Deandrea Mills, Student Participant
Central High School
La Crosse, WI

The Sustainability of Biofuels in Kenya

"And all their love was thinned with money, and all their fierceness dribbled away in interest until they were no longer farmers at all, but little shopkeepers of crops, little manufacturers who must sell before they can make"-John Steinbeck, The Grapes of Wrath. Subsistence farmers, or farmers that are able to provide for basic needs with little or no surpluses for marketing, make up some of the most vulnerable of food insecure groups in the world. These farmers are thinned with money and dribbled away with interest; they are food insecure because of their state of poverty and low agricultural productivity. In Kenya, a country where 80% of the people are involved in agriculture, half are living below the poverty line, and over 35% are undernourished; subsistence farming is prevalent and in dire need of innovation. Biofuels, liquid or gaseous fuels derived from biomass that can be used as a source of fuel, may just be this innovation. This type of fuel has been proven to emit less greenhouse gas and is therefore in demand by many countries. If Kenyan farmers could increase their crop productivity, they would not only have more food, but also could utilize crops for biofuel production, increasing income. Currently, only food crops are used to produce biofuels, but technologies are emerging for cellulosic ethanol, technologies that could use crop residues or almost any form of biomass and convert it to ethanol. However, Kenya's farmers are not yielding enough for either market due to a number of factors. The country must be able to sustain the biofuels market without displacing domestic food production if it wishes to receive all of its benefits. In the question of sustainability, a close look must be taken at the lives and practices of the subsistence family farmer in order to see the barriers of production, so that solutions can be developed and implemented.

A "typical" subsistence family farm in Kenya consists of eight to ten family members each with the life expectancy of 55 years.[17] A wide variety of fruits, along with maize, wheat, beans, and potatoes are eaten, with very little meat and eggs. The literacy rate is 85%, and the per capita income is $250.[7] The family farm is a 1¼-acre plot and grows maize, cassava, sweat potatoes, and fruit. Most farmers are too poor to afford motorized pumps and the fuel to power them, so only a handful irrigate the soil year round. Along with this, according to the World Food Programme[6], weaknesses in maize pricing and marketing have lead to unstable domestic prices, lowering the production and access of consumers to maize. With no impartial substitution to inspect the production and marketing of maize, the Kenyan seed company has a monopoly over KARI. Inequitable markets are hence shown to be a major barrier to improving agricultural productivity and farm income.

Other major barriers include climate and water scarcity. The country's altitudes and rainfall vary to extremes. Altitudes range from sea level to above 5000m in the highlands, and average rainfall extends from less than 250mm to over 2000mm in high potential areas[16]. Unfortunately, most of the country is classified as arid to semi arid, and consequently water scarcity is a problem. Only 15% of the country receives adequate rainfall for two dependable growing seasons.[14] While rainwater can be harvested in areas receiving 50-80mm of rain, it often requires modern technologies subsistence farmers do not possess. Irrigation is basically nonexistent, causing many farmers to depend on rainwater for crop growth. For these reasons, climate and water scarcity are adverse for agriculture and thus obstacles in improving productivity and income.

Kenya's climate and water scarcity combine to produce a lack of arable land or land suitable for farming. Only one third of the land is arable (the highlands, coastal plains and lake region), and 83% is classified as arid to semi-arid.[16] Likewise, 14.4% is salt-affected due to salinization.[12] This means that, in certain areas, water mobilization is more difficult for plants, there is toxicity of certain ions to plants, and soil degradation is occurring. A lack of arable land is an impediment to increasing yields.

