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The Impact of Biofuels on Food Security and Natural Resource Degradation in China

Faced with a growing global demand for an environmentally damaging, finite energy supply, our world is caught in a seemingly hopeless quandary. Thankfully, now there is a possible escape route – biofuels. Essentially, biofuels are fuels obtained from biomass, which is generally plant material. Biofuels are a renewable energy source and would provide a green alternative to fossil fuels, while offering new income and employment to farms and rural communities around the world. In addition, it would reduce the dependence of countries on unstable, foreign energy sources. Bioenergy already accounts for 10% of the world energy supply, and the potential to better exploit many unused crop residues and grow energy crops is enormous. Biofuel production in China has been off to a promising start. In 2005, China produced 920,000 metric tons of ethanol and an estimated 100,000-200,000 tons of biodiesel. Currently it is the world's third biggest producer of ethanol. Ethanol production is expected to increase to nearly 4 million tons by 2010, and biodiesel production to 2 million tons. China expects biofuels to meet 15% of its transportation energy needs by 2020. The overall effect that this vigorous biofuel production will have on the many impoverished Chinese is not certain. In the past few decades, poverty reduction in China has had optimistic results. In 2001, there were 400 million fewer people living on under $1 a day in China than 20 years earlier. A staggering half of this decline was in the period 1978-84. This was because beginning in 1978, China adopted a predominantly successful series of economic reforms leading to rapid economic growth and poverty reduction. However, biofuel production could reverse the trend of poverty reduction, primarily by raising food prices. The creation of bioenergy uses resources (land, water, and labor) that cause it to compete with food and feed production. This would lead to higher food prices in many poorer countries, such as China. On the other hand, biofuel production would benefit the poor in some ways. The poor would gain from cheaper energy. However, since the poor typically spend a much larger portion of their consumption budget on food than on energy, this trade-off is unlikely to be favorable. The rural poor might also gain from greater employment and income in the bioenergy sector. In China, a good portion of the poor are small farmers. They would profit from the higher good prices and the possible new markets. Now, the question is, how would all these pros and cons balance out, and what would be the net impact on the poor? It turns out that this escape route provided by biofuels is sinuous rather than straight-forward. In order for biofuels to develop into a safe, efficient alternative to fossil fuels, every turn must be explored carefully.

Biofuel production would provide a fruitful industry for both big corporations and subsistence family farms to capitalize on. There are approximately 525 million family farms worldwide. The overwhelming majority of these farms, 87%, are located in Asia. China alone contains 193 million. Agriculture employs almost half of China's workers. The family farm is often defined as an operated unit that derives most of its labor and enterprise from the farm family. Using this definition, in high-income economies the family farm can be very large in terms of land size by using modern labor-saving machines. However, the family farm in low-income economies, such as that of China, is typically only a few hectares to even less than one hectare. The 1997 Chinese census found that out of China's 193 million farms, 189.4 million (98%) were less than 2 hectares. The average farm size in China is only 0.67 hectares.

The dissolution of the people's communes in 1978 initiated the transformation of China's rural economy toward a market oriented, family-centered economy. By 1982, it resulted in the almost complete disbandment of all communes and the restoration of family farming. In China, village officials maintain ownership and redistributive power over land. Almost all farmland is distributed to family farms according to family size. This results in the limited alienability of land and a roughly equal per capita land distribution within each village, which handicaps farmers. However, over the years, the direct exercise of state power has been reduced and the power of farmers has expanded.

Currently, the standard of living of family farm households in China is fairly decent. The average income is still low in rural areas, but most families have sufficient food and clothing, consume an adequate diet, and can afford such amenities as a television.

The main staple in farmers' diets is grain. In the south, rice is the most popular grain. In the north, people prefer wheat, which is used to make noodles. Corn, millet, and sorghum are also eaten. Vegetables, especially cabbage and tofu, rank second in the Chinese diet. Rice, cotton, tea, and sweet potatoes are the main crops grown in southern China. In the far south, farmers grow tropical crops, such as bananas, oranges, and pineapples. Wheat is the major crop in the north, followed by millet and sorghum. Many farmers also raise livestock, mainly chickens, ducks, and hogs.

The 2002 household survey conducted by CASS (Economics Institute of the Chinese Academy of Social Sciences) found that the average rural household size is just over four people. It also reported that the net farm income was about 1,260 yuan per year. Including other sources of income, the per capita rural disposable income was about 3,300 yuan per year.

China's family-farm system has demonstrated its superiority to the former collective system by providing incentives for farmers to raise productivity. For example, the national grain harvest shot up from 304.8 million tons in 1978 to 407.3 million tons in 1984. The advantage of family farms lies in their predominant reliance on family workers who have strong personal incentive to elicit hard work for the sake of their own family's well-being. Another major advantage of family farm operations is their ability to utilize the labor of women, children, and aged family members who have little employment opportunity outside their own farm. This makes family farms a great option for biofuel production.

There are various obstacles to raising agricultural productivity and farm income on family farms. First, the major limitation of family farms is that no individual farm is sufficiently large to profitably build infrastructure necessary for its own economic activities. Therefore, it is essentially important for the government to supply infrastructure such as roads and irrigation systems. When China first began policy reforms in 1978, the transportation infrastructure in China was poor. Since then, the government has given high priority to road development.

