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Thailand: Sustainable biofuel development in Thailand to benefit subsistence farmers

Since the 1990s, Thailand has seen rapid modernization after implementing policies leading to marked improvements in commercial agriculture, urbanization, education, and healthcare. Amidst this progress, however, nearly half of its population has been left behind. In 2008, 49.7 percent of Thailand's total labor force was farmers, a group of individuals whose wellbeing was often ignored in recent government policies (“Country Profile: Food Security Indicators”).

Increasingly, Thailand has been contributing to greenhouse emissions due to urbanization and commercial agriculture. In recognition of Thailand’s contributions to climate change, in 2008 the Thai government issued a series of mandates ordering a significant increase of the use of biofuels by 2022 (Salvatore 20). However, this policy largely ignored the voice of subsistence farmers. Instead, it called for an increase in the production of biofuel crops such as cassava (a tuber), sugarcane, and palm-oil – cash crops primarily grown by commercial famers.

An increase in commercial agriculture due to biofuel initiatives could have adverse effects on subsistence farmers, whose livelihood would be threatened by land buy-outs, lagging technologies, and soil degradation. In addition, climate change has caused severe flooding, extreme draught, heavy storms, and rising sea levels – all factors that threaten the wellbeing of the most important crop of Southeast Asia: rice. Thai subsistence farmers rely on rice for food and sometimes as a cash crop. Although it is necessary for the food security of rural Thailand to stop the advancement of global warming, it is also essential that green technologies be implemented at the local level. These technologies must utilize non-food sources such as cellulose and algae to deter global warming and improve the economic outlook for subsistence farmers.

Thailand is primarily an agricultural state, with the chief exports being rice, rubber, cassava, sugar cane, and chicken (“Country Profile: Food Security Indicators”). Although these are mostly cash crops, the typical Thai subsistence farmer relies primarily on rice for food. Most of Thailand's rice is grown in its flat, treeless, central plains region (G. Campbell 12). In the summer months between April and September, Monsoon winds bring heavy rainfall and humidity (10). During this period, farmers plant rice, which requires 70 inches of rain for successful harvest. In the dry season between October and March, farmers harvest the rice (12).

Thailand's rivers play an important role in food production as sources of fish and irrigation. Thai fishermen harvest nearly 1.8 million pounds of fish from the country’s rivers annually. Intricate networks of canals, known as klongs, connect Thailand's rivers, providing a source of irrigation for farmers without access to a natural river (13). Thailand's main river, the Chao Phraya, floods annually, depositing soil, nutrients, and water necessary for rice production (12).

In 2010, the average farm size was 8.9 acres (Isvilanonda); this number has been declining since 1995, when the typical farm size was 11.1 acres (Thepent). This disparity is the result of declining soil quality, the division of family farms between multiple inheritors, the conversion of agricultural land into urban settlements, and increased agricultural efficiency. Rural families are slightly larger than urban families, with the average household in non-municipal areas being 4.0 persons and the average municipal-area household being 3.7 persons (Population and Housing Census). Rural households sometimes have numerous extended family members living under one roof (Kislenko 133). Arranged marriages, adolescent marriages, and poverty are also more common in rural areas than urban areas (131-133).

Despite several shortfalls of rural life, Thai women often have more power compared to women in other Southeast Asian nations because of the matrilineal family structure and the female management of household finances (127). All Thai children have equal rights to education, and free mandatory schooling is offered until age 15 (“Overview”). 98 percent of Thai children attend primary school; 68 percent of males and 77 percent of females attend secondary school (“Thailand Statistics”). All individuals have similar access to healthcare due to Thailand's universal healthcare program, established in 2002. However, people usually must travel to the nearest city to receive these benefits, and some medical procedures are not covered under the policy (“Thailand: Healthcare for all, at a Price”). This results in a relative healthcare-disadvantage for rural residents.

Although the wellbeing of Thailand's overall population is rapidly improving due to industrialization and advances in commercial agriculture, these developments do not necessarily benefit small-scale farmers. Almost 90 percent of the nation's poor are farmers, a result of urbanization and advances in technology (Fan 8). For now, small-scale farmers produce most of the nation's commodities; however, the Thai government, seeking modernization, has been implementing policies to promote industrialization and commercial farming. As commercial farmers adopt new agricultural techniques and technologies their profits grow rapidly, often allowing them to buy-out subsistence farmers. Of the small farms that survive, few are able to afford the advanced machinery available to large-scale producers (26-27).