Aside from unfair marketing, all of the chief barriers limiting Kenya's agricultural productivity and farm income deal with the land and climate. Drought has in fact been labeled as the main cause of food insecurity in Kenya.[6] Thus, reversing natural resource degradation and adapting farming to water scarcity and climate change is the foremost vital factor in being obtained—the first step for Kenya to make to find a market in biofuels. Cultivators cannot earn sufficient income because they are unable to yield enough crops to both eat and sell. Subsistence farmers, after all, are defined by their ability to produce only enough food to live on. More than 35% of the population is undernourished.[13] The principle lack of water leaves 38% without drinking water, much less water for irrigation. [5] Food insecurity in Kenya is therefore severe, especially considering the dramatic undesirable effects of upcoming climate change. As Michael Case, WWF climate change scientist, states "East Africa depends heavily on rain-fed agriculture making rural livelihoods and food security highly vulnerable to climate variability such as shifts in growing season conditions".[3]

The environmental shifts negatively affecting food security Case speaks of are only getting worse. Aridity and salinization are increasing. According to Lepri,[12] the world is losing, on average, 10 hectares of land suitable for cultivation every minute. Land is being degraded and biodiversity diminished. If things continue, there could be a sea-level rise, extreme weather events, altered biodiversity, and even human health concerns. A study done by Perret[16] showed that climate change (increasing temperature) would increase the crop evapotraspiration (Etm) of all crops selected in the study by about 10-11% in all districts of Kenya, except Vihiga (8-9%) and Migori (5%). A higher Etm means more sensitivity to lower water supply. As farming is made more difficult by climate change, subsistence farmers must begin to adapt and avoid further environmental harm if they wish to produce enough food to support the family. Those farmers interested in the biofuels market may require drastic changes in their agricultural practices to produce above and beyond their typical outputs.

A non-profit organization called International Development Enterprises (IDE) has helped countries like Bangladesh, Nepal, and Zambia through their innovations in affordable small plot irrigation. Lack of irrigation was mentioned as a productivity constraint for subsistence farmers in Kenya. IDE developed a $30 treadle pump that allows for a $100 net income increase and a $5 modular drip irrigation system, both designed for the micro-plot farmer. The treadle pump is for ½ acre of vegetables and the drip system irrigates a kitchen size plot and can be expanded to an acre. With a 1¼-acre plot and no irrigation, the typical Kenyan subsistence farmer fits the description of someone who could use this type of equipment. While it is complete in design, the difficult part comes in the rural mass marketing—the establishment of private sectors that manufacture, distribute, and install the technology at the village level. Proven to be effective, rural Kenyans could use these new designs in their cultivation and see a positive difference in yields.

In the case that these new tools are not effectively marketed in Kenya, farmers should aim for what is called dry farming. Dry farming is the profitable production of crops without irrigation on land with a low average or highly variable rainfall.[4] Their main goals should be as follows: 1. Conserve and utilize the available rainfall to the fullest extent, 2. Condition the soil to absorb as much water as possible, keeping losses by evaporation and transpiration to a minimum, and 3. Choose the right crops for the region and plan cropping so that it does not stress the environment.

Not any place can be dry farmed, however. According to Randy Creswell and Dr. Martin Franklin, authors of Dryland Farming: Crops & Techniques for Arid Regions[4], there needs to be over 250mm of rainfall per year. Also, there can be no clay, sand, or gravel that interferes with the capillary movement of water. Soil must be at least 450mm deep.

There are many different practices made by profitable dry farmers. For example, windbreaks can reduce the effects of wind (trees are cheaper than non-living materials). A light shade can minimize heat as well as retain moisture. The runoff of water can be lessened through the leveling of cropland. Both drainage and weeds should be controlled, so that there is a suitable outlet for excess storm water to pass after saturating the soil, and so that weeds are not competitors for nutrients. Reducing the number and spacing of plants is also helpful in conserving soil moisture. Tillage and planting should be done in proper moisture conditions, likely only at the beginning of the rainy season. All dry farmers should know a manual soil test in order to specify these soil moisture conditions. A stubble mulch, done after harvest, has the benefits of wind speed reduction, improved water penetration, and decreased water runoff. However, stubble mulching has its drawbacks and thus should only be used in certain conditions (during the dry season, or during the rainy season if there is high soil nitrogen/low plant nitrogen needs). Fallowing may be impractical to subsistence farmers, but is also often used and sometimes necessary in dry farming. Another aspect of dry farming, choosing the right crops for the region, can be very complicated—yet overall, drought resistant and quick maturing varieties should be grown. These are some of the many components of dry farming that can be utilized by farmers in semi-arid regions to increase productivity. Still, they need to be explained so that they are properly done or more environmental harm may occur.

