what he terms the '*Marketers Responsibility Thesis*'.[34] This implies that marketers of GM products have a moral obligation to both label products and to incur expenses promoting autonomy, thus a *prima facie* duty of beneficence to follow that cause of action. It then appeals to the importance of this obligation and the slim chance of it being honoured without legal regulation to derive the '*Mandatory Labelling Thesis*,' in that governments of societies in which GM products are marketed are morally obligated to legally require that those marketing these products label GM products as such for consumers. Neither thesis he argues is satisfied by negative labels and is neutral on the precise content of the required positive label as well as on the level of GM ingredients sufficient to require a mandatory label.

The primary problem facing the autonomy argument is that the promotion of consumer autonomy is not sufficient, in itself to obligate the government to

[34] The Autonomy Argument for the *Marketers Responsibility Thesis* implies that all other things being equal gaining some information will increase the autonomy of some consumer's purchase decisions and those marketing the product are able to provide them with that information by adopting practice X then it is *prima facie* morally obligatory that those marketing the product adopt X; some potential consumers of GM products will increase the autonomy of their purchase decisions by gaining the information that the GM products are GM and those marketing the GM products are able to provide them with that information by labelling GM products as such. Therefore it is *prima facie* obligation on those marketing GM products to provide potential consumers of their products with the information that the products are GM by labelling them as such.

require labels. Any one of a wide variety of labels will promote consumer autonomy, for example, labels to country of origin or environmentally friendly labels, so what makes the case of GM foods different? Perhaps, as Markie (2008: 103) concludes, GM products carry a greater risk to consumers; perhaps society has a special interest in promoting GM based purchase decisions just as it has a special interest in promoting health-based purchase decisions? Yet if it is developed to rely on such points as these, the autonomy argument loses its most attractive feature, in that it is no longer independent of claims about the nature, risks and benefits of GM foods.

Wolf (2008: 197) suggests that in order to support consumer autonomy, it is not necessary to ensure that people make choices that comport with their expressed values. Rather respect for consumer autonomy requires that people have access to the information they need to make informed choices. A labelling regime is permissible only if it violates no rights. By parallel reasoning, the *status quo* with no requirement that foods containing GM components be labelled as such is justifiable only if it violates no rights. Hansen (2004) argues that if the group that desires the information is small, then their autonomy is fully respected by the presence of negative labels. Rubel and Streiffer (2005) counter argue that consumer autonomy is about individuals and about whether individuals have the information that they think is necessary to make important decisions and not about the number of consumers who care about the information. [35] MacDonald &

[35] Rubel & Streiffer (2005:76) further extend this argument by stating that many people who wish to know about GM content may simple value the knowledge for its own sake and may end up purchasing GM foods regardless. Another group may simply value having the information available or resent being denied the

Whellans (2007: 188) remain adamant that companies should not feel ethically obligated to take unilateral action to label, so long as they are in good faith marketing a ‘legal’ product that they feel poses no threat to the public.[36]

A positive and negative labelling regime would have very different costs and different degrees of restriction associated with them. Hansen (2004) asserts that negative labelling is preferable because it places labelling costs upon those consumers who desire information about GM content. Rubel and Streiffer (2005) disagree by arguing that there are many circumstances where the costs of providing information should be shared by all consumers, even those who do not desire the information, for example, in ingredient and nutritional labelling.

3.5. Interests Served?

In examining whose interests are served or set-back by a labelling regime it is the interests of consumers who on most accounts are overwhelmingly in favour of positive labelling proposals who would most directly benefit, although it is sometimes argued that labelling would serve consumer desires and but not their interests since many concerns about GE foods may be based on false beliefs or misinformation about their safety. Two considerations are relevant in evaluating

information on the label even if they do not actually read it.

[36] The authors however qualify this statement by stating that there remain legitimate concerns about GM foods that need to be addressed by the food industry and regulators to accurately assess the safety of foods created through modern biotechnology. They continue that they are apprehensive about potential conflicts of interest that can arise in partnerships between regulatory agencies and private corporations and the resulting potential for regulatory capture. They conclude that they believe these issues to be ones of social policy and not corporate ethics.

this charge. First, the argument supposes that consumer dispreference for GE foods has its basis in the false belief that these foods are dangerous, while it may be true for some consumers; this is not the only cognitive basis for this widespread preference pattern. If the consumer preference for non-GM foods were based on simple lack of information, it should be expected to disappear when consumers are provided with appropriate scientifically based information about its safety, but on the contrary evidence suggests that consumers who know more (at least those who know a little more) are more, not less sceptical about GM foods.

The second response to the view that labelling serves consumer desires and not their interests simply insists that people must, in most standard circumstances, be regarded as the best guardians of their own interests. The attempt to supplant people's expressed interests with the interests others believe them to have is, at best, unacceptable paternalism and at worst oppressive exploitation.

Another class whose interests would be advanced consist of producers who grow or sell non-GM foods that would be labelled. On the assumption that consumers would regard the positive label as the mark of an economically inferior product, more consumers could move consumption to the non-GM food market, increasing price and demand. Not all non-GM producers are small farmers and often this industry is just as heavily industrialised as traditional agriculture. There is therefore some reason, although less than conclusive, to predict that an increase in demand for non-GM products might provide disproportionate benefits for smaller over larger producers. Those disadvantaged by positive labelling could include producers of GM foods and people and corporations engaged in research.

The consumer's right to know may be analysed in different ways. It may imply a right to not pay for something until one's questions about it have been answered; it may imply that it is impermissible to sell an item unless full disclosure is present or it might imply that sellers or producers have an obligation to disclose certain things that are true about the products they sell or produce. Whether consumers may plausibly be understood to have a right to know the properties and ingredients of the items they purchase will depend on how this right is articulated and on precisely what claims, liberties and powers this right is understood to contain. A right to know could be elaborated in ways that would restrict the liberties and claims of consumers as well as sellers and that it might be disadvantageous to both. If the right to know is simply an assertion that sellers have an obligation to disclose the presence of ingredients from GM sources, then we cannot simply assert *a priori* that consumers possess this right. If they do, then this right must be defended as the conclusion of an argument about the different morally or ethically relevant considerations that come in to the labelling debate; it cannot be inserted as a premise in such arguments.

The Nuffield Council on Bioethics (1999: 127) maintain that a genuine choice of non-GM foods should remain available with foods containing GM material being properly labelled so that consumer choice can be exercised. More effort should be made to disseminate accurate and accessible information and what is being done to test and monitor their safety.[37] If effective choices are to be offered it will also be necessary for food produces to segregate food from GM and non-GM sources and to label it appropriately. They conclude that the case for a viable labelling system is overwhelming and that a market-driven solution will need to be reinforced by statutory regulation requiring GM content to be specified on labels, however where products derived from GM sources are chemically indistinguishable from non-GM products they do not think it is necessary nor practical to make universal labelling a statutory requirement.

