Julie Perkins, Student Participant
Upper Arlington High School
Columbus, OH

To what extent will implementing Jatropha production raise the standard of living of a subsistence farmer in Tanzania?

I. HISTORICAL BACKGROUND

After many years of economic reform and billions of dollars in aid, Tanzanian farmers are still living in extreme poverty with little hope for improvement in the near future. The average subsistence farming family cultivates between .9 and 3.0 hectares, which is passed down through families ("Agriculture" 1). Typical crops include maize, sorghum, millet, rice, wheat, cassava, potatoes, bananas, or plantains (1). Agriculture is mostly rain-fed with 70% of Tanzanians cultivating land by hand hoe, 20% by ox plough, and 10% by tractor (1). Tanzanian farmers spend 75% of their total income on food alone, which is low in nutritional value--supplying less than 2,100 daily calories per person ("Tanzania" Greenwood 456). The poorest 20% of the population consumes only 7% of what is produced ("Household Budget Survey" 4). Women constitute the bulk of the agricultural labor force ("Agriculture" 1). They contribute about 70% of the food crops along with complete responsibility of livestock production, child care, provisions of water, domestic energy, food processing, and marketing ("Tanzania" Greenwood 459). While the overall literacy rate is 69.4% ("Tanzania" World Almanac 834), rural women are half as likely as men to have an education ("Tanzania" Greenwood 460).

Since its independence in 1964, the Tanzanian government tried to improve the economic situation of rural farmers; however, these programs failed to achieve sustainable improvements ("Tanzania: 'MKUKUTA'" 2). Initially in the 1960s farmers formed cooperatives to raise agricultural prices by setting a parity price, which is tied to a historical or composite price (Meertens 335). At first, there was an increase in production; however, because prices were set too high, it was impossible for the farmer to compete in an open market. In 1963, the government replaced the cooperatives system with the National Agricultural Products Board, which monopolized both the price setting and marketing of crops (335). This change proved ineffective. Plagued by corrupt practices, misused funds, and inefficient management, the board made little progress (335).

In 1967 the government devised a replacement policy-- the Arusha Declaration, "a socialist policy aimed at equal growth for all Tanzanians" (Meertens 335). The policy guided control of agricultural production and marketing by distributing technology and setting crop prices (335). In the early stages, crop volume increased, but, by the late 1970s no farmers had an incentive to produce since the official price for maize fell to half the free market price produce (336). Unfortunately, this program, like previous initiatives, resulted in food shortages. Unable to purchase the food needed in the open market, consumers scrambled to purchase crops on the black market (336). Economic growth through government initiatives proved once again to be unsustainable.

Finally in the 1980s, the government solicited the IMF/World Bank-backed Economic Recovery Program for help in increasing output of food for domestic consumption and export markets (Meertens 336). A World Bank loan funded the government program designed for distribution of agricultural technology, such as equipment and fertilizer (336). The program brought initial increases in crop output but once again production eventually declined. The program fell victim to overuse of one input, fertilizer, leading to diminishing returns and declining productivity. Lower crop production levels ultimately caused calories per capita to fall below The World Bank's acceptable level of 2,330 calories per day (339).

There were other attempts during this time period to develop the rural economy, but they too fell short. For example a nation wide road-building project did not benefit the rural farmer. New roads constructed in urban areas rarely extended to remote villages. In the early 1990s, a tarmac road was built connecting the capital with major rural regions, but without the construction of smaller roads connecting villages, farmers had little access to markets (341). Due to this inefficient road system, the cost of transporting surpluses became a barrier for farmers because transportation costs twice as much as the price of crops (341).

Not only was infrastructure ineffective, the rural farmer was also unable to obtain the credit to expand operations. In 1995, the government funded Agricultural Inputs Trust fund, which dedicated credit to agricultural development (Meertens 341). The program intended to provide loans for the importation and distribution of agricultural inputs (341). Most of the monies were granted to private traders who used the loans to expand their businesses and increase profits (341). Unfortunately the rural farmer was unable to access the fund or other forms of credit because they lacked the expertise to apply for loans. So as with attempts to set prices, the credit access program failed to reach the rural farmer.

While these examples are not exhaustive, they should serve as proof that millions of dollars have come into the Tanzanian economy without having a significant effect on the rural farmer. Over the last 60 years, programs intended to raise crop prices, infrastructure, and expand credit failed to reach the rural community.

