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Biotechnology Companies' Monopoly: Potentially Harming the Diversity and the Sustainability of Agriculture

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Modern agriculture has started to rely more on the use of biotechnology over the past years in order to intensify the output and nutrition of food in developing countries. The use of generically modified crops, pesticides and herbicides has been increasing and the agricultural market is monopolised by few big companies, that have been questioned on account of their causing potential damage economically, environmentally and socially.

The use of biotechnology has been a controversial topic since it was firstly introduced and taken into use in the 1970s. To this day, biotechnology companies keep breeding and selectively modifying plants in order to enhance some of the most wanted qualities, such as making plants more productive and stronger. It has been questioned how safe the use of the genetically modified crops is in reality, and what kind of long term risks they can potentially bring: the toxins transferring to soil and species, biodiversity and loss of traditional crops for example, which can bring economical struggle for resource poor or smaller scale farmers. Another controversial topic has been the use of intellectual property rights and patents, that the biotechnology companies demand when providing their products to farmers.

This paper will concentrate on economic, environmental and social aspects of biotechnology and the effect of genetically modified organisms, and seeks the answer what type of problems may occur in agricultural industry when being heavily led by biotechnology companies.

Keywords	Seed Industry, Agriculture, Biotechnology, Genetically Modified Organisms, Pesticides, Herbicides, Environment

Contents

Abbreviations and Definitions

GM

Genetically Modified

GMO

Genetically Modified Organism

But

Bacillus thuringiensis

IR

Insect Resistant

IPR

Intellectual Property Rights

GATT

General Agreement on Tariffs and Trade

WTO

World Trade Organization

No-till Production Method

Farming Method, in which seeds are deposited directly in to the untilled soil, which has preserved residue from previous crop.

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1 Introduction

The growth of population has added pressure on the food supply of the world and it keeps intensifying. It has been estimated that by the year 2050, the demand for food will be twice as much as in 2005. The need for food is growing in developing countries both nutrition and volume wise, which takes great amount of resources, especially if the need for meat keeps growing and the demand for corn and soy for animal feed rises. Around 40 percent of available lands is used for food production and it requires more fresh water resource than any other action of human. The deforestation, constantly expanding growing lands and other aspects, take heavy impact on the environment and can bring serious long-term damage (Cassidy, 2015).

In recent years, certain tools provided by science and technology to the agriculture industry have affected food production and other aspects around it worldwide. The new biotechnological tools have changed many conventional systems, which has enabled to produce food at unusual rates. The development also has been accompanied by strong changes in social and economic factors, and in the management of Earth's productive assets. The natural interaction with Earth has become manipulated by technological companies that have allowed humans to selectively breed and modify living organisms in order to enhance the wanted characteristics, such as to make durable and more productive plants and other species. The development of these aspects have raised some controversies and arguments both for and against their implementation since the 1970s (Food and Agriculture Organization of United Nations, 2001).

Modified products can bring risks to the food production worldwide, for example for food safety and uncertain environmental problems, of which one of the biggest concerns has been the fear of transfer of the toxins or allergens to non-targeted species and the environment. Other aspects of the issue are ignorance of the potential long-term negative consequences of these products, such as decreased biodiversity and the degradation of conventional crops, which leads to potential economic struggle for smaller scale farmers (Food and Agriculture Organization of United Nations, 2001).

Genetically modified organisms are tools that can be managed "democratically" in the interest of certain players that hold political, economical and technological power in the

industry. The main sectors benefiting from it have been the large-scale agricultural producers and private sector technology developers, located mostly in developed countries. The current situation with intellectual properly rights and patents creates barriers to ensure that the benefits in developing countries would be shared more fairly with smaller scale farmers (Food and Agriculture Organization of United Nations, 2001).

1.1 Research and Methodological Design

Biotechnology companies have promoted industrial agriculture to be the solution for increased crop yields, and the use of genetically modified organisms and chemicals as an alternative for conventional farming. The crop yields have grown around 20 percent globally in the last 20 years, therefore one of the greatest aspects in the 21st century will be doubling the supply for food in less than 50 years. Biotechnology companies say to have the solution for world hunger, but studies have shown that the provided GM crops have not had significant impact on the crop yields nor contributed to the issue of food security so far (Cassidy, 2015).

The development of genetically modified organisms has raised many controversial aspects and ethical issues concerning the modern agriculture and food production. The purpose of this study is to explore different variables that are linked to biotechnology companies and agriculture. The study seeks to answer the research question on how biotechnology companies potentially harm conventional agriculture. The goal is to analyse the available studies and determine how much the biotechnology corporations have affected the agriculture industry and society both in recent years and in the future.

When planning the methodological steps on writing about this particular subject, many aspects should be taken under consideration since there are a lot of factors that are related to each other. In this paper, the main concentration will be on the biotechnology companies that provide the genetically modified products such as the seeds and pesticides, farmers, and other topics around these such as the economic, social, and environmental factors. The main methodological approach will be analysing scientific studies and other materials based on the biotechnology companies and the results on genetically modified organisms, pesticides and others. The materials that are

used in this report have been collected from various bibliographical resources and online materials on the subject.

2 Genetically Modified Organisms, How Did It All Get Started?

Since the beginning of agriculture, the genetics of food have been modified by humans for over 10,000 years. Today, the technologies used by humans to modify plants and animals have become more advanced, but in the beginning it all started with a desire to enhance wanted characteristics in plants and animals. The present day genetically modified DNA recombinant technique has been used for over 25 years (Gmoanswers.com, 2018). In the following table, the history of genetic modification in crops is explained in more detail:

Figure 1. The History of Genetic Modification in Crops. Source: gmoanswers.com.

In earlier times, some of the most common human modified plant hybrids included cotton, potatoes, bananas, seedless grapes and watermelons, apples, coffee, alfalfa, peanuts and strawberries for example, and all of these plants are capable of fertilizing one another. Nevertheless, if humans had not intervened in enhancing some wanted characteristics, these plant varieties could be rare in modern agriculture. In this way, humans have altered crops for years without more specific knowledge of DNA or plant genetics. Modern biotechnology differs from the earlier times, since the plant can be modified with various sources of genes such as bacterial, animal, fungal or another plant, and it is no longer dependent on natural formations or changes in the plants (Lurquin, 2002).

The research on genetically modified organisms started in the early 1980s, when researchers were given projects to research the effect of genetically modified organisms. Since the beginning, it was pointed that the government and biotechnology industry should handle the matter responsibly and intelligently due to this technology's new potencies. Genetically modified organisms were released commercially in the 1990s. Shortly after the release, scientists divided in to two groups, either supporting or resisting the whole idea of releasing and using GMOs in the consumer market, and the opinions still vary to this day (Druker, 2015).

Nowadays there are eight commercially available GMO crops that are used in food production: corn, soybeans, cotton, alfalfa, sugar beets, canola, papaya and squash. Apples and potatoes were recently reviewed by the FDA and USDA and will be available commercially soon (Monsanto, 2018).

2.1 The Qualities of GMO Crops

In agriculture, the crops are constantly under threat of disease and parasites. For the benefit of farmers and even the consumer, it is desirable to be able to control the pathogens such as viruses, bacteria, fungi and insects. The less crop loss the farmer has, the lower the price becomes for the consumer in the market. In order to achieve the desired crop protection, additional herbicides need to be used to control weed growing, since they decrease yields as much as pests (Lurquin, 2002).