Lappé and Bailey (1999: 119) argue that if the remedy to consumers 'right to know' is labelling, few if any food manufacturers are availing themselves to the cure. The argument they give is that '*they can't*' and the reason being that once the transgenic food product reaches the open market, virtually all of it has been mixed with non-GM conventional product. The attack on consumer sovereignty is being fuelled by the industry's reluctance to permit labelling arguing that any

[37] Heslop (2006: 227) maintains that if GM-ingredient presence labelling becomes mandatory, the food industry will have to put inconsiderable effort into ensuring that consumers are well informed through educational programmes to prevent massive rejection of foods with GM ingredient labels. This should lead the industry itself to be better informed about consumer interests and decision making. In the case of GM foods, the contents of educational programmes, that is what is said about GM foods and by whom, may turn out to be even more controversial than the decision concerning the requirements to label and the contents of the label itself.

such label would stigmatise otherwise wholesome products and would provoke unwarranted consumer anxiety and fear about food safety. Secondary concerns such as cost of labelling and its proportionality to the public health risks posed by mislabelling have also been raised. This approach is both dangerous and short-sighted. If GM foods are as much or more wholesome than ordinary foods, then I support the call to industry to make its case openly to the public. If public fears are exaggerated, let industry dampen them with the kind of educational and advertising campaigns they have preferred over the years to sell other synthetic food products. The government and industry's reluctance to fully test and clearly label GMO's have reinforced the opposition's worst fear that multinationals corporations are colluding with government regulators to hide important information about biotechnology. Access to information to allow consumers to make informed choices would then in my opinion also require a regulated approach encompassing agreed upon standards, testing, impartial certification and objective enforcement.

Chapter 4: Justice

Behind both the balancing of the welfare of different people and groups and the balancing of their competing rights, lie ideas of justice (Nuffield, 1999). Here consideration is given to the extent that politics has become embroiled within agricultural production and distribution. Of interest is whether the international conglomerates or 'gene giants'[38] possess excessive market power in relation to new entrants to the market and whether the benefits of GM-based farming will be directed towards those to whom they will do the most good which raises issues of disparity between the richer and poorer societies.

4.1. Food Security: Beyond Poverty and Hunger:

World hunger and poverty drive the polemics concerning the potential benefits and risks of biotechnology for developing countries. The debate has been between those who want to avoid technology in favour of simpler solutions and those who strive for further technological breakthroughs. Winston (2002) maintains that both approaches have merit, but poverty stricken nations need to develop their own perspectives and policies about the balance between transgenic crops and small scale indigenous agriculture.[39]

[38] These include for example: Monsanto, Pharmacia, DuPont, Syngenta, Aventis, Dow, and Calgene.

[39] These should include considerations regarding environmental risks, food safety, intellectual rights and economics as they access the known or potential benefits of biotechnology. So far, the GM crops developed and put in commercial production are not, with the exception of maize, the major staple food crops of the most marginal farmers in developing countries and developed for US farmers most relevant to their production constraints. For resource poor and small-scale farmers in developing countries, the key food crops would include rice, wheat, maize, cassava, plantain, millet, sorghum and legumes, while constraints

It is a commonly held view that transformation of agriculture is a moral imperative for reducing poverty and hunger and promoting equity in many of the world's poorer countries Robinson (1999: 72). This is predicted on a Malthusian analysis of hunger which represents the ethical justification for employing agricultural biotechnology. [40]

Altieri and Rossett (1999: 155) argue that biotechnology companies often claim that GM seeds are essential scientific breakthroughs needed to feed the world, protect the environment and reduce poverty in developing countries. This claim, they argue rests on two critical assumptions, the first is that hunger is due to a gap between food production and human population density or growth rate, the second is that genetic engineering is the best or only way to increase agricultural production and meet future food needs.

The first claim can be addressed by concluding that there is no real relationship between the prevalence of hunger in a given country and its population, that the world today produces more food *per* inhabitant than ever before and that the real causes of hunger are poverty, inequality and the lack of access to food and land with too many people simply being too poor to buy the food that is available or lack the land and resources to grow it themselves. As far as the second claim is

would include low yield, drought, pests, diseases and low soil fertility (Fukuda-Parr: 2007).

[40] Ramaswami and Pray (2007: 158) emphasise that the pro-poor potential of GM crops is more often than not asserted through Malthusian arguments that increased population pressure requires more productive technologies. However it is well known that hunger is equally an outcome of unequal entitlements to food.

concerned most innovations in agricultural biotechnology have been profit-driven rather than need-driven. The real thrust of the genetic engineering industry is not to make third-world agriculture more productive, but to generate profits.[41] The challenge for the gene-giants and its opponents is to reach a point where both the company and developing countries benefit at no one's expense- a point will have to balance corporate profits with humanitarian impulses Winston (2002).

Given the limits of redistribution there is an ethical obligation to explore the possible contributions which GM crops can make in relation to reducing world hunger, malnutrition, unemployment and poverty (Nuffield, 2003). It is unacceptable to reject such exploration on the basis that there are theoretical possibilities of achieving the intended ends by other means.[42] Tragically the leading players, US based industry advocates on the one hand and European consumers and environmentalists on the other simply do not represent the interests of farmers or consumers in poor countries (Paarlberg, 2000).

[41] This they illustrate by pointing out that Monsanto's herbicide Roundup and Bt (Bacillus thuringiensis) crops (which are engineered to produce their own insecticide) are aimed at winning a greater herbicide market-share for a proprietary product and to boost seed sales at the cost of damaging the usefulness of a key pest management product as a powerful alternative to insecticides. These technologies respond to the need of biotechnology companies to intensify farmer's dependence upon seeds protected by intellectual property rights which conflict directly with the age-old rights of farmers to reproduce, share or store seeds. By controlling germplasm from seed to sale and by forcing farmers to pay inflated prices for seed-chemical packages, companies are determined to extract the most profit from their investment. The integration of the seed and chemical industries appear destined to accelerate increases in per acre expenditures for seeds plus chemicals, delivering significant lower returns to growers.

[42] Providing farmers with, for example, pest-resistant crops is a more appropriate solution than the alternative of leaving them to rely on food donations supplied by the World Food Programme (WFP) or other organisations, if their harvest is destroyed by pests or viruses.