Although a typical Thai subsistence farmer relies mostly on rice for their livelihood, the recent international push for biofuel production could jeopardize valuable food-producing land. For now, Thailand is not reliant on biofuel – it accounts for only 1.3 percent of the nation's total energy production and 0.8 percent of its domestic energy consumption (Salvatore 18). However, domestic and international mandates may increase Thailand's incentive for biofuel production.

Under the Alternative Energy Development Plan (AEDP), implemented by The Department of Alternative Energy Development and Efficiency (DEDE) in 2008, Thailand aims to reach 20.3 percent dependence on alternative energy by 2022. The main objectives of this plan are to replace dependence on foreign oil and to increase fuel security. To do so, the DEDE plans to encourage the production of alternative energy resources, increase research and development, and enhance industrial alternative energy technologies. The main energy source the AEDP plans to utilize is biofuel, with a fivefold increase in production by 2022 (20).

In addition to domestic policies mandating the production of green energy, the international demand for biofuel crops such as cassava is driving the Thai farmers into the global biofuel market of which they have no control. In the first years of the 21st century, China diverted much of its maize outputs to ethanol production. After several years, the nation faced a drastic decline in food supply and an increase of prices; in 2007 the Chinese government prohibited the production of ethanol from grains. However, a few years later, Chinese scientists developed a method for converting cassava, a tuber, into biofuel. China quickly expanded its cassava production, built more ethanol plants, and began importing the crop from Southeast Asian nations such as Thailand. In 2010, 98 percent of Thailand's cassava exports went to China, and cassava chip production grew by 400 percent (Rosenthal).

Increased demand for biofuel crops such as sugarcane, palm oil, and cassava could present subsistence farmers with the chance to cultivate new crops and seek profit for their yields; however, the production of cash crops on land originally cultivated for food would have adverse effects on food security. With an increase in cash crop production, subsistence farmers’ land would be threatened by buy-outs from commercial farmers. The increased demand for sugarcane, cassava, and palm oil would cause the production of rice to decline, with an estimated decrease in exports by 15 percent annually (Salvatore 33). This would raise rice prices and decrease food security.

Because of the growing westernization of Thailand's urban class and the decline in prosperity of its rural class, Thailand can expect to see an increased division between social classes. Due to poverty, rural women often have fewer rights than their urban counterparts. Therefore, an increase in biofuel production and the subsequent increase in rural poverty will have adverse effects on rural women. Currently, impoverished rural women are often forced into prostitution or arranged marriages (Kislenko 128-131).

Biofuel production and the subsequent increase in food prices are on the rise. In 2004, one percent of the world's grain sources were converted to biofuels; by April 2011, this number had risen to six percent (Rosenthal, graph). Food prices rose sharply between 2007 and 2009 and then returned to normal growth rates until 2010, when there was once again a spike in food price growth rates ("FAO Food Price Index"). Often the poorest people in developing countries are most affected by rising food prices because a larger proportion of their income goes to purchasing food (Salvatore 98). A study by the International Food Policy Institute examined the current biofuel plans of multiple nations and concluded that if successful, these plans would lead to a 26 percent price increase of maize, 18 percent increase of oilseeds, 11 percent increase in cassava, and 8 percent increase in wheat. In developing nations, these price increases would lead to a two to five percent decrease in caloric intake and a four percent increase in child malnutrition ("Impacts on Poverty and Food Security" 79). According to a study by the FAO, the rice-producing subsistence farmers in Southern and Northeastern Thailand would see the greatest rise in poverty with the growth of biofuel production (Salvatore 26).

The introduction of a cash crop for biofuels could have positive implications for some farmers in developing nations. An increase in commercial agriculture has been associated with the demographic advancement of many nations. For example, Brazil has seen high levels of progress since it began mass-producing biofuels in the mid-1980s. In 2001 it was estimated that the biofuel sector employed over one million Brazilian unskilled workers and the Brazilian government approximates that 20 million people have escaped from poverty in the last decade ("Impacts on Food Security" 82). In 2010 the Brazilian economy grew 7.5 percent (Smale). Granted some of this growth is because of other factors, the biofuel industry has contributed to Brazil's advancing economy; the nation exports one billion gallons of ethanol annually (Hofstrand).

If Thailand terminates its current biofuel programs, subsistence farmers may still be affected by rising food prices and would have more limited options for entering Thailand's export-based economy. At this point it would be difficult for Thailand to completely eliminate its biofuel crop cultivation without economic decline. The nation would have to alter the cash crops it produces and may have trouble competing in the global economy if it refuses to export biofuel. However, by altering the current system of biofuel production, it could preserve its outputs while increasing food security for poor subsistence farmers.