II. PROBLEMS

With the population growing at a higher rate than food production, Tanzania could be headed into more poverty if a sustainable program cannot be developed. With more than 50% of the population below the nation's poverty line and with 39% of all Tanzanian's living in absolute poverty, significant changes need to be made in order to improve the standard of living ("Tanzania" Greenwood 455). The biggest downfall of past aid programs was that they did not distributed directly to the most impoverished Tanzanians—the rural farmers. Instead of waiting for money to trickle down from a complex, and often corrupt system, programs should be devised to directly impact villages. These new programs should help farmers decide the best strategy for improving their standard of living. Additionally, policies should emphasize property rights, government access to credit, compelling incentives, development of new markets, and construction of adequate infrastructure, so that Tanzanian farmers might finally experience positive change.

A. PROPERTY RIGHTS

In the past, farmers were denied access to credit because they could not provide the collateral for loans. According to the Index of Economic Freedom 2007, Tanzanian ranks below the world average in protecting property rights (2). Most rural villagers cultivate land that their families have possessed for generations; yet, the system that exists to formalize property rights requires extensive paper work and an expensive survey (Tagama 2). These costs, approximately one-tenth of annual income, are too high for families struggling to meet their daily food requirement ("Tanzania" EuropaWorld 4345). The government and aid programs should work towards implementing a simple affordable method for formalizing property rights so that the farmer can use the land as collateral in obtaining loans.

B. INFRASTRUCTURE

The lack of rural infrastructure isolates the farmers and limits their potential income. Most roads, especially in the rural interior, are unpaved and the common methods of rural transportation are bicycles, on foot, donkeys, and oxen; thus, it is impossible to transport large amounts of crops to competitive markets ("United Republic of Tanzania" 4). The lack of roads reduces access to more efficient inputs and larger markets.

The farmers' isolation is magnified by a lack of communication infrastructure. The average farmer does not have access to technologies including the Internet and telephones. With the 33,000 Internet users in Tanzania concentrated in urban areas, farmers have no computers to access vital information on agricultural methods ("Tanzania" World Almanac 834). One successful program, The First Mile Project, provided Tanzanian farmers with cellular phones giving them access to information and prices ("Boosting Farmer's Profits" 3). Framers used the information to take their crops to market when supplies were low and demand was high (3). The initial investment of $200,000 helped farmers improve market timing and improve crop income by $1.8 million (2). Programs like The First Mile Project go to the root of the problem and consequently bring real sustainable change.

C. POOR GROWING CONDITIONS AND USE OF FUELS

Much of the land in poor villages has limited arability. Inadequate and inconsistent rainfall coupled with a long dry season makes it difficult to grow enough to sustain themselves, let alone enough to be sold for cash at market ("Water" 1)

Additionally, Tanzania's use of various fuels is important to consider. Tanzania is currently heavily dependent on foreign oil, which is holding the economy back. Tanzania spends 40% of its foreign exchange on petroleum product imports, which is the main cause of the trade deficit ("Liquid Biofuels for Transportation" 102). This hurts Tanzania's terms of trade because import prices are rising faster than export prices. The money spent on foreign petroleum inhibits economic growth because it uses funds that might otherwise be used to buy the technology needed for economic development. In addition, the demand for petroleum products grows 30% each year, so that the current demand for petroleum cannot be met ("Energy" 1). This impacts the village farmer with a surplus by making transportation to urban markets prohibitively expensive.

At the village level 90% of energy needs are currently met with firewood and charcoal. These fuels, when burned in poorly ventilated houses, have adverse affects on health ("Initiatives on Small" 2). Indoor air pollution is responsible for 1.6 million deaths, or one death every twenty seconds ("Indoor Air Pollution" 1). Since it is burned in the home, health problems fall disproportionately on women and children (2). Due to their poverty, there are few alternatives to biomass fuels, and consequently, farmers are stuck in a situation where they must sacrifice health in order to cook and stay warm.

III. POSITION

In order to achieve sustained development and to increase the standard of living, a plan needs to be put into place that is directed towards improving the typical farmer's living conditions. That plan should include Jatropha, a non-edible crop that can be grown on marginal land and used to produce fuel (Parsons1). Jatropha is well acclimated to Tanzania's sparse, inconsistent rainfall and dry season (2). It is a perennial shrub plant in the tree family that can be grown easily on arid land, along roads, as fence borders, or on sloping land (1). Production can incorporate a whole community, is sustainable over time, and will have further health and social benefits for the rural family. Despite the challenges of growing crops on Tanzanian land, the Jatropha plant acclimates well to the environment. Jatropha can grow without irrigation in arid conditions where other crops like corn and sugar cannot grow, since it only needs a minimum of 600mm of rainfall a year (3).

