Bt corn – college essay

Research Question “ Evaluation of the commercialization of Bt-Corn breeds: how it is both economically efficient and overall beneficial for the environment. ” Abstract This paper discusses and evaluates both the negative and positive aspects and raised controversial issues regarding Bt-Corn, a transgenic maize developed through genetic engineering and biotechnology methods, and will finally conclude that the commercialization of Bt-Corn breeds for the past 14 years have been both economically advantageous and beneficial for the environment.

The purpose of this paper is to further educate and inform the general audience regarding issues relating with genetically modified organisms and will try to disprove negative speculation and ambiguity with statistical data and experimental evidence. Introduction Recent development and advances in the field of biotechnology and genetic engineering has enabled scientists today to improve crop varieties through alteration of their most fundamental building blocks, their DNA.

These alterations of the genetic material allow scientists and researchers to develop ‘ new species’ and breeds of organisms which posses certain altered favored traits, which would not otherwise naturally exist in the organism. (Peairs, 2007) However, there is much ambiguity and controversies surrounding the whole field of genetic engineering of organisms and their commercialization.

Bt-corn, a breed of transgenic maize whose genetic material has been altered to include the ability to produce a certain toxin that has specific insecticidal property against pests, has been commercialized now for several

years in the US and also in several other countries such as Canada, Germany, Spain, Argentina, Honduras, South Africa and the Philippines. (Wu, 2006) The prefix ‘ Bt’ from Bt-Corn originates from Bacillus thuringiensis (Bt), a species of soil bacterium that produces the insecticidal crystal protein or delta endotoxins, toxins that kill crop pests.

Genetic engineering has allowed scientists to take the single gene that controls the production of the delta endotoxins from Bt, create a modified version of it and synthesize it with the DNA of selected corn species using recombinant DNA technology. This new set of ‘ genetic code’ allows the plant to produce the delta endotoxins by itself; hence it is able to repel crop pests by itself. This newly acquired attribute is like a miracle for farmers, not just corn farmers since the insecticidal attribute of ‘ Bt’ has also been implemented in several other crops such as Bt-potatoes and Bt-sweet corn.

However, there have been several issues raised against the commercialization of Bt-corn in recent years due to investigations, which reveals how Bt-corn pollen proves to be lethal to other species of organisms that are not considered as pests. (Peairs, 2007) This paper will discuss, evaluate and finally demonstrate how the commercialization of Bt-Corn breeds is overall both economically efficient and beneficial for the environment through the following points: * Origins of Bt and Bt-Corn * Mode of action of Bt toxins Economical and environmental advantages of Bt-Corn * FDA regulations on genetically modified organisms * Controversies and issues raised * Evaluation Origins of Bt and Bt-Corn As previously stated above, Bt-Corn is a breed of transgenic maize whose genetic material have been altered and combined with the insecticidal crystal protein-producing

trait of the common naturally occurring soil bacterium, Bacillus thuringiensis. Shigetane Ishiwata, a Japanese biologist, was the first to discover Bacillus thuringiensis (Bt) in 1901.

However, it was not until Ernst Berliner rediscovered it in 1911 in Thuringia, Germany, that the bacterium was named Bacillus thuringiensis. In 1938 a French company started commercially producing the combination of the bacterium and its toxin crystals as a pesticide, calling it Sporeine, and in the 1950's American organic farmers started using Bt on their crops as a way to control pest. (Aroian) As research methods improved (1960's) and new Bt species were found producing thousands of other specific toxic proteins, more and more farmers started to use Bt.

However, it was not until advancements in genetics and genetic engineering in the 1990's that researchers were able to detect and isolate the specific genes that trigger production of the toxins and transfer it into certain species of crops, such as Bt-Corn. The first Bt crop that was registered with the USEPA (United States Environmental Protection Agency), which allowed for its commercialization, is the Bt-Corn. (Aroian) In 2004, Bt-Corn comprises more than ? of the total acres of cornfields in the United States itself. Wu, 2006) According to Clive James, the chair of the ISAAA (International Service for the Acquisition of Agri-biotech Applications), today (2002) the total Bt-Corn fields in the world approximates to 25 million acres. (James, 2002) Mode of actions of Bt toxins Bacillus thuringiensis produces certain proteins, categorized as crystal proteins, which are very specific, well known for its ability to target and inhibit specific metabolic processes of certain species of organisms, mainly insects.

Investigations have revealed that most of these insecticidal crystal proteins, when activated (when they come into contact with their specific host), attaches itself to the epithelium cells of the gut of the insects and causes the generation of pores in the cell membranes. These pores in the membranes of the epithelium cells, outermost cells that line the surfaces of structures, such as the gut, of organisms, disrupts the osmotic balance of the cells, causing them to swell and lyse. (Hofte, 1989)

In simpler terms, basically these proteins (toxins) cause imbalance of water absorption (osmotic imbalance) in the cells of the ‘ organs’ of specific insects, which causes these cells to swell and break (lyse). They are also very specific and selective on the species of insects they are able to affect, making Bt toxins potent in eradicating pests while being relatively harmless towards other organisms. There is substantial evidence that the toxins (insecticidal crystal proteins) are not harmful to human health nor are they detrimental for the health of vertebrates (mammals, reptiles, amphibians, birds, bony fish and sharks).

