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China: Achieving Food Security Through GM Crops

Introduction

If you asked your grandparents about the Great Chinese Famine, they may be able to supply you with a couple pieces of relevant information. Over sixty years ago, from Spring of 1959 to the end of 1961, China experienced one of the most significant food shortages ever. Caused by a decision made by former Chinese leader Mao Zedong, this famine starved over 30 million to the point of death, and is regarded by experts as “perhaps the most overlooked cause of 20th century mortality” (Smil). Although another breaking point such as this hasn’t happened since, the current condition of China’s food infrastructure is anything but stable. With hazardous chemical deposits presenting in crops and a rapidly growing population, issues concerning food security in China are unfortunately all too common. However, a future-proof resolution isn’t impossible. With the implementation of GMOs and widespread policy reform, a version of China with stable food security is attainable.

China is tasked with supporting a population of over 1.4 billion, making it the most populous country on planet Earth. With this added pressure, every aspect of the country’s infrastructure is harder to maintain. Food security is one of those aspects. Currently, 54.7% of the land area is being used for agriculture, with 11.3% being actually arable (suitable for crop sustainment) (CIA World Factbook). China’s signature commodity is rice, with over 145 million tons produced in 2022 (USDA). Other important crops include corn, cotton, millet, & soybeans (Britannica). Although they produce such a large amount of crops, families struggle to attain safe, sufficient food. Underdeveloped agriculture infrastructure such as rural irrigation, drainage, and transportation is mostly to blame (Qin et al.). Although it will certainly be a challenge, I believe China is capable of providing safe & accessible food to everyone.

Country & Family

The typical Chinese family is small, two parents along with one, sometimes two children. Past family planning laws have restricted couples to one birth per family in an effort to control population growth in China. This law has since been replaced with a new law allowing two births per family in 2016, which was succeeded by a law allowing three births per family in 2021. The nation is still seeing effects of the original child law initially implemented in 1980. Even with these laws being repealed, the birth rate has yet to see a significant spike. In contrast, the birth rate has been on a steady decline since 2016, with rates going from 1.8 children per mother in 2017 to 1.3 in 2020 (World Bank). Although you would think smaller family sizes would make safe, clean food more accessible to families, that is incorrect. Due to an unprecedented population and lacking infrastructure for its billions of citizens, attaining resources without a catch is uncommon for the average family in China.

There are two typical families that are found in China, each with their own characteristics: rural & urban. Urban families are the bulk of the population, making up a staggering 63% of the total. On the other hand, 37% of Chinese live in rural areas and/or villages (World Bank). This small contrast makes a lifetime of differences for these two types of families. Rural children fall behind urban children in many aspects. According to Lijun Chen from The University of Chicago, only 48% of rural children aged 3-5 are currently enrolled in kindergarten, compared to the 76% of their urban counterparts. Similarly, nearly a quarter of all rural families live below the poverty line while a mere 9% of urban families do. Average

family income also sees a disparity between urban and rural families, with \$5,296 and \$1,955 of yearly disposable income, respectively (Unicef).

Living in a rural setting also limits access to essential services like electricity, health care, and safe water sources. Considered everyday aspects of life by the urban population, these services are amenities to many rural families. H. Ruan from PubMed corroborates this idea, citing separated healthcare systems & extreme travel distances as the main causes for this disparity. Although it may seem like no commonalities exist between the two, both urban and rural families feel the effects of food security everyday.

Challenge & Impact

It's an amazing feat that China is able to support their massive population with a sufficient amount of food. However, this achievement isn't as impressive as it seems once you start to focus on their methods of maintaining this level of food production. The root cause for China's food security issues is of course their unprecedented population. Because of the rapid growth rate of their population, urban areas replacing rural land is all too common. Cities grow and new developments are constructed daily to facilitate the growing population of China. This displacement of rural areas decreases the amount of land available to cultivate crops. According to Yong Xie, the amount of cultivated land will amount to around 2.53 million hectares from 2000 - 2030, or about .02% of total land area in China. Although this percentage seems small, it equates to less crops being produced in a nation where each and every seed makes a difference. On the other hand, some studies are reporting an even greater year over year decrease in arable land. According to Global Agricultural Productivity, the land available for agricultural uses decreased by 1.25% from 2006-2015. No matter what the exact percentage, it's clear that this is a real problem continuously progressing.