Burning ethanol releases similar amounts of carbon dioxide into the atmosphere as burning gasoline. However, some say ethanol is more environmentally sustainable to burn compared to gasoline. When plants undergo photosynthesis, they absorb carbon dioxide from the atmosphere and use energy from sunlight to integrate it into starches (N. Campbell 181). To produce biofuel, these starches are fermented to create ethanol, which is then burned, producing energy and releasing carbon dioxide back into the atmosphere. When fossil fuels are burned, they release carbon dioxide that plants removed from the atmosphere millions of years ago (Howell). The carbon dioxide released by biofuels was more recently in the atmosphere than the carbon dioxide released by fossil fuels. Unlike fossil fuel, burning biofuel does not cause a net increase in atmospheric carbon dioxide.

Although burning biofuels is perhaps greener than burning fossil fuels, recent studies have suggested the production of biofuel is not as environmentally friendly as once thought. Producing ethanol is water intensive. An increase in ethanol production in Thailand, where only 12 percent of citizens have access to safe drinking water, could divert millions of liters of fresh water to biofuel manufacturing and away from subsistence farmers (“Country Profile: Food Security Indicators”). Overall, it takes an average of 1,817 liters of water to produce one liter of ethanol from cassava (Salvatore 55).

In tropical areas in Southeast Asia, South America and the South Pacific Islands, farmers often destroy forests to create space for production of biofuel crops such as sugarcane and palm oil seeds. Because native plants are typically more efficient at removing carbon dioxide from the atmosphere than agricultural plants, many scientists speculate the production of biofuel crops could have adverse effects on atmospheric carbon dioxide levels (“Biofuels Could Hasten Climate Change”).

Regardless of ethanol's effects on climate change, if global warming continues, biofuel production will increase in response to growing environmental awareness and rising petroleum prices. This increase in biofuel production will decrease the food security of Thai subsistence farmers. However, extreme climate change could be equally detrimental to the world food supply. With growing global temperatures, coastal areas such as Thailand are expected to see an increase in flooding, drought, severe storms, and rising sea levels. Rice is extremely sensitive to temperature variation; one degree of warming has the potential to significantly reduce rice yields (Kisner). To effectively combat climate change and enhance food security, there needs to be increased development of green energy without threatening the food supply.

One potential source of energy is cellulosic biofuel. Instead of obtaining energy from starches such as cassava, sugarcane, and maize (which are important food sources), cellulosic biofuel can be derived from the stems, leaves, and wood of any plant (Ratliff). Companies in Iowa and Nevada have already developed technologies to produce biofuels from corncobs and municipal solid waste (“POET to Showcase Cob Harvesting,” “Home Page”). After harvesting rice, Thai subsistence farmers could sell a portion of leftover rice husks to cellulosic ethanol plants. Currently, rice husks are simply abandoned in fallow fields after the rice has been harvested. When the husks decompose, they release large levels of methane, a greenhouse gas, into the air, contributing to global warming. In 2005, Thai rice paddies released the methane equivalent of 46.7 million tons of carbon dioxide (Kisner). By clearing only a portion of the rice husks farmers would still reap the fertilizing benefits of decomposing organic matter. However, utilizing rice husks as fuel would increase food security by reducing food-source based-biofuels and lessen climate change by reducing methane emissions.

Another potential energy source is biofuel derived from algae. Like all plants, algae use sunlight, water, and carbon dioxide to convert carbon dioxide into sugar. This sugar can be fermented and converted into fuel. Algae consume massive amounts of carbon dioxide, which reduces atmospheric greenhouse gasses. Producing one liter of algal oil would result in the elimination of 3.5 kg of greenhouse gases (Howell). Algae can grow in almost any environment as long as there is sunlight and carbon dioxide; it can even be cultivated in an ethanol factory. Evidence has shown that algae can grow in open ponds and wastewater, but it is more efficient to grow it in conditions with closely-regulated carbon dioxide levels.