According to Peairs, these toxins are considered to be very selective and very safe for humans and non-targeted organisms when compared to the most conventional and common pesticides used nowadays since they only attack certain groups of insects. (Peairs, 2007) Economical and environmental advantages of Bt-Corn It has been several years now, more than a decade, since the commercialization of Bt-Corn breeds and now more than ever, we are able to see statistical data and actual evidence that overall, using Bt-Corn is both economically efficient and beneficial for the environment.

Economic advantages of Bt-Corn According to a study by Brookes, there have been substantial net economic benefits at the farms, totaling up to $5 billion in 2005 and $27 billion during the first decade (1996-2005) of the commercialization of genetically engineered crops. For the genetically engineered maize species, including Bt-Corn and other forms of genetically modified corn, boosted farm incomes by over $3. 1 billion since 1996. In the United States alone genetically modified maize crop income benefits accumulates to a little under $2. 3 billion, which is about 88% of the world GM maize crop income. (Brookes, 2006) The main reason for its economic advantage is its ability to produce higher yields of the same, or even better, quality of produce compared to ‘ organic’ corn because two reasons. The first reason is that since pests are not lured to the crop, they unhindered and are able to flourish and produce more yields. The second reason is that the ability to self-produce insecticidal toxins allows farmers to cut down costs to maintain the crop since they do not have to purchase massive amounts of pesticide.

This also means that less time will be spent on crop walking and the application of pesticides and herbicides, less usage of energy associated with less spraying, savings in costs of machinery and machinery usage (from less spraying and reduced harvest times) and also the unseen benefits in the health and safety of farm workers that is caused by handling pesticides. (Brookes, 2006) Environmental advantages of Bt-Corn The usage of Bt-Corn allows farmers to stop the usage of environmentally hazardous chemicals, may it be pesticides or herbicides.

Overall between the years 1996 and 2005, GM crops have caused the net reduction in the environmental impact on the cropping area by 15. 3% while the total volume of active ingredient usage has also been reduced by 7%. Specifically in the GM maize sector there have been a net reduction in the environmental impact on the cropping area by 4. 6% through the reduction of pesticide usage and another net decrease in 4% in the environmental impact through the usage of more environmentally benign herbicides. Brookes, 2006) There has also been a decrease in greenhouse gasses emission; excess greenhouse gasses emission is a factor contributing to global warming. Brookes states in his article, that the two main reasons for the decrease in green house gasses emission is due to two factors. The first being reduced fuel usage from the less frequent need of using pesticides and herbicides applications (machinery used for spraying). From 1996 to 2005, it is estimated that there has been a reduction in carbon dioxide emission of 4, 613 million kg, calculated from the reduced fuel usage of 1, 679 liters.

In comparison, the permanent carbon dioxide savings from reduced fuel usage from 1996 to 2005 by planting GM crops is equivalent to the removal of 2. 05 million cars from the road for one year, assuming that a car does an average of 15, 000 km per year, producing 2, 250 kg of CO2 per year based on the fact that an average family car produces 150 grams of CO2 every km. (Brookes, 2006) FDA regulations on genetically modified organisms With the development in genetic engineering and biotechnology there is urgency and a need to both control and oversee products and methods used, especially relating with food products.

The Food and Drug Administration (FDA), the Environmental Protection Agency (EPA) and United States Department of Agriculture (USDA) are the three main supervisors of genetically modified foods. The FDA, the official government agency in charge of regulating food, drug and cosmetic laws and ensuring safety of food (other than meat), food additives, medicines, medical devices, veterinary drugs, cosmetics and genetically modified food products, plays the major role in the actual ‘ screening’ of products that are available for the public.

The FDA categorizes genetically modified food products under the ‘ GRAS’ list; the GRAS list comprise of products that are ‘ generally recognized as safe’, which demands the manufacturers to be responsible for the safety of their own products, allowing them to place products into the market without pre-approval of the FDA because whole foods are GRAS. Whole foods are foods that are unprocessed or unrefined such as unprocessed meat, poultry and fish, fruits and vegetables, and non-homogenized milk (basically unprocessed milk; straight from the animal).

The manufacturer bears responsibility for ensuring the product is not adulterated or misbranded. However if there is proof that the product is adulterated, or detrimental to human health (animal health for animal products), then the products may be taken back from the market and the manufacturer may be prosecuted. (Gertsberg, 2009) Controversies and issues raised The development and continuation of research in the whole issue regarding genetic engineering of any organisms itself raises much issues.