There are several reasons why the GMO crops have been created, not only to achieve a desired quality in the crops, but also to make them resistant to certain insects or disease. Some of the main characteristics that are developed for GMO Crops are explained more in depth below:

Insect Resistance - Benefits the farmers with full-season protection against some targeted pests, and also lowers the need to apply pesticides, which results in lower costs of input. The insect resistance plants also reduce the environmental exposure to toxins, such as other species, human, and soil (Gmoanswers.com, 2018).

Drought Resistance - This quality helps the crops to grow in more dry areas, which can help to save water and other environmental resources (Gmoanswers.com, 2018).

Herbicide Tolerance - Allows farmers to eliminate weeds by using herbicides such as glyphosate when needed since the crops can tolerate specific herbicides. The usage of no-till production methods is said to help preserve the top soil, prevent erosion and reduce carbon emissions (Gmoanswers.com, 2018).

Disease Resistance - Helps to prevent bacteria, virus and fungi in crops. (Gmoanswers.com, 2018).

Besides being resistant to biological stress such as weeds, viruses and bacteria, the plants also resist physical stress, such as frost and soil salinity. Soil salinity is something that can limit the production rate of agricultural crops, since high sodium amount has an effect on water balance in plants and is also a major cause of losing farming land and deforestation. Therefore, it is an important aspect if it becomes possible to farm crops in these high-salinity soils to break the cycle (Lurquin, 2002).

There are also plants that are naturally more tolerant to sodium, since their cells can process it better, and in the 1990s a Canadian research group took the gene and planted it in other non-sodium resistant plants. It raises the question, what would be the effect on human health to consume these foods due to their increased dietary sodium. Thus, the possible consequences should be well evaluated before spreading such methods in genetically modified crops (Lurquin, 2002).

3 GMOs, World Hunger and the Environment

The methods that are currently being used by biotechnology companies have been disputed to be lacking, the biotechnology industry is lobbied, and their monopoly makes small scale agricultural businesses face economical struggle. For example, only some of the nutrients' chemical analysis have been reported, and genetically modified crops are considered equal to its conventional crops (Magahi, B.M. and Ardekani, A.M.,2011).

According to an analysis from 2010 made by Food & Water Watch, the biggest biotechnology companies and trade associations had invested during the years 1999 to 2010 over US $ 572 million in campaign contributions and lobbying to establish a political bond (Food & Water Watch, 2010).

In the past, industrial agriculture has been boosting the output of the largest yielding crops. Between 1961 and 2001, the regional food production per-capita had doubled in Southeast Asia, the Pacific, South Asia, Latin America and the Caribbean. This was made possible by farming high yielding crops in specific monocultures, and using synthetic pesticides and fertilisers. This development had lifted farmers out of financial struggles and improved diets in general (Heinrich Böll Foundation, 2017).

Yet, agriculture that is relying on biotechnology has not yet delivered food security on a large scale and will face challenges in the future as well, since the methods that are used can harm both environmentally and socially. The biotechnology companies insist that by producing more food with GM crops they can help with the world hunger. This statement can be questioned, since the problems are more in depth and depend not only on boosting the output of food. The problems lay in the proper distribution of food and how to uplift the living conditions of the poorest. This could be improved by ensuring nutritional foods and stable income. Nowadays, the total calorie amount of edible crops produced in the world would be about 4 600 kcal per person per day, but only around 2000 kcal is available for consumption (Heinrich Böll Foundation, 2017).

In 2008, the Stockholm International Water Institute published the following numbers of the calorie losses out of 4 600 calories: 600 calorie loss happens after the harvest, such as spoilage or storage loss of the produce. Another 800 calories were estimated to be lost during the distribution, and 1200 calories end up being used for feeding the livestock. These numbers were presented without adding the use of fuel crops (Heinrich Böll Foundation, 2017). If these plants would be used for food supplies, it could increase the calorie supply by eight percent. The non profit World Resources Institute conducted a recent analysis which results pointed that by 2050, 29 percent of all calories that are currently produced would be consumed for biofuel (Cassidy, 2015).

The heavy industrialisation of agriculture can potentially slow down the output of food due to its negative effects on nature, the most significant being land degradation.

Current degradation is proceeding by 12 million hectares a year, and over 20 percent of agricultural land has been reported as degraded. For long-term productivity, increased usage of pesticides in order to maintain productivity levels in farming bring risks, since viruses, fungi and bacteria become more resistant to chemicals. This creates a cycle for farmers that keeps increasing pesticide use and their costs, and further damages the environment. The damage can be seen in productivity, since major crops yields have started to elevate in different regions, for example maize in Kansas, United States and rice in Hokkaido, Japan. A global meta-analysis of yield developments conducted from 1961 to 2008, showed that yields did not improve, stayed the same, or even fell in about one third of the areas that grew maize, rice, wheat and soybeans (Heinrich Böll Foundation, 2017). The following figure shows the yield developments more in depth:

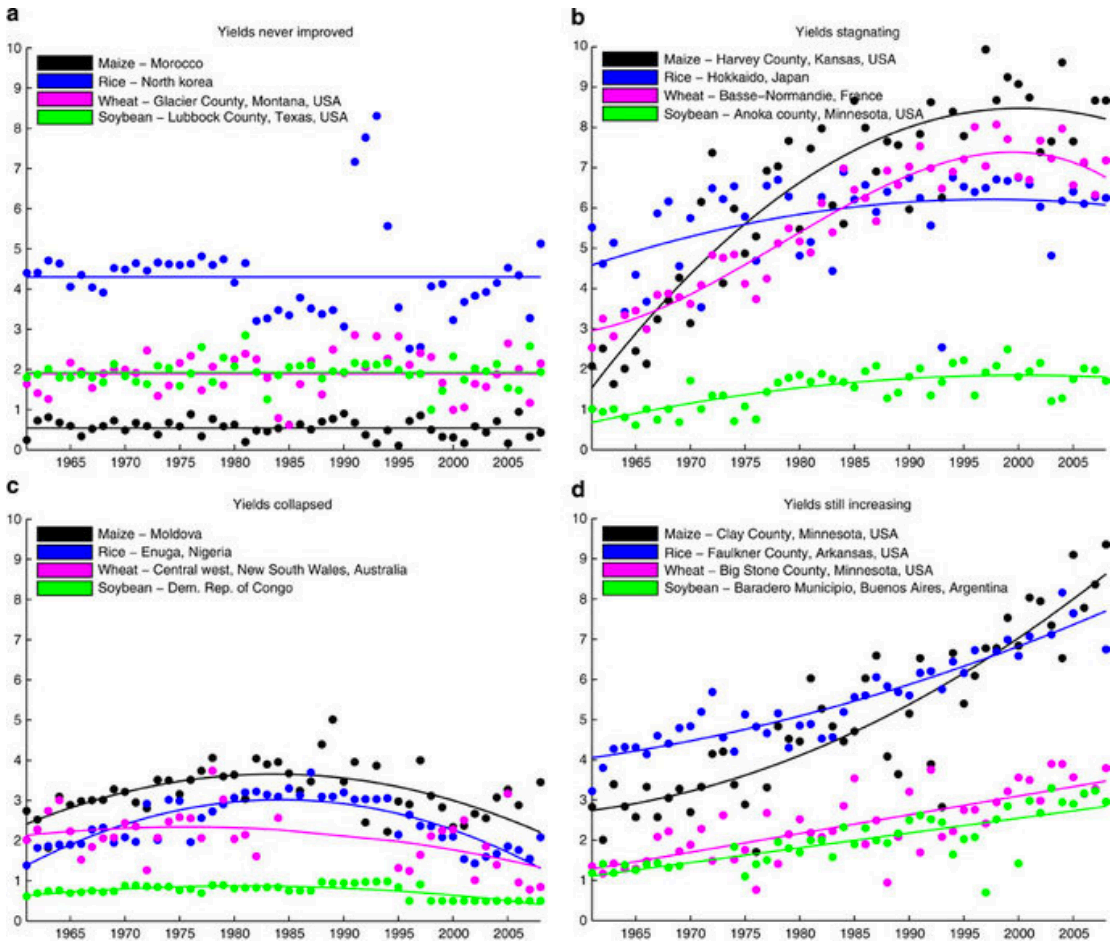

Figure 2. Illustrative Examples for Each of the Four Types of Global Crop Yield Trends. (Source: Nature Communications volume 3, Article number: 1293 (2012).