This isn't the only problem accelerated urbanization causes for the Chinese agricultural industry. Xie furthers his research by adding that "the unemployment rate among land-lost farmers is approximately 20–30% in China". Simply put, 3 in 10 farmers that have land seized for urban construction are unable to retain employment. Since the workforce is the core factor in the agriculture industry, this too leaves room for food production rates to plummet.

Land availability and workforce size aren't the only issues caused by urban sprawl, unfortunately. Along with residential buildings and services, industrial complexes such as factories and manufacturing plants are being erected in place of crucial fertile land. In addition to the previous two disadvantages, factories pose a unique issue: chemical pollution. When factories are constructed near fresh water sources, the pollution created by these buildings contaminates the water used for irrigation and indirectly affects crops. Not only does this instigate problems for plant growth, but these chemicals often remain within crops up to the time when they're placed in the grocery store and onto the consumer's plate. This sets the stage for immense health complications.

One study conducted by Professor Hon-Ming Lam et al. concluded the main hazardous chemical polluting the Chinese crop supply is the element cadmium. This element has been known to cause chronic conditions such as osteoporosis, (a weakening of the skeletal system), or even renal failure; in the most severe cases, death. The data they collected provides an in depth insight of the effects of cadmium exposure: in "2007, results of a survey by Nanjing Agricultural University showed that 10% of rice samples collected from six agricultural regions were tainted with the metal. A follow-up investigation in 2008 of rice samples collected from markets in southern China showed that the level of cadmium exceeded the state food security standards in 70% of the samples tested. Another investigation in the coastal region of the Fujian province showed that more than 16% of rice samples exceeded the safety levels for lead, and more than 11% exceeded the levels for cadmium." With rice being a staple in Chinese

cuisine and one of the most consumed & exported commodities in the nation, this data raises concerns for the Chinese population.

While water contamination is a major factor in chemical pollutants ending up in food, another source contributes just as much to the issue, if not more: fertilizers & pesticides. China is notoriously known for its excessive use of agrochemicals, and these additives are detrimental to the human body. Many specific chemicals are responsible for these problems, with Qianhui Li et al. naming “nitrogen and phosphorus, pesticide, and heavy metals” as the main perpetrators.

Similarly to factory runoff, these chemicals also have major health implications. Professor Lam touches on this subject in his research. According to him, fertilizer use in China “is associated with algal blooms in lakes and reservoirs that contaminate drinking water with toxic microcystins, leading to diarrhea, liver cancers, and other outcomes.”. Just like the factories mentioned before, these chemicals can end up in water reservoirs, causing numerous health defects.

Lam later mentions that China is “the largest pesticide producer and exporter in the world”, with 2.5 million tons produced in 2020, according to Statista. Li found that in the year 2000, China used almost double the amount of pesticides as the USA, Japan, and the UK all together. To further demonstrate the reach of this problem in China, Li cites the Ministry of Environmental Protection and Ministry of Land Resources to report that 19.4% of arable land is polluted. Li also cites Zhang et al. to write that “about 10.18% arable land of China is polluted by heavy metals, and 13.86% of grain production is thus contaminated.”. If 13.86% of grain produced in China is contaminated by these heavy metals, that exposes 100s of millions of citizens to the possibility of irreversible health defects.

Each piece of data shows how large of an issue this is. With the rate of fertilizer being used, a significant portion of food produced contains dangerously elevated levels of heavy metals. This inference brings me to my final point.

With the topic of chemical pollution being a widespread issue in China, citizens have grown to distrust domestically produced food. After all, no one wants to consume food that has a near certain chance of containing pesticide residue. Recent scandals such as one involving a domestic baby formula responsible for the death of six infants in 2008 have further influenced this stance (Liu). This overall weariness of the agricultural industry has led to a preference for imported goods rather than domestically produced food among the Chinese population. According to Zongyuan Zou Liu, “safer, more diverse, and higher-quality food” are the reasons for choosing imported over domestic food.

