

Jack Foley Chatham High
School Chatham, NJ, USA
China, Sustainable
Agriculture

China: Decreasing Reliance on Fertilizers and Pesticides to Improve Soil Quality

China is a country that holds great diversity in every aspect of being. Currently there are 1.3 billion people living in China right now, with 59.2% in urban areas and 40.8% in rural areas (World Development Indicators Database 2019, World Development Indicators 2019). The expansive Chinese land holds about 3.6 million square miles and includes geography from plateaux to valleys, plains, hills and more (The Globalist 2018). This great regional diversity leads to a vast difference in climate in different regions of China, where east and south China are subject to Monsoon season, but the monsoons do not reach past mountains and plateaux to the east, causing areas such as Xinjiang and Tibet to get very little rainfall (Food and Agriculture Organization).

The Chinese Communist Party is in control of the government; it is essentially an authoritarian state, with Xi Jinping as the current President of the nation. The power is very centralized into its seven-member Politburo Standing Committee and 25-member Politburo, which are the highest decision making bodies in the government, along with the president. However, there is still room for local governments to have some authority, as there is a decentralized fiscal system in place, but Beijing still has control over all local governments (Lawrence and Martin 2013).

Currently in China, the arable land is estimated to be about 12.665% of land available, about 110.0 million hectares (World Bank 2016). Some of the major crops include cereals (78%), beans (10%), sweet potatoes (8%), and other crops (4%) (Food and Agriculture Organization n.d.). Though China does churn out quite a lot of crops for the small amount of farming land, it has one of the lowest size of farms in the world. 90% of all farms in China are estimated to be around 2.5 acres big, about the size of 2.5 football fields (National Geographic 2018).

The average family size in China is about 3.1 people (United Nations 2017). In most urban areas, the majority of the population lives in high rise apartments that usually are of smaller size (Gálvez and Cheshmehzangi 2015). However in more rural areas, the housing quality seems to deteriorate, as the house life is estimated to last around 15 years, as opposed to the 30-40 year life of the urban housing (Hu et al. 2010). As demonstrated later in the paper, with sustainable farming practices, quality of life and housing can improve from increased profit from higher crop yield.

Chinese diet has been rapidly changing to become increasingly more Western in nature, by adding in much more meat, poultry, and eggs. Less people are eating coarse or refined grains that are common in traditional in Chinese diets; instead they are incorporating more Western food trends into traditional recipes. With the growth of Westernized food trends also came the growth of supermarkets. To facilitate growing movement towards Western culture, new wholesale stores like Walmart and Sam's Clubs started

to open up in the 1990s, along with convenience stores like 7-Eleven (Zhai et al. 2015). In urban areas, newer technologies such as microwaves and electromagnetic cooker furnaces have decreased the time it takes to cook food, promoting more time for people to spend on other activities (Ma 2015).

China has extreme variation in terms of minimum wages. Urban areas tend to have higher minimum wages, for example in Shanghai, the minimum wage is 2,480 renminbi (RMB, the Chinese currency) per month, which is about 358 USD. Other examples of high wages include 2,200 RMB in Shenzhen and Beijing, which is around 318 USD. Some of the lower wages in rural areas include 1,120 RMB (162 USD) in Liaoning, 1,130 RMB (163 USD) in Hunan, and 1,150 RMB (166 USD) in Anhui (Koty and Zhou 2020). Similarly, the employment by sector in China includes: services (45.171%), agriculture (26.56%), and industry (28.269%) (Industrial Labour Organization 2019). It is important to note that there is a difference between the wages of urban areas, such as Beijing and Shanghai, and rural areas. Lack of development in these areas cause a lot to live in poverty, especially since declining soil quality does not allow for the same output of crops, leading many rural farmers to still struggle to make a living.

As for healthcare, many rural families have a lack of healthcare because of factors such as shortage of healthcare facilities, trained professionals, and disadvantaged economic status (Yuan et al. 2019). However, the Health System in China has greatly improved over the past 10 years. In 2015, China introduced a new system of special healthcare to help provide health insurance for severe diseases. These can include cancer, kidney disease, and acute myocardial infarction. The National government has also put in place a system of obtaining licenses and maintaining a checklist of health guidelines that need to be followed for all provinces, which is modelled after that of many Western countries (Mossialos et al. 2016).

China does have a problem with access to drinking water, especially since about 80% of China's water lies in the South of the country, yet 41% of the population cannot access the water. Additionally, 28,000 rivers have dried up in the past 25 years. Industries such as coal mining and agriculture also greatly affect the supply because coal takes up 20% of available water, and agriculture 70% of water (Davies and Westgate 2018). Contrastingly, the toilet situation has gotten better in China since the 1990s. The availability of toilets in rural areas has increased from 7.5% in 1993 to 78.5% in 2015, with harmless sanitary toilets at 57.5% in 2015, meaning toilets that are safer and cleaner, for instance toilets that flush water or have a three-septic-tank. Yet, 17 million households still do not have access to a sanitary toilet, private or public (Cheng et al. 2018).