Utilizing available techniques and becoming aware of these concepts will greatly assist the family farm. Farmers will be able to produce higher yields, farm more land, and choose the right crops and agricultural practices. If this can be managed, the biofuel industry will likely become viable and in much shorter reach for Kenya. This is significant because there are many possible benefits biofuel production would have on the environment, the country of Kenya, and most importantly the poor subsistence farmer.

The use of biofuels themselves helps to relieve the environment of greenhouse gas emissions. For example, biodiesel derived from rapeseed has carbon dioxide emission levels 53% lower than petroleum diesel; for soybeans, the reduction is 41%.[11] Compared with gasoline, CO_2 emissions from corn ethanol are 12% less.[11] Making ethanol from cellulose is also cheaper than gasoline, estimated to be $1.50 to $2.50 with a prospective lowered cost of 90 cents. These are very important facts in keeping the market necessary and appealing to importing countries overwhelmed with concern of global warming.

The country overall would benefit significantly if biofuels became a primary export; it could produce its own fuel and create new jobs. Kenya currently relies on imported petroleum to meet 75% of her commercial energy needs.[2] Making her own fuel would allow a drop in this percentage. New jobs, including the opportunity of ownership in a biofuel plant, are a favorable effect considering 40% of population is unemployed[7,15]. If cellulosic ethanol is used, providing new habitats for wildlife may increase biodiversity. If these are not of top priority to Kenya, perhaps helping her rural farmers out of food insecurity is.

Opened opportunities and choices would be given to these farmers, improving the livelihood of the subsistence family farm. They would have two markets to sell to—the fuel or the food, giving them a choice amongst competing prices. These poor farmers would be able to use food energy crops already grown such as maize, sugarcane, or cassava for biomass conversion. As mentioned above, the unbalanced market is a major barrier to increasing income. Perhaps making crops available for two different markets would help this problem.

Cellulosic ethanol or ethanol produced from grasses and agricultural waste rather than feedstock is an upcoming viable type of biofuel production. This would be beneficial to Kenyan farmers because they could plant new crops designed specifically for energy conversion such as Jatropha, a non-food crop whose oil is typically used for soaps and candles, or a new developing variety of corn that yields more ethanol. Moreover, perennial grasses for biomass conversion (for instance Miscanthus) could be rotated according to climate or profitability. These grasses would reduce soil erosion because they require less tillage. In effect, they could be planted on more marginal land, expanding acreage. Agricultural residues could become a second crop. Cellulosic ethanol is more favorable than corn ethanol in terms of greenhouse gas reduction.[11] Having two markets to sell to, along with cellulosic energy conversion, would give farmers more flexibility in their cash crop strategies and land use enabling them to increase their income.

While there are evidently many advantages of implementing biofuels, there are limitations to the promises it brings. Most importantly, there is the question of sustainability. Many are asking if there is enough land to produce fuel and food concurrently. For Kenya, this is particularly a thought to consider as both are already sufficiently lacking. As one article[1] brings up, “Assessing and projecting (Africas) biomass energy potential is extremely complex because there are so many factors at play. Some of those factors can be predicted quite precisely (demographic trends), for others this is far more difficult (e.g. climate change effects)”. The author leaves out planting decisions and technological advancements, but these are also things the outcome depends on. Then there are those that answer the question with replies such as “On a worldwide scale there is enough available cellulose feedstock to replace 50% of transportation fuels—360 billion gallons—by the middle of this century without impacting availability of food”[10] or “The energy content of (the Earth’s) annual biomass production is estimated to be more than 6 times world energy use”.[8] The overall issues of potential and sustainability are debatable and as a result biofuels are made a precarious investment.

