Jessica Gammon
Phillips Academy Andover
Andover, MA
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Sustainable agricultural practices in china to protect food security

For thousands of years China has exploited its fertile land to feed its historically enormous civilization. But with policy changes during the latter half of the 20th century, China experienced unprecedented growth in agricultural production. Grain production increased 70% from 1970 to 1989, and the total production of meat, fruit and aquatic products in 1989 had increased four times from what it was twenty years earlier (Ge, Chen, and Shen). Over the past 30 years, 400 million Chinese people have risen above the poverty line of one U.S. dollar a day ("China" World Health 63). Increased agricultural production and decreased population growth resulted in greatly improved food security and poverty rates, and have contributed the most to higher living standards since the 1970s ("Agricultural Transformation, Growth and Poverty" 6).

Ironically, the largest problems facing food security today are the unsustainable agricultural practices that allowed for the 20th century's increases in food productivity. Widespread irresponsible agricultural practices combined with industrialization have caused China's current environmental crises, affecting its food productivity and perhaps its historical food self-sufficiency. China must strive to reach the United Nations Millennium Development Goal of ensuring environmental sustainability by investing in research and education to implement sustainable agricultural practices and protect the nation's food security.

Today, the average Chinese rural family consists of two parents, often grandparents, and one or two children. According to China's family planning policies for the Han majority, if the first child of a peasant is born a girl or disabled, a couple may have another child, but cannot have more than two children without facing consequences in most cases. Since the vast migration of rural Chinese to cities, about one-third of Chinese rural children live without one parent, leading to the increasing feminization of agriculture as men migrate more often than women, as well as more responsibility left to the grandparent generation (Stack). The average Chinese rural family farms on less than one acre of land, and what is grown depends on the region of China, but the most common crops are rice, wheat and corn ("China Agricultural and Economic"). Most Chinese farmers have limited access to healthcare, especially in very remote communities lacking infrastructure, but education is relatively accessible; nine years of education is compulsory for all Chinese citizens, and the literacy rate is currently 92.2% ("China" World Factbook)

Rural Chinese families are much healthier today than before the reforms of the late 20th century, but although China was the first developing country to reach the United Nations Millennium Development Goal of halving extreme poverty rates, China still faces the challenge of eradicating rural poverty and lessening the wealth disparity between rural and urban citizens ("Rural Poverty in China"). Inhabitants of rural areas account for about fifty percent of the Chinese population, but city residents earn three times more than rural residents, and poverty is almost nonexistent in cities while relatively common in rural areas ("Rural Poverty in China"). The disparity in health and nutrition between rural and urban Chinese is striking; the 2000 census reported the average life expectancy of urban residents to be 75.2 years, but only 69.6 for rural residents, and less developed provinces exhibited even larger disparities ("China Human Development Report" 9). Additionally, in 2000, only 3% of children living in cities were underweight, while 14% of rural children were. 3% of city children were shown to be stunted while 20% of rural children were

stunted, exemplifying the need to improve the health of the rural Chinese ("China Human Development Report" 56).

Of all the innovations that began China's agricultural revolution last century, excessive fertilization has become one of the most strikingly unsustainable and harmful in modern times. Although China feeds about 20% of the world's population on about 10% of the world's arable land, Chinese land is not especially fertile, and Chinese farmers therefore rely heavily on fertilizer (Qiu). In 1980, when surveys found much of Chinese land to be deficient in phosphate, the Chinese government instituted new policies to increase the availability of phosphate fertilizers to Chinese farmers. Since then, Chinese phosphate fertilizer consumption has increased 5% each year, and today China has become the world's largest phosphate fertilizer consumer and producer (Qiu) (Wang et al.). In 2006, China used about 12 million tons of phosphate fertilizer, with SSP and FMP, MAP, DAP, NPK, and TSP accounting for about 4, 3, 2.5, 1.5, and 1 million tons respectively (Zhang and Zhang). But phosphate rock is mined; it is not a renewable resource. Although China's phosphate stores are rich, they are being rapidly depleted and forcing China to tap into lower-quality phosphate rock, which is less efficient and poses a greater pollution risk. Even these low-quality reserves are expected to last only for another 15-60 years (Wang et al.).