However, most of the issues raised within the field of genetically modified organisms (GMOs) are issues regarding perspective and ethics, since there is much fear and ambiguity that most people feel when they think and speak about this issue. Controversies with genetic engineering There are not enough, if there are any, substantial, academic, plain physical experimental proof that genetically modified organisms are hazardous to both the health of humans and the environment.

The main issues raised regarding GMOs are that there is a risk there new allergens will arise from the ‘ unknown’ effects of combining different DNA sequences with each other, increased toxicity levels in organisms do to a faster metabolism, the possibility of unwanted/unintended gene transfer between different species, loss of biodiversity and basically unknown possible effects on different organisms related. (Turner, 2007) There are also several other ethical issues raised, such as the monopoly of world food production by several ompanies, problems with intellectual property and non-mandatory labeling, which is the case in the United States. Non-mandatory labeling violates the rights of consumers to choose between ‘ organic foods’ and genetically engineered foods. Monarch butterfly issue and Bt-Corn Several years ago, an issue was raised regarding how non-pest (non-targeted) species of organisms, the Monarch butterfly species in this case, were affected by the delta endotoxins contained in the pollen of a certain species of Bt-Corn. The issue revolves around how Monarch butterflies population was in danger of being killed through the poisoning by the Bt toxins.

Monarch butterflies would migrate and lay their eggs on areas near the Bt-Corn fields. Their larvae feed on milkweed plants, a species of plants that grow in same regions as the Bt-Corn. However, Bt-Corn pollen would scatter throughout the area and lay on these leaves. Several investigations revealed some mortality in Monarch butterfly caterpillars that consume these pollen-covered milkweed leaves. (Peairs, 2007) Following the recent controversy, a number of private parties assembled and conducted workshops and investigations regarding this issue sponsored by the Agricultural Research Service (ARS) of the United States.

Scientists and researchers were assembled from U. S. and Canadian universities, ARS members and several other environmental organizations, in a joint effort to prove whether the issue has a scientific basis. (Hellmich, 2008) Laboratory experiments done with pure Crystal toxins (Bt toxins) mixed with artificial diets revealed that a certain type of Cry toxin, Cry1Ab, was harmful to Monarch caterpillars but other types of the Cry toxins were not toxic to them.

Field studies done along with lab experiments conclude that there were not any adverse effects observed on the Monarch caterpillars who fed on milkweed leaves dusted with natural levels of the commonly found Bt-Corn pollen species. All but the single Cry toxin proved to be safe. The results of this experiment caused for the termination of the production of Bt-Corn species 176, which expressed high amounts of Cry1Ab toxins. (Hellmich, 2008) Several other studies were conducted to compare between the mortality of Monarch caterpillars in agricultural and non-agricultural habitats, where there aren’t any Bt-Corn species in the area.

Results from this experiment show no significant differences in mortality rates of the caterpillars. (Hellmich, 2008) Another study conducted compared the mortality rates of Monarch caterpillars exposed to Bt-Corn species and ‘ organic’ corn species with the commonly used pesticide, cyhalothrin. Experimentations revealed how, “…nearly all monarch larvae on milkweed plants inside the field were killed. ” Hence Bt-Corn is safer than traditional commercial insecticides and pesticides. (Hellmich, 2008)

The final risk assessment brought forth by Hellmich regarding the Monarch population and Bt-Corn is that the risks are negligible since exposure of the Monarch caterpillars to Bt-Corn pollen is low. Furthermore, the current commercially available Bt-Corn species and hybrids revealed low toxicity. Hellmich concludes that, “ The bottom line from these studies is that all commercial Bt corn hybrids have negligible effects on populations of monarch butterflies, especially when compared with traditional insecticides. ” (Hellmich, 2008) Evaluation

In conclusion, through research and investigations conducted by researchers across the world, we can see how the commercialization of Bt-Corn for past 14 years have significantly benefitted both society and the environment through the ability of farmers to cut down costs, usage of energy, fuel and CO2 emissions into the atmosphere, increase in yields and decrease in the use of harmful chemicals such as pesticides and herbicides. We also see that most of the issues raised surrounding the issue of Bt-Corn and genetically engineered organisms are mostly just a matter of perspective and preferences.

Lack of education and an open perspective regarding genetically modified organisms is the main hindrance towards improvements in the current agricultural field. Bibliography Aroian, R. (n. d.). History of Bt. UCSD – Aroian Lab. Brookes, G. (2006, October). GM crops: the first ten years – Global socio-economic and environmental impacts. 1-106. Gertsberg, D. (2009, August 30). Introduction To The Regulation of Genetically Modified Foods by the FDA . Retrieved May 2, 2010, from GMO Journal: Food Safety Politics: http://gmo-journal. com/index. php/2009/08/30/introduction-to-regulation-of-gm-foods-by-fda/

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