To possibly change the agricultural practices, the business model of biotechnology companies should be thought through on how it can be improved, since now some problems occur due to relying on specialised producers and homogenous products, which grows dependency on chemical inputs in farming. More diverse farming models can bring higher yields without damaging the environment and is more supportive socially as well (Heinrich Böll Foundation, 2017).

In the following quotes, the definitions of adequate food which should be provided are explained:

The committee of the UN on Economic, Social and Cultural Rights considers that the core content of the right to adequate food implies:

> "The availability of food in a quantity and quality sufficient to satisfy the dietary needs of individuals, free from adverse substances, and acceptable within a given culture; The accessibility of such food in ways that are sustainable and that do not interfere with the enjoyment of other human rights."
>
> General Comment 12, paragraph 8 (E/C.12/1999/5)

The Special Rapporteur of the Sub-Commission on the Promotion and Protection of Human Rights of the UN Commission on Human Rights has stated:

> "State obligations require active protection against other, more assertive or aggressive subjects - more powerful economic interests, such as protection against fraud, against unethical behaviour in trade and contractual relations, against the marketing and dumping of hazardous or dangerous products. This protective function of the State is widely used and is the most important aspect of State obligations with regard to economic, social, and cultural rights, similar to the role of the State as protector of civil and political rights"
>
> (E/CN.4/Sub.2/1999/12)

Based on these quotes made by The UN Committee of Economic, Social and Cultural Rights and the UN Commission on Human Rights, the biotechnology companies that keep spreading their business and patenting seeds are not following the core consideration of providing adequate food to nations since there is still some uncertainties when it comes to GMOs.

Biotechnology giant Monsanto alone had over 17 500 employees, profits of over US$ 1 billion and facilities in 47 countries in 2010. It still has communicated that their main

concern is to contribute to sustainable development and help to reduce world hunger, which they are planning to solve with genetically modified seeds and pesticides, which raises the concern for limiting the ecosystem (Robin, 2010).

The statement of providing nations with more nutritious food and solving the world hunger can be questioned, since for example the monetary amount used by biotechnology company Monsanto alone in the 2000s to promote its GM products and spread the message of helping the world hunger, was much larger than the amount used to develop one of the most promising products, the Golden Rice, which was designed to help with vitamin A deficiency in certain countries. Comparing the facts of starving nations and promoting GMOs can divide opinions and raise questions on moral aspects of these types of campaigns (Robbins, 2012). Despite the contributions and statements that have been made by biotechnology companies, the overall world hunger statistics have not seen a dramatic change in the past years, although in fact the number has risen affecting 11 percent of the whole World's population according to the World Food Programme organisation (World Food Programme, 2017).

3.1 Safety of Genetically Modified Foods and Human Health

Food has large variation in composition and nutritional values, and food safety is a major concern among consumers around the world. Consumers want to be aware of if the genetically modified products that reach the market have been appropriately tested to ensure safety and to identify problems. Since these products are complex, the research on the safety of genetically modified foods is still difficult and controlled. There are studies conducted on pesticides, industrial chemicals and food additives for example.

One study that has been most discussed was conducted by French molecule biologist Gilles-Eric Séralini, whose study showed that genetically modified food would be damaging to health. The study was conducted on rats who developed cancer tumours while being fed genetically modified corn.

Before the environmental toxins reach low-level exposure to health, it takes significant amount of time. This particular study had researched the impacts on health by using rats, who were fed genetically modified corn which was available commercially,

together with glysopgate based herbicide called Roundup. After the study finished, the research group discovered that the rats who were fed the GM corn and exposed with lower levels of glysophate, which was still below the permitted level than the most drinking water in Europe, had strongly damaged liver and kidney, as well as disturbances in hormones. In most of the groups of rats that were treated, they had also developed large tumours and mortality (Séralini et al., 2014).

Originally the study was published in 2012 in *Food and Chemical Toxicology* journal and caused a lot of critique, and was removed from the journal later on. The biggest critique that the study had received was that the rats that were used in the study were not the right kind, and the number of them was too small for conducting such study.

3.2 Agent Orange by Monsanto

Monsanto had been the main manufacturer of chemical called Agent Orange during the Vietnam War, which was designed to demolish plants in order to provide better visibility of the ground. When spraying the Agent Orange chemical, millions of Vietnamese were affected. The chemicals have been connected to many problems, such as cancer, birth defects and other diseases, according to the Red Cross in Vietnam. There has been a concern that the latest modified corn and weed killer Roundup provided by Monsanto could cause similar misfortune as Agent Orange. Instead of reducing the use of pesticides in GM crops, the amount of herbicides has been increasing, and the biotechnology companies keep pushing their new products to the market bringing potential risks for both environment and health. Nevertheless, Monsanto has received a positive reception in Vietnam for their GM seeds stating that they aim to improve yields and feed the growing population with affordable prices. People who oppose this are concerned that by entering developing countries and imposing intellectual property rules, such companies could be damaging the agricultural industry, since that would give them the control and allow them to monopolize with patents keeping the prices high. The original model of Trans Pacific Partnership has originally been intended by the US business, for the interest of US business (Leung, 2014).

4 Global GMO Storm

The use of GMO crops has grown globally, but there are a few developing countries who grow them in distinctive levels compared to other countries, and there are reasons why some adopt to the GMO crops more successfully than others. The level of effectiveness of a farm can be measured by the fact can the farmer adopt and continue the use of new technology, but there are also other aspects other than their technical performance. Economic studies from 2006 conducted in developing countries have found have found both positive and also fluctuating economic yields in the adaptation of genetically modified crops. Studies have presented that when defining the level and distribution of economic advantages, aspects such as the national research capacity of agriculture, environmental regulations, food safety, IPR and market of inputs of agriculture have similar role as technology. The economic impact of GMO crops in farming is dependent on the cost and return of the growth of them when comparing with unconventional crops. The most studied GMO crops have been conducted on insect resistant (IR) cotton in Argentina, China, India, Mexico and South Africa. In the study conducted in 2006 by Food and Agriculture Organization of the United Nations, the results were overall positive, since farmers who used GMO crops achieved higher effective yields, greater revenues and smaller costs in pesticides. These aspects paid off for greater prices paid for the insect resistant seeds, resulting in increased net income (Raney, 2006).

