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14. ABSTRACT To the casual observer, genetic engineering in agriculture and global stability would appear to have very little in common with each other. The connection becomes evident when viewed through the lens of globalization in terms of economics, politics, environmental impacts, and hunger. Genetic engineering in agriculture affects global security by creating instability in several different ways. First, there will be negative impact on the global economy as multinational corporations continue to concentrate power and in-turn, increase their ability to influence national and international decision makers to ensure policies are favorable to their bottom line. Second, there will be negative impact on the environment by the use of additional chemicals and the expansion of farming to ensure profit margins. Third, the postulation that genetic engineering in agriculture will help address world hunger will actually exacerbate the true problem of hunger - which is distribution.					
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MASTER OF MILITARY STUDIES

TITLE:

**THE POTENTIAL OF GENETIC ENGINEERING
IN AGRICULTURE TO AFFECT GLOBAL STABILITY**

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Executive Summary

Title: The Potential of Genetic Engineering in Agriculture to Affect Global Stability

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Thesis: Genetic engineering in agriculture will impact global stability in several different ways. First, multinational corporations will increase their ability to influence decision makers to ensure national and international political and economic policies are favorable to their interests. Second, there will be negative impacts on the global environment by reductions in biodiversity and the emergence of irrepressible pests and weeds. Third, there will be a negative impact on the problem of global hunger as big business pushes the proliferation of genetic engineering in agriculture as the best solution to increase yields when the real problem is not production, but distribution.

Discussion: The idea of genetic manipulation in agriculture is thousands of years old, dating back to man's first efforts of plant domestication. Over the last 200 years, and especially the last thirty years, genetic manipulation has changed dramatically. A more accurate description of the more deliberate action is the term "genetic engineering." In agriculture, genetic engineering describes the science of manipulating the genetic material (DNA) of plants by adding or taking away genetic sequences from the same or different species in order to achieve a result that is more desirable than the outcome would have been had nature run its course. This paper does not delve into the science or even the raging safety debate over the use of genetic engineering in plants that produce food for humans and food for animals that humans consume. As outlined in the thesis above, this paper explores the connection between genetic engineering in agriculture and global stability. Examining the relationship between genetic engineering and the global economy, the environment, and world hunger establishes a clear linkage.

Conclusion: To the casual observer, genetic engineering in agriculture and global stability would appear to have very little in common with each other. The connection becomes evident when viewed through the lens of globalization in terms of economics, politics, environmental impacts, and hunger. Genetic engineering in agriculture affects global security by creating instability in several different ways. First, there will be negative impact on the global economy as multinational corporations continue to concentrate power and in-turn, increase their ability to influence national and international decision makers to ensure policies are favorable to their bottom line. Second, there will be negative impact on the environment by the use of additional chemicals and the expansion of farming to ensure profit margins. Third, the postulation that genetic engineering in agriculture will help address world hunger will actually exacerbate the true problem of hunger - which is distribution.

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Preface

Writing this paper was one of the most difficult tasks that I have undertaken. There were many long days and many long nights of research after which I simply scratched my head and wondering *why in the world* I was tackling this topic. I do not have a background in genetic engineering or in agriculture. My interest in the topic developed over time and is partially rooted in my training as a logistician and in some personal circumstances involving dietary restrictions doctors have placed on my family due to some ongoing medical complications.

The research was, and in some cases remains, outside of my ability to fully understand. I have gained a new respect for anyone involved in genetic engineering and especially agriculture. I always thought farming was fairly easy. I could not have been more wrong. Based on my research, I discovered that farming is getting more complicated and difficult every year. Despite the trials and tribulations of the research, I still believe there is significant value in stepping outside of the box and exploring the various realms of the possible.

I want to first and foremost thank my wonderful wife for coaxing me back in off the ledge on a regular basis when I became frustrated and contemplated throwing in the towel on the whole project. I want to also thank a few of my command and staff classmates and some of my closest friends for their encouragement and support. You know who you are and I could not have finished this without you. Thanks. Last, but not by any measure least, I want to thank a gentlemen that I have the privilege of serving in Afghanistan with and who has provided me with sage and extremely helpful guidance throughout this process. Thanks Wes. You are a good man.

Most people have seen or experienced first-hand the ongoing paradigm shift in advancements in technology from meeting needs to satisfying wants. The consumer frenzy to get the latest gadget is only surpassed by the industrial frenzy to develop yet another gadget with different or more capabilities. The nexus between advancements in technology and profit is at the root of the shift, which applies to almost all disciplines of technology, including biotechnology. This paper will focus on one particular flavor of biotechnology, genetic engineering, and more specifically, its use in agriculture. Genetic engineering in agriculture will impact global stability in several different ways. First, multinational corporations will increase their ability to influence decision makers to ensure political and economic policies are favorable to their interests. Second, there will be negative impacts on the global environment by reductions in biodiversity and the emergence of irrepressible pests and weeds. Third, there will be a negative impact on the problem of global hunger as big business pushes the proliferation of genetic engineering in agriculture as the best solution to increase yields when the real problem is not production, but distribution.

