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## **Environmental Challenges with the Production of Biofuels in India and its Implications for Food Security**

What determines whether a crop survives or fails? What determines whether a planting one year produces enough food for a family and whether that can continue the next year, or the year after that? Answering such questions is vital to sustaining the happiness and productivity of millions of people around the globe. Of course, such goals are inherently multidimensional, involving a host of factors that require attention in order to achieve and maintain those goals. There are significant starting points though, including the rampant hunger in the world. Hunger inhibits the productivity of individuals, harming their ability to escape poverty and create a socially and economically sound society. Therefore, working to create a state of food security is essential for the world's developing nations.

What better place to start than in India, the site of the largest number of undernourished people in the world, 212 million or approximately 20% of the country's population. The most efficient way to reduce the number of undernourished people and generate a continual state of food security is to increase the sustainable productivity of subsistence family farmers in rural regions of the country. This accomplishes two tasks, first it ensures a stable source of food for these family farmers (where most of the food insecurity lies) and second it creates a stable source of income for these farmers. If they can generate enough crops to sell, this not only increases the farmers' health and profits, but also feeds the other non-farmers in the communities and allows them to be productive workers who gain an income as well. In recent years, a potentially huge market for these farmers' crops has emerged, biofuels.

Stable, cheap supplies of energy maintain developed nations' production and sustain their economies. They are vital for the advancement and wellbeing of any country. The world's energy is centered in fossil fuels concentrated heavily in the Middle East, parts of Africa, South America, and Canada. Their superiority lies in their relatively constant and stable supply, and their practical and economical use. These advantages have waned in recent years due to increased political tensions and threats in the Middle East. The substantial rise in U.S. gas prices between 2001 and 2007 is indicative of this. This has translated into increased prices for transportation and areas relying on transportation such as delivery services and imported goods. There has also been a mass realization that fossil fuels are not renewable in any sort of reasonable timeframe (taking millions of years to form in the first place) and that supply may be running short and can't be truly sustainable. On a more global scale, continual use of these fossil fuels has had immense environmental implications, mainly climate change. This is an area of intense political and scientific debate, but there is a widespread consensus that climate change is occurring. Humans' role in that is more ambiguous but many respected scientists conclude that the use of fossil fuels has greatly accelerated the process of climate change. When fossil fuels like gasoline are burned to release energy, many compounds are emitted including carbon dioxide. Carbon dioxide is a greenhouse gas, trapping heat in the earth and increasing the average temperature of the earth. This "global warming" has seriously affected poor, rural farmers in India and throughout the world with increasingly severe weather, drier growing seasons and increased drought, resulting in reduced productivity. Projections of a world with the continued pace of climate change paint a bleak world with major crop loss and devastation. International bodies such as the UN and individual policy-makers from around the world have been searching for ways to combat this crisis and among all the treaties and benchmarks is use of alternative energy sources, which include biofuels. Biofuels include ethanol and biodiesel, and are made from the sugars found in vegetative matter such as corn and sugarcane. Biofuels are said to be less polluting, renewable, marginally more efficient, and less expensive. Countries such as

Brazil have already made significant transitions to biofuels and other countries like the United States are partially utilizing them and are seriously considering stronger commitments to them. This appears to be a prime market for family farmers in countries like India to enter. Not only would it help to fight global warming, but it would also be a good source of income and economic growth for these farmers and their countries.

Farmers cannot simply just start using crops for biofuels though. They still need food for themselves and to sell. Status quo crop production is not nearly sufficient to meet these uses so if any advancement is to be made, a *substantial increase* in productivity must occur. Several major impediments to such an increase exist, including the current climate situation and water scarcity, and other natural resource depletion and degradation such as deforestation and poor uses of land such as to render them less fertile. These are already big challenges in themselves to tackle if production had to be increased for food alone. With the addition of biofuels though, that makes the task that much harder and if not done carefully and thoughtfully, growing crops for biofuels could make the situation even worse.

