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China, Factor 1: Plant Breeding

## **China: An End to Apple Importation**

It can be hard to solve all of the world's problems. Instead, focusing on food security for one crop is more plausible. Making one crop readily available prepares the way for future advancements. The methods used to increase photosynthesis could be applied to other plants. China is the fifth highest country in apple importation, it imports 300,995 tons of apples per year (25 Countries That Import The Most Apples). However, it is the leader in domestic apple production, by producing a total of 37,001,601 tons of apples per year (Communiqué on Major Data of the Second National Agricultural Census of (No.1), Zai-Long). By increasing the photosynthesis in apples, production cost would decrease as well as the need for importation of these apples. Increasing photosynthesis in apple trees would increase the total crop yield, therefore allowing apples to be produced more sustainably and at less cost to the consumer. By making apples less expensive, this would allow impoverished people to improve their diets. Apples are a very popular fruit in China (Jain). They also provide numerous nutritional benefits including vitamins, minerals, and antioxidants (Nordqvist). The goal of increasing photosynthesis in apple trees could be accomplished by inhibiting the glycolate metabolism through plant science (Oliver). By increasing photosynthesis, crop yield would be increased, and the apple trees would have the ability to be produced more efficiently.

Due to the historical legacy of communism and the modern political system in China, the country consists mostly of small farms (Gulati). Increasing photosynthesis would help to provide a more efficient and sustainable way to produce apples. Only about 116,580 square kilometers of land is dedicated to permanent crops (Staff, Butler). This land area is used to feed China's current population of roughly 1.36 billion, which is projected to increase to around 1.38 billion by 2050 (China Population Live, Kochhar). This will only cause a greater decrease in farm size as more space will be needed to house a population growth of 25 million.

All throughout the history of China, the family has been the center of Chinese life (Upton-McLaughlin). A typical low income farming family is about three people (China: Household Size 2015). However, a typical Chinese household usually contains three generations of the family. This is due to the importance of family in Chinese culture. The structure is that the eldest male in the house is to be respected, even if that person does not work any longer. The typical Chinese family is patriarchal, with the males being the head of the house (Zhihua). Chinese family affects the way of life for all Chinese students. It impacts everything in their life, even their farming methods and job choices as they are handed down through generations.

A typical Chinese diet contains steamed vegetables, with little animal protein (Smith). It was found in the China study that communities in China that eat the least animal protein had the least health problems (Campbell). It is a diet that relies on mainly local fruits and vegetables that are in season. Fruits like apples are popular due to their easy cooking methods and the variety of ways they can be prepared in Chinese cooking. The Chinese diet is one that focuses on the healing properties of food, rather than focusing on the flavors of food. It is believed that foods affect a person's overall physical and spiritual well being (Smith).

A Chinese diet contains both warm and cold foods. Warm foods are thought to help those who are cold. However cold foods were thought to be relaxing and calming. They were thought to provide the

ability to reduce stress and anxiety (Smith). In China apples are thought to reduce the risk of heart disease and decrease constipation issues. By simply smelling apples it is thought that apples will reduce stress and cleanse the spirit. (Chinese Food Therapy). According to scientific research, apples have many health benefits and are considered to be a superfood. A superfood is a food that is rich in nutrients that is thought to be very beneficial to the human body (Superfood). Due to the amazing health benefits of apples it is no wonder why apples are considered to be very important.

Apples originated from Western China and about two to ten million years ago (Mullins). This was around the time when the first humans were living. They are a popular Chinese crop and were one of the first crops to be purposely planted when farming was becoming a popular practice (Carr). When modern people arrived they probably began eating apples right away due to their accessibility. The seeds were easy to spread as people traveled across China planting apple seeds with them as the crop was most likely profitable at that time. For the medieval people the best thing about apples was that they were harvested quickly before winter. They also were able to be preserved, allowing for a sweet treat during cold winter months with few options for food (Synan). Due to their lack of refrigeration apples were able to become a relatively easy crop to grow and allowed for fresh fruit closer to a cold winter. While the first apples are different from the apples that are known today, the importance of apples to the ancient Chinese culture can not be denied.

Two hundred and sixty million students and over fifteen million teachers in around five hundred and fourteen thousand schools make up China's educational system (Education in China a Snapshot). This causes China to have the largest educational system in the world. Chinese children outperform the majority of students around the country. The average score on a test given in Shanghai is the same as the ninetieth percentile in the United States of America. On the other hand, Chinese students tend to lack critical thinking skills that are necessary for understanding things like product labeling, and general agriculture (Anderson). Chinese students tend to be amazing test takers but do not fare as well in the real world. Chinese students are generally unprepared for life outside of school with real world decisions. This is due to the inability of the Chinese educational system to prepare the students for the real world and help them with necessary knowledge.