This paper will begin with a brief introduction to genetic engineering in agriculture. Then, the connection between genetic engineering and agriculture and global stability is established. The first element studied is the impact of consolidation of power among a small number of multinational corporations that conduct the vast majority of genetic engineering in agriculture and how, as a result of globalization, consolidation of power will negatively affect global stability. The next topic addressed is the negative impact on the environment resulting from genetic engineering in agriculture. A compromised environment will see declines in global food production. This will create civil unrest and global instability. The final item analyzed is the impact on world hunger. Agribusiness conglomerates seeking to increase profit margins are

proselytizing genetic engineering as a necessary component to solving food shortages, but in actuality, these shortages are less a question of production and more the result of improper distribution. The paper concludes with a tertiary glance at a few other considerations regarding genetic engineering in agriculture.

Given the relatively narrow scope of this paper, it is impossible to explore the full range or depth of implications associated with genetic engineering in agriculture, global stability, and the global security environment. However, it is important for the reader to understand that while the term “global stability” appears throughout this work, inherent to this are implications for global security. Diplomatic and military professionals are all too aware of the fact that as global stability decreases, so does global security.

There are several terms used throughout scientific and non-scientific communities to define the same practice. Gene technology, modern biotechnology, transgenics, recombinant deoxyribonucleic acid (DNA) technology, and genetic engineering are synonymous. These terms define the science of manipulating the genetic material of an organism by adding or taking away genetic sequences from the same or different species in order to achieve a different result than the outcome would have been had nature run its course.¹ For the sake of simplicity and consistency, this work uses the term genetic engineering. Genetic engineering in agriculture is the process of altering plant DNA in order to produce desired results that range from plants that can produce toxins to kill pests that may feed on them, to plants that are resistant to certain herbicides, and even plants that produce valuable substances such as oils or antibiotics.²

The role of humans in genetic alteration dates back thousands of years.³ Genetics took a giant leap forward in the mid-1800s with the work of Gregor Johann Mendel, a scientist and a monk in a small abbey in what was then Austria-Hungary (now the Czech Republic).⁴ Through

his work with the common pea plant, Mendel was the first to identify the basic rules of inheritance by observing the passage of traits from one generation to the next.⁵ During the next 100 years, advancements in genetics were limited to discovering or isolating various genes such as the first cancer causing virus in 1911 and streptomycin, an effective antibiotic against tuberculosis.⁶ The actual process of genetic engineering was not theorized until the 1950s and it was not until the 1970s that the science of genetic engineering was truly realized when scientists demonstrated the ability to transfer DNA from one organism to another.⁷ This led to the development of Genetically Modified Organisms (GMO).⁸ The very first GMO was a bacteria developed by Ananda Chakrabarty in 1972 that was supposed to help control oils spills by “eating” the oil.⁹ In the mid-1970s, one of the pioneers of modern genetic engineering, Herbert Boyer, started a company called Genentech. Genentech began to modify the DNA of certain domesticated bacteria to produce insulin. This is where genetic engineering began to change course.

The path towards the ownership of genetically engineered products began in 1980, when the U.S. Supreme Court finally ruled on the Ananda Charkrabarty case that dated back to the 1972 bacteria. The decision allowed for the ownership of the bacteria in the form of a patent.¹⁰ This was a landmark case, as prior to this decision patents were unavailable for living organisms. In the early 1980s, Genentech went public with its insulin producing process.¹¹ The millions of dollars in profits realized by Genentech’s genetically engineered insulin revealed the potential of the new science and newly granted patent rights.¹² Agribusiness took particular notice.

Calgene was the first to strike by trying to crack into the \$4 billion a year tomato industry. Ordinary ripe tomatoes are rather delicate and, as such, picked from the vine while still green and treated with a small amount of ethanol gas to turn them red.¹³ Calgene was able to

isolate the gene that caused a tomato to ripen and manipulate it to slow the process down. This resulted in the Flavr Savr tomato, the first food modified by genetic engineering.¹⁴ As a result of the Supreme Court decision, the windfall of Genentech, and the potential of the Flavr Savr, corporations dealing in fertilizers and pesticides saw the potential of genetic engineering. These companies invested significant resources into research in order to ensure that they were the first to harness biotechnology to further their industrial ambitions.