Then there are the more specific constraints the market may have. Stripping the land of crop residues for cellulosic ethanol would reduce nutrient recycling into the soil, decreasing its fertility, which would contribute in making the operation unsustainable. This also entails harm to the environment. Whereas the combustion of biofuels may emit less greenhouse gas than fossil fuel, the manufacturing of biofuels requires fossil-based energy (except for Brazils sugarcane conversion). On the contrary, according to Laney[11], some studies contend that cellulosic ethanol could reduce the need for fossil fuel-laden input and if produced from low-input crops, second generation energy crops could significantly reduce the amount of fossil fuel consumed in the production of biofuels. Supplying one's own fuel was shown to be a plus of manufacturing biofuels. However Harbinson[9] brings up question of whether Kenya truly would support those energy needs or if she would simply meet richer nations demands. Perhaps she will not produce biofuels but simply export biomass. One cannot be certain the land would be split properly for production allowing enough food for the community. The livelihood of the subsistence family farm could easily be harmed by failure of appropriate involvement in the investment.

Simply put, the only way for Kenya to successfully employ the biofuels market is to be certain she can sustain it without affecting food production and availability. Insuring its sustainability implies solving the major barriers of agricultural productivity. For those farmers curious of the biofuels market, drastic changes means a lot of investment of time and hard work towards exporting cleaner and cheaper fuel for income, which puts the family farm at risk if the business fails. Accordingly, if subsistence farmers are going to invest such energy into the market, the government must make sure it does everything in its power to assure that it succeeds. Moreover, there will have to be a great deal of communication and working togetherness in the process. Corporations and the government will have to play many roles in order for biofuels to be implemented in a beneficial and sustainable fashion.

Due to the fact that "These markets are just beginning to develop as the benefits of renewable energy are being increasingly documented and recognized, and issues of production rates, costs, handling, and energy conversion efficiencies are being documented and improved through research"[8] a keen insight should be kept on such things by corporations, the government, and farmers alike. While these documentations appear to be moving in a positive direction, the environment is currently degrading. Assessing the potential of the land is therefore complex. Nevertheless the government and/or corporations must do this in order to properly invest in biofuels.

Many studies have already been done on Kenya and her climate, for example by CEEPA[16] and VAM[6]. The most vulnerable of districts and divisions are known, and the major barriers to efficiency have been declared. Now those must be looked upon and solved using a number of small steps. Corporations should acknowledge that the poor are trapped in disadvantage and in order to change this, they must start with recognizing what they have, what they know, and what they are able to do. There are many great solutions already available.

The distribution of IDE's technology (by IDE itself or by any institute eager to help the cause of food insecurity) or any similar technology ought to be taken into practice in Kenya to help small farmers with the irrigation of crops. Also, considering some areas are still supplied with water, national water management could help to decrease shortages in others. In light of climate change impacts and current problems with dry farming, governments and/or organizations should consider the distribution of seasonal climate forecasts so that farmers can prepare, adapt, and make more informed decisions. Energy crop planting should not only be taught to achieve higher yields, but also so as to prevent further environmental stress. Informing farmers on how to successfully dry farm and/or giving them irrigation technology—along with assuring things are available to them by adequate marketing are key. In addition, because market subsidies and inputs are a barrier in production for most subsistence farmers, if such a system was developed so that they would not have to compete with US farmers, it would be a tremendous advantage.

Clearly, things can and must be done in order to see changes in the level of food insecurity in Kenya. Biofuels are shown to be a new interest to many countries, with their promises for a cleaner environment, less fuel dependency, and increased job opportunities. For subsistence farmers the present market, along with emergent cellulosic ethanol, means more choices and thus more control. On the other hand, implementing biofuels in the wrong fashion may allow for serious consequences, such as decreased soil fertility or loss of resources—consequences leading to insustainability. Kenya, then, has two options: either to pursue the investment of biofuels amid its risks or continue searching for other solutions to food insecurity. Right now the industry does not appear to be a viable option. However, if the major barriers of production, i.e. lack of arable land, water scarcity, and unstable marketing, are in some way lessened or removed, there may be more potential. One way to remove these barriers is for farming to adapt to the situation. Some options to doing this are affordable irrigation and the use of instructional dryland farming. Additional yields or more farmland, leads to the exciting possibility of having surpluses made into fuel or exported for income. As an intricate web of issues, food insecurity deals with more than solely the factors of production. For example, concerns of health, population, and gender roles also come into play. The main barriers, however, are plainly the most detrimental. Kenya, or any country in a similar disposition, should therefore simply consider all aspects of biofuel production in her careful decision for a better future.

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