Additionally, 100% of the population has access to electricity and in rural families, around 29.2 percent of families use landline phones at home; about 92.9 percent own mobile phones (World Bank 2017, Chen 2018). As for infrastructure, around 40,000 villages in rural areas cannot be accessed by road, and 70% of all villages do not have paved roads (Rosenberg 2013). However, China rolled out a new program in late 2018 to fund a greater amount of rural infrastructure projects by using the Pledged Supplementary Lending (PSL) program. This program helps the People's Bank of China offer low cost loans, which then funds rural infrastructure plans (Chen and Cameron-Moore 2018). This can help with contact of

small-landowning farmers, as more developed infrastructure will allow researchers to reach many more farms to teach them sustainability practices.

Currently, China only has about 0.2 acres of land to devote to each citizen, which is only estimated to go down as rapid industrialization increases. They are short on land to produce livestock, which is in higher demand in a Western Diet. The usual Western Diet calls for about 1 acre of land per citizen (Weller 2017). As a result, a dilemma starts to rise when examining the sustainable agriculture idea in China. China has done an amazing job of lifting much of the country out of poverty, but that has left a strain on the natural resources available to the country and the sustainability of food supply. Some major problems include soil and water pollution from the use of agrochemicals, soil erosion, and deforestation. In fact, 80% of Chinese lakes suffer from eutrophication, limiting the amount of clean water available. China also has a practice commonly known as “pollute first, and then clean up,” which does not allow for sustainably sourcing food for many generations. The increased standard of living and food output make it hard to say that the trends are getting worse, yet the current pace of production is not supportable. It is detrimental to continue in this direction without moving to sustainable practices (Dearing 2015).

In urban and rural areas, the use of nitrogenous fertilizers contaminates the soil and water, causing a concern for the health of Chinese citizens. Nitrogen in the fertilizers begins to seep in the soil, then moves on to groundwater. Many farms located near big cities also affect the drinking water there, making the concern worse. This can cause enlargement of the thyroid gland, increase in prevalence of 15 cancers, two birth defects, and possibly hypertension (Gao et al. 2012).

A plan to help increase the sustainability of crops and soil quality can be modelled after a study based in France, where the researchers theorized a way to reduce pesticides to help sustainable agriculture. The plan was to set up an example of crop rotation and crop diversification as a way to promote sustainable plans for agriculture in the future. This method was able to reduce reliance on pesticides and nitrogen based fertilizers, with an added benefit of consuming less energy, therefore being more energy efficient (Lechenet et al. 2018).

Crop diversification is known as using many different crops in an rotational way to increase soil quality, pest management, and it can even increase the income of small farm holders, which is a very prevalent situation in rural China. In a separate study in Malawi, researchers took a similar step as the researchers in France, by diversifying crops with small farmers. They added legumes to the maize monocropping and saw a 17-38% increase in yield of maize for the small farm owners. In addition, by adding a maize-legume system of farming, the volatility of the crop prices decreased, which stabilized the income for the farmers in that region (Food and Agriculture Organization 2018). Malawi’s climate is characterized by its wet tropical seasons and dry and hot off seasons, with a cool period in between the two (World Bank Group 2011). This is similar to the climate of southwestern China, especially the areas closer to the sea. The suggestions for Malawi might translate better into the parts of China that are similar, the subtropical parts, but might not do well in the more northern regions.

The French study held similar effects. The researchers saw that increasing the crop rotation with legumes in Burgundy, less nitrogenous fertilizers were needed to be used. One of the most interesting parts of this was the observation of weed resistance among the crops as a result of the rotation. The newer form of crop diversification allowed for alternating herbicides, which changed the selective pressure on the weeds present. This allowed for a larger sensitive weed population, thus resulting in a high herbicide efficiency, therefore reducing herbicide usage in soil (Lechenet et al. 2018). France's climate is temperate, similar to the northern areas of China, making it easier to think the plan would fit well in China's northern climate.

Given that crop rotations have proven to work in two different climates, tropical in Malawi and temperate in France, there is a large possibility that structuring it to fit the crops native to China, it can translate very well. However, neither climate fits the Tibetan Plateau, which does not engage in much farming, however it still utilizes land for herding. Another consideration is that both the Malawian and French study used legumes in their crop diversification, yet legumes do not make up a large part of Chinese agriculture, where cereals are far more common. This is a consideration to think that legumes in the crop rotation might provide what is needed to be successful.