Other larger companies were also interested in genetic engineering, but not to produce food. They were very interested in finding ways of leveraging the new science to secure future demand for their already flourishing business of agricultural inputs such as herbicides and pesticides. Genetic engineering was the wave of the future and competition was fierce. The investment of hundreds of millions of dollars into research and development pulled in the best researchers, while preventing smaller companies from establishing themselves. Eventually, a few of the largest companies emerged by leveraging their access to significant financial resources and the universities whose genetic engineering research they funded. The exorbitant cost associated with genetic engineering led to the drive to secure ownership of the discoveries. Leaning on the 1980 Supreme Court Decision, corporations employed teams of lawyers to create patents on virtually every aspect of their innovations. This marked the beginning of the consolidation of power as the industry viewed accomplishments to this point in genetic engineering to be just the tip of the iceberg.

Industry leaders realized the real money was in owning as much of the agricultural chain as possible. The largest corporations already owned significant shares of the fertilizer, pesticide, and herbicide market. It was in controlling seed technology that these large corporations could truly dominate the market. Owning the modified seeds and all the agricultural inputs virtually

guaranteed a perpetual product demand. Companies would genetically engineer the seeds to be resistant to their herbicides, allowing farmers to spray the herbicide without fear of damaging the crops.¹⁵ The use of genetic engineering to introduce DNA into a plant that caused it to produce toxins that killed pests that normally fed on them followed.¹⁶ The goals of the corporations were: (1) expand the scope and range of their industry by gaining a share of the multi-billion dollar seed market, (2) cement the marriage of the two industries through genetic engineering of the seeds to work only with their proprietary agricultural inputs, and (3) gain additional sales to farmers by advertising increased yields and requiring annual seed rebuys. With the patents in place and profits margins increasing, larger corporations began to gain economies of scale by acquiring smaller competing firms. Prior to their ascension into genetic engineering, many of these companies already possessed some political influence. As their span of control increased, so too did their ability to influence policy makers.

The increasing connectivity of national economies through globalization has allowed multinational agribusiness corporations to leverage their political influence. This has the potential to impact global stability, as international policies that are favorable to profit margins are not always in line with national security interests. Three developments are crucial for understanding how this influence emerged: the consolidation of power within agribusiness, the rising cost of agricultural inputs, and the international expansion of intellectual property rights.

The infrastructure, science, processes, and equipment involved in genetic engineering make it a very costly endeavor, running into the hundreds of millions of dollars. Over time, the high expense contributed to preventing smaller firms from gaining access into the industry. Another consideration is the amount of time associated with genetic engineering advances. In some cases, the development of a single trait can take years of trial and error to produce a viable

specimen. These factors, combined with the proliferation of patents after the 1980 U.S. Supreme Court decision, explain why only the largest companies with the deepest pockets can be competitive. The larger corporations began purchasing the smaller firms at a rapid pace in the 1990s.¹⁷ For example, Monsanto acquired interests in five different firms over a two year period in the mid-1990s. This cost Monsanto an estimated U.S. \$8 billion and made it rank second in world market share for seeds.¹⁸ The consolidations of companies resulted in the global expansion of their interests and opened new markets for genetic engineering.¹⁹ In addition, the interests of the newly acquired companies in unrelated fields served to add to overall net influence.²⁰

There are several examples that are illustrative of the nexus between genetic engineering, consolidation of power in agribusiness, and the global economy. The first is a Congressional Research Service (CRS) document released in April of 2010.²¹ The CRS document outlined the basics of a trade conflict between the United States and the European Union (EU).²² To summarize the CRS report, the U.S. and two other countries were pursuing a claim against the EU for its block on the import of genetically engineered agricultural products such as corn.²³ Pressure from agribusiness was a major reason the U.S. was pursuing relief from EU restrictions. According to the summary of the CRS report “[i]ndustry estimates that the moratorium [was] cost[ing] U.S. corn growers some \$300 million in exports to the EU annually.”²⁴ Another, more direct example, is in an excerpt of a Department of State Cable released by the notorious website, *Wikileaks* and reprinted by *The Guardian*, a news website based in the U.K. “In response to recent urgent requests by [Spanish rural affairs ministry] state secretary Josep Puxeu and Monsanto, [this] [P]ost requests renewed US government support of Spain’s science-based agricultural biotechnology position through high-level government intervention.”²⁵ The

discussion above involves countries that represent a very significant portion of the world economy and, as such, wield significant world influence. This situation is not an anomaly. An article released in December of 2012 by the Economic Research Service (ERS), a sub-agency of the United States Department of Agriculture (USDA), reached the conclusion that “concentration in several global agricultural input industries has risen significantly...”²⁶ The article continues, “[t]he largest firms have increased their market shares and account for most of the investment in (and ownership of) new innovations in these industries.”²⁷ In this excerpt, the term “industries” refers to agricultural input industries directly linked to genetic engineering as a result of the continued consolidation in agribusiness. In 2009, eight multinational corporations controlled more than 75% of the global seed market. Of these eight, six led the market in the production and sale of agricultural chemicals.²⁸ By the very nature of globalization, the economic scale of these corporations translates into a significant amount of national and international political influence. As demonstrated by the language in the Department of State cable, this increased political influence can be effective. When the United States takes action based on the influence of big business, any alignment with national security and national strategy objectives would be purely coincidental. This can cause long term impacts to the global economy and, as economies become threatened, so too will global stability and global security.