Thus, Thailand could take two paths with algae production: cultivate algal fields in fallow rice paddies, or establish commercial plants with the capacity to grow algae and convert it to ethanol. In the 2007/2008 growing season, Thai farmers used 262,000 tons of nitrogen fertilizer. The misuse of fertilizer in Thailand has contributed to diminished soil quality, greenhouse gas emissions, and farmer debt (Kisner). It could be beneficial for subsistence farmers to leave a portion of their rice paddies fallow once every few growing cycles and allow algae to grow in the place of rice. If a portion of the algae was not harvested, it could fertilize the soil for future rice production cycles without the use of chemical fertilizers. This would be especially effective if algae were genetically engineered to allow for nitrogen fixation, a trait of legumes that allows nitrogen to be returned to the soil (N. Campbell 764). Harvested algae could be sold to a biofuel plant to be converted into ethanol. Although the specific economic benefits and drawbacks of this solution would need to be examined, it is possible that it would improve overall food security by increasing soil quality and reducing the effects of climate change.

Another option for producing algal ethanol is to establish production facilities capable of cultivating algae and processing ethanol in the same facility. Companies such as Solix in Colorado and Aquaflow in New Zealand have already implemented technologies for the production of algae-based biofuel. Like a cellulosic ethanol plant, it would be expensive to establish an algal ethanol plant, but with Thailand's already large biofuel budget, the project could be possible.

The establishment of a cellulosic or algal ethanol production facility would be a sustainable strategy for increasing food security and reducing global warming. The plant would provide income for farmers and create jobs for moderately skilled laborers.

Thailand’s expanding biofuel industry has come to the attention of several global organizations. In recent years The World Bank and Thai government joined to create a Country Development Partnership for Environment (CDP-E) in response to Thailand’s rapid industrialization and subsequent degradation in its land, air and water resources (“Thailand Environment”). Additionally, The United Nations Development Program (UNDP) is currently creating provincial regulations in Thailand to expand renewable energy education, private sector engagement, stakeholder cooperation, and infrastructure improvement (“Promoting Renewable Energy”). The industrial standards created by these organizations would ensure that ethanol plants would be environmentally and financially sustainable in the long run; however, these regulations could create additional short-term and long-term expenses.

Currently, biofuel production facilities cost over $100 million to establish and require water and energy sources to maintain (Doggett). This cost would make it difficult for a rural Thai village to maintain a cellulosic ethanol plant without government assistance. The DEDE is a division of Thailand’s Ministry of Energy. It provides no-cost capital to banks, which then provide low-cost loans and tax incentives for companies that adopt alternative energy plans (“Department of Alternative Energy”). Since the implementation of the AEDP in 2008, the development of alternative energy solutions has been a high priority on the Royal Thai Government’s national agenda (“Energy Policy”). The Thai government has already diverted millions of dollars to the development of clean energy sources. In 2011 alone, it spent $180 million on biodiesel production (Bell 837). By reapportioning a fraction of the DEDE's annual budget from 2012-2014, it is possible that there would be sufficient funds to partially subsidize one or more cellulosic or algal ethanol plants.

With government subsidies, corporations would likely invest in the establishment of the ethanol plants. It would be most economically feasible for existing Thai biodiesel companies such as Songkhla Biofuel to expand their current plants or to invest in new factories ("Ratchaburi Invests in a Biofuel Company"). This strategy proved effective for the largest biofuel producer in the United States, POET LLC. After a $105 million loan from the federal government, the biofuel company is establishing a cellulosic ethanol plant in Emmetsburg, Iowa that will be capable of converting corncobs into biodiesel by 2013 (Doggett).

It is in the best interest of Thai subsistence farmers for green initiatives such as cellulosic and algal ethanol to be implemented on the local level. Currently, the wellbeing of Thai subsistence farmers is threatened by governmental initiatives to increase biofuel outputs with commercial cash crops. The establishment of cassava, sugarcane, and palm oil farms reduces the amount of land available for the production of rice, Thailand's staple subsistence crop. In addition, the fertilizers and intensive agricultural techniques required to produce these crops threaten Thailand's soil quality and waterways.

However, climate change in Thailand cannot be ignored. An increase in global temperatures will contribute to flooding, drought, severe storms, and rising sea level - all factors that would threaten Thailand's agricultural sector and food security. To combat climate change and improve food security, green initiatives must be adopted on the local level. If the Thai government and biofuel corporations effectively subsidize cellulosic and algal ethanol plants, all sectors of society could see modernization. These plants would create semi-skilled manufacturing jobs and allow Thai subsistence farmers to participate in the global economy by giving them the opportunity to sell the non-food byproducts of rice production.

Over the past several decades, urban areas of Thailand have seen advancements in mechanization, education, healthcare, and women's rights. However, many of these advances have yet to reach the poorest areas of rural Thailand. With global climate change on the rise, there is an opportunity for new industries to be introduced to these rural areas, bringing modernization, employment, and food security to subsistence farmers.

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