In order to fully understand how climate change and resource depletion/degradation affect the Indian subsistence farmer, the characteristics of the average Indian family farm must be known. About sixty percent of the rural population engages in farming and about seventy percent of the country's total population lives in rural areas. The average family size is a little more than three children and while the national average literacy rate is fifty-seven percent, in rural family farm areas it decreases significantly. It is important to note that in the past five years, farmer suicide rates have skyrocketed due to the hopelessness they've felt in with their situation. This has become an important aspect of the Indian family farmer social dynamic. The average Indian income is \$721, but as with education is almost half that in rural areas. The rural diet consists mainly of wheat, assorted pulses and lentils, and rice. The average farm size is 1.4 hectares or 3.5 acres. Crops that are grown include, wheat, rice, coarse grains, oilseeds, sugar, cotton, jute, tea, sugarcane, cashews, and potatoes. In the past ten years, India's agricultural growth slowed down to less than two percent a year. Indian farming makes use of irrigation techniques, but most rural farmers can't afford expensive fertilizers. There has been almost a virtual collapse in the agricultural extension system in most states, limiting farmers' access to better technologies. Many use some forms of traditional techniques for planting and weeding. Agricultural productivity is greatly hampered by lack of access to better technologies, increasing resource degradation of the soil in particular and groundwater overuse.

Current patterns of climate change are already harming India's family farmers and are projected to hurt crop yields even more. Average global air temperature has increased by about 0.8° C above pre-industrial levels. The average temperature is supposed to increase from 1.4° C to 5.8° C by 2100. These changes are supposed to result in increases in severe weather and increased drought during the growing season. In some cases, increases in temperature lead to accelerated crop growth, but that just shortens the growing season. Cereals are a big part of India's crop base and such changes can lead to poor vernalization (hastened flowering) and reduced yield. Data from the past fifty-seven years from North America, China and the former Soviet Union, show nighttime temperatures increasing much more than daytime temperatures, due to increased cloud cover due to air pollution. This has the potential to reduce reproductive development in many crop species and consequently, their seed yield, hurting the ability for future planting. Additionally, projections using current climate trends indicate that in the Indo-Gangetic plain of India, where 90 million tons (15 percent) of wheat is grown, yield would shrink by half by 2050 and threaten the food security of some 200 million people.

Resource degradation poses another serious challenge to the ability of farmers to meet their requirements for food security and income. Past attempts at solutions have created extensive problems of resource degradation including soil erosion and run-off into water supplies. Also, in the relatively water rich, irrigated regions where high levels of productivity have been achieved, maintaining profitability is

an increasing concern. The government is being forced to protect farmers' profitability, at the expense of the environment evidenced by declining water tables in the high productivity northwest irrigated region, which highly constrains the region's productivity. Current practices of irrigation are harming soil fertility in the long run. When the water evaporates, it leaves salt back in the soil, harming future growth. Irrigation also leads to loss of soil nutrients (such as zinc, copper, and iron) which plants need to grow. Soil degradation seriously affects agricultural production, about 85 million hectares (210 million acres) of India's farmland are affected. High levels of fertilizer use and decreasing resource efficiency are also contributing to groundwater pollution. High levels of pesticides used in many areas have become a major health hazard. With these issues, the sustainability of the family farm is highly questionable.

Water scarcity is a major burden for the Indian subsistence farmer. India's water supply is being stretched thinner and thinner. This is primarily due to mismanagement of resources, although over-pumping and pollution are also significant contributors. Climate change is exacerbating the problem by causing extreme drought.

India's agricultural sector currently uses about ninety percent of the country's total water resources. Irrigated agriculture has been fundamental to economic development, but unfortunately has been misused to the extent it has led to groundwater depletion. Due to water pollution in rivers, India draws eighty percent of its irrigation water from groundwater. As water scarcity becomes a bigger and bigger problem, rural and farming areas will be hit the hardest. Thus far, food security has been one of the highest priorities for politicians, and the large farming lobby has grown accustomed to cheap electricity, which allows extremely fast pumping of groundwater, which they are unwilling to give up for the sake of water conservation. If India wants to maintain its level of food security, farmers will have to switch to less water intensive crops and engage in better methods of irrigation. Otherwise India will end up being a net importer of food, which would have massive ramifications for the global price of grain, and hurt the rural Indian farmer even more.