Genetic engineering in agriculture also impacts global stability through the rising cost of agricultural inputs. Over the past twelve years, the average price of agricultural inputs has increased dramatically.²⁹ According to the ERS, the most dramatic increase has been in the area of “Crop Seed” prices, which have more than doubled when compared to the price that agricultural products bring on the market.³⁰ In addition, the cost of fertilizers has almost doubled.³¹ The dramatic increases in price coincided with a significant amount of agribusiness

consolidation. As ERS concludes, “[g]reater market power resulting from the structural changes in agricultural input industries means farmers may pay higher prices for purchased inputs.”³² The exorbitant cost of conducting genetic engineering research and the need to recoup the investments to develop proprietary genetically engineered seeds is causing the rising price in inputs. ERS continues; “With stronger legal protection over their intellectual property and fewer firms offering competition, firms can charge higher prices for their new innovations.”³³ While there are other factors that contribute to input price increases such as increased energy and labor costs, there is a strong correlation with the development of genetic engineering and the subsequent consolidation.³⁴ As input prices continue to rise, fewer farmers will be able to maintain profit margins and will go under. This will lead to increases in global food prices and decreases in global food production. As prices increase and production decreases, global stability will be impacted as civil strife and world hunger escalate.

The third element that connects genetic engineering in agriculture to global stability by means of potential influence on the global economy is the growth in international acceptance of intellectual property rights. The theft of biotechnology can threaten the very existence of some companies, preventing them from recouping any return on their research. It is not unreasonable to think that the protection of intellectual property is part of what encourages scientific innovation.

The continued development of international organizations, such as the United Nations and the World Trade Organization has served to globalize protection of intellectual property rights. With international policies in place, such as the Trade Related Intellectual Property Rights or TRIPs, corporations have many of the same protections that patents offer in the United States.³⁵ Despite these protections, genetically modified seeds have leaked out via black market

channels and have shown up in several countries that have national caveats against the use of genetically engineered seeds. While there currently is no precedent regarding multinational agribusiness corporations seeking compensation for international violations of intellectual property rights, it is a real possibility. In fact, the precedent has already been set in North America.

Large agribusiness companies have engaged in aggressive enforcement of patent protection, in some cases employing private investigators. Monsanto has an annual budget of \$10 million and a staff of over 75 people dedicated to investigating patent infringement.³⁶ Many of these cases are usually over before they even start. One case in Canada, *Monsanto versus Percy Schmeiser*, gained international attention, as it represented the realization of a significant fear of opponents of genetic engineering in agriculture: cross pollination or outcropping.³⁷ These terms describe the process by which the pollen of plants can be blown or carried by other vectors and pollinate other plants.

Monsanto brought suit against a small farmer (Percy Schmeiser) for growing crops that contained patented genetically engineered traits without permission. The farmer claimed that he did not knowingly grow modified crops so the modified seeds must have blown off of a truck passing by or been carried over by wind or insects from a neighboring field. The legitimacy of this claim is debatable given the concentrations found in the field, but quickly became a moot point once the Canadian Supreme Court ruled. The Court not only ruled in favor of the corporation, but went on to state that it did not matter how the seeds ended up on the farmer's property. Any use, intentional or unintentional, represented an infringement on the patent. The verdict was and remains significant as a reflection of the philosophy of the legal community on the matter.

Farmers are enticed to purchase modified seeds with the promise of greater profits from greater yields. The problem is that farmers cannot afford the price of the package, do not want to sign a contract prohibiting the reuse of seeds, or live in a country that currently prohibits the use of modified seeds. Farmers that acquire engineered seeds illegally are opening the door for a host of concerns regarding global stability. The least likely of these concerns is that the large corporations who own the patents will pursue legal action against these individual farmers from other countries through the WTO or other international organization. The effort, expense, and negative international attention associated with such an action would outweigh any small benefit gained. The bigger risk of litigation lies in propagation from one of the small plots growing unlicensed genetically engineered crops covering at most a few dozen acres into a larger commercial plot covering hundreds or thousands of acres. If the commercial plot is a national asset, then it becomes a national concern. For example, if this occurred in a country like China, that is a rising superpower with a very significant population and heavily nationalized industries such as agribusiness, it could make for a very complex issue with strategic implications. Tensions between two global superpowers could considerably affect global stability. Significant as this may be, of equal or even greater concern in the long term, are the potential impacts on the environment.