In China, fertilizer over-application and efficiency rates are abysmal. China's average fertilizer consumption on cultivated land is two times that of developed countries. Nitrogen fertilizer consumption on farmland is 2.5 times higher than the world average and phosphate fertilizer consumption is 1.86 times the world average. But fertilizer efficiency is only about 30-40%, half of what it is in developed countries, and nitrogen fertilizer efficiency has decreased from 30-35% in the 1980s to less than 20% in 2007, while the world average is 33% (Zhao et al. 901) (Zhang et al.) In 2006, China used 40 million tons of nitrogen fertilizer, and Urea accounted for half, a 15% increase from 2005 (Zhang and Zhang). This fertilizer overuse is a result of both the availability of fertilizer, and Chinese farmers' lack of proper fertilizer education. One study showed that only 10% of Chinese farmers' knowledge of fertilizer use comes from government-funded educational programs, while 90% comes from fertilizer dealers, neighbors, and personal experience (Zhang et al.).

This fertilizer over-use and low efficiency has had drastic and obvious effects on China's ecosystem, especially its water bodies. Fertilizer run-off into water bodies causes a boom of plant and algal growth, which depletes oxygen and kills aquatic life. This process is called eutrophication, and The Chinese Ministry of Environmental Protection wrote in their 2011 report that "the lake (reservoir) eutrophication problem was still preeminent" as 53.8% of lakes or reservoirs surveyed showed signs of eutrophication. The report cited fertilizer components as one of the most prevalent pollutants. The most recent Chinese algal bloom off the coast of Qingdao in Shandong province this July made international headlines and shed light on the seriousness of agricultural pollutants in Chinese water bodies (Jacobs).

To make matters worse, the increasing wealth of Chinese citizens has caused a shift in agricultural demands to meat. Although as of 2006, 53% of pigs and 50% of beef and dairy cows belonged to families on small private farms, the number of concentrated animal feeding operations doubled from 1991 to 2005 (Wang et al.). The animal production sector of Chinese agriculture exhibits the lowest nutrient efficiency, as much of the nutrient-rich animal waste is not properly disposed of and lost to the environment, further polluting Chinese ecosystems (Wang et al.).

Intensive inorganic fertilizer use has harmed not only Chinese ecosystems, but also the farmland it was intended to help. Long-term use of nitrogen fertilizer has harmed much of China's farmland by rapidly acidifying it, stunting plant growth and making crops more susceptible to disease and infestations (Zhang). Neglect of organic fertilizer such as manure in favor of inorganic phosphate and nitrogen-based fertilizer has depleted soils of organic materials and therefore lessened health and overall fertility. The average organic material content in Chinese farmland is only 1.5%, compared to North America, which is 2.5-4%. In China's north east region, organic material content has decreased from 8-10% to 1-5% (Zhao et al. 902).

It is imperative that the Chinese government addresses the issue of over-fertilization through policy changes, the education of farmers, and encouraging sustainable alternative practices. First, the Chinese government must reduce the subsidies provided for fertilizer, thereby limiting fertilizer accessibility. Second, the Chinese government must invest more in farmer education to better inform farmers of the appropriate level of fertilizer use and the dangers of over-fertilization, such as soil acidification. Unlike in more regulated countries, farmers in China apply fertilizer themselves instead of certified companies, and many apply generously and above the set standard in order to reduce risk (Meng). Many are also unaware that applying fertilizer directly to the roots of seedlings is more effective then applying fertilizer by tossing it onto the ground while planting, a common practice in China (Tilman 673) (Biello).

In addition, the Chinese government must encourage the shift to agricultural practices that lesson the need for inorganic fertilizer to begin with, such as zero tillage. Zero tillage allows for the buildup of organic material in soil, resulting in increased nutrient richness, reduced erosion, and better water absorption (Dumanski et al. 63). Zero tillage could help to reverse the depletion of organic material in Chinese soils.

But one of the largest challenges facing widespread improvement and implementation of new techniques is simply the lack of infrastructure. For example, the animal waste produced from Chinese large-scale animal feeding operations ideally could be processed into organic fertilizer and used to close the nutrient cycle on Chinese farmland. However, much is simply dumped and its nutrients go on to pollute Chinese ecosystems. If better infrastructure existed, animal waste could be processed and transported to use on cropland as organic fertilizer (Wang et al.).

Although excessive fertilization is perhaps the most striking of China's unsustainable agricultural practices, pesticide use skyrocketed along with fertilizer in the late 20th century. Between 1952 and 1990 pesticide use increased by more than 110 times, and today China uses more pesticide than any other country (Li et al.) (Zhao et al. 902). Studies have shown that 50% of pesticides used on cotton and 40% used on rice are excessive (Zhao et al. 902). Excessive pesticide use leads to pesticide resistant strains of pathogens and insects, as well as environmental pollution. Additionally, pesticide use threatens human safety, especially in China where farmers are uneducated on suitable protection for pesticide use, and where the proportion of highly noxious pesticides is high (Zhao et al. 902). About 100,000 people in China annually are poisoned by pesticide use, and 10% of these poisonings prove fatal (Li et al.).