The genetically modified seeds have been causing different problems around the world in the agriculture industry. Once every plant is contaminated globally, biotechnology companies will be able to take even more royalties, which will affect North America, South America, and Africa. During the years 1993-2012, the United States exported on average 20 percent of its produced corn to other countries. In the following chart the tonnes of corn are presented in more detail to give an overall image of the volume of exported corn from the United States:

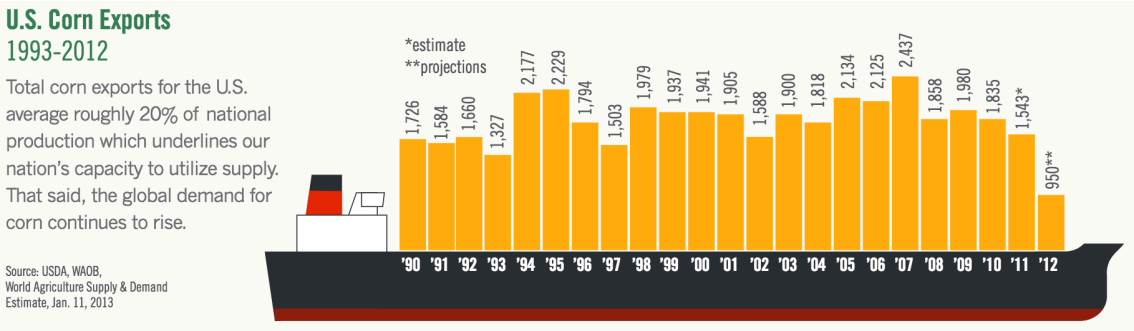

Figure 3. The US Corn Exports 1993-2012. Source: National Corn Growers Association.

In the following part, the situation of China, Mexico, Argentina and India will be covered more in depth: GM Cotton growing in China, biodiversity issues in Mexico, soy bean crops in Argentina, and seed market issues in India.

4.1 Genetically Modified Cotton in China

In China, insect resistant cotton is grown by millions of small scale farmers, and the country showed the best results in the study in with productivity, incomes, equity and sustainability. The success can be linked to their well progressed public agricultural research system, which also successfully had produced its own pair of crop types that were insect resistant, which were later integrated into local cotton varieties that competed with Monsanto's IR cotton seeds. This resulted that the price of the GMO seeds was much lower in China compared to other countries, and that the farmers could achieve higher profit returns. Compared to other countries, farmers in China had lower yield benefit, since damage by pests used on conventional cotton crops was managed by strong use of pesticides. With time, China had successfully reduced the chemical pesticide use on cotton crops, which has been an significant improvement for environmental and farmers' health aspects (Raney, 2006).

4.2 Mexico: Clasping the Control of Biodiversity

In 2001, Nature published a study signed by David Quist and Ignacio Chapala, two biologists from University of California, Berkeley, that created a stir and revealed certain practices of Monsanto. The study found that conventional Mexican corn in Oaxaca had been contaminated by Roundup Ready and Bt Genes. This information had caused a particular noise since in 1998, Mexico had prohibited crops of transgenic

corn, to preserve their unique biodiversity of their plants, which had its origin from Mexico (Quist & Chapela, 2011). In Mexico, “industrial corn” refers to the six million tons of corn which comes in every year from the United States, and 40 percent of it is genetically modified. Due to the North American Free Trade Agreement, NAFTA, made in 1992, it is difficult for Mexico to prevent the importation of corn. The competition is challenging for local Mexican corn producers since the imported United States corn is sold at nearly half the price. For example, 11 percent of corn was exported by United states in 2007 to Mexico worth over 500 million US dollars. The overall United States originated amount of corn that was consumed in Mexico was around 30 percent. It was estimated that between the years of 1994 and 2002, the Mexican corn price had fallen by 44 percent, which took its toll on many small scale farmers and even putting them out of business and make them loose their property (Robin, 2010). If the Mexican corn will be fully contaminated, the farmers of the country will be completely dependent on multinational biotechnology corporations because of the patented seeds, fertilisers and insecticides. Traditionally farmers in Mexico have been farming corn without chemical products for centuries (Quist & Chapela, 2011).

This conducted study by David Quist and Ignacio Chapela began while Chapela was working in Mexico for 15 years teaching local Indian communities how they can analyse their environment. His student, David Quist, wanted to start a workshop on GMOs. Chapela and Quist began the comparisons of DNA between genetically modified corn and conventional can of corn they had purchased in the US and the pure local Mexican corn. To their surprise, they made a discovery that the samples they took of the pure Mexican corn contained genetically modified DNA. After their discovery, they reported to the Mexican government which conducted the test again and confirmed that the contamination was real after which 22 farming communities were tested by the government and discovered contaminated corn in 13 of these farms. After the results were published, the two biologists began to have problems similar to Gilles-Eric Séralini’s case where they were told that both of them lack any technical competencies and expertise to conduct this type of study (Quist & Chapela, 2011). The study related to GMOs provoked once again unconditional promoters of biotechnology companies. According to Chapela, one part from where the attacks against the study were coming from was his former colleagues at Berkeley’s biology department, who had gotten a contract worth 25 million dollars with Novartis-Syngenta, another biotechnology company. The contract of 5 years gave the company rights to patent a

third of the discovered corn types used in the study. Later on in 2002, the article was subject to a request for retraction by a scientist at Berkeley, who was funded now by Novartis-Syngenta, and another retraction request came from Monsanto on the same year (Quist & Chapela, 2011).

4.3 Argentina: Soybeans

In comparison to China, Argentina has experienced IR cotton in a different way due to effect of IPRs. In Argentina, the IR cotton has enforced IPRs by Monsanto, which has resulted in much higher prices compared to conventional cotton seeds. Due to this, the IR cotton is not as widely farmed and has smaller returns, compared to genetically modified soybeans that Argentine farmers have been farming eagerly. The GM soybeans in Argentina have increased productivity approximately by 10 percent in the year of 2006, and the cost saving have been more in favour for small farms (less than 100 hectares in this case) compared to large farms. Small farms have been more likely to use seeds that are uncertified and this has led them to get lower seed prices. The overall global welfare in 2006 had benefitted from GM soybeans worth over 1,2 billion US dollars, of which 53 percent had been distributed to consumers, secondly 34 percent for biotechnology firms, and lastly 13 percent to farmers. It has been concluded that the crucial difference between IR cotton and GM soybeans has resulted when Monsanto firstly entered the Argentine market with GM soybeans and failed to patent them, due to this they have been incapable to implement strict IPRs. Argentine GM soybean growers received around 90 percent of the benefits (Raney, 2006).

According to researchers, Argentina started to experience an economic crisis when genetically modified soya was proposed as a good solution for resource poor farmers: it resulted in soil bacteria damage and it was letting weeds that were herbicide resistant to grow rapidly and hard to manage. Soya has been one of the most grown crops in Argentina, having more than 11 million hectares located on pasture lands, of which 98 percent are genetically modified. After the economic crisis in the country, soya became one of the most important cash exports in the form of cattle feed to Europe and other places. One of the concerns pointed out by researchers has been that the dependence only on soy can bring bigger problems for the economy of the country (Brown, 2004).

As one example, biotechnology company Monsanto is selling and growing genetically modified soya, which is the company's biggest success. The soy that Monsanto is providing is resistant to their glysophate herbicide called Roundup, which had increased soya production for over five years to 2002 by 75 percent, this has led to small farmers struggling financially. Despite this, a report in N*ew Scientist* magazine said that due to crop complications, the use of herbicide has doubled in conventional systems. This has led to numerous cases of surrounding small farmers to loose their crops and livestock because of the herbicide spray that was used in surrounding farms. In Argentina alone, 150 000 small farmers have been forced out of the way in order to be able to grow more genetically modified soya. Since there has been such a dramatic increase in farming soya, the production rate of other essential crops for example rice, corn, lentils, potatoes and milk has reduced. Monsanto's response was that the problem had to do with the crop as a monoculture, not because it was genetically modified. Colin Merritt, Monsanto's biotechnology manager in Britain, added that "if you are going to farm any crop to the exclusion of any other, you will get problems." Monsanto suggested that it would be more sensible to grow soya in cycle with another type of crop, in order to provide some recovery time for the soil (Brown, 2004).