Many are touting the advancements in genetic engineering in agriculture as the coming of the next Green Revolution.³⁸ This is an important comparison for a number of reasons, such as impacts on global hunger and the environment. As genetic engineering and its relationship to global hunger is covered the next section, we will turn our focus to the environment. The Green Revolution describes a series of agricultural developments that occurred in the 1960s and 1970s, primarily in the United States.³⁹ There were advances made in the fields of fertilizers, pesticides,

and farming equipment. Globalization was on the rise aided by technology and growing economies. There was a renewed determination to address world hunger. These developments coalesced to drive rapid and significant increases in global agricultural output.⁴⁰ The theory behind the Green Revolution was that the resultant increases in global food production would stem the growing problem of world hunger. Some estimates indicate that the Green Revolution saved millions of lives. There is no doubt that the conceptual underpinnings at the heart of the movement were morally and ethically sound. Over time, however, yields associated with application of the tenets of the Green Revolution began to decline.⁴¹ Advances in science and technology combined with an emerging environmental consciousness to raise new concerns focused on things like sustainability and the future. The impacts of the Green Revolution were enormous, both on world hunger and on the environment.⁴²

As more farmers embraced the advancements in technology, agriculture became more industrialized. Farms grew bigger to offset the growing costs associated with the advances in technology. The use of advanced irrigation techniques utilized on larger areas resulted in massive increases in not only the amount of water used, but also in the amount of top soil erosion. In addition, the application of significant quantities of chemicals still occurs in developing countries in hopes of achieving greater yields. The spread of the application of these technologies outpaced the spread of the knowledge on best practices for their use. Given the number of variables, the extent of the impacts on the environment of the Green Revolution is impossible to quantify. Suffice to say, there are long term impacts on water sources and top soil from these so-called advances that future generations will need to address.

There were and still are many who believe the Green Revolution was the only answer to address the burgeoning problem of world hunger. Segments of the population today are firmly

ensconced in the belief that technology will be the key enabler to perpetuate the existence of mankind and that genetic engineering in agriculture is the next Green Revolution. They may be accurate in ways they may not have considered. There are several distinct ways the introduction of genetically engineered crops into mainstream farming on a global scale will affect the environment, and as such impact global stability. Three of the more significant environmental impacts are the reduction of biodiversity, the development of resistant pests and weeds, and the potential for unknown and unpredictable consequences.

The proliferation of genetically engineered crops has contributed to the reduction of biodiversity.⁴³ Biodiversity enables plants to survive in different climates, respond to shifts in the global ecosystem, and maintain healthy fruit and/or seed yields.⁴⁴ As Charles Darwin discovered and posited in his book *On the Origin of Species*, natural selection applies to all living things.⁴⁵ Plants that possess the most favorable characteristics for survival have the advantage during propagation and, as such, their successful traits become dominant. In the aforementioned Flavr Savr tomato, one of the most significant problems that Calgene ran into during the development process was not accounting for the many different varieties of tomato plants. Calgene experienced disastrous consequences during some of its initial trials. The variety of plant chosen to test the genetically engineered tomato was not suited for the climatic conditions of the trial site. This is an important reflection on the significance of biodiversity. In addition to climatic conditions, plants must survive in a complex ecosystem of other living organisms, which, like the plant, are evolving as a result of natural selection as well. There is a delicate balance to any ecosystem. In some cases, it is a symbiotic relationship in which all parties benefit, but in other cases, it is a matter of survival. As throngs of pests or outbreaks of bacteria cut wide swaths through plant life, the strongest are left to pass along their traits, making

the protective characteristics that allowed their parents to survive more dominant in the next generation. The connection to genetic engineering and global stability is the impacts of a reduction of biodiversity. Reductions in biodiversity have the potential to impact global food production, by eliminating resilience, leading to global instability.

Humans understand the importance of preserving the environment as a base enabler for human life but routinely act in ways that negatively impact the environment. Sometimes this is the result of deliberate action and other times the environment changes as a secondary effect to human pressures. Regardless of the causal factors, negative changes to the environment can impact global food production. Since there is already widespread global hunger, impacts to the environments ability to produce food will adversely impact global stability.