Investments in better infrastructure would help to solve China's pesticide problem as well as its fertilizer problem. Farmers clearly need better access to information on pesticide use to end superfluous application and better protect themselves. The government must also decrease subsidies on pesticides, to make them less available. In addition, investments in research and education are imperative to implementing sustainable pesticide alternatives to radically reduce pesticide use. For example, in 2000, researches in Yunnan province collaborated with farmers and found that planting a disease-susceptible rice variety alongside a disease-resistant variety

increased the yield of the susceptible rice to 89% more than when it was planted in monoculture. The new system was so successful that farmers no longer needed to use any pesticide to protect their rice crop (Zhu et al. 721-722). Investing in scientific research and creating the infrastructure and tools to bring education and technological advances to Chinese farmers will revitalize Chinese agriculture and protect Chinese food security in the future.

However, many factors other than unsustainable practices threaten Chinese agriculture. For example, as China continues its industrialization, urbanization continues to swallow Chinese farmland. Because urban land promises more economic benefits than farmland, urban land developers are often given priority and many farmers have been displaced throughout China's industrialization period (Zhao et al. 899). Because of shrinking farmland and a demanding population, many Chinese farmers work marginal land such as steep slopes and unfertile soil (Zhao et al. 899). This coupled with unsustainable agricultural practices leads to the erosion of soil and desertification – another phenomenon destroying Chinese farmland, especially in the arid north and west (Fang et al. 380). In China, there are 3.9×10^5 km^2 of sandy desertified land, and most is distributed in the north. Every year, desertification costs China $2-3 billion, while indirect losses are about 2-3 times more (Fang et al. 380). The Grain for Green program implemented in 2002 offered subsidies for the conversion of sloped and other marginal cultivated land back into grassland and forests. The program did help to address the problem of desertification, but it did not help address the problem of shrinking farmland across China (Li). But China's 12^{th} Five Year Plan, approved in March 2011 by the National People's Congress, recognizes the country's "vulnerable agricultural basis" and claims that China's total farmland will not decrease at all in the next five years (*China's Twelfth Five Year* 2, 4).

Another factor threatening China's food security is climate change, which will amplify China's soil degradation problems by causing more frequent drought in the semi-arid north leading to more desertification, and causing water logging of southern soils (Tao et al. 169). The ever-worsening threat of climate change is all the more reason for the Chinese government to invest in agricultural research and infrastructure to implement changes to address threats to productivity.

Currently, urban Chinese consumers' growing concern over food safety and environmental health has helped to fuel shifts to organic agriculture among the rural Chinese. For example, in Beijing's Haidian district, Renmin University established the organic Little Donkey Farm agricultural project based off of the Community Supported Agriculture (CSA) model (Shi et al.). In the CSA model, consumer members of a farming organization purchase produce before the growing seasons begin, then different crops are delivered as they are harvested throughout the season. This way, concerned consumers have access to high quality, sustainably grown produce, and the farmers do not have to shoulder all the risk. Although realistically this model would be difficult to apply to very poor areas where a wealthy and concerned market does not exist, the Chinese middle-class is expanding from the large cities such as Beijing and Shanghai into smaller cities and towns. CSA model farms may begin to appear in more and more rural areas.

But even without belonging to a CSA farm, Chinese farmers can tap into the "organic" market. Through education services provided by programs such as United Nation's Development Program, many farmers are learning that by growing their produce pesticide-free, they can fetch higher prices on the market (Pitt). However, the success of organic farming is variable and would not be a viable option for all Chinese farmers, as the yield losses are substantial for certain crops grown in certain soil types (Seufert, Ramankutty, and Foley). But fertilizer over-use is so serious in China, that field studies have shown that reducing fertilizer application by 20-30% would not affect harvests, and even increase crop yields (Vermeulen) (Biello).

Although growing consumer demand and educational programs have encouraged sustainable farming, the Chinese government must still act quickly to educate Chinese farmers on proper fertilization and pesticide use, then work to encourage sustainable alternatives, such as zero tillage. In addition, the government must uphold its promise to protect agricultural land, as stated in the 12th Five Year Plan. Both the Chinese government and Chinese farmers must recognize the long term benefits of sustainable farming, and work to begin an agricultural revolution to protect China's soils, environment, and food security.

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