Currently, China is the biggest importer of soybeans, corn, rice, wheat, & dairy among all countries, and there is data to back this up (Liu). Reported by ChinaPower, “Chinese soybean imports grew from \$2.3 billion to nearly \$38.1 billion, leaving China as the world’s largest importer of the legume, by a wide margin.”. Additionally, they reported that in 2017, China imported \$105B worth of food while exporting only \$59.6B. Liu also found that China’s food self-sufficiency ratio plummeted from 2000 to 2020, going from 93.6% to a staggering 65.8%. These numbers should raise some concerns. Although China is able to provide for their citizens’ changing dietary preferences, it isn’t a stable nor future-proof strategy to rely on other nations for a large portion of your food. One can never predict what trade disputes, famines, or climate factors will affect another country’s ability to supply food. For example, trade disagreements between America & China in 2017 resulted in a 50% drop of Chinese soybean imports from the US (ChinaPower). Therefore, it’s possible, yet unwise to be dependent on the agricultural successes of other nations to feed your people.

Currently, China’s food security situation isn’t terrible, but action needs to be taken as soon as possible to prevent irreversible damage. The population won’t stop growing, and urbanization won’t slow down anytime soon. Because of this, action needs to be taken swiftly & carefully to stabilize agricultural

infrastructure in China. By implementing the following changes, China can go from relying on international support to being able to produce clean, high-quality food for its citizens and become truly self-sufficient.

Solutions & Recommendations

Although there are many different issues affecting China, each with its own unique challenges, they all can be traced back to one common cause: population growth. Without a rapidly growing population, the effects of urban expansion would be greatly minimized, and the potency of hazardous chemicals would be lessened. However, slowing population growth isn't a reasonable or attainable solution. Therefore, it's necessary to look to the next link in the chain of food insecurity for our revision: chemicals & fertilizers.

The primary reason for agrochemicals being used so extensively in China is the reliable outcome that they produce: steady plant growth, high yield, and protection from climate & pests. However, their dangerous and counterproductive side effects offset the benefits they contribute to China's agricultural process. Chemical deposits, water & soil contamination, and health issues are just a few of these. My proposed solution isn't to entirely phase out agrochemicals; they are an essential part of modern-day farming practices when used in moderation. Instead, introducing a new technology, GMOs (Genetically Modified Organisms), while significantly reducing the use of agrochemicals is the solution that best fits China's needs. A genetically modified organism is an "animal, plant, or microbe whose DNA has been altered using genetic engineering techniques." (National Geographic). This altered DNA can serve a variety of purposes, such as increasing crop yield, strengthening resistance to the elements or pests, and helping crops to grow bigger & faster. By implementing GMOs, China can achieve the same positive effect of agrochemicals without the chemical pollution. Since GMOs are simply plants with altered DNA, they do not contaminate the plant with heavy metals in the way that agrochemicals do.

As mentioned before, 37% of Chinese citizens reside in rural areas, with a majority of them earning a living through the agriculture industry (World Bank). These families work long hours and earn little return for their work. Rural communities in China need a solution that is both available and affordable, and GMOs check both of those boxes. Although GMO seeds are more expensive than typical varieties, the expenses saved from reduced fertilizer and pesticide use more than offset this cost. On top of this, the increased yield of GMO crops would result in heightened income for rural Chinese families (Alliance for Science). In the United States alone from 1996-2020, farmers turning to GMO crops saw an average increase in income of over \$100 per hectare (Genetic Literacy Project). A similar revenue boost would be very likely in China. Additionally, the increased yield of GMO crops can help to make up for the land lost to urban expansion, a growing issue in China. If GMOs were to be implemented, these benefits could be seen as soon as the end of the next growing cycle, when farmers sell their crops and bring in additional income.

Not only would the impact of GMOs be seen in the livelihood of rural Chinese farmers, but also in the public health sector of China. The chemical deposits left behind by fertilizers & pesticides is prominent and detrimental to the health of Chinese citizens. Because GMO crops aren't coated with added pesticides, the effects seen from agrochemicals will significantly decrease if GMOs were to take their place.