The production of food is not just a necessity of life, but an integral part of social and cultural practice and a substantial part of people's livelihood in developing countries depends on agriculture. Nuffield (2003:82) conclude and I support their argument that the potential of GM crops to benefit small-scale farmers whose crops are seriously affected by droughts, pests or viruses should be explored as far as possible but with recognition that in assessing whether GM crops should be used or not, it is essential to focus on the specific situation in the particular countries, asking the question: '*How does the use of a GM crop compare to other alternatives*?' All possible paths of action must be compared, including inaction, in respect of improving, in a cost-effective and environmentally sustainable way, human health, nutrition, and the ability to afford an adequate diet. They do not take the view that there is currently enough evidence of actual or potential harm to justify a blanket moratorium recommending that research on the use of GM crops in developing countries be sustained, governed by a reasonable application of the precautionary approach. Risks arising from the adoption of GM crops need to be compared with risks of other possible courses of action, and of the status quo. [43]

[43] It is interesting to note that in 2002 following a devastating drought Zambia refused food from the US containing genetically modified seeds. The Zambian government firstly had reason to believe that there was sufficient GM free corn in the world's granaries and that they would be able to secure enough of it with donated aid funds; secondly, although Zambia was not against GM crop *per se,* their government had been advised by top scientists to favour the precautionary principle which basically meant that until food was proven safe it was off-limits; the third reason being that Zambia exports agricultural products to Europe and European consumers were basically anti-GM resulting in a potential contamination of the country's corn, even though the majority of exports were horticultural and did not include corn and finally Zambia lacked a system of internal regulations for monitoring and testing GM crops and products. Pringle (2003: 187) and

4.2. Patents:

A further issue of justice is whether the larger seed and agrochemical companies possess excessive market power in relation to new entrants to the market, researchers, consumers, unorganised businesses and farmers of the developing world. Patents are a means of allocating ownership, assigning control, regulating access and apportioning benefits and that one cannot pretend that the profound changes under way in patent law exist outside of a larger milieu. As patents reflect power relationships and those that recognise the contributions of some but not of others are based on injustice and will be unstable and unsustainable Fowler (1995:224).

The patent systems in the US, Europe and elsewhere were founded to deal with mechanical inventions and now have to cope with modifications to biological systems. Patents were usually awarded to individuals and small companies to give them intellectual rights over their inventions. Now multinationals have a great deal of influence over the patenting process with patenting lawyers having to make decisions on broad patent applications covering major food crops that have implications for food security (Nottingham, 1998).

The cost of developing new products may inevitably be such that only substantial enterprises will have the resources to undertake. Large companies naturally carry out research that is in their interests and gives them an advantage over

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The Economist (21 September 2002).

their competitors. They acquire patents in order to protect their technology and products. There may also be a clear advantage to a few large companies to pursue a degree of vertical integration so as to tie in both their customers and their own suppliers.

The significance of these concerns is contingent on the extent to which such imbalances of power exist. If non-GM seeds continue to offer advantages to farmers that are unmatched by GM seeds, the problem may not be acute. But where all the best varieties of the major crops will be genetically modified or where poorer countries are excluded from adopting GM seeds resulting in crops becoming uneconomic or where domestic food supplies are deprived of potential improvements, greater imbalances persist.

The most discomforting aspect of plant biotech is the new level of control over food production that the technology has put into the hands of a few international conglomerates (Pringle, 2003). The patent system allots these companies ownership of living organisms essential to food production, but not just on the product but on each step in its production. This property rights system has resulted in two disturbing trends: it encroaches on the rights of poor farmers in underdeveloped countries and curbs independent research by the broad patents issued in the US and also Europe. As an example, to make their clients' patents cover as much of the transgenic process as possible, lawyers wrote them to include '*all transgenic cotton plants*' or '*all genetically engineered soybeans*.'

Although rival companies objected, the bigger corporations always had a way out namely drop the costly patent challenge and buy the company.[44] In other cases, several patents overlapped, with one of the most notorious involving transgenic pesticide technology using the bacterium, *Bacillus thuringiensis* (Bt), with several companies filing patent applications as they completed parts of their research.[45] The new patent regime has also led to the major restructuring of the seed industry through mergers and acquisitions, often solely for the purpose of buying patent portfolios.[46]

For the companies, patent protection for the intellectual property represented by GM crops have become an essential component of their research and marketing strategies, while for critics it has become an unethical barrier separating farmers from their rightful access to seeds. The corporate perspective is a simple one – it takes a huge financial investment to make a genetic modification into a crop and bring it through the regulatory process to market and this level of investment is

[44] As an example, when the biotech company Agracetus was awarded a patent covering genetically engineered soybeans in 1994, Monsanto was outraged and launched a legal challenge charging that one company would have a monopoly over all transgenic soybeans. Monsanto then bought the company and the patent, so now in addition to the patent on soybeans, Monsanto also owns patents in both Europe and the US on genetically engineered cotton. (Pringle, 2003: 94).

[45] The result was hundreds of overlapping patents with at least four different companies claiming ownership of corn varieties transformed with the Bt pesticide gene and it being almost impossible for a researcher to find ways through this patent thicket (Pringle, 2003: 94).

[46] Pringle (2003; 93) remarks that between 1995 and 1998 Monsanto, Du Pont and Novartis had spent $30 billion acquiring other agbiotech companies and by the end of 1998 Monsanto had been involved in eighteen acquisitions. Novartis was formed by the merger of Sandoz and Ciba-Geigy. Du Pont set up joint ventures that were worth more than $5 billion. Lambrecht (2001: 113) explains that none of the gene-giants were as active as Monsanto whose acquisitions would establish the ST. Louis Biotech leader as the second largest company in the world.

justifiable only if a patent protects that investment from infringements. As GM crops are susceptible to intellectual theft,[47] it is more imperative than patent protection be extended to GM crops than to traditional varieties as it is easier to steal a given genetic modification than it is to engage in the complex and long-term breeding schemes required to produce a conventional variety.

Multinationals holding broad patents on techniques and major crops are increasingly resulting in a greater amount of cross-licensing and intercompany arrangements for the use and development of biotechnology. An important trend is the '*interfirm's cooperation agreement*' whereby companies that have complementary expertise or parallel market interests cooperate on a selective basis. Networks of alliances and joint ventures have implications for small companies who may be forced out of business as arrangements between companies are characterised by a process of give-and-take and small companies may not have enough to bring to the negotiating table (Nottingham 1998). Some commentators even suspect that larger companies may be seeking increased regulation of GM plants in order to create a competitive disadvantage for smaller more innovative firms and that entrepreneurial companies are more likely to fail, because of red tape, long delays and expensive field validations.

[47] This is because any competent breeder can cross a new GM crop containing a novel gene with its own variety; a gene placed into one GM crop can be removed by another company's scientist and reinserted into the same or a different crop and anybody who does this gets the benefit of many years of even decades of research in a very short time.

In an attempt to control the way proprietary genes are used, the major agrochemical companies have drawn up licensing agreements which farmers must agree to sign and abide by if they are to use the transgenic seeds. If farmers violate the agreement, they are required to pay as liquidation damages a sum equal to one-hundred times the applicable fee for the registered gene, multiplied by the number of units of transferred seed, plus legal costs. The implications are that farmers could risk losing their farms.[48] Although Monsanto has renounced use of Terminator Technology,[49] Pringle (2003) argues that the technology behind it has not been abandoned with the introduction of the '*Exorcist,*'[50] which includes a method of killing off alien genes at the end of the plant's life cycle so that they do not appear in the pollen or the seeds and

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[48] For example, Monsanto's 1996 '*Roundup Ready Gene Agreement'* which was required to be signed when farmers bought the Roundup Ready soybean seed gave the company extraordinary influence over the way farmers used the seed, what inputs could be used to grow the seed and the access Monsanto were allowed to farm growing the seed. Growers had to pay a technology fee on top of the cost of the premium-priced seed and give Monsanto the right to inspects and test their soybean fields for up to three years. Growers also had to use only Monsanto's Roundup Ready brand of glyphosate herbicide. The use of any other brand would have been regarded as a violation of the agreement. Growers also had to relinquish the right to save seed or replant patented seed or sell seed derived from it.