Despite Monsanto's claims, Argentina has faces problems with fast spreading weeds that are resistant to the Roundup herbicide. The type of weeds could easily develop into "super weeds" which would be impossible to control. Originally Argentina welcomed the genetically modified soya since it was promised to solve a problem of soil erosion, since soya is planted by directly drilling the seeds into the soil. Opposed to this, Adolfo Boy, a member of Grupo de Reflexion Rural, said that "the bacteria were needed for breaking down vegetable matter, and by using Roundup for the crops made the soil inert, to the point that the dead weeds did not rot anymore", he told *New Scientist* (Robin, 2010).

4.4 India: The Seeds of Suicide and Destroyed Farming

Monsanto has desperately been attempting with its public relations to remove the association with the cases of farmers' suicides in India by advertising their seeds and herbicides actively in the country. Monsanto has grown its control over the cotton seed supply, and in the year 2003, 95 percent of India's cotton was controlled by them. Indian environmentalist Vandana Shiva has opposed globalisation and the use of

genetically modified crops. She states that the current model of industrial agriculture is too dependent on chemical fertilizers, pesticides and fossil fuels which places a tremendous burden on the Earth's resources (Shiva, 2013).

In 1988, when the Indian seed market was appointed by the World Bank, Monsanto had the chance to get in to the seed market in India, which made the Indian Government to forcing the Government of India to liberalise the seed sector. This changed the market after Monsanto had entered. For example, companies in India found themselves locked with licensing arrangements, and concentration within the seed sector increased. Secondly, the farmers' seed resource became the intellectual property of Monsanto, again collecting its royalties and raising the prices of seeds. Thirdly, India's openly pollinated cotton seeds were replaced by genetically modified hybrids. What had once been a renewable resource had become a non-renewable and patented material. The cotton that had been earlier grown amongst food crops, had to be now separated as a monoculture, which made it more vulnerable to pests, diseases and failure in crops. Monsanto also had started suppressing India's local regulatory process and utilised public resources to market their own genetically modified products (Shiva, 2013).

The seed monopoly of Monsanto has been destroying any alternatives, profiting from royalties, and increasing monocultural vulnerability. These actions have led to cycles of debt, distress in agriculture and even suicides amongst farmers in India. The talk of technology and PR of Monsanto has tried to hide the real objectives of ownership and control over the seed market in India. Monsanto's genetic engineering is just a way for them to control the seed and food systems through the patents and intellectual property rights. Now India has created community seed banks to store GM- free seeds and try to help and support the local farmers to go organic (Shiva, 2013).

5 How Corporations Control the Food Worldwide

Having only a few leading agriculture companies in the world, gives them advantage of setting the prices, terms and conditions, as well as the political framework. The foods that are being consumed in North, have been produced cheaper in the Global South. Yet, the incomes go to the multinational biotechnology companies and small farmers are left as the weakest links in the value chain. Moreover, the ecosystem is being

degraded and slowly destroyed. By controlling the agricultural chain, in addition to where only one company has the control of biggest share of the market, the horizontal integration, the strategy of corporation aims at vertical integration by processing products and producing inputs. The control becomes about the value chain and adding the chance for access to cheaper raw materials in the production line (Gura & Meienberg, 2013).

When monopoly of biotechnology company appeared, the economic power turned to political one, since the biggest companies have the better opportunity in lobbying, which gives them an advantage in the market. This results in circuits of aggregation become fixed, or controlled by limited players. At certain point, these companies who have reached the monopoly can stabilize their income by ceasing to compete on the basis of the prices. Large companies have the benefit to showcase their intention to raise the prices or restrict their output, while others usually have to follow and suit to their needs. The market is no longer competitive when four firms control 40 percent of it, and in recent decades, the percentage has been reached in the agricultural input industry. It was estimated in 2009, that the largest pesticide providing companies controlled over 59 percent of the market globally, and seed providing companies had controlled over 56 percent globally (Howard, 2009).

In the following chart are presented the biggest seed corporations in the world, the biggest being Monsanto and Bayer:

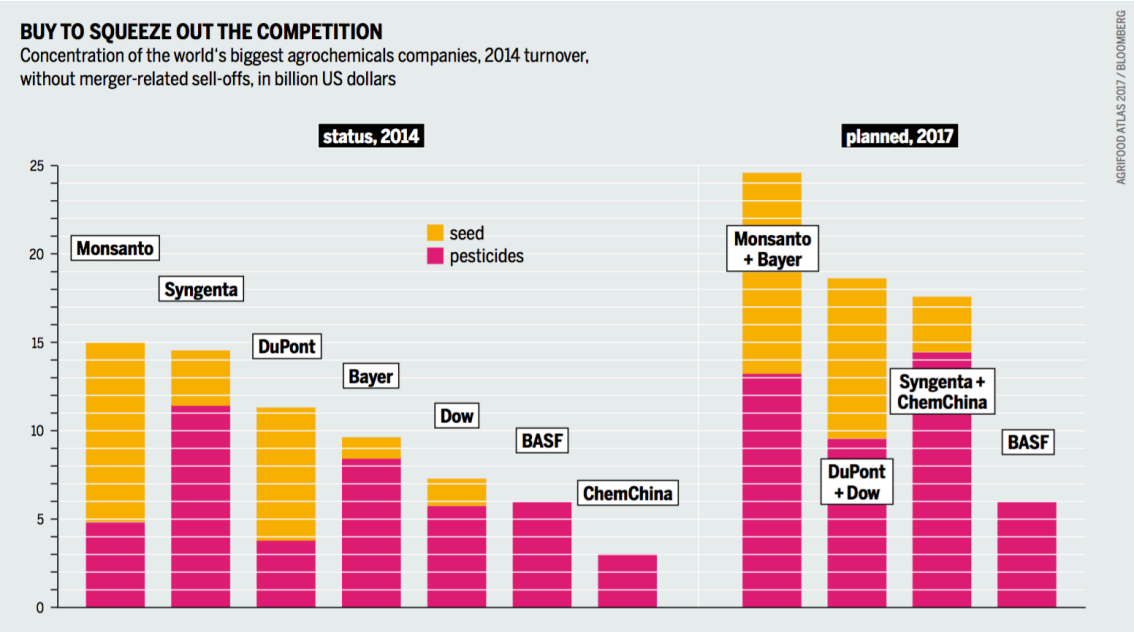

Figure 4. World's Biggest Agrochemical Companies, 2014 Turnover. Source: Agro food Atlas

The domination of biotechnology corporations in politics and in public discussion has been growing; numerous lobbyists have started to promote corporate interests, such as in the earlier example of Ignacio Chapala's case in Mexico. Slowly the biotechnology companies' lobbyists and employees have been starting to work in governmental positions in US, such as Monsanto's former attorney Clarence Thomas becoming a Supreme Court of Justice, where he later defended the company in various cases considering genetically modified product versus farmers, such as "Monsanto Co. c. Geertson Seed Farms" and "Bowman v. Monsanto Co." Another person, Michael R. Taylor, was promoted to Commissioner of the FDA after working years as a Vice President of Monsanto (Sager, 2014). These positions can give an advantage for lobbying for interests of the corporations on food standards, for example approval of pesticides, GMO seeds, trade agreements, or conducting researches on their products (Gura & Meienberg, 2013).