From the increased income to struggling rural farmers and the health benefits that would be seen nation-wide, I believe that genetically modified organisms would be a great solution that satisfies China's specific needs. Consumer confidence in domestic crops would rise, & the added income would boost the economy and help Chinese in rural communities to sustain their family.

Unfortunately, the act of introducing GMOs into the Chinese agricultural landscape is a challenge that will take the support & collaboration of many entities. Despite being the first country to ever cultivate a genetically modified crop in 1988, almost all GMOs are currently prohibited in China (Joseph Maina). Only a select few: papaya and cotton, are approved for cultivation. Why is this? Since the advent of GMO technology, China has long been a frontrunner in international research & development. In fact, from 1988 to 2009, the country was ambitiously working towards the commercialization of GM rice (Xiao & Kerr). In 2009, production safety certificates were issued to GM rice & maize and production was set to begin in the following years. However, the approval for certification was not done in a transparent manner; it was announced publicly three months later and hidden in a slew of other approvals (Xiao & Kerr).

This event was the turning point of the commercialization of GM rice in China. Conspiracies and distrust quickly spread throughout China about the transparency of GM crops, and concern arose about the safety of these crops (Xiao & Kerr). From 2003 to 2010, citizen trust in GM crops fell over 50%, and distrust rose over 50% as well (Xiao & Kerr). Because of this, the government feared citizen disapproval and became almost silent on the issue, and they have been since. No further progress has been made on the commercialization of GM crops in over a decade, and it's the one thing that could resolve the issues China is facing.

In order to get the ball rolling on GMO commercialization in China, trust needs to be rebuilt between the government, the public, and GMO technology. Without trust between these, the government will be weary to make strides toward GMO development, and citizens will be resistant to new GM crops. Regaining the trust of both the government and the people of China is a unique challenge that isn't present in many other countries struggling with food insecurity, and it needs to be addressed before any change can be made. How can a difference be made if the change is rejected by the people that need it?

The roadblock to implementing this technology isn't a matter of resources or funding, but rather a lack of trust & education. However, the political landscape in China is different from what most of us are used to here in America. The media in China is heavily censored, and most government opposition is suppressed. The Chinese government is able to handpick what is shown in the media, and "The Chinese people lack access to dissenting views, and the fear of severe punishment deters those who want to speak out, imposing a nationwide culture of self-censorship" (US Department of State). This precedent makes it difficult for any widespread education or outreach opposing government opinion to happen in China. It also makes it near impossible for the public to do anything to influence the government in their stance.

Because of this, the solution must start with the help of outside organizations. International groups such as The United Nations need to approach the Chinese government directly and rebuild their confidence in GM technology. After years of weariness, they will be reluctant to return to GMO commercialization, so strong encouragement will be necessary. The government initially changed their stance on GMOs after fear of public disapproval, so The United Nations should form a plan with the Chinese government that involves public education. Once trust is established within the government, outreach to the citizens of China-particularly those in rural regions-will be the final step to GMO commercialization and implementation. With the government & citizens both confident in the use of GM crops, they can be used throughout rural China to revamp the way that crops are grown and used in China.

I truly believe that GMOs are the perfect solution for China. They can eliminate the effects of agrochemicals, and bring China towards a more sustainable agricultural industry. GMO crops will reduce the need for pesticides, which will purify the domestic crop supply from toxic metals and chemicals. From this, the Chinese public will regain trust in domestically produced produce, which will in turn reduce the need for importing crops. China can finally sustain their population with their own crops, and

not need to rely on other nations. Every significant problem challenging food security in China will be resolved.

Conclusion

The Great Chinese Famine was resolved by simply transferring working peasants from mines & factories to farms. However, the present condition will require a more complex solution and execution. It's time that China assesses the situation and does what's best for food sufficiency. Through GMOs & rebuilding trust, the effects of chemical substances can be eradicated in a few short years. It won't be a simple task, but securing a future-proof solution is essential for maintaining food security in China.

The current state of China's food infrastructure is similar to that of a car, low on fuel without a gas station in sight. Although it can continue down the road for a few miles, it faces certain collapse without urgent intervention. The low fuel light of China's food infrastructure is lit up on the dashboard, and it's time to do something about it.

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