Production is easily integrated into a rural economy at the village level (Del Greco and Rademakers 1). The plant is a perennial with a life of 35 to 40 years, meaning the farmer will not have to replant each year, which will save both money and time ("United Nations" 9). It is a high yielding crop producing 22,000kg of oil per hectare in some cases (Del Greco and Rademakers 2). Raw oil can be obtained with a simple cold pressing of the seeds, but it can be further refined with simple processing

machines (2). The plant oil can be used to operate the simple diesel engines that villages typically use grinding grains, oil pressing, carpentry tools, pumping water, and lighting (3). There are other more efficient engines villages could purchase for various uses that cost approximately US$4,300, which could be obtained through aid grants or loans from the World Bank or national government ("The Multifunctional Platform" 5).

By implementing a successful Jatropha production program, the whole community can become involved. According to the Lewis model, an agricultural community with seasonal planting and harvesting has unemployment labor for much of the year; therefore, the opportunity cost of starting a new industry in a village would be low. By utilizing unemployed members of the community, others will be free to specialize in areas of Jatropha production such as seed distribution, growing, harvesting, seed processing, energy production, and marketing the trade surplus. This collaboration of lesser employed would work with the current community structure and strengthen Tanzania's close-knit communities and culture.

To begin a new agricultural project like this, it is necessary to provide education to the community on the various facets of the program. World Bank and government aid could be used to provide grants to bring in experts to manage and educate the rural farmer. The experts would inform the farmer on all aspects of the program and communicate the potential benefits. Technological infrastructure such as the Internet and telephones would also be implemented to allow farmers to keep informed on the latest agricultural techniques, market prices, and contact with experts in Jatropha production. Grants will be needed to get the program started until the farmers' income begins to increase.

Development of human capital will lie at the center of the program's success. At first, the resources should be targeted at a small population of one or two villages. In this way the unique challenges and advantages of each community can be explicitly addressed, and it can be insured that all aspects are accounted for. If the program targeted many communities, the funding, resources, and experts would be spread thinly. With close communication with experts in agriculture, farmers could begin sustainable Jatropha production. By setting up the program in an effective way, the villages will see a windfall as unused resources and new knowledge create a new and productive industry.

After the program is implemented in one village, it can spread geometrically to other villages. According to economist William Easterly, "technological knowledge is likely to *leak* from one person to another. Technology reaches its potential when high-skilled individuals *match* with each other" (Easterly 146). The goal of the Jatropha program is to provide a fuel source and crop surpluses to be sold in the market. An important part of the sustainability will be the sharing of ideas; therefore, incentives should be created so that members of a Jatropha community can travel to other villages to start the program and to set up an ongoing mentoring relationship. With higher incomes and new crops to sell at market, rural communities would have an incentive to improve infrastructure like roads. Additionally, an economic incentive should motivate Tanzanians to share the program. In the first year of implementing the program, a village could take out micro-credit loans from NGOs such as ASAP to hire a member of a Jatropha-producing village. After the village starts to see benefits in the form of increased incomes, they can afford to pay back the loan and members of this community can also spread the idea.

The Jatropha program is structured similarly to programs that are having some success on Tanzania's rural poverty. The VI Agroforestry Programme in Tanzania, which attempts to reduce dangerous levels of deforestation, has developed a very successful agroforestry project with small farmers around the Lake Victoria area (Barklund 3). This program also educates by organizing villages and mentoring (6-9). Farmer households participating in VI are between 56% to 72%, depending on their location (8). Also, the program approaches "groups" of farmers as opposed to individual farmers (9). Farm tours are organized to successful villages and farmer group workshops are conducted thereafter (9).

The program is sensitive to the older traditional farming practices and believes in communicating direct benefits to the farmers, not lofty environmental and societal benefits (9).

In addition to the profitable Jatropha oil, other joint-products are also produced. The waste left over from oil extraction can be used in soap production, for fertilizer, and for clothing dyes (Parsons 2). Soap production can provide an additional income for families and seed cakes are an excellent organic fertilizer, containing nitrogen, phosphorus, and potassium, which can be used to improve crop yield (2). Soap and fertilizer provide a supplement to the income from oil, and they will be especially beneficial to those who do not own land. Also, by producing their own fertilizer, farmers will reduce the cost of inputs.