As these six biotechnology companies merged into three, it has raised concerns amongst consumers and farmers on how how it will impact on the food system globally. In 2016, the companies stated before the US Senate Judiciary Committee in Washington prior to merge, that their fundamental stand was to reorganise the global agriculture by combining the companies' expertise and provide better efficiency for both farmers and consumers. The merge would potentially rise the prises and lesser the competition in marketplace, since not only the companies will be able to increase price

of their produce, such as the seeds and chemicals, but it can lead to less innovative and less variety of products for farmers to choose from. In 2016, the sales of the biotechnology companies faced declining sales with exception of Bayer. It can be argued that the companies are more concerned to enchant their profits rather than developing new technologies, since the United States agriculture market for example has been demanding natural and organic products that can let their farmers grow crops with more profits (Purdy, 2016).

This merge can potentially widen the possibilities of new resources or example in genetics or plant breeding, and to new markets in which the other company has already access to. Company merging in general can also be connected technological developments for example, which can lead to increased costs when releasing new products to market. Potential increased prices are usually easier to cope for the big firms, since they already have dominance of the market. These acquisitions of companies have to be firstly reviewed by antitrust authorities, who aim to prevent imbalance in the competition in a market, prevent counter-competitiveness not to increase prices, lack of choice, or oligopolies. Nevertheless, the seed industry has been concentrating drastically over the past years, and keeps going with these new acquisitions. For comparison, in 1985, the top four companies represented eight percent of the whole commercial market, 12 percent in 1996, and 2016, the representation had grown to 51 percent. The main sectors that will be affected by the merge of the companies are the farmers, due to seed prices, seed selection, diversity and variety. Other sector that will be affected are other smaller seed providing companies since the market competition and power will get more challenging. In general, the whole agricultural chain can face chances in plant breeding, ownership of patents and genetics, quality, volume and security of the food (Bonny, 2017).

To analyse why did the merge happen in first place, several things can be noted: for example, during the years 2015 and 2016, the biotechnology companies who provided seeds and pesticides had encountered economic difficulties, when their seed and pesticide sales decreased due to decrease in agricultural prices and revenues, as well as weather conditions. During the years 2014 and 2015, the sales of pesticides had decreased by 9 percent globally and the pesticides regulations were tightened in many countries (Bonny, 2017).

5.1 Intellectual Property Rights

Literate Patent -letters were firstly given in Europe in the year 500, where Monarchs gave documents for others in order to permit someone else to concur land for them and to establish import monopolies. Nowadays patents have become a way to conquer economies and market shares (Shiva, 2001).

As the economy grew, industrialized countries went to seek for international markets and wanted to secure their position with the help of free trade agreements, such as the GATT agreement that was used in Uruguay and is now part of WTO rules. In the 1980's, United States faced a recession in the economy while other industrialized countries took the lead in the competition. Due to this, US decided to develop patents and intellectual property rights to boost their trade and to better access the domination of international market. Patents have become big part of their trade policies: In the year of 1947, intellectual property rights covered less than 10 percent, 1986 the number grew to be over 37 percent, and by the year 1994 the number was over 50 percent (Shiva, 2001).

The amount of given patents to biotechnology companies for GE plants and seeds has increased year by year especially in industrialised countries. The given patents allow the biotechnology companies to use the patented plants as their private property and are considered the owners by law. By claiming a patent, it gives the "intellectual property right" to suppress patented plants and seeds from farmers, this forms boundaries that the farmers can no longer exchange the patented seeds, even this is something that has been a tradition for centuries in the past. For using the seeds, the farmer must sign a contact with the biotechnology company who is providing the seeds and pay for the farming. In cases the seeds have been farmed without a contract, would it be on purpose or by contamination of GM pollution from other crops, they can be fined for breaking the regulation of IPR. Currently, the biotechnology companies have patented GE plants, seeds, and individual genes of the plants (Research Foundation for Science, Technology and Ecology / Navdanya, 2004).

When companies take the general knowledge of natural biodiversity and make it into commercial, proprietary, and protected with intellectual property rights, the

communities who loose this information get impacted in several ways:

1. The crops that the biotechnology companies sell as their own property combined with the free trade prohibition create monopoly both in biodiversity and information.

2. When the biodiversity of certain area becomes valuable in other parts of the world, it will be taken advantage of more easily, for example in the case of medicinal plants. When the use of local assets changes, the need for local market shifts abroad to satisfy foreign market. This can cause scarcity and eventually the prices will rise.

3. The over usage of biodiversity can lead to extinction.

4. The limited resources for example in developing countries combined with intellectual property right derivatives take resources and the assets and the original possessor's product out of their range.

5. The communities who give the knowledge loose their part in growing market.

6. Other communities, who's traditions allow to lean on freely tradable or cheaper seeds and who can get the information freely or with low prices, become depended on commercial benefits due to IPR (Shiva, 2001).

5.2 Patenting Living Organisms

In late 1986 during the presidency of Ronald Reagan, the government was planning to reduce the regulations on companies. During this time, one of the spokespersons of Monsanto, Leonard Guarraia, requested that their business should be nevertheless regulated by the government. Monsanto was planning to expand its business and with the help of new technology, it could create and patent new type of foods. At this point, Monsanto wanted to start buying various seed providing companies around the world and replace them with their own patented GM seeds, since this would give them the market power in the industry. They had concerns about the reaction of consumers and

environmental activists. Their credibility had suffered through the years of Vietnam War, since the use of herbicide Agent Orange that was not suppose to cause any health problems. By involving governmental regulations and other aspects, their credibility would rise and bring more safe image to the consumers (Smith, 2005).

Over seventy thousand patents are granted each year by the US Patent and Trademark Office, of which approximately 20 percent contain living organisms. Biotechnology company Monsanto alone was granted with 647 patents that were for plants during the years 1983 and 2005. According to John Doll of the US Patent Office, they could now “grant patents on genes and transgenic plants and animals, any product of genetic engineering”. Once a company has been able to isolate the gene and describe its function, it can be patented” (Robin & Holoch, 2010).

By bringing GM food to the market, naturally the biotechnology companies aim to make good profit both financially and time wise. This is also important aspect for the farmers, since they also need to make profit from their crops and consumers seek for reasonable pricing when buying the ready produce. GM plays a role in the economical impact once its brought to the agricultural market. From the beginning, biotechnology companies have invested great amount in the development of GM produce and have patented their creations in order to protect their rights for them. The patents have become one of controversial topics when it comes to the GM produce. By using patents, there is risk that the price of the patented seed will rise so much that smaller scale farmers could possibly not afford the varieties in third world countries. Also cross-pollination has risen in the past years as one of the problems of the GM farming. Farmers have claimed that in some cases, the choice of using GM seeds has not been from their own choice, but due to cross-pollination from other fields (Murnaghan, 2018).