There is a severe health care crisis in China, particularly in rural areas.. Many people do not have access to affordable health care insurance. There are almost no routine check ups in poor communities. There is also very little access to education about health and other topics. It is common for mild injuries and illnesses to become fatal due to the poor health care options. There is also currently very limited access to preventative health care for working class citizens. There is also no education about nutrition, health, and balancing meals (Poverty in China and Rural Healthcare).

The average rural farm size is around 0.64 acres (Weller, The World Factbook: CHINA, Lowder). This means that most farms are very small and inefficient. A good way to fix this problem is farm enclosure. This is combining the smaller farms and making them into a larger one. By doing this, the farms would become more efficient and have a higher crop yield. With a combination of changing farm scale and increasing photosynthesis apple production would become much more efficient (Big Facts on Climate Change, Agriculture and Food Security). A higher crop yield of apples would help to overcome the inefficiency of smaller farms in China.

Small farms are less efficient than larger farms. This is mainly due to the fact that smaller farms make less money than larger farms. As farm size increases the profit will generally increase (Haspel). This makes it easier to buy machinery that helps to improve efficiency. It is also more efficient to have large farms with more employees doing the same task with the same equipment rather than a farm that has many crops but not enough money to buy specific machinery for each separate crop. Another advantage of a large farm is better access to technology and other practices that would help with more efficient

agricultural practices. Increasing photosynthesis in apple trees will be useful to help to improve crop yield and efficiency of farming apple trees.

Forty-one million metric tons of apples were produced in China in 2015. This means that China produced 55% of the world's apples (Cook). However, 25% of these apples rot during transportation. Therefore, buyers will pay less for apples due to the fact that they will rot during transportation (Clode). This is an issue because many farmers are losing money due to the apple waste. Coupling an increase in photosynthesis to improve crop yield, together with improved plant breeding to produce more rot resistant apples during transportation, would assist the Chinese farmer in becoming more profitable.

Agricultural practices vary greatly due to climatic issues (Tilman). Training and pruning of apple trees varies greatly. Most agricultural practices are passed down between families. Rootstocks are generally chosen based on expense and not on benefits to the apple trees. Education for the farmers is necessary to unify these practices, and make them more efficient (Huang). Using specific rootstocks, such as the O.3 rootstock, and more nitrogen will also help to improve photosynthesis. Another agricultural practice that could be improved is cutting the canopy of the apple trees in a specific way to increase photosynthesis.

One of the major barriers of agriculture in China is the lack of education for farmers. The Chinese educational system creates good test takers yet students lack critical thinking skills necessary to adapt farming practices to today's challenges. Farming practices are passed down by the families, and may not represent modern knowledge and technology. The government does not help in finding better ways to improve agriculture or to teach the country's farmers through continuing education. It also does not allow for easy access to information that would be helpful to the farmers in China.

Due to the apple rot in China's transportation network, most Chinese apple farmers lose money on their crop as it's being transported to market. This causes poverty in the farm community which keeps farms smaller and less efficient without the economic resources to invest in improvements. By increasing crop yields through photosynthesis, farmers would make more of a profit, and would be able to invest in new technology to make their farm more efficient.

In rural China, modern stores are very rare (Atsmon). There is no simple transportation among the stores and the suppliers. It is difficult for people to access fresh produce. Many fruits and vegetables rot during transportation. This is a problem because produce that is moldy is not the best source of nutrition and consumers are unwilling to purchase moldy produce. It would be helpful for the Chinese people to have easy access to apples which have many vitamins and minerals. The fruits and vegetables go to the cities first, then to the suburban area then to the rural area last. This significantly limits the amount of fresh fruits and vegetables. This makes it harder for rural Chinese citizens to be able to access adequate nutrition.

The most efficient way of increasing photosynthesis is through inhibiting the glycolate metabolism. This is because the creating the glycolate takes valuable carbon dioxide resources. This decreases efficiency because it wastes carbon dioxide. The purpose of the glycolate is to speed up photosynthesis, but it does not matter if the process is sped up if there are not enough reactants to create the glucose. By increasing the production of glucose, the glucose can be used to produce more fruits. This will allow more apples to be produced.