[49] In 1998, Delta and Pine Seed Company was granted a US patent for the so-called 'Terminator Gene', a gene which functions by producing a toxin that kills seeds if they germinate. When included in a GM, the Terminator provides an ironclad guarantee that farmers cannot violate patent rights by replanting second-generation seeds. Monsanto saw the benefits in moving beyond agreements into more forceful and irrevocable protection and began negotiating to buy the patent. The uproar from the antibiotech movement became too intense for the company and it withdraw the offer and publicly promised not to insert the gene in any of its products (Winston, 2002: 186)

[50] This technology uses a little enzyme that automatically snips off all the genes spliced into a plant at a particular stage of the development of the fruit before the pollen starts to ripen and become active. The success of this method rests in the timing and some scientists remain skeptical that it could ever be totally reliable as it might excise all the foreign DNA from the plant fruit but not from the seeds (Pringle 2003: 194).

therefore cannot be passed to a wild relative or the next generation. Critics view this technology as just another way of preserving the seed company's intellectual property rights. It has just as the '*Terminator*' did; put flesh to the bones of the political argument- that a handful of life science companies are bent on controlling the food chain.

The proliferation of patents also spells trouble for the small peasant farmer in developing countries. The danger is that as the big biotech corporations start to take an interest in the staple crops, especially rice in Asia, the publicly funded research institutions will find it increasingly difficult to supply poor farmers free of charge with the latest and best improved varieties. The oligopoly of biotech conglomerates have sought protection for their process patents in less developed countries as well for example, the use of laboratory procedures and the contents of gene cassettes have become more restricted and available only to those who could afford them. Patent protection has not been a great concern to most farmers in developed countries for whom annual seed purchases have been common practice for generations, but concerning in developing countries with the threat that they will destroy established farming practices and diminish the diversity and availability of traditional crop varieties. These concerns have failed to make inroads in the regulatory legal system with the focus shifting to that of public opinion in their demands that international trade and agricultural organisations recognise the fundamental right of farmers to have direct access to seeds (Winston, 2002).

The special features of GM crops make it appropriate from an ethical and justice stance not to grant patents even if we think the patent system is in general justified on grounds of social utility for securing an adequate supply of useful new inventions. [51] This argument falls into two parts; the first looks at the justifications for patents in general where we assume (and conclude) that the process of GM modification is not intrinsically wrong and that insofar as GM crops present ethical challenges they do so for reasons that are extrinsic to the process of genetic modification and in the second part that there are at least three relevant types of cases where it would be cogent to refuse to grant patents.

Wilson (2007: 277) argues that patents should be refused where they would increase the difficulty of designing new products to such an extent that we have what Heller (1998) terms a '*tragedy of the anticommons*' where multiple owners are each endowered with the right to exclude others from a scarce resource and no one has an effective privilege of use. Cases such as that of *Golden Rice*[52]

[51] Wilson (2007: 262-264) lists the following categories as excluded from counting as patentable subject matter in most states: inventions that are not technical in nature (a scientific theory as they are basic tools by which we can construct new knowledge); immoral and inventions contrary to public order are excluded because of the social function that the patent system aims to fulfil; methods of surgical and veterinary treatment which would prevent all others from freely using a technique that could save lives or prevent suffering and some countries have taken advantage of Article 27.3(b) of the Trade Related Aspects of International Property (TRIPS) Agreement to exclude patents on animals other than micro-organisms thus restricting ownership of living organisms.

[52] Golden Rice was supposed to be a GM crop that would be of benefit to those in Asia who suffer blindness as a result of Vitamin A deficiency from eating a diet consisting mainly of rice. Golden Rice was supposed to prevent this, by allowing the body to convert the beta-carotene that had been genetically engineered into the rice into Vitamin A. Pringle (2003: 25) argues that the anti-golden rice forces told

have suggested to many that this is indeed a serious worry. Research on Golden Rice was funded non-commercially by the Rockefeller Foundation, who commissioned an audit of the patents and technical property rights they would have to licence and discovered that more than 70 patents would have to be licensed to establish a freedom to operate. As a result they decided to transfer the intellectual property rights to AstraZeneca to bring the product to market. It is difficult to know how strong a conclusion we should draw from this one case as Golden Rice's inventor has argued that it was only as a result of patents that the information that he needed to licence was made public and so the research would not have been possible without patents. The key problem is that we simply do not have the data that would decide this issue and do not have enough evidence to say whether or not the restrictions that patents place on GM crops will have consequences on the level of innovation that are positive or negative, so the question of whether there is a tragedy of the anticommons remains open.

Africans and Asians there was nothing worthwhile in the Golden Rice (not even the Beta-Carotene), it was also claimed (by Greenpeace), that one would have to consume in excess of twenty pounds of Golden Rice a day to meet the daily requirement of Vitamin A. In many underdeveloped countries a pound of rice per person per day is a luxury and even if scientists increased levels of beta-carotene in the rice, people eating it would needed enough fat in their bodies to complete the chemical reaction from food to vitamin. The final argument against Golden Rice focused on the rice plant itself, a variety known as *Taipei 309,* a short grained japonica type suited to northern temperate zones but not found in the tropics or eaten by the poorest people. The scientists had chosen this variety because it was easier to perform the genetic engineering experiment on than on the *indica* varieties. No one knew how Golden Rice's new combination of genes would behave in *indica* rice varieties common to tropical zones where great numbers of people suffer from hunger and malnutrition. By the time the critics had done their work, Pringle (2003: 27) states that agribusiness claims about Golden Rice looked absurdly overblown and even the original sponsor, the Rockefeller Foundation was forced to admit that the prospect of immediately saving the sight of half a million children had been exaggerated and that for the moment they had only a research project several years away from producing a viable crop.

Wilson (2007) maintains however that in so far as this uncertainty is merely an empirical one, there are reasons to favour an approach that does not allow patents which would be superior on grounds of justice as it would allow each person to make use of a given resource regardless of their personal circumstances, whilst a society with patents will restrict access to the good to those who are able to pay.

Wilson (2007:279) then argues that patents are unjustified where research would go quickly enough without them. Even assuming that removing patents on GM crops would decrease the rate of innovation, it does not follow that the pace of research would then be inadequate, but rather that it would be an effective way of making some progress on the crises of trust that has beset GM crops. This would serve another equally important purpose as it seems unlikely that GM crops can reach their potential to benefit society until the problem of trust has been resolved. Two factors that have certainly been significant and that removing patents on GM crops could remedy are the feeling that major changes are happening very quickly without adequate time for reflection; and the feeling that the risk/benefit ratio of GM crops thus far has been lopsided with the risks falling to everyone whether they have consented or not whilst the only apparent benefit has accrued to patent holders and retailers.