The problems that patented seeds create for farmers are wide; due to the patenting of the seed the farmer cannot save and replant the seed and he or she must always use Monsanto’s proprietary chemicals for the crops. When buying the seeds, the farmer makes an agreement of confidentiality statement and agrees to pay a technology fee of 15 US dollars to Monsanto per acre yearly. By planting the patented seeds, the farmer also allows Monsanto to audit their farm for three years after the use of their patented seeds. If the contract is broken, Monsanto fines the farmer or can take all the profits

from the crops, or even destroy it (Shmeister, 2001). Patents in the agriculture industry can potentially lead to several other problems as well:

1. Patents help western biotechnology companies to reach monopoly in the agriculture market, which leads to farmers being dependent on their produces such as seeds, pesticides and fertilizers. Farmers' narrowing choices harms the biodiversity, their business, culture, and may cause the disappearance of their own breed of seeds (Shiva, 2001).

2. Royalties cause the rise of prices (Shiva, 2001).

3. The economy fluctuates due to intellectual property rights, which can put small farms in cycle of debt or completely out of business (Shiva, 2001).

4. The patents and intellectual property rights that are granted for biotechnology companies and their seeds are not concentrated for the demand of food, but more for the business purpose (Shiva, 2001).

5. The decay of food security can create the need for imported foods which does not support the local market (Shiva, 2001).

The system of contracts that are made with farmers should be as fair as possible, not to lead to a system that puts farmers in financial struggle or create apprehension between farmers, or farmers and companies. Now it seems that farmers are set against each other in order to protect corporate intellectual property rights. The seed market monopoly is complicating the situation further, especially outside the United States. It was identified by the International Assessment of Agricultural Knowledge, Science and Technology for Development, that some problems may start to occur due to concentration: the limitation of the seed market results only in a small amount of suppliers, a lack of research on the subject, and declining varieties of seeds. Also the competition barriers rise and entry for new competitors has become extremely challenging. The decline in competition has led to risen prices of seeds, as an example, the cotton prices had gone up by three to four times in United States ever since the

genetically modified cotton was available and started to dominate the agricultural market (Robin, 2010).

6 Benefits of Sustainable Agriculture

During the past decades, the short term productivity rates have been prioritized over long term resilience and sustainability in agricultural practices in developing countries. In the 1970s “The Green Revolution” was promoting crops that are high in yield, such as rice, which was heavily used with chemical fertilizers and pesticides in order to increase the input of the crop. This has resulted in long-term issues with soil, health and has increased disease and pests in crops, offsite pollution, and loss of diversity in genetics. Some agricultural practices around the world have still remained with inefficient methods and have not adapted to new ones, which limits the long-term sustainability of the food production chain (United Nations, 2017).

GM food is said to be one of the solutions for world’s food problems, such as malnutrition and soil erosion, but in recent years it still has not shown a significant change in these problems. For example, in the case of golden rice, which has been under development for over a decade but is still not available to the public to farm. In the following section, some of the benefits of conventional faming are covered more in depth:

Improvement in Soils and Cleaner Environment - By favouring sustainable agricultural farming, there is a higher chance of reducing soil erosion, improving the framework and the capacity of holding water, since these factors are critical in preventing crop failure in times of dearth. In sustainable farming, the soil also has more biological activity with more beneficial insects, fungi and micro-organisms, that are which are valuable for recovering nutrients and preventing diseases in the soil. With sustainable farming, the risk of erosion and water pollution decreases due to little or no use use of chemicals on the crops (Research Foundation for Science, Technology and Ecology / Navdanya, 2004)

A research on apple production chain and organic apples was conducted by the Food and Agriculture Organisation of the United Nations (FAO), wich showed that organic apples were more profitable due to their price premium, had quicker returns on investment and fast recovery of costs. It was concluded by FAO, that organic farming

that is well managed can lead to better environmental circumstance levels (Research Foundation for Science, Technology and Ecology / Navdanya, 2004).

The Usage of Diversity and Supporting Biodiversity - Biodiversity in agriculture is one of the important factors for income and food security. Organic farming can support and benefit species that have declined during the past years, since diverse farming is more productive compared to monoculture. In China, rice farmers have managed to double their yields and decreased the amount of harmful diseases in crops by using two type of varieties in their crops. By organic practices, farmers and enhance beneficial aspects of soil, such as recovery, rehabilitation degraded soils, its structure and water infiltration (Research Foundation for Science, Technology and Ecology / Navdanya, 2004).

Efficiency and Profitability - In the long term, organic farming can be commercially more sustainable and produce more per unit of resources or energy, for example small farms have shown that they are capable of producing larger amount per unit compared to the characteristics of conventional farm. In these cases, the yield per unit area per crop can be lesser than on a larger monoculture farm, the final output per unit area can be over dozen crops and several animal produce, making it much higher. The costs of organic farming usually end up being lower compared to conventional farming, which brings comparable or larger net returns even without the price premium of organic products. When comparing the net returns while adding price premium, organic produce usually ends up more cost-effective (Research Foundation for Science, Technology and Ecology / Navdanya, 2004).

Benefiting Local Communities and Improvements in Food Security - By practising sustainable agriculture, it draws towards indigenous knowledge of the farmers who can use their experience and innovative skills. This helps them to use local low-cost resources that are already available and improve their autonomy, which enhances both social and cultural connection with locals. By producing more organic crops locally, it brings higher food security and has more health benefits. Organic food can be considered safer, since organic farming do not use heavy pesticides and herbicides, thus contains less harmful chemicals. Also, organic farming prohibits artificial food additives that have been linked to cause health problems. When the agricultural productivity is succeeding, it can increase the food supply and incomes, which fights

poverty, malnutrition and increases access to food while improving overall health and life. When the agricultural productivity rises, it has also shown an increase in food supplies and higher incomes, which helps to reduce poverty, gains better access to good, prevents malnutrition more efficiently, and generally improving health and life of locals. One example that has been used was on local sales and distribution in UK, where each one pound that was spend at an organic food delivery service box scheme, generated 2,59 pounds for local economy, and as for comparison, each one pound that was spend at a supermarket, only returned 1,4 pounds for the local economy (Research Foundation for Science, Technology and Ecology / Navdanya, 2004).

7 Conclusion

The current agricultural system has become vulnerable to weather and to pest disruption because of declining biodiversity in commercial seeds. This is an important aspect since climate conditions are going to be potentially more unpredictable in the future.

The ownership of seeds via IPRs has both increased and concentrated, causing negative impacts on development, crop diversity and choice of farmers. The patents have limited farmers in their access to research, innovation and conventional development of crops. In the long-term, the current agricultural system could need a renewal and not be so monopolised in order to support next generation plant breeders and farmers. The low-cost inputs of the system are acquired from non-renewable resources which may not be sustainable in long-term. Food security, crop diversity and farming choices have been shifted and concentrated to private sector biotechnology companies which makes the future of food security unpredictable and narrows the diversity in crops (Rural Advancement Foundation International, 2014).

Biotechnology companies seem to have gained acceptance for their operation since they have had an advantage of the fact that the subject is complicated and truly understood mostly by scientists. For the average consumer it can be hard to filter and gain the information about the genetically modified produce and make a conclusion is it truly safe to consume and is it harming the environment. Biotechnology companies could have had the advantage persuading scientists with a combination of funded

research projects and sufficient ambiguity in test results and make sure they have a backup group who could speak for them and genetically modified crops and their safety. Another aspect is their strength in political side by having former employees in the position to make decisions on preventing genetically modified products to be labelled for commercial uses and accepting different pesticide chemicals for farming. This is becoming a global issue so it would need to be considered in a global scale.