Increasing photosynthesis by inhibiting the glycolate metabolism in apple trees would increase crop yield (Oliver). It would help to increase the amount of apples that are produced. This would make apple farming a more profitable business for farmers as less trees would be needed to make more apples.

By doing this, apple farming and domestic apples could become cheaper. This would lower the need for apple importation and make apples less expensive and more accessible. Providing the ability for impoverished people to add apples to their diet allows for better nutrients. The apples could help to fight against malnutrition and malnourishment, as they would become a cheaper source of produce.

A typical farm family could make more of a profit off of their apple trees. They could also have better access to fresh fruits. They would be able to have a more efficient farm practice (Rom). This would be helpful as it would allow for more of a downtime, allowing for more opportunities to increase their education about modern farming techniques. If these families were able to make a better profit from the apples, they would also be able to spend more money on food that will give them more of an adequate nutrition.

Currently, China is connected to the United Nations in order to get valuable information about farming (FAO.org). However, China does not share its findings or information to the small farms, which make up most of the apple production. This limits the ability for farms to develop more, and for farmers to have the ability to better their farming practices. This makes it harder to provide information and to find ways to increase crop yield.

The overall rate of photosynthesis in apple trees has stayed relatively consistent throughout the domestication of apple trees (Fan). This is due to the lack of scientific advancements that are necessary in order to increase the photosynthetic rate of apple varieties. However, the fluctuation of seasons does cause a normal change in the rate of photosynthesis in apple trees (Fuji). Aside from deviations in crop yield due to environmental factors such as climate change and large storms, the rate of general photosynthesis has stayed relatively consistent.

Ending the importation of apples would be environmentally beneficial. It would help to decrease fossil fuels used by the boats or planes that bring the apples into China, thereby reducing the carbon footprint of apple consumption in China. By ending the importation of apples, China would greatly decrease its environmental impact for one specific crop. Starting to reduce the carbon footprint of one specific crop would help increase knowledge and opportunities to make similar improvements in other crops, thereby having a greater environmental benefit in China.

Increasing the yield of apples would also benefit China's economy. China could then start to export its apples which would be more profitable due to their advances in apple production. They could sell them to countries like Russia, which has the highest amount of apple importation in the world (25 Countries That Import the Most Apples). This would benefit the general economy of China which allows for more money in their economy. The new profits from apple production could go to educating farmers, or allowing rural communities to have better access to healthcare.

A remaining barrier is still the lack of efficient transportation networks causing food waste or apple rot. The apples are not transported as soon as picked and currently 25% of apples rot on their way to market. This is a problem because flooding the market with more apples from increased crop yield could inadvertently increase apple rot due to poor transportation capacity and a lack of efficient movement to market. In order to fix this, plant breeding could be used in order to help to prevent rot on their way to market through improved apple varieties.. This would help farmers gain more of a profit from apples as they no longer would be paid a lower price due to the loss of the apples during their transportation.

A project that could be fixed would be the issue with transportation. A better electronic system could be designed to help organize it a little bit better. Trains and trucks could be loaded more efficiently

as soon as the apples were picked. The trucks and trains carrying these apples could then leave the farm as soon as they were loaded and then transported to local rural communities first, then the suburban areas, and the final destination in the cities. This would help reduce the amount of time the apples were transported.

The Chinese government should share the information about increasing photosynthesis in apple trees. It should publish a free farmers journal to share the best ways to increase photosynthesis, and what farmers can do in order to increase photosynthesis in apple trees. Organizations that sell apple tree rootstocks should offer ways to discount apple rootstocks for trees that were more rot resistant. It should also announce to transportation companies new ways to properly transport the apples. Communities should work together to share their information about the new farming practices. The Chinese government could hire extension specialists, similar to those found in United States land grant Universities to help educate rural farmers on modern farming techniques.

A typical farm family can help to spread information. They can do this by sharing their ideas and practices with their neighbors, and by organized discussion groups facilitated by extension specialists hired by the Chinese government. They can also share knowledge of how to purchase rot resistant apple trees and share tips on how to increase photosynthesis through using the dismol spray method. The farm families could also find what works to help to increase crop yield better.

In conclusion, increasing photosynthesis in apple trees would be very environmentally beneficial. While increasing photosynthesis in apple trees would not solve all of the problems in the world, it will help to fix some of them. Increasing photosynthesis in apples would help to end apple importation, and would benefit Chinese farmers by improving their income which leads to better nutrition, education, and health care.

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