I would argue that removing patents on GM crops will allow the moral consensus more time to catch up with the science; it would increase openness and the democratic accountability of research by shifting research back towards the public sector; and the renewed emphasis on the public sector and democratic accountability would make it more likely that research done would produce GM crops that would be a recognisable benefit to society. Patents can also be unjustified if they have unethically unacceptable risks. Some patents on GM crops, where they are applied in the developing world will involve excluding subsistence farmers from access to a technology that could be vital for meeting their basic needs and where these needs can be met without cost to the company.

Resnik (2004) maintains that we should take a consequentialist approach to GM patents but subject to various ethical arguments. He suggests that the appropriate way to is to adopt the *Precautionary Principle*. Wilson (2007: 271) argues that Resnik's application is unconvincing as he fails to define any criteria by which we should determine whether a given response to a plausible threat is reasonable and without such criteria his claim that regulated patents are a reasonable precaution is unsupported.

Resnik (2004) considers only three plausible risks that are introduced by patents on GM crops, namely the threat they pose to farmers in the developing world, worries about exploitation and concerns about the commodification of agriculture. In each case he suggests that the threats posed are plausible but that a reasonable precaution to take against the threat is to regulate patents rather than refusing to grant them at all. Wilson (2007) argues, that Resnik says little about why granting regulated patents would be a more reasonable reply than to ban them completely. However Resnik (2004: 197) is of the view that a full ban would be an unreasonable response to the moral, social and economic problems related to patents which are likely to yield many benefits to society and would be an overreaction to the threat they pose.

Wilson (2007) then states that in order to be able to assess the quality of Resnik's argument we would need to have a better specified conception of what counts as a reasonable precaution, and an example that shows up is Resnik's plausible threat posed to people in developing nations by patents on GM crops. The plausible threat here is that the likely benefits of GM crops will accrue disproportionally to those who are already well off and the harm as a reduction of food security disproportionally to those who are already very badly off. Wilson (2007: 272) concludes that the plausible threat is that patents will make society less just in Rawlsian terms, but what would the reasonable response to this threat be? Resnik has not yet said enough to determine whether it would be more reasonable to respond by regulating patents on GM crops or by not granting patents at all. Wilson (2007) suggests that there are two obvious ways that Resnik might attempt to further his conception of "reasonable" – by taking reasonable precautions against losses of utility or by taking what is reasonable in its ordinary sense. Neither option provides a solution as reasonable in consequentialist terms takes us back to decision-making under uncertainty which

Resnick introduced the precautionary principle to solve and maximising utility is not sufficient for a reasonable response, because there can be clear cases where we think it would be reasonable to take precautions against an event that would maximise utility. Wilson (2007) uses Nozick's example of the utility monster[53] as a persuasive example.

4.3. Bioprospecting or Biopiracy:

Another aspect of patents is what Millum (2010: 24) alludes to as '*bioprospecting*' or '*biopiracy*' or the search for valuable chemical products in natural biological resources with potential uses in medicine, agriculture and other industries. [54] As a great deal of the world's biodiversity is found in developing countries who lack the research capacity to make use of it, it has also lead to concern that

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[53] 'The 'utility monster' is a thought experiment in the study of ethics. It was created by philosopher Robert Nozick in 1974 as a criticism of utilitarianism. In the thought experiment, a hypothetical being is proposed who receives as much or more utility from each additional unit of a resource he consumes as the first unit he consumes. Since ordinary people receive less utility with each additional unit consumed, if the utility monster existed, it would justify the mistreatment and perhaps annihilation of everyone else, according to the doctrine of utilitarianism. According to the philosopher Robert Nozick: "*Utilitarian theory is embarrassed by the possibility of utility monsters who get enormously greater sums of utility from any sacrifice of others than these others lose . . . the theory seems to require that we all be sacrificed in the monster's maw, in order to increase total utility*." This thought experiment attempts to show that utilitarianism is not actually egalitarian, even though it appears to be at first glance.' As cited in Wikipedia (http://en.wikipedia.org/wiki/Utility_monster.[Accessed 13 September 2010].

[54] Winston (2002: 186-187) argues that rights organisation's are demanding that farmers be compensated for the development of modern crops by generations of ancestors who selected and modified wild plants only to have these crops co-opted by biopiracy for genetic modification without payment. The raw plant material serves as a substrate for genetic engineering developed through ten thousand years of agricultural history and demands that these diverse varieties be considered intellectual property and accorded the same patent status as genetically modified crops engineered by biotech companies.

bioprospectors will take what is valuable without compensating the community from which the samples come or whose knowledge led to the discovery.[55] Pringle (2005: 142) describes as '*biopirates*' those who serve commercial masters, work in a new world where publicly funded agriculture has been in steady decline, where farmers buy new seeds each year instead of saving them for harvest and where US patent laws have allowed the protection of living organisms and where plant breeders from the North have an opportunity to make fortunes hunting new varieties in the biological diverse regions of the South. Some of the more rapacious expeditions of these new plant hunters and the monopoly patents they acquired on plant varieties scavenged are so offensive that agricultural leaders in those developing countries have called for urgent reform of the property rights system.

As traditional knowledge frequently fails to meet the criteria for intellectual property on the standard justifications given in the Western tradition, namely, it is not the product of work done by the people who possess it and it is already public among them incentives are not required for its creation or dissemination, however considerations of justice give us reason to support benefit-sharing

[55] As an example, Millum (2010: 24) describes the famous Hoodia case, where in 1995, following nine years of development the South African Council for Scientific and Industrial Research (CSIR) applied for a patent on the chemical components of the plant which suppressed appetite. Three years later, they signed a licensing agreement with a private company named Phtyopharm that developed a program with Pfizer for commercialisation of Hoodia products for the lucrative Western weight loss market. All this research and development proceeded without the knowledge of the San people and only in 2001, following extensive press exposure, did the CSIR enter into negotiation with the San about whether and how they ought to benefit from Hoodia's commercialisation.

arrangements with the recognition that these agreements are neither equivalent to nor sufficient for justice. This point has two important qualifications. First, the resources expended by third parties on facilitating fair benefit-sharing agreements should be balanced against other uses of resources to promote global justice including for example other mechanisms that help impoverished people who do not live in areas of scientifically valuable biodiversity by supporting their claims to land rights and secondly we should not be as concerned about the property rights over genetic resources of people whose present situation is not unjust.

Concluding, I would argue that indigenous people's property rights over genetic resources and the claim to benefit sharing that they warrant are just a means to a distinct moral goal but that when considering how these benefits should be shared other moral considerations may make a difference, for example if community members are employed by bioprospectors then they may deserve special compensation for their work and the details of particular bioprospecting projects are important, for example, the nature of the benefits that are expected to be generated and the involvement of the local communities which may vary from case to case (Millum 2010: 32). Interestingly it appears that biotech companies have not completely dismissed this concept as they do not want to alienate the potential market for GM crops in developing countries; they also have to be wary of their own access to patent protection if they very strongly oppose the concept that traditionally selected plant varieties have some inherent intellectual property value[56].