For example, in the Guizhou region of Southwest China, rice and maize account for about 70% of all grain output for that region alone. Yet, Guizhou has a variety of biodiversity among other crops, where they can produce soybean, potato, sorghum, and wheat in addition to their output of rice and maize. Therefore a crop rotation schedule can be based off of the seasonal aspects of each of the plants.

Winter

wheat sowing best happens at around 15-18°C, so those crops can be placed at times of cooler temperatures in about late September, in preparation for cooler months. Oppositely, maize is more suitably sowed in temperatures at around 20-25°C, closer to summertime to allow for optimized harvesting (Ma et al. 2019). These specific examples do not limit the amount of crop rotations that can happen, but provide a basis for a model that can be spread around China and be changed according to regional variations.

There are some negatives that can be associated with the study the French scientists proposed. They saw that there could be a decrease in productivity as a result of a lower pesticide usage on the soil. However, they also addressed this in discussing that especially among grains, the productivity was not properly correlated to the scale in which they were using to determine the productivity of multiple sources. This suggests that even with a decrease in use of pesticides, it might not cause any decrease in productivity among the grains (Lechenet et al. 2018). Even if there is some decrease in productivity, the positives and negatives also need to be balanced out. China needs to adopt more sustainable practices with the use of pesticides, herbicides, and fertilizers to maintain soil quality needed for the nation to progress. If they do not achieve this, the food production will drastically decrease by lack of prospectiveness in sustainable agriculture.

The major implementers of this plan would be the national Chinese government with help of the regional

provinces in administering the plan. The government should also enlist the help of the United Nations Environment Programme (UNEP), which has worked with China plenty of times before in developing policies such as helping China's Green Economy Initiative (United Nations Environment Programme n.d.). The UNEP would help provide research and accountability for China, while China focuses on distributing funds and personnel across the provinces to work with farmers. In addition, to help in terms of funding, China should work with the World Bank to allocate funds directly to the effort. The World Bank just announced a plan for China to allocate 1.0 to 1.5 billion dollars each fiscal year to China (Lawder 2019). China should make a five year plan to work with the World Bank to err on the side of \$1.5 billion. If the project is successful in implementation, after the 5 year deal is over, China can work to increase the loans from the World Bank to facilitate reaching everyone in the country. The project can also sustain itself on this budget because if over a period of time, farmers are able to decrease their dependence on fertilizers and pesticides, their income would stabilize with crop diversification. This would stabilize their ability to sustain the project because their income meets the requirements that the solution needs.

Other feasible ways to facilitate implementation of this solution would be to work with NGOs inside and outside of China. Groupe de Recherches et d'Echanges Technologiques (GRET), a French based NGO, has worked to implement sustainable agriculture initiatives in many Southeast Asian countries, whose climate is very similar to that of China. It specializes in working with small farms, oftentimes family owned, and giving autonomy to the farm owners and teaching them the skills they need (GRET 2020). Currently, China and the UN Food and Agriculture Organization (FAO) maintain a good relationship and are working on a multitude of issues, food security and sustainable agricultural development among them. China is provided with 80 million USD a year to work on these goals. The FAO is another plausible organization to work with within China to promote the solutions explained (FAO 2017). Foreign NGOs sometimes may have trouble working in China, but if they work with domestic partners, they should be better off. It must be acknowledged that they may face some challenges in their work, such as sidelining by the Chinese government or restrictions on what is possible to accomplish (Feldshuh 2018). To help implement the plan, a special push needs to be brought to facilitate good communication between rural farmers and researchers and implementers, who are at the head of the deal. First, the methods which the farmers need to use have to be effectively communicated to them. This can be done by making some adjustment to methods based on the situation. This can be through specific local agents, preferably even agents who speak the language of the area, such as Uyghur, Mongolian, and Tibetan, in their preferred areas. If there is no minority language, then it is important that the interpreter be well versed in any dialect they might come upon. This interpreter or liaison can also help interpret some scientific ideas that many of the farmers might not understand, and therefore would feel discouraged. In addition, implementers should look to influence a lead farmer in the area, possibly convincing them with incentives such as stable transportation of goods or selling market, or possibly supplying them with supplies needed. By working with the lead farmer, it will create a bandwagon effect for the rest of the farmers to get onto the idea of crop rotation. If the village farmers see the one lead farmer as trustworthy, then if the lead farmer works to improve crop rotations, so will many others in the area. Finally, the most important aspect in enforcing these practices is patience with the farmers to build a trust bond between them. This takes time and that is all there is to it (Cui et al. 2018).

As a result, with the implementation of a crop diversification and rotation plan, Chinese farmers can stabilize income and crop yield for the years to come. Though the implementation may be gradual, this plan makes sure that future generations of the world can rely on rich soil quality with less destructive pesticides and fertilizers to support their food production in the world. They can keep producing enough to fulfill the needs to support the 1.4 billion people that China amasses.

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