Second, there should be ample agricultural research conducted, which is the most effective means of promoting the production capability of small farms. To a large extent, under-investment stems from the weak incentive for the private sector to conduct research and development on agricultural technology, partly because small-scale farm producers are incapable of internalizing the benefits from the research and partly because it is difficult to establish effective protection on intellectual property rights regarding agricultural technologies.

Finally, it is essential to improve markets for family farms. Critically important for small family farms to achieve economic efficiency is the development of agricultural product and input marketing networks in rural areas. Otherwise, their small transactions would be handicapped compared with large planters' bulk product sales and input purchases. Improvements in transportation and communication are also effective in reducing trade risk and transaction costs and thereby promote new entry and competition. Furthermore, development of institutions for the service of market information, such as standardization of measures and weights, commodity exchange, crop forecasting, and regular quotation of market prices in mass media, can also improve market efficiency.

Agricultural productivity in China is being threatened by natural resource degradation. Natural resource degradation is a global problem; the situation worsens as the increasing world population places more demands on land for food production. In China, land degradation along with water scarcity is resulting in a devastating dilemma. It's understandable how this situation came to be. China has 22% of the world's population but only 7.2% of the world's farmland and 5.8% of the world's annual water resources.

In terms of the extent, intensity, and economic impact of land degradation, China is one of the most affected countries in the world. In 1999, total direct costs from land degradation were estimated at $7.7billion, while indirect costs were $31 billion. Over 40% of China's land area is adversely affected by wind and water erosion, loss of grazing, deforestation, and salinization. Only about14% of its total land area is suitable for cultivation.

The poorest areas of China feel the greatest impact of land degradation. There is a positive correlation between poverty and ecologically sensitive environments. In those areas, poverty and land degradation feed off each other in a destructive downward spiral.

The root causes of land degradation include the previously mentioned high poverty in the most vulnerable ecological zones: 90% of China's poor live in areas of moderate to severe land degradation. In addition, living standards, especially in urban areas, are rising rapidly, leading to an increased demand for meat and livestock products, which prompts further overuse of grasslands. There is also a growing use of chemical fertilization in farming. Finally, there are inadequate regulatory environment laws for dealing with land degradation, along with meager financial incentives for conservation.

Water scarcity is just as severe of a problem as land degradation. China's water is highly polluted, covering 1/3 the length of all its rivers, 75% of its major lakes, and 25% of all its coastal waters. As expected, all this polluted water leads to a myriad of health problems. 300 million people are drinking contaminated water on a daily basis. 190 million suffer from water-related illnesses each year. In addition, nearly 30,000 children die each year from illnesses caused by consuming polluted water.

Unfortunately, bioenergy crops optimized for rapid growth generally consume more water than natural flora and many food crops. Some biomass crops like sugarcane compete directly with food crops for irrigation water. Others have been observed to lower the water table, reduce stream yields, and make wells less reliable.

China has a long history of investment in soil and water management, with terracing for rice documented for over 3,000 years and water management on a large scale for even longer. Over the past several decades, China has made a major effort to overcome desertification in the arid and semi-arid areas. The typical approach is engineering based combined with revegetation and farm-based conservation. In the 1990's, China's total investment in sustainable land management swelled from $2.2 billion to $6.5 billion. Investment in soil conservation has also grown at 10% a year. This is a solid start, but more needs to be done.

Around two-thirds of useable farmland in China is not used to its full potential. Farmers are reluctant to improve their yields by making long-term investments in irrigation and other changes because, as mentioned earlier, their property contracts are not always dependable and respected. In their reasoning, there is no use to improve their farm if they might not be able to remain long enough to profit from it. A farmer's land could be taken away or reduced for various reasons. Since land is distributed according to family size, if the family size was reduced for some reason, part of that family's land would be redistributed to a different family that had grown in size. In addition, the government is able to take land for nonagricultural purposes as urban or industrial development. Rarely are farmers adequately compensated for the land.

Therefore, if China wants individual farming households to make improvements in soil and water management, it should eliminate farmers' insecurity regarding their property holdings and also prevent unnecessary reclaiming of land by the government. In addition, China should provide financial incentives. It began doing this in 2004, when it changed its agricultural policy to subsidize rather than tax agriculture.

If precautions are not taken, biomass production could exacerbate natural resource degradation not only in China but all around the world. Bioenergy crops pose a particular challenge for good soil management because the plant material is often completely harvested, which removes valuable plant residues that help sustain soil productivity and structure and avoid erosion. Residues are an especially important potential biomass energy source in densely populated regions, where much of the land is used for food production. For example, in 1996 China generated crop residues in the field plus agricultural processing residues totaling about 790 million metric tons, with a corresponding energy content of an impressive 11 exajoules (EJ). However, farmers must make sure to keep enough plant matter on the land, even though this practice may reduce the harvestable yields of bioenergy crop material.