Chapter 5: The Natural/Unnatural Debate

Extrinsic objections to GE foods focus on the alleged harmful consequences of GMO's including issues involving general welfare, rights and justice and although complex, are unequivocally ethical issues (Streiffer and Hedeman, 2005). Intrinsic concerns argue that the process of making GMO's is objectionable in itself (Comstock, 2000). These are issues that arouse great passion and are

[56] The most ambitious international agreement concerning the sharing of profit and intellectual property between developed and developing countries has been formulated by the UN sponsored '*Convention on Biodiversity,*' which was drafted at the end of the UN Conference on Environmental and Development held in Rio de Janeiro in 1992. It aims to provide a framework for the appropriate access to genetic resources and the fair and equitable sharing of benefits arising from their utilization. Winston (2002: 188) argues that it is hoped that this high-minded agreement will be expressed in real terms through global efforts to conserve plant varieties in seed banks, programs to maintain indigenous agricultural practices, the development of workable ways for traditional farmers to save even genetically modified seeds, mutual participation in product development, shared economic ventures, the implementation of provisions for affordable access to biotechnology for farmers in developing countries and joint ownership of patents and licence fees. He doubts though that the scenario will materialise into meaningful action as the guidelines are voluntary and although the language of the international community may be inclusive, the tangible mechanisms to implement farmer's rights remain elusive. Lewis & Ramani (2007) state that the Convention has no enforcement mechanism of any sort and the principles espoused can only be enforced when they are incorporated into the national access legislation of the signatory countries, should they choose to institute them. The scope of the international measures that have been developed merely recognise the right of indigenous people to their traditional knowledge, none of the instruments specify a regime to protect such knowledge.

ethical in a different way. They arouse feelings, less of moral concern than of disgust and revulsion with the idea of the unnaturalness of genetic modification (Nuffield, 1999: 13).

5.1. <u>Playing God</u>?

The debate appeals to intrinsic concerns firstly in that it is possible to hold religious views to the effect that modern biotechnology is blasphemous. It rests upon the views that God has created a perfect, natural order and for scientists to attempt to improve that order by manipulating DNA, which is the basic ingredient of all of life is thereby crossing species boundaries instituted by God which to some are not merely presumptuous but sinful. The concern here is that modern biotechnology is trying to displace the first Creator. Straughan (2000: 163) submits that not all religious believers would make such claims and even among Christians there is no unanimous condemnation of biotechnology *per se*. Indeed there is some scriptural support for the view that humanity has been given an approved, privileged position of dominion over nature by God and some modern theologians even see biotechnology as a challenging positive opportunity to work alongside God as a co-creator.

For the proponents of such a stance, the wrongness appears to be self-evident, but things that are allegedly self-evident in their wrongness are often highly '*suspect*' [57] and require a rational reconstruction to see whether there is any

[57] Rollin (2006) uses as an example: the inherent wrongness of racial mixing or of allowing women into male dominated occupations.

possible coherent argument in their defence, even if such an argument has not been clearly articulated by opponents of genetic engineering.

When one adopts a theological stance, one can certainly understand the qualms that religious leaders might have about genetic engineering. The Judaeo-Christian tradition has been staunch in its beliefs that God created living things according to its own kind, with the clear implication that species are fixed, immutable and clearly separated from one another. Consider for example, the nineteen century and contemporary opposition by religious factions to Darwin and Darwin's notion of the origin and flux of species illustrates the significance placed on fixed kinds by religious groups. For humans to meddle with species, possibly to create new species, to blur the line between species and indeed as Darwin did, to argue that humans and animals are continuous is to erode the special place of humans and to trade comfortable predictability and order for uncertainty (Rollin, 2006: 137).

Clearly then both traditional ideology and rational self-interest mitigate in favour of conservative church or synagogue opposition to genetic engineering, but what is crucial is that such concern even if well-founded, does not represent a social moral issue. Advances in knowledge and technology that fly in the face of religious tenets may appear to be morally problematic to adherents of those tenets but that in itself does not create a moral problem for our secular society in general or for its social ethic. The point Rollin (2006: 138) is making is that merely theological concerns do not serve as a basis for asserting in the social ethic that genetic engineering is intrinsically, morally wrong. On the other hand, the fact that a concern is theologically based does not mean that concern has no moral import. To simply dismiss a concern without examination simply because it may be couched in theological language is to commit a version of the '*genetic fallacy'* – confusing the source of an idea with its validity, for putatively religious concerns may well be metaphorical ways of expressing social moral concerns for which no other ready language exists. What about other religions? Cook (2005) maintains that like Islam, both Hinduism and Buddhism appear to give rise to more opposition to GM than support, making Judaism and Christianity the exception rather than the rule among religious attitudes to GM.[58]

Rifkin (1985) argues that genetic engineers increasingly view life from the vantage point of the chemical composition at genetic level. From this reductionist perspective, he states that life is seen merely as the aggregate representation of chemicals that give rise to it and that scientists see no ethical problem whatsoever in transferring one, five or a hundred genes from one species into the

[58] Brunk and Coward (2009) as cited in *Religion Dispatches* (2009) explain that for Jews there are myriad contradictions in consuming GM foods. In Conservative and Orthodox Jewish focus groups genetic modification presented few problems in part as many North American participants were largely unaware that they were consuming transgenic food, while reform scholars presented more opposition. Muslim ethical teachings provide few guidelines on food safety, but one conventional ideal of Muslim ethics relates to '*fitra'* or the preservation of God-given naturalness. Hinduism because of its diverse communities and pluralistic beliefs would seem more split on the issue of genetic modification with suggestions that if genetic material were inserted into certain foods that are associated with specific characteristics like purity (*sattva*) it might be seen to be contaminating the soul. Buddhism, they argue is not so much concerned with the outcome of genetic modification but the motivations behind it.

hereditary blueprint of another species. For they truly believe, he asserts that they are only transferring chemicals coded in the genes and not anything unique to the specific animal. By this kind of reasoning all of life becomes what he terms '*desacralized*,' reduced into a chemical level and available for manipulation. Rollin (2006: 138) argues that the notion of '*desacralized*' is pivotal here. *Prima facie* this seems to be a theological notion, yet Rifkin operates from a secular perspective, so what he has in mind is outside of a religious context and presumably what he means is that one commits some sort of metaphysical or secular transgression having moral import when one adopts the stance he deplores in his statement above.