In conclusion, biotechnology companies should be strongly regulated due to their excessive monopoly in the agriculture industry. Their actions are reported to cause negative social, environmental and economical issues. Modern biotechnologies are alternative way of selective breeding, which should require further study and monitoring to estimate their possible risks and health impacts. The reliability of the current studies and claims about GMO has to be conducted without any corruption aspect involved. Basic ethical considerations should also be made since GMO are influencing consumers and farmers worldwide.

The genetically modified organisms' development has raised many controversial aspects of ethical issues concerning agriculture and food production today. The countries producing these GMO products should be clear and responsible of their regulatory policies to ensure that all safety measures would be tested before releasing the products to consumers. Human rights to sufficient food should be respected and the consumer has right for informed choice of GMO product. If the GM produce is the solution for future, biotechnology companies would need to increase their efficiency in yields rapidly by the year 2050. It is also worth noticing, that the volume of food is not the core issue but the efficient distribution, education and diversity in countries where hunger and malnutrition are a raising concern.

References

Bonny, S. 2017. *Corporate Concentration and Technological Change in the Global Seed Industry.* [online] Available at: http://www.mdpi.com/2071-1050/9/9/1632 (Accessed 20 April 2018).

Brown, P., 2004. *GM Soya 'Miracle' Turns Sour in Argentina.* [online] Available at: https://www.theguardian.com/science/2004/apr/16/gm.food (Accessed: 14 November 2016).

Cassidy, E., 2015. *Feeding the World Without GMOs, Environmental Working Group*. [online] Available at: https://cdn3.ewg.org/sites/default/files/EWG%20Feeding%20the%20World%20Without%20GMOs%202015.pdf. (Accessed 15 April 2018).

Damrosch, Rolf (No date) *What is no-till farming?* [online] Available at: http://www.rolf-derpsch.com/en/no-till/what-is-no-till-farming/ (Accessed 16 April 2018).

Food and Agriculture Organization of the United Nations (2001) *Genetically Modified Organisms, consumers, food safety and the environment*. [online] Available at: http://www.fao.org/3/a-x9602e.pdf (Accessed: 26 November 2016).

Gura, S. and Meienberg, F. (2013) *Agropoly - a handful of corporations control world food production*. [online] Available at: http://www.econexus.info/sites/econexus/files/Agropoly_Econexus_BerneDeclaration.pdf (Accessed: 7 November 2016).

Howard, Phillip H. *MDPI, Sustainability: Visualizing Consolidation in the Global Seed Industry: 1996-2008*. [online] Available at: http://www.mdpi.com/2071-1050/1/4/1266. (Accessed 4 April 2018).

Leung, Brian. (2014). *Vietnam, Agent Orange, and GMOs.* [online] Available at: https://thediplomat.com/2014/11/vietnam-agent-orange-and-gmos/ (Accessed: 13 March 2018).

Lurquin, Paul, F. (2002) High Tech Harvest: Understanding Genetically Modified Food Plants. Westview Press.

Maghari, B.M. and Ardekani, A.M. (2011). 'Genetically modified foods and social concerns', 3(3).

Monsanto. (2018). *GMO Facts: What You Need to Know | Monsanto*. [online] Available at: https://monsanto.com/innovations/biotech-gmos/articles/gmo-facts/ (Accessed 1 February 2018).

Murnaghan, I. (2018) *Economic Impact of GM Foods.* [online] Available at: http://www.geneticallymodifiedfoods.co.uk/economic-impact-gm-foods.html (Accessed 10 March 2018).

Purdy, C. (2016) *Six companies are about to merge into the biggest farm-business oligopoly in history.* [online] Available at: https://qz.com/786382/monsanto-bayer-dupont-dow-chemical-and-syngenta-defend-their-coming-oligopoly-mon-dd-dow-syt/ (Accessed 19 April 2018).

Quist, D. and Chapela, I.H. (2011) 'Transgenic DNA introgressed into traditional maize landraces in Oaxaca, Mexico', Nature - International Weekly Journal of Science, 414.

Ray, D.K. et al. (2012). *Recent patterns of crop yield growth and stagnation*. [online] Available at: https://www.nature.com/articles/ncomms2296#f1. (Accessed 15 April 2018).

Research Foundation for Science, Technology and Ecology, Navdanya (2004). *Genetic Engineering*. [online] Available at: http://www.navdanya.org/attachments/Genetic_Engineering5.pdf. (Accessed: 5 March 2018).

Robbins, John. (2012). *Can GMOs Help End World Hunger?* [online] Available at: https://foodrevolution.org/blog/gmos-world-hunger/. (Accessed 15 April 2018).

Robin, M.-M. and Holoch, G. (2010). The world according to Monsanto: Pollution, corruption, and the control of the world's food supply. New York: Distributed by Perseus Distribution.

Rural Advancement Foundation International (2014). *2014 Summit on Seeds and Breeds for 21st Century Agriculture.* [online] Available at: http://rafiusa.org/docs/2014SummitProceedings.pdf (accessed 16 April 2018).

Sager, J. (2014) *Monsanto controls both the white house and the US congress.* [online] Available at: http://www.globalresearch.ca/monsanto-controls-both-the-white-house-and-the-us-congress/5336422 (Accessed: 7 November 2016).

Schmeister, P. (2001*) Heartbreak in the heartland: The true cost of genetically engineered crops.* [online] Available at: http://www.mindfully.org/GE/GE4/Heartbreak-In-The-Heartland21jul02.htm (Accessed: 26 November 2016).

Séralini, G.-E., Mesnage, R., Defarge, N. and Spiroux de Vendômois, J. (2014) 'Conflicts of interests, confidentiality and censorship in health risk assessment: The example of an herbicide and a GMO', Environmental Sciences Europe, 26(1).

Shetterly, C. (2016) Modified: GMOs and the Threat to Our Food, Our Land, Our Future. Putman.

Shiva, V., (2001) Voiko tietoa omistaa? Patentit kehitysmaiden uhkana. Pystykorvakirja. English Original: Protect or Plunder? Understanding Intellectual Property Rights. Traslated by Jarna Pasanen and Marko Ulvila.

Shiva, V. (2016) *The seeds of suicide: How Monsanto destroys farming*. [online] Available at: http://www.globalresearch.ca/the-seeds-of-suicide-how-monsanto-destroys-farming/5329947 (Accessed: 5 November 2016).

Specter, M. and Ross, A. (2014*) Seeds of Doubt*. [online] Available at: http://www.newyorker.com/magazine/2014/08/25/seeds-of-doubt (Accessed: 5 November 2016).

Supreme Court of the United States (2010) *09-475 Monsanto Co. V. Geertson seed farms (06/21/2010).* [online] Available at: https://www.supremecourt.gov/opinions/09pdf/09-475.pdf (Accessed: 5 December 2016).

United Nations (2017) *Global Land Outlook.* [online] Available at: (http://www2.unccd.int/sites/default/files/documents/2017-09/GLO_Full_Report_low_res.pdf) Accessed on 11th of February 2018).

Walia, A. (2015) *New study links GMOs to cancer, liver/kidney damage & severe hormonal disruption*. [online] Available at: http://www.collective-evolution.com/2014/07/15/new-study-links-gmos-to-cancer-liverkidney-damage-severe-hormonal-disruption/ (Accessed: 26 November 2016).

World Food Programme (2017) *World Hunger Again On The Rise, Driven By Conflict And Climate Change, New UN Report Says*. [online] Available at: https://www.wfp.org/news/news-release/world-hunger-again-rise-driven-conflict-and-climate-change-new-un-report-says. (Accessed 15 April 2018).