If a path of biofuel crop production was pursued in the current environment or anything like it, success would be very difficult to come by. They would put a huge tax on already deteriorating natural resources. In water-short countries like India, increasing agricultural production of biofuels will simply add to the strain on stressed water resources. Almost all of India's sugarcane, the country's major ethanol crop, is irrigated. The water required to grow sugarcane greatly outweighs the water resources needed to process the fuel. Research at the International Water Management Institute (IWMI) in Sri Lanka has shown that at a global average, the amount of crop needed to produce one litre of biofuel evaporates between 1000 and 4000 litres of water, depending on the type of feedstock and conversion techniques used. Sugarcane in Brazil evaporates around 2200 litres for every litre of ethanol. But in this water-rich region, the demand is easily met by abundant rainfall. In more arid countries, irrigation must make up the shortfall. In India, a litre of sugarcane ethanol requires 3500 litres of irrigation water. As India's population continues to grow over the next few decades, demand for food and thus water to grow that food, will rise. People's improved standards of living will cause diets to shift towards more sugar, oil, vegetables, meat and dairy products, all of which typically require more water to produce. Because of its limited water resources, India will face serious challenges to meet the predicted increase in demand for food produce, let alone sustain any further growth prompted by expanding biofuel production. By 2030, India's demand for cereal is set to rise by 60 percent, and more than double for sugar. Analysis by the IWMI indicates that even under the most optimistic scenario, the demand for irrigation water will increase by 13 percent or 84,000 billion litres of water. Growing sugarcane to produce the 9 billion litres of ethanol needed to meet just 10 percent of India's gasoline demand by 2030 could add another 22,000 billion litres of irrigation water to the figure, assuming water efficiency improves. Parts of India have already breached their limits of sustainable water use, even without the added strain of trying to grow crops for biofuels. Major indicators are falling water tables in India's heavy grain/wheat producing region,

Punjab and increased competition for water.

Additionally, biofuel crops are considered a threat to food production due to the vast amounts of land needed for growth. Initiatives by the Indian government, aim to utilize supposed wastelands for crop production, in order to not tradeoff with food-based agriculture. However, several researchers have contested the categorization of such lands as wastelands on the grounds that such lands are an integral part of the livelihood of the rural poor, including the family farmer. A majority of these wastelands are classified as common property resources (CPR). The means that collective groups such as villages own the resources and membership in the group entitles the individual to whatever the land can give them. Research on CPRs has revealed that they in fact play a vital role in the lives their owners by supplying a wide variety of commodities like food, fuel wood, fodder, timber, and thatching material for home roofing. Several studies on CPRs in arid and semi-arid regions of India show that CPRs contribute between twelve percent and twenty-five percent of the poor household income and the poorer the household, the more important the contribution of CPRs. Therefore, these wastelands the government of India wants to use for biofuels are in fact an extremely important resource for the family farmer and disregard for the role of these lands in the rural Indian's lives is likely to cause further hardship and help no one.