A large concern when implementing the production and use of biofuels in the world economy is the effect on food prices. Already, the 1% of transport fuels coming from biofuels globally has caused a steep rise in grain and vegetable oil prices, which the poor cannot afford (Lambe 1). The rural poor are the group most affected by rising prices of staple foods; therefore, it is necessary to find a crop that will not compete ("United Nations" 7). Jatropha is non-edible and therefore cannot be sold for biofuel instead of for food (9). It can be grown on land unsuitable for food crops such as along roads, property borders, and on fallow land and will not compete for limited resources (9). Additionally, with the additional income generated from production, farmers can purchase better quality food from markets.

Critics of the Jatropha program believe it requires villager to make too radical of a change; however, as part of the mentorship program, experts will be communicating the numerous benefits of the program. Jatropha is not like most other fuel sources; it burns clean (2). Jatropha is a substitute for coal and wood used currently and will reduce much of the unhealthy air pollution currently in the farmers' homes.

Women spend a large portion of their time inside the home, cooking and taking care of the children, which explains why 59% of all indoor air pollution deaths are women ("Indoor Air Pollution" 2). Women and children also spend one-third of their time searching for biomass fuels, like wood ("United Nations" 6). By using Jatropha oil as fuel, women and children would experience health benefits and also have more time for productive activities. With the extra time, women could concentrate on other income producing activities, like soap production from Jatropha seed residue.

Yet another benefit is that children will not have to collect fuel and therefore will have time for education. Currently, 70% of Tanzanian school-age children begin primary school, but less than 10% progress past 7th grade ("United Republic of Tanzania"). Often, children, as young as age five, take on serious domestic responsibilities ("United Republic of Tanzania" 4). This is especially true in the case of girls; therefore, families often cannot afford to sacrifice farm labor for education (4). With children freed from the burden of fuel collection they will be free to pursue education and better living conditions.

Another environmental benefit is that Jatropha will reduce the burden on scarce resources like forests. According to the UN Millennium Ecosystem Assessment 60% of ecosystems are "being degraded, or used unsustainably" ("Agriculture and Environment" 1). Deforestation is a large problem in Tanzania as people destroy natural resources in an attempt to provide for basic needs. Eventually, these resources will become scarce, driving rural farmers into worse poverty unless sustainable changes can be made.

IV. CONCLUSION

The rural subsistence farmer of Tanzania is in desperate need of effective and sustainable economic development. Since Tanzania's 1964 independence, a variety of programs have poured large amounts of money and resources into the economy without helping those who are most desperately in

need. These programs have failed to sufficiently raise both crop prices and crop inputs and to expand infrastructure, property rights, and credit. With daily calorie intake dropping, farmers are desperate for long-term change. The Jatropha production system has the potential to do just that. It is well suited for the challenges of Tanzania's environment and can be processed and used at the village level. The plan is easily integrated into the village community in a way that benefits all members. Although funding will be needed initially, as the program becomes sustainable and as farmers' incomes increase, the program will spread. The program is designed such that human capital is developed and villages can aid other villages. Beyond increased income, there are numerous benefits of the program. Rural health will be improved and there will be time for other productive activities. Implementing a Jatropha production program could potentially improve the standard of living, the quality of life and the prospects of future generations.

Works Cited

"Agriculture." The National Website of the United Republic of Tanzania. 15 Sept. 2007 <http://www.tanzania.go.tz/agriculturef.html>.

"Agriculture and Environment: Time to Act Globally." Agriculture 21. FAO. 18 Sept. 2007 <http://www.fao.org/AG/magazine/0704sp1.htm>.

Barklund, Ake. "The VI Agroforestry Programme in Kenya, Tanzania and Uganda." Afornet. Oct. 2004. 18 Sept. 2007 <http://www.afornet.org/images/pdfs/Vi%20AgroForestry%20Programme.pdf>.

"Boosting Farmer's Profits through Better Links to Markets." Rural Poverty Portal. IFAD. 15 Sept. 2007 <http://www.ruralpovertyportal.org/english/regions/africa/tza/voices/stanley.htm>.

Del Greco, Giovanni Venturini, and Laurens Rademakers. "The Jatropha Energy System: An Integrated Approach to Decentralized and Sustainable Energy Production at the Village Level." Ingegneria Senza Frontiere. 15 Sept. 2007 <http://www.isf.lilik.it/files/jatropha/jes.pdf>.