A good example of the impact of human activity on the environment exists in medicine. As the use of antibiotics has exploded over the last century, resistant viruses have evolved, forcing the use of stronger doses or different formulas.⁴⁶ As we connect this action-reaction cycle back to genetic engineering in agriculture the implications for global food production and global stability come to light. As genetic engineers modify crop plants to carry toxins that affect both pests and weeds, the pest and weed families will also adapt. The strongest will survive, passing down the traits that made them successful to their offspring. This will result in the development of pests and weeds that are resistant to the toxins. This is the same phenomenon experienced with the commercialization of surface treatments of insecticides and herbicides. Farmers needed to increase dosage rates in order to keep up with evolution. As explained by evolutionary biologists “[t]here is only adaptation, moves and countermoves in a game of chess that never ends.”⁴⁷ The true loser in this biological spiral is the environment. The long term

concern is that pests and weeds that are resistant to even the highest levels of either the topical chemical treatments or the toxins produced from the genetically engineered plant will evolve.

A good example of resistance in the insect world is the tobacco budworm. Tobacco farmers in the Southeastern U.S. in 1975 and 1976 had a poor harvest due to the emergence of a tobacco budworm that was resistant to the insecticides that the farmers had been using.⁴⁸ New chemicals were developed and the problem seemed to be resolved.⁴⁹ The cycle approached climax again in the 1990s as new forms of resistant budworms began to take a toll on tobacco harvests. Farmers increased the frequency of spraying just to control the new budworms.⁵⁰ To combat the resistant pest, industry turned to genetic engineering. Plants were modified to contain a naturally occurring toxic compound known as *Bacillus thuringiensis* (Bt).⁵¹ The tobacco budworm was once again under control. The question now is how long will it take for a new budworm to evolve that is resistant to Bt? It is important to note that Bt is used world-wide by industrial and small farmers alike in all methods of employment from genetic engineering to spray treatments.⁵² Bt is even used by organic farmers as it is a naturally occurring insecticide.⁵³ Given its global use, the impact of pests developing resistance to Bt would have the largest impact on agriculture since the development of genetic engineering. While the tobacco budworm is a relatively insignificant pest, the problem its resistance brings to light is quite significant. If resistance develops on a larger scale to pests that feed on staple crops such as corn and wheat, there would be catastrophic impacts to global food production. This would undoubtedly affect global stability.

There are examples throughout history in which government and/or big business were convinced that there was little or no risk in the development and use of certain emerging technologies. Perhaps one of the best examples, as it relates to agriculture, is

dichlorodiphenyltrichloroethane or DDT. Developed shortly before WWII, by Swiss Chemist Paul Muller, DDT was a “miracle insecticide.”⁵⁴ Marketed as being “perfectly safe”⁵⁵ and through proven effectiveness, the use of DDT exploded. During WWII, Allied Forces used DDT extensively to confront the insect infested jungles of the Pacific. After the War, use of DDT expanded to the U.S. when entomologists discovered a more economic use of DDT by diluting it and dispersing it through aerial spraying.⁵⁶ It was not until the release of Rachael Carson’s book *Silent Spring* in 1962 that concerns over the effects of DDT surfaced.⁵⁷ Finally, in 1972, after 30 years of persistent and expansive use, DDT was labeled a carcinogen and subsequently banned.⁵⁸ Edward Tenner captures the consequence of the unknown of DDT perfectly in “Why Things Bite Back”; “DDT came to menace the future because it seemed so safe in the present.”⁵⁹

Scientists have been actively studying DNA for over 60 years and yet our understanding how it works is still developing. A recent reminder of this fact surfaced with discovery of the first quadruple helix DNA molecule referred to as the “G-quadruplex.”⁶⁰ In comparison to the study of DNA, agricultural genetic engineering is relatively young, and, as such, there are undoubtedly aspects and impacts of the science that are unknown at this time. The fear of the unknown impacts of genetic engineering in agriculture increases with the understanding that when plant DNA is modified there “is no way of knowing in advance exactly how it will interact with the thousands of other genes of that organism’s genome.”⁶¹ In addition, the imprecision of the various methods of genetic engineering create additional potentialities for unknown results. Pinstrup-Anderson and Schioler describe the accuracy of all the current techniques in *Seeds of Contention*: “These techniques do not, by any means, work every time...” they continue “...its [genetic modification] precision is limited, inasmuch the transferred gene is randomly placed in the chromosome of the recipient organism...”⁶² While it is true that modified plants are tested to

confirm that the desired change has occurred, the fact remains the imprecision of the science of genetic engineering and our incomplete knowledge of DNA demonstrate the very real possibility of unknown consequences.

Genetic engineering in agriculture is hailed as a safe and effective way to address a vast range of agricultural concerns from pests to lack of water.⁶³ Like DDT, the claims are even more dangerous as they contain some elements of truth. Genetic engineering in agriculture has produced some positive results such as increased yields and the potential to develop crops that may be able to thrive in arid or semi-arid environments like South Africa.⁶⁴ But, like DDT, genetic engineering pursuits are outstripping a comprehensive understanding of its impacts on the environment. If unforeseen impacts of genetic engineering result in negative consequences for the environment, it may be too late to reverse course resulting in irreparable damage to global food production capacity, which would adversely affect global stability.