Rollin (2006) argues that one can deduce from Rifkin's argument that one transgresses against life when one views life as a bunch of chemicals. Rifkin appears to be inveighing against reductionism, which supports in its epistemological version that all phenomena can be explained by appeals to the laws of physico-chemistry or in its metaphysical version that all natural objects are nothing but a bundle of chemicals. Even if reductionism is both incorrect and conducive to morally wrong actions, Rollin (2006: 141-142) argues that it does not follow that genetic engineering is wrong. To prove this one would need to show that all reductionism is inherently morally wrong, rather than capable of leading or even likely to lead to bad consequences and that genetic engineering is inherently connected to reductionism. He argues (2006: 141) that we may surely grant that reductionism may be metaphysically wrong in attempting to ignore qualitative differences, epistemologically wrong in allowing for too few types of explanations and even morally wrong insofar as it leads to pernicious ignoring of real individual differences, but does this allow us to say that genetic engineering is inherently wrong? He concedes that there can be no logical basis for such an inference, by arguing that even if many genetic engineers are in fact reductionists, it does not follow that they must be, for one can hold a number of perspectives on the nature of things and still engage in genetic engineering. One could be a reductionist and argue that current configurations of matter in motion be sacred in Rifkin's sense or even in a theological sense and thus should not be tampered with.[59]

Concluding, a belief that genetic modification is intrinsically wrong need not rest upon a religious basis. Agnostics and atheists would naturally be unmoved by arguments against blasphemy, but might still share what Straughan (2000) describes as a widely felt concern that biotechnology is in some sense unnatural and wrong. Yet it is no easy task to identify and agree about what is to count as natural or unnatural. Depending on the context in which it is used, the word '*natural'* may mean innate or normal or perhaps when natural is contrasted with artificial or man–made, but on the basis of that distinction practically every element of our modern western life style is unnatural. Yet if every domestic or farm animal, every garden plant or agricultural crop is thought of as the result of

[59] Rollin (2006: 141) suggests that such an argument may proceed as follows: God made everything out of the same fundamental stuff according to basic laws but did so in the best possible way and thus we should preserve and not tamper.

unnatural interference then the concept of unnaturalness becomes so broad that it becomes meaningless.

5.2. <u>Breaching Natural Boundaries:</u>

The more specific or serious charge of unnaturalness that has been levelled against plant and animal biotechnology is that it breaches natural species boundaries and violates natural integrity of species. Rollin (2006: 143-144) questions what sense can be made of the appeal to the inviolability of species? He argues that although humans can unquestionably decimate a species or destroy it completely, he ponders whether we have done harm to the species? He asserts that the harm done is in a morally relevant way to the plants and animals that comprise the species or perhaps to humans who depend on those plants or animals or who admire them aesthetically or the humans who care about biodiversity or the animals that depend on the members of the vanished species. He maintains that we have not harmed the species as a species is not sentient, only the members of certain species are. He argues further (at 147) that the notion of species appears to be a fuzzy concept, one that is not precise or definable but that captures our intuitive tendencies about groupings. What we find in the world and given the evolutionary paradigm, species are going to have fuzzy boundaries as new species emerge from old species by new selection pressures that favour changes that have emerged by chance. Modern biology does not accept the notion of species as fixed, immutable kinds, a notion that Rollin (2006: 147) terms '*biblically enunciated and articulated in Aristotle'*. He argues that in post-Darwinian biology, nature is forever experimenting with modifications of extant species, most of which modifications will prove to be deleterious, but a small number of which will contribute to the incremental changes that eventually produce new species. One can argue according to Rollin that if species are not fixed, as far as nature is concerned and humans are part of nature, there is no reason why humans cannot produce new species not to breach the species barrier but to accelerate the sorts of modifications that have thus far been effected by using artificial insemination.

I support Nuffield's argument (1999: 14) that unease is aroused by the thought of breaches of the species barrier where for example fish genes are put into strawberries. They question though in what way is a gene that is found in a fish and which might be similar in structure and function to one found in a micro-organism, plant or animal, a fish gene? Some would say that it is no more than a defined stretch of DNA in a fish cell, but that does not seem to settle the unease. Biblical premises have as we have seen yield positive duties as well as restrictions on what we may do with the world. Another principle to be added to the debate is termed the '*stewardship principle*' - or God's gift of sweeping authority to use the raw materials of nature wisely. The parable of talents is at home in both Jewish and Christian thinking and God's injunction to be 'fruitful and multiply' is a moral injunction to such a degree that Orthodox Judaism, for from restricting scientific inquiry has no problem with GM foods arguing that kosher is not a question of biochemistry.

Rollin (2006: 153) concludes by stating that a great deal of attention has been devoted to the claim that genetic engineering is intrinsically wrong. This he argues is because these claims have the strongest hold on the social mind and are difficult to refute. Such claims when unpacked fall into two categories: either a religious appeal that cannot be translated into secular moral terms or appeals to what he terms '*portentous but vacuous notions*' such as desacralizing nature or breaching species barriers or they turn out to be claims that genetic engineering is wrong because it will have bad consequences or cause great harm (extrinsic concerns).

The concern that GM foods transgress natural barriers raises a question: how does nature set boundaries and why is their transgression wrong? Anthropologists have explored this question in discussing ideas of pollution and some critics of GM crops talk of cross-pollination from GM crops as pollution.[60] Clearly, notions of contamination are invoked by both sides in the debate. For the pro-GM lobby, genetic modification is a way of achieving purity, creating

[60] The concept of pollution has been said by some anthropologists to refer to illicit boundary-crossings and they have thought that all cultures seem to have some conception of pollution because all cultures have some conception of what Nuffield terms 'things in the wrong place'. Sometimes the undesirability of pollution has a simple practical explanation. Grit or dust in the oil will wreck the engine; coal dust in the air will give us black lung. Not all sorts of wrongness have an easy explanation of that kind. Racism is an extreme, though widespread symptom of the desire for purity. Many yearnings for natural purity have little or no justification. Tribes that kill twins at birth appear to do so out of a sense that human beings are rightly born singletons and that only animals have multiple births, but they seem to take these drastic measures without much thought about what exactly what would go wrong if they did not do so. Nuffield (1999: 15) question whether it is possible that some of the fears of GM crops are not of the same sort?

monocultures, uncontaminated by weeds or pests; for the anti-GM lobby it is the genetically *un*modified which is pure and the introduction of new genetic material which is impure as are subsequent escapes of pollen and pests. The natural/unnatural distinction is one of which few practicing scientists can make much sense. Whatever occurs, whether in a field or a test tube occurs as the result of natural processes and can be arguably explained in terms of natural science.

5.3. **The Ethical Implications of Animal Genetic Engineering**:

The boundary between human beings and animals has undergone profound changes and has been disappearing in two senses. One is moral and the other biological. Morally, we now acknowledge the moral status of animals that have the ability and capacity to suffer and that their welfare ought to be taken into consideration in moral deliberations, public policy and civilized law. In a biological sense, and due to advances in animal science and biotechnology we are able to shape animals according to our will and produce them containing the characteristics we desire by means of selective breeding, genetic engineering, and cloning (Pascalev, 2006).

Agricultural biotechnology makes it possible to extend patenting to living organisms and the animals that carry them. The driving forces behind the use of advanced technology in animal production are low costs, increased productivity and increased profit. Ethicists, animal rights activists and the public at large are concerned that many of these practices are morally problematic. Rollin (2006) states the claim that genetic engineering, particularly of animals is wrong because it can or will inevitably generate bad consequences is highly troubling. As traditional selective breeding has been increasingly supplemented by various forms of biotechnology it has added to human wealth but had a negative impact on animal health and welfare and on genetic diversity (Gambourg & Sandøe, 2003: 133). These drawbacks require us to ask whether some ways of using the tools delivered by animal genetics are morally unacceptable or are defensible?