There are things Indian farmers can do to increase their crop yields and get a foot in the biofuels market. A general shift to more climate-resilient crops is needed. Already, institutions such as the Consultative Group on International Agricultural Research (CGIAR) have done extensive research and continue their efforts to produce crops that can withstand increased stress brought on by heat and drought. Along with more tolerant crops, more efficient uses of water should be pursued. Employing methods such as drip irrigation, where water flows from a raised bucket into pipes with emitters scattered throughout the area being watered, and the water slowly drips into the soil at the base of the plant. This costs as little as \$5 per system and ensures water is used efficiently. Additionally, greater collective stewardship and responsibility with water can guarantee that it is conserved and can help more people. Better soil management is another measure that should be taken. Reducing tillage, leaving crop residues in the soil, and increasing fertilize efficiency can all go a long way in improving the situation of the Indian family farmer. In places like India, Pakistan, and other areas of South Asia, half a million people are already engaging in "zero tillage" technology with their rice and wheat systems. This keeps the soil intact, crop residues in the soil to naturally fertilize it, and as a result has conserved the soil and water while raising productivity. Methods like this should be expanded throughout the subcontinent. In order for the rural farmer in India to become better aware of the environmental situation and to help improve it, he/she needs better access to world markets for things like staple foods and horticulture. This is where other nations' governments and international groups like the World Bank or International Monetary Fund can act to make it easier and less scary for these farmers to enter the world market and become active member in it. These groups can ease restrictions, create incentives, and lower the risk for a farmers in India.

Additionally, CPR wastelands can be spared. In comparison with wastelands, India's net-cropped area is in the vicinity of 150 million hectares out of which less than thirty percent is irrigated while the rest is rainfed. Farmers in this rainfed region are among the most economically disadvantaged, largely due to scarcity of water and their resulting inability to raise cash crops like rice, wheat, sugarcane, edible oils etc. The cultivation of biofuel crops that are both commercially valuable and not water intensive can provide valuable opportunities for raising these peoples' income without having an adverse impact on national food production or on the landless poor who depend on CPRs. Annual crops like sweet sorghum and castor, which are already being cultivated, and which can be used to produce ethanol and biodiesel are better candidates than sugarcane. These annual crops allow the farmers to practice crop rotation methods to maintain soil fertility and are more efficient with water resources. This is the area where the government of India should be encouraging biofuel crop production.

India is in a unique position relative to many other developing nations who face these problems of resource degradation and climate change in that it has the economic capital to implement changes. It can take the gains it has made from its booming industrial economy to bring its critical agricultural sector up to speed and to fight climate change. Significant gains in the agricultural sector would go ways to fighting India's rural poverty and advance India's development. An increased interest with biofuels can help to sustain India's growth by helping to ensure a cheap, stable supply of energy and become a new form of export for the country. But India can't do much outside of India. The problems associated with climate change can never be resolved unless other nations and global institutions step forward and rejuvenate their efforts in fighting it. This means that leaders of countries be held liable by the world for their country's part in climate change through the UN. This means leaders actually discuss tangible ways to combat the issue and create benchmarks that must be met or there will be consequences. No nation should be above these conditions. It is true that this may seem too politically intrusive and forward, but the situations is such that it demands such firm action. The family farmers of the world cannot afford to wait any longer and nations must realize that this is in their best interests. If the family farmers lose, these nations lose too. Private organizations and corporations should continue their work in research and solution development and always be striving for a more economical and efficient way to do things like increase crop yields and lower water waste.

Resource degradation interacts with climate change and water scarcity to create a very poor situation for small farmers in India. Climate change is accompanied not only with global warming, but with increasingly violent storms. Possible areas for cultivation on the coast get flooded out and global air temperatures affect crop growth in their most critical of phases, hurting yields and ultimately farmer's food security and income. Extensive resource degradation due to mismanagement and improper resource usage also harms crop yields and leads to increased poverty and economic depression amongst small farming groups. Water scarcity is symptomatic of both resource deterioration and climate change. A majority of agriculture is irrigation based and lack of water, renders crop amounts small and farmer profits negligible. Current emphasis on biofuels doesn't necessarily help the current situation, serving as a tradeoff between food based agriculture and fuel based agriculture. Instead of using designated wastelands, small farmers' lands should be utilized to grow these biofuel crops in order to increase their income and thus ability to obtain a stable supply of food. Crops that more tolerant to changing weather conditions should be grown and action should be taken to preserve water resources and soil quality. In this way, the Indian subsistence farmer can move beyond plain subsistence and become a reasonable force in the global market.

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