The idea that in the 21st Century there are people in the world that die from starvation while the majority of developed countries are awash with food is like a splinter in the mind of the “enlightened” west. This is the reason that discussions on the subject of world hunger are fraught with emotion. Large multinational corporations with interests in agribusiness are aware of this and are leveraging it by claiming that genetic engineering in agriculture is part of the answer.⁶⁵ This outlines the final link between genetic engineering in agriculture and global instability discussed which is that genetic engineering in agriculture can help solve global hunger.⁶⁶

Certain terms that describe the condition of global hunger have come into vogue as of late. The terms are “Food Security” and “Food Sovereignty.” Food Security is not only having

access to the enough of the right kinds of foods, it is also being secure in the knowledge that the availability is not temporal.⁶⁷ Food Sovereignty describes a nation's organic capability to maintain Food Security. As with the Green Revolution, proponents of genetic engineering in agriculture are making the claim that leveraging technology to increase the global food supply will decrease food insecurity.⁶⁸ Multinational corporations are not alone in this hypothesis. There are national and international agencies that are also referring to the genetic engineering of food as the next "Green Revolution" and a significant step toward addressing the global food insecurity and food sovereignty concerns.⁶⁹ Those who oppose genetic engineering in agriculture and numerous national and international agencies focused on hunger do not argue against the benefits of increased production. The argument they make is that the production of food is not the issue; it is the distribution of food that is the problem.⁷⁰

Between one-fourth and one-third of all food produced is never eaten and disposed of as "waste" or "loss."⁷¹ "Waste" describes food that is sent to market, does not get purchased and is disposed of, or is purchased and never used. "Loss" describes food that never makes it to market because it was deformed, damaged, or began decomposing before arriving. Various levels of recycling help divert some of the waste and loss to efforts such as source material for other products, fertilizers, or animal feed. World hunger would be greatly reduced if an effective effort was put forth to address the problems of food loss and food waste. This would have the effect of increasing food security, but would most likely not increase food sovereignty. The connection to global instability is within the context of production versus distribution and the role and power of agribusiness in forwarding its agenda.

Multinational corporations have filed hundreds of patents for genetic engineering processes for plants that have valuable traits that can help address food sovereignty. To date,

none of these products have been brought to market. To be sure, profits play a role; otherwise, there would not have been a rush to patent the technology. So it remains unclear why the release has been delayed. The question of distribution goes beyond improving harvesting, storage, and distribution pipelines. Two other factors are affecting food security and food sovereignty. The first is economics. Food is a commodity, and like all other commodities it is subject to supply and demand. Farmers who produce food commercially for resale need to generate profits. Companies that purchase food for resale do so with the idea of making a profit. They are “supplying” a demand, but not necessarily concerned about meeting a need.

The United States is a great example of the contradictory relationship between food production and hunger. The U.S. exports some 230 million tons of grain every year. In addition, the U.S. exports a variety of other food stuffs throughout the globe. The U.S. enjoys one of the highest calorie diets of any country on the planet and is one of the most industrialized countries in the world. The agribusiness complex leverages the latest in logistics technologies to ensure maximum efficiency in the production, harvesting, storage, and distribution pipelines. So why is one in seven families in the U.S. labeled as food insecure?⁷² Interestingly, the U.S. government has started to phase out the term “hunger” and has replaced it with “food insecurity.”⁷³ The reasons are that the word “hunger” is too emotive, and acknowledgement that the efforts of the agribusiness are to produce food for a profit and not to feed people. In order to capitalize on the significant costs associated with the Green Revolution’s components of fertilizer, insecticides, herbicides, and advanced farming machinery, farmers needed to expand the amount of crops grown. Increased production turned out to not be enough, as even today, farmers receive subsidies to offset the difference between the incomes they generate from their crops over the cost of farming.⁷⁴

It is understandable how the tangential connections are challenging, especially considering the myriad of issues illustrated above. However, as the information is layered together, the connection between genetic engineering in agriculture, global hunger, and global stability becomes more clear. Corporations are leveraging the emotional nature of the issue of global hunger to garner greater acceptance of modified crops. In addition, corporations are trying to use a public relations “sleight of hand” tactic to disguise their true profit motives under the guise of philanthropy. The result will be the same as the Green Revolution. Production will increase temporarily, but global hunger will persist. As global hunger persists, global stability will be in question.

This work, has examined the potential of genetic engineering in agriculture to affect global stability. To the casual observer, genetic engineering in agriculture and global stability would appear to have very little association. The connection becomes evident when viewed through the lens of globalization in terms of economics, politics, environmental impacts, and hunger. Genetic engineering in agriculture affects global security by creating instability in several different ways. First, there will be negative impacts on the global economy as multinational corporations continue to concentrate power and in-turn, increase their ability to influence national and international decision makers to ensure policies are favorable to their bottom line. Second, there will be negative impacts on the environment by the use of additional chemicals and the expansion of farming to ensure profit margins. Third, the postulation that genetic engineering in agriculture will help address world hunger will actually exacerbate the true problem of hunger - which is distribution.