The precise definition of animal welfare is the subject of intense scientific and ethical debate. Fraser (2004) maintains that the diversity of scientific dimensions of animal welfare requires a multidisciplinary approach and a balance of science with philosophical values. These are identified as the '*five freedoms'*, and include: freedom from hunger and thirst,[61] freedom from discomfort,[62]freedom from pain, injury and disease, [63] freedom to express normal behaviour, [64] and freedom from fear and distress[65] (MacArthur Clark, *et al*., 2007). The welfare problems associated with animal husbandry relate in part to breeding goals connected with high levels of productivity. Marie (2006) argues that the increased intensification of animal production together with the accelerated

[61] By ready access to fresh water and a diet to maintain full health and vigour.

[62] By providing an appropriate environment including shelter and a comfortable resting area.

[63] By prevention or rapid diagnosis and treatment.

[64] By providing sufficient space, proper facilities and company of the animals own kind.

[65] By ensuring conditions and treatment which avoid mental abuse.

introduction of new biotechnologies as a consequence demand a new focus on ethical and sustainable aspects of livestock productions.

Genetic engineering allows for the change and manipulation of the genetic make-up or genome of farm animals in new and profound ways. Some of the ways affect only individual animals and are not passed onto future generations,[66] while other changes involve germ line modifications and can be inherited. Both types of modifications can be used to promote animal food production through increased productivity, faster growth, improved ability to digests lower quality cheaper foods and improved quality of animal products (more muscles mass and less fat) and increased disease resistance.

A biotechnological procedure may be considered intrinsically objectionable for any one of many reasons: for example it may result in very severe or lasting pain for the animals concerned; an unacceptable violation of the integrity of the animal; associated with the mixing of kinds of animals to an extent that it is unacceptable; it generates living beings whose sentience has been reduced to an excessive extent [67] and perhaps most importantly that the proposed modification is morally objectionable in treating the animal as raw material upon

[66] As in the case of somatic cell therapy, which modifies specific cells of an individual animal to produce desired characteristics without changing the heritable traits of the animal.

[67] Adapted from the Farm Animal Welfare Council's '*Report on the Implications of Cloning for the Welfare of Farmed Livestock*' (1998) as cited in MacArthur Clark, *et al*. ,(2007).

which our ends and purposes can be imposed regardless of the ends and purposes which are natural to them.[68]

Novel breeding techniques have the capacity to produce animals whose integrity has been altered to an unacceptable degree and who raise a broader set of ethical considerations than a purely welfare based approach. MacArthur Clark *et al*. (2007:279) use as an example the commercial acceptability of a strain of laying hens that are 'genetically blind'. Researchers in Canada concluded that when compared with sighted hens, the blind birds laid more eggs, consumed less food, were less affected by flock size and stocking density and had better feather cover.

If we are to evaluate genetic engineering from the perspective of animal welfare, some of the modifications seem to improve animal welfare because the new trait may benefit the animal, for example, disease resistance or the engineered animal would be sufficiently expensive to ensure good veterinary care and optimal living conditions. However from an animal ethics perspective, such positive outcomes may still not be sufficient to justify the modifications because they are motivated by the wrong reasons- profit seeking rather than respect for the animal and although they may receive better care, these benefits may be offset by limitations on the natural behaviour of the animal, restricted movement and indoor confinement.

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[68] Farm Animal Welfare Council's '*Report on the Welfare Implications of Animal Breeding and Breeding Technologies in Commercial Agriculture'* (2004). FAWC. London.

What is also of concern is that the experiments to date show that the insertion of genes is neither foolproof nor fully predictable, with the scientific knowledge and technical capabilities being imperfect and possibly leading to unforeseen negative effects, unpredictable mutations, miscarriages and deformities. MacArthur Clark *et al*., (2006: 277) expand on this to include the low efficiency of genetic modification of the genome in pigs, sheep and cattle; the high levels of embryonic loss; the incomplete knowledge of the genome for most of the major farmed species and the fact that potentially desirable traits such as disease resistance and improved production are polygenic and require the alteration and co-ordinated expression of several genes.

Perhaps the most notorious example of genetic engineering gone wrong is the case of the Beltsville pigs (1985). Human growth hormones were used to increase growth rates and weight gain, reduce carcass fat and increase feed efficiency. Although certain goals were achieved (weight gain, decreased carcass fat and feed efficiency), unanticipated effects with significant negative impacts on animal welfare were noted. This included life shortening pathologic changes (including kidney and liver problems); a wide variety of disease and symptoms notably lethargy, lameness, uncoordinated gait, bulging eyes, thickened skin, gastric ulcers, severe synovitis, degenerative joint disease, heart disease, nephritis and pneumonia. Sexual behaviour was anomalous- females were anoestrous and boars lacked libido. Other problems included tendencies towards diabetes and compromised immune functions (Rollin, 2006;168).

The use of genetic engineering to increase productivity through increased animal size and growth are equally problematic. Transgenic fast growing sheep have been reported to have large internal organs that are two to three times bigger than normal, increased muscles size in cattle have resulted in the increased size of the litter and calves requiring Caesarean section for delivery and causes great stress to the ewes, in sheep. In addition there is much controversy over the use of genetically engineered *bovine somatotrophin* (BST) which increases the incidence of mastitis, cystic ovaries, disorders of the uterus, retained placentas and other health problems including indigestion, bloating, diarrhoea and lesions of the knee and raised levels of insulin growth factor 1 in the milk. In pig production, genetic modifications have aimed to increase the uniformity of animals which directly decreases genetic diversity. Reiss and Straughan (1996) have noted a project at the University of Wisconsin to produce genetically engineered turkeys that are unable to produce the hormone *prolactin* which naturally triggers broody behaviour with the intention of increasing laying efficiency by up to 20%.

Another problem is that many novel technologies are developed from commercial sources without proper evaluation of welfare implications and before regulatory provisions can be developed. MacArthur Clark *et al.* (2007: 274) illustrate this by referring to the '*juvenile in vitro embryo technique'* (JIVET) currently used in Australia where follicle growth in juvenile animals (calves of 8-10 weeks old and sheep and goats of 6-8 weeks old) is stimulated offering the potential to substantially reduce generation levels and produce multiple progeny. They argue that it is essential that targeted surveillance is made of farms where new technologies developed under laboratory conditions but recently released into commercial practice have been implemented and that there is a need for a period of commercial trials before novel techniques may be available for general use.

In conclusion, it is unlikely that the commercial development of GM animals as a source of food will be progressed unless the regulatory, ethical, economic and environmental issues as well as public concern can be addressed. The extent to which GM will be incorporated in future livestock breeding strategies may well be determined not by scientific developments but by public acceptability of the technology. Opposition to GM crops by consumers, retailers and environmentalists continues to influence their commercial application and there is no reason, to believe that a similar level of opposition would not develop if the technology became incorporated into livestock breeding and agricultural food production.

Although these effects are not unique to genetic engineering, their frequency and severity is higher in genetically engineered animals than in conventional breeding. Another concern I would raise is that the changes produced occur much faster and have greater consequences because of the possibility to transfer genes across species and can profoundly affect the welfare of the animal and its offspring and should be subjected to careful ethical evaluation.

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