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Developing Infrastructure in Mozambique

In order to satisfy the demands of an exponentially growing population, world food production must increase by at least 50 percent in the next 20 years ("Food Prices"). Even now, food production is insufficient: the number of undernourished people in the world increased from 900 million in 2008 to 1 billion in 2009 ("1.02 Billion People Hungry"). Sadly, the most vulnerable group in developing countries consists of isolated smallholder farmers who are unable to participate in the global agricultural exchange and improve their livelihoods. Despite smallholders' separation from the rest of the world, it must be realized that small farmers can be part of a solution for the global food crisis. However, integration can only happen if the farmers' countries are "given the development, economic and policy tools required to boost their agricultural production and productivity" ("1.03 Billion People Hungry") similar to what occurred during the Green Revolution in the 1950s. With the help of agronomists such as Dr. Norman Borlaug, many smallholders throughout the world received the Green Revolution's techniques, technologies and financial support. Global food production soared and millions of farmers, including smallholders, began producing profits. Unfortunately, financial support for smallholder agriculture over the past few decades has declined, while global food prices have increased ("Africa's Turn"; Mutamba).

Similar to the benefits of the Green Revolution, improved prospects for smallholders can yield positive results in the 21st century. Around 2 billion people live and work on 500 million small farms ("Food Prices"). These smallholders are vital components in combating world hunger, especially since they comprise a large part of the world's undernourished population and have the potential to become agriculturally efficient. With access to better seeds, fertilizers, infrastructure, and markets, smallholders in developing countries can help reduce hunger and participate in the global economy just as their counterparts in China propelled their economy forward in the 1980s. Backed by the government, smallholders revolutionized Chinese agriculture, and China quickly rose to become the world's foremost food exporter (Sachs). Unlike China and other beneficiaries of the Green Revolution, most African countries did not experience positive agricultural growth. Sub-Saharan Africa contains 16 of the 18 most undernourished countries in the world ("Human Development Reports"). If Africa unites with willing governments and non-governmental organizations, its smallholders will have a better chance at freeing themselves from the chains of poverty.

One country that will benefit greatly from improvements in agricultural processes is Mozambique. Even though there is plenty of arable land, more than half of its citizens live below the national poverty line and approximately one-third of households are food insecure. Mozambique ranks 172 out of 182 countries in the United Nations Human Development Index 2008—2009 ("Mozambique" WFP) while the U.S. ranks 13th. According to the World Bank's report in 2009, Mozambique has a GDP per capita of $440, as contrasted with its neighbor South Africa at $5,678 and the United States at $47,988. Furthermore, Mozambique contains varied and diverse agro-ecological zones divided into the country's 10 provinces and 128 districts. With a population of around 22 million, Mozambique has many areas that are sparsely populated—more than 66 percent of Mozambicans live in rural areas and agricultural activities represent around 70 percent of national employment ("Mozambique" WFP). In spite of its problems, Mozambique can support smallholders, but it needs help.

Mozambique's unpredictable rainfall causes recurrent droughts and floods. Although Mozambique has a tropical maritime climate, winds usually cause the moisture and potential precipitation to bypass the country in many places. Thus, some areas receive high levels of rain while others do not. To illustrate,

certain southern areas average only 760 mm of rainfall a year, while the northern highlands receive 2000 mm annually (King 13). Because irrigation covers only around 3 percent of land, rainfed farms often lack water during the dry season from April to October and their crops suffer ("Mozambique" FAO). During the wet season, however, Mozambican smallholders must sometimes contend with devastating floods that destroy crucial infrastructure and crops.

Given that Mozambique has been identified as a country with agricultural potential, the present status of agriculture in Mozambique demonstrates suppressed farmers' productivity. Of the 799,380 square kilometers constituting Mozambique, 46 percent of the land in Mozambique is arable but only 10 percent of the arable land is currently in use. Only 3 percent of the land being used is irrigated ("Mozambique" FAO). Additionally, farmers in Mozambique use inefficient and ineffective traditional farming methods and low-yield seeds ("Rural Poverty").

Smallholders in Mozambique must be supported in sustaining their households. Eighty percent of poor families make their living from smallholder subsistence farming ("Rural Poverty"). There are 3.2 million smallholder families who produce 95 percent of the agricultural GDP. On average, a family of five farms 1.4 hectares and typically grow maize, cassava, beans, sorghum, and rice as food crops, along with sesame, cotton, cashews, and tobacco as cash crops. Most smallholders cultivate family farms with low-yield seeds, inefficient techniques like shifting agriculture (where land is used, then abandoned) and equipment such as hoes and hoses ("Mozambique" FAO). Although Mozambique possesses the human resources capable of increasing production, subsistence farmers must practice better agricultural skills. However, there is a gender disparity that limits the skill development of women who are the majority of smallholders. Women usually take charge of food crop production, but due to the male-dominated societal structure, have less access and control over resources ("Rural Poverty"). Overall, smallholders in Mozambique face a problem when trying to increase food production and security—they cannot raise themselves out of subsistence farming and into market-oriented agriculture. To commercialize, smallholder farmers need better seeds, less expensive inputs, widespread irrigation, well-functioned storage facilities, greater access to markets and credit, and more agricultural knowledge. Investments in infrastructure will create opportunities for smallholders and enable them to achieve greater productivity and food stability.