While each of these three aspects of genetic engineering represents a potential impact to global stability, it is the confluence of all aspects that present the largest risk. To gain a better

appreciation of why it is important to see a connection between genetic engineering in agriculture and global stability, other factors require consideration. This is by no mean an exhaustive list of concerns, but rather an examination of some the most relevant and realistic trepidations.

To start, different cultures throughout the world hold different views on genetics and the ownership of life in the form of patents. This relates to religious, ethnic, or cultural beliefs and values that do not agree that life of any kind can be owned or patented. Another consideration is the impact of physical needs on psychology and behavior. As human beings, we have wants and needs. Most of us want to be happy and healthy, but we all need to subsist in order to survive. The need to consume food (and water) is physiological, but if not met it can lead to psychological effects. The hungrier a person gets, the harder it is to maintain a rational level of thought as survival becomes paramount. When combined with the powerfully protective maternal or paternal instincts, this state becomes heightened. It is one thing for a man or woman to be hungry. It is quite another thing if a man or woman also has a hungry child. Rational behavior will eventually give way to irrational behavior as hunger persists.

Another issue that deserves attention when considering the impacts of genetic engineering in agriculture on global stability is population. A certain level of Malthusian concern is healthy when we consider that while it took 130 years for the world population to grow from one billion to two billion, the increase from five billion to six billion will only take a decade.⁷⁵ In addition to overall population growth, advances in medicine and education about fitness, diet, and overall health management, people have long lifespans, resulting in an overall net increase in the population. More people living longer means dramatic increases in food consumption.

We must also consider shifts in agricultural production. More crops are being grown to support the emerging field of bio-fuels. This cuts into crops grown for food, effecting global food supply, and eventually global stability. In addition, as countries develop, their diet shifts to include more products such as beef.⁷⁶ This increase in the amount of beef consumed requires more cattle. More cattle require more food, so agriculture shifts to producing feed for cattle, again detracting from the global food supply and impacting global security.

As globalization continues to redefine itself through advances in communications, economic structures, and transportation modes, the previously overwhelming obstacles of space and time will become less of a restraint. As a result, multinational corporations will continue to expand into multidimensional conglomerates with revenue streams that are in the billions of dollars. The scale of these entities has redefined their relationship with governmental structures as illustrated during the recent economic crisis in the United States and other countries when several conglomerates were deemed “too big to fail”.⁷⁷ As a result, these private firms received financial assistance from the government to prevent their collapse. This will result in even closer ties between big business and government. Along these same lines, it is worth considering some thought-provoking “cross-pollination” of personnel between agribusiness and government. Some examples are Associate Justice Clarence Thomas, who was a lawyer with Monsanto prior to joining the Supreme Court. He was involved in the decision that cleared the path for the patenting of life forms. In addition, Donald Rumsfeld was on the board of directors of one of Monsanto’s subsidiary companies.⁷⁸ The result is a deepening of the connection between government and big business. When combined with consolidation of power, this will increase the level of influence big business has on policy makers. A subtle example of this can be found in President Barack Obama’s preface to the 2010 U.S. National Security Strategy.

“Our long-term security will come not from our ability to instill fear in other peoples, but through our capacity to speak to their hopes. And that work will best be done through the power of the decency and dignity of the American people — our troops and diplomats, but also our private sector, nongovernmental organizations, and citizens. All of us have a role to play.”⁷⁹

Another consideration for genetic engineering exists in the expanding world of drug trafficking organizations (DTOs). The billions of dollars in capital associated with the global drug trade allow DTOs to procure advanced weapons, communications systems, and transportation assets. None of these investments address one of the largest limitations on the production of drugs, which are the environmental requirements of the parent plant that produces the drugs. The drug problem would get much worse if DTOs are able to leverage genetic engineering applications in agriculture to develop plants that can, like poppy, proliferate in harsh conditions with little or no water. Worse yet, DTOs may one day be able to engineer common plants to produce the same materials that coca, poppy, and marijuana plants produce. While these examples appear far-fetched, processes already exist that could make them a reality. One in particular, biopharming, splices various genes, some of which are human, into plants to produce pharmaceuticals.⁸⁰ The process has already moved beyond the realm of theory. In 2003, sixteen lymphoma patients received an experimental cancer drug produced by, of all things, a tobacco plant.⁸¹ That was over ten years ago. Given the rate at which technology advances, one can only imagine what has occurred since then.

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