Easterly, William. "Economist's Adventures and Misadventures in the Tropics." The Elusive Quest for Growth. Cambridge: MIT, n.d. 145-49.

"Energy." The National Website of the United Republic of Tanzania. 15 Sept. 2007 <http://www.tanzania.go.tz/energyf.html>.

The EuropaWorld Year Book 2007. Ed. Joanne Maher and Philip McIntyre. Vol. 2. London: Routledge, 2007.

"Geography, Agriculture, and the Economy." Rural Poverty Portal. IFAD. 15 Sept. 2007 <http://www.ruralpovertyportal.org/english/regions/africa/tza/geography.htm>.

"Household Budget Survey 2000/01." National Bureau of Statistics Tanzania. July 2002. 15 Sept. 2007 <http://www.tanzania.go.tz/agriculturef.html>. Path: Statistics; The Tanzanian Budget Survey (HBS) conducted in 2000/01.

"Index of Economic Freedom: Tanzania." The Heritage Foundation. The Wall Street Journal. 18 Aug. 2007 <http://www.heritage.org>.

"Indoor Air Pollution and Health." World Health Organization. 15 Sept. 2007 <http://www.who.int/mediocentre/factsheets/fs292/en/print.html>.

"Initiatives on Small Scale Liquid Biofuels Production and Use in Tanzania." United Nations. 15 Sept. 2007 <http://www.un.org/esa/sustdev/sdissues/energy/op/biofuels/biofuel_sawe_tanzania.pdf>.

Lamb, Gregory M. "Biofuels Show Promise, but Also Present Problems." The Christian Science Monitor 10 May 2007: 17. ProQuest Newspapers. ProQuest. Upper Arlington High School Lib. 15 Sept. 2007 <http://proquest.umi.com/login>.

"Launch of Maendeleo Agricultural Technology Fund in Tanzania." Farm Africa. 15 Sept. 2007 <http://www.farmafrica.org.uk/news.cfm?id=45>.

"Liquid Biofuels for Transportation in Tanzania." Deutsch Gesellsschaft fur Technische Zusammenarbeit. 15 Sept. 2007 <http://gtz.de/de/dokumente/en-biofuels-for-transportation-in-tanzania-2005.pdf>.

Meertens, Bert. "Argricultural Performance in Tanzania under Structural Adjustment Programs: Is It Really so Positive?" Agriculture and Human Values 17 (Dec. 2000): 333-46. 15 Sept. 2007 <http://www.springerlink.com/content/hh51625082420112>.

"The Multifunctional Platform." Le Réseau des Plates-Formes Multifonctionnelles. 16 Sept. 2007 <http://ptfm.net/old/PPt_PTFM_english_web1.ppt>.

Nelson, Fred. "Concerts and Global Agreements Won't Solve Land Degradation." Namibian. 18 Aug. 2007 <http://www.namibian.com>.

Parsons, Keith. "Jatropha in Africa: Fighting the Desert & Creating Wealth." EcoWorld. 16 Aug. 2007 <http://www.ecoworld.com>.

Tagama, Herald. "Tanzania: Formalizing the Informal." African Business Jan. 2004: 50+. Questia Online Library. Questia Media America. 3 Sept. 2007 <http://www.questia.com/>.

"Tanzania." The Greenwood Encyclopedia of Women's Issues Worldwide. Ed. Lynn Walter and Aili Mari Tripp. Westport: Greenwood, 2003. 455-69.

"Tanzania." The World Almanac and Book of Facts. 2007 ed. World Almanac, 2007.

"Tanzania: 'MKUKUTA,' a Home-grown Agenda for Change." International Development Association. The World Bank. Mar. 2007 <http://www.worldbank.org/ida>.

"Tanzania: Regional and Global Integration." World Bank. 13 Sept. 2007 <http://www.worldbank.org/tz>.

United Nations. Commission on Sustainable Development. Small-Scale Production and Use of Liquid Biofuels in Sub-Saharan Africa: Perspectives for Sustainable Development. 15 Sept. 2007 <http://www.un.org>.

"United Republic of Tanzania." CultureGrams World Edition. ProQuest. 13 Sept. 2007 <http://online.culturegrams.com/>.

"Water." National Website of the United Republic of Tanzania. 15 Sept. 2007 <http://www.tanzania.go.tz/waterf.html>.