Agricultural research could alleviate the effect of biomass production on the environment as well as minimize its competition with food production by enhancing the biomass traits of dual-purpose food crops, developing new biomass crops for marginal lands where there is less competition with food crops, and developing sustainable livestock management systems that are less dependent on biomass residuals for feeds. Currently, biofuels are based on the generation of ethanol from sucrose or starch derived from vegetative biomass and on the generation of biodiesel from vegetable oils and animal fats. This is achieved by first-generation technologies. In the future, there is enormous potential to develop cellulose-based bioenergy systems by using second-generation technologies. However, in most cases they are 10-15 years away from being commercially viable. Crops can generate more cellulose per hectare than sucrose , starch, or oils. Plant breeders can increase cellulose production by making photosynthesis or nitrogen metabolism more efficient. They must also select for enhanced water- and nutrient-use efficiency under resource-conserving systems that provide overall energy savings and cut emissions of carbon dioxide and pollutants. This would allow biomass to be grown on lands not suitable for food production, which would substantially reduce fuel-food competition.

Agricultural research can also help improve the energy efficiency of biomass crops, enhancing their value as renewable energy sources with low net carbon emissions. Even though biofuels have been praised as being a less environmentally-damaging source of energy than fossil fuels, this is not entirely true. The net impact of a specific bioenergy depends on how it is generated. Given that bioenergy can be generated in many ways using various feedstocks and various energy technologies, few universal conclusions can be drawn about its environmental effects.

Biomass production typically involves the consumption of fossil fuels. The amount used depends on the particular form of biomass and the production method. It includes fuels consumed by farm machinery in land preparation, planting, tending, irrigation, harvesting, storage, and transport; fossil feedstocks for chemical inputs such as herbicides, pesticides, and fertilizers; and energy required for processing the crop into a useable biofuel.

Annual crops generally require more energy than perennial crops because they involve greater use of machinery and a higher level of chemical inputs. For many perennial energy crops, energy ratios (the quantity of useful bioenergy crop produced per unit of fossil fuel consumed) for feedstock production are high enough to make them attractive energy resources.

The potential positive impact of biofuels on the environment would benefit many countries, such as China. It is predicted that in a couple years, China will overtake the United States as the world's top emitter of greenhouse gases. In addition, according to World Bank research, sixteen of the world's twenty most polluted cities are in China. Even more disturbing, a recent World Bank investigation found that 750,000 people die prematurely in China each year, mainly from air pollution in large cities. Of these, 350,000-400,000 die from the high air-pollution levels in Chinese cities and 300,000 die from exposure to poor air indoors. Beijing had engineered the removal of nearly a third of the World Bank report on pollution in China, including the previous fact, because of the concerns that findings on premature deaths could provoke social unrest.

Biofuels have potential as an alternative to fossil fuels, but if biofuel production is not approached correctly from the start, disastrous consequences may result. Launching and developing a new industry like bioenergy poses difficult challenges for the private sector. There must be substantial investments made up front, but they can yield minimal return until sufficient scales of production and demand have been achieved to slash unit costs. Achieving these scales depends on complementary investments throughout the market chain, which is not realistic until bioenergy costs have fallen to a level competitive with alternative energy sources. The solution is for governments to provide initial incentives to help launch the industry. It can offer tax rebates on biofuels (but not on oil-based gasoline and diesel), mandate fuel blending requirements (like the European Union's current requirements that diesel contain at least 2% biodiesel), offer investment incentives such as tax exemptions or holidays on bioenergy investments by industry and subsidies to consumers, and invest directly in research and development and relevant infrastructures. So far, China has given subsidies of up to 1300 yuan per metric ton to four state-owned, corn-based ethanol producers, but it has not given any to biodiesel production. When developing biofuel production, the goal is to implement a system that will both benefit the poor and help the environment. Agricultural research could reduce the competition of biofuel production with food production. It is possible to develop biomass crops that are more efficient and yield much higher amounts of energy per hectare or unit of water, or to develop and grow biomass in less-favored areas. Second-generation technologies that enable cost-effective conversion of cellulose-rich biomass would greatly expand this option. Also, it would be beneficial to invest in increasing the productivity of the food crops themselves, or to focus on food crops with residues that can be used for bioenergy and breed varieties that generate larger amounts of residues. Finally, barriers to international trade in biofuels must be removed. The world has enough capacity to grow all the food needed as will as large amounts of biomass, but not in all countries and regions. Trade enables countries to focus on growing the kinds of food, feed, or energy crops for which they are most competitive. As with all crops, bioenergy crops need to be grown and managed responsibly, and farm-level incentives for sustainable farming (such as secure property rights and locally managed externalities) need to be in place. In some countries, it may not be possible to grow bioenergy feedstocks at costs that are competitive with fossil fuels. Instead of diving head-on into biofuel investment, policymakers need to take a step back and evaluate the capability of their country to compete in the biofuel market. For many countries, especially in temperate climates, it may prove more cost-effective to continue to use fossil fuels and buy carbon offsets, or to import biofuels from countries that can grow them more competitively. Bioenergy offers an attractive escape route, but in order for its full potential to be reached, then both the public and private sectors must cooperate and make long-term commitments and investments in innovation.

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