An investment to improve roads will integrate Mozambique's smallholder farmers into the economy. It is difficult enough for farmers to access agricultural inputs without adequate roads; however, prices several times higher than the international prices dissuade purchases as well. Due to the high cost of transporting to rural areas in Mozambique, a lack of inputs denies Mozambican smallholders the ability to intensify their agricultural production and produce surpluses (Coughlin 10). Without access to viable roads, smallholders cannot access markets. Consequently, they are forced to sell low "at the farm gate" because they need the money immediately. Selling at a low price further reduces smallholders' profits, so that in years of bad harvests or natural calamities, smallholder farmers' families are less food secure. Another problem resulting from lack of adequate roads is that agricultural extension officers are restricted by Mozambique's poor transportation networks. They cannot provide farmers with new techniques and technologies to improve agricultural production and productivity because it is difficult and time-consuming for extension agents to approach the rural smallholder farmers in Mozambique on the underdeveloped roads (Coughlin, 34). Without more agricultural knowledge and technology provided by extension agents, smallholder farmers will remain in a rut of subsistence farming.

The current number and quality of roads do not provide adequate transportation, especially to smallholders. Between 1992 and 2002, 7900 km of rural feeder roads were opened. However, compared to the median 90 km per square km in southern African countries, Mozambique has one of the least dense road networks with only 32 km per square km. In rural areas, the density of the feeder roads is only 20 km per square km, making services to rural places very expensive. Only 57 percent of the road network

is currently in good or fair condition. Moreover, many of the roads in this condition are in urban areas and therefore do not help smallholder farmers. Smallholders' transportation opportunities are further limited during rainy seasons when road quality drastically declines (World Bank 2006 36, 46). While there is an adequate east-west corridor to link Mozambique and its neighboring countries, the only way to cross the Zambezi River from the Southern regions to the Northern ones is by a small ferry. Therefore, all the agricultural, food-producing regions in the North are cut off from the industrial South and Northern farmers can only sell to Malawi or other neighbors while Southern Mozambicans purchase food from South Africa. Until a 2.4km bridge over the Zambezi is completed, Mozambique will continue to face limited development of national markets, reduced mobility of people and goods, and raised transportation costs (African Economic Outlook 397).

Although road conditions in Mozambique have improved in the last two decades, more investment is needed for lower-priced inputs, greater access to markets, and an availability of information and techniques. If money is spent on rural feeder roads, the percentage of small farmers who sell crops will increase beyond its current 33 percent. Families cannot prepare for years of bad harvest if they are not able to sell surplus crops in years with good harvests (Coughlin 7). Better road condition would encourage traders to buy produce from farmers during rainy seasons when rural roads usually become impassable and during the dry season when vehicles risk damage on the roads (Gatu and Rodman 36). As demonstrated in rural Uganda, improvements in small rural feeder roads can have a large impact. The number of poor Ugandans was reduced by 3 times as much by investments in feeder roads as investments in primary or secondary roads (Pinstrup-Andersen and Shimokawa 19). This parallels the effect that 1km of low-quality roads in rural China brings a higher return to the country's total GDP than 1km of high-quality roads in the same area (Pinstrup-Andersen and Shimokawa, 13). Mozambican smallholders need more rural feeder roads to connect them to input and output markets. As road network density and road quality improve, small farmers will enjoy the benefits that adequate access to transportation brings to agriculture.

In addition to lowering input costs and opening access to markets, the Mozambican government must invest in irrigation to improve food security and aid agricultural intensification. Farmers will be able to harvest a greater surplus in years with favorable weather and still produce food in years of drought. Irrigation can increase crop growth and fulfill the water needs of high-yield seeds; it also provides water during drought seasons and enables crops to survive. Despite the benefits of irrigation, 97 percent of agricultural land in Mozambique relies on rainfed agriculture, which is less efficient and productive than irrigated agriculture. More specifically, controlled irrigation gives farmers the ability to manage water and increase efficiency.

Mozambique experiences droughts frequently, so rainfed agriculture exposes farmers to possible crop losses. If a system of irrigation is put into place, smallholders would be more resilient to droughts and empowered to increase intensification of their farms. Concurrent with an overall decrease in public-sector spending for agriculture, however, government spending on irrigation has declined. Irrigation in Mozambique is also expensive: farmers must pay from $1000 per hectare to $2000 per hectare depending on the type of irrigation, and around $500 a year for maintenance ("Water Profile"). As a result of the prohibitive costs, only 0.9 percent of the cultivable land is irrigated (World Bank 2005 78). Smallholders in Mozambique risk losing their harvests at a rate of over 50% while using rainfed agriculture ("Water Profile"). Thus, as irrigation expands, food security will increase. Small-scale irrigation would reduce vulnerability to droughts and allow farmers to harvest crops and always provide for their families. Investment in small-scale and low-cost irrigation schemes by the Mozambican government would increase the quality and quantity of crops. Irrigation can be as simple as small dams and reservoirs to help the smallholder farmers raise their income and produce higher-quality crops (The World Bank 2006 40).

One solution for small-scale community-based irrigation is to build concrete "sand dams," which have already been proven useful in Kenyan villages. These dams eliminate the need for women to spend hours obtaining water and can store a large supply of clean water under a sand layer which keeps the water from flowing away after rains. Sand dams can further enhance irrigation for smallholders and contribute to food productivity. During dry season, farmers will have access to water to keep their crops and their livelihoods intact (Shenk). Other low-cost smallholder solutions could include drip irrigation and treadle pumps. Drip kits are easily maintained and improve food security by allowing production during dry seasons, conserving and regulating water use, and intensifying production. For shallower wells, treadle pumps are another cost-effective, human-powered and easily maintained way to access clean water and build resilience and food security ("Small Scale Irrigation").

Even if Mozambicans achieve higher productivity from inputs and irrigation, they may not benefit from the increased surplus without well-functioning storage facilities. Many Mozambican smallholders lose a large portion of their produce to rot and pests because they do not have access to adequate storage facilities or storage techniques ("Storage in Mozambique."). As a result, farmers must sell immediately after harvest if they have access to a local market. The scramble to sell happens simultaneously for all farmers so the market becomes flooded with produce and prices drop. Other times, farmers have no option to delay a sale because the decision to sell depends on whether the farmer's family needs to make purchases, pay medical bills, or settle debts (Gatu and Rodman 22). Either farmers do not have access to markets and their surplus is wasted, or they are forced to sell their produce at artificially low levels. Most smallholders store their produce using traditional methods. Since this is done without pesticides, much of the harvest is eaten by pests or rotted away if farmers cannot sell immediately. Farmers who are able to store products securely, however, can make profits just by waiting for several months and selling after prices climb (Coughlin, 8). Through WFP's Purchase for Progress Program, some Mozambican smallholders have received grants for on-farm silos and communal warehouses as well as training in fumigation and other post-harvest activities to preserve crops that are in adequate storage facilities ("Storage in Mozambique."). As a vital addition to Mozambique's infrastructure, community and on-farm storage can allow farmers to sell their produce at a higher price and increase their profits. Smallholders will be motivated to produce more food because it can actually be sold for a profit. With better storage and the resulting profits, farmers will be empowered to acquire capital and further intensify their farms.

Along with physical infrastructure such as roads and irrigation, soft infrastructure also needs to be improved. Farmers' associations, financial systems, and agricultural extensions can provide crucial services to smallholders. In Mozambique, smallholders do not have adequate access to rural finance infrastructure and, as a result, cannot raise capital to invest in their farms and increase productivity. There are virtually no savings or credit facilities available in rural Mozambique. Only 2.9 percent of rural farming households can access credit and even then, this credit only comes from large concessionaire companies that administer large cash crop schemes. Banks in Mozambique only lend around 10 percent of portfolios to agricultural activities, and the great majority of this lending is not to smallholder farmers because many commercial banks do not have the economic infrastructure ready to support smallholders (Couglin 39). Banks consider smallholder farming a high risk investment due to the unpredictability of harvests and the fact that small farmers cannot provide sufficient collateral and can only pay banks after harvest. As a result, smallholder farmers encounter difficulties when attempting to access formal banking services. Better financial support structures for smallholders, such as micro credit loans and micro savings accounts will allow farmers to access capital in order to purchase inputs for farm intensification and sell their produce for a greater profit. One program in Mozambique, the CCCP-CCOM (Caixas Comunitárias de Crédito e Poupança e de Operadores de Microfinançasforms) forms associations that lend traders commercial microcredit loans and lends farmers agricultural loans. Since agricultural loans do not require interim payments, they are beneficial to farmers with limited cash flow during growing season. Both types of loans rely on micro-credit (e.g. small loans and personal goods as collateral) but

agricultural loans combine micro-credit techniques with rural financing techniques to offer services to smallholders (Vletter 47).

While improving the rural financial system can help many individual smallholder farmers, farmers' associations bring benefits to large groups of smallholders. Farmers' associations can help farmers acquire agricultural inputs, receive credit from financial institutions, and sell their produce. There are many farmers' associations in Mozambique, but they usually do not possess the capacity and business skills to successfully represent members. The Alliance for a Green Revolution in Africa supports a program called the Rural Markets Promotions Program to help smallholders change from subsistence style farming to market-oriented farming. The program will help farmers to access markets by improving their own associations as well as those of small agricultural traders. With both groups empowered, trade will flourish and smallholders will be more integrated into the national economy ("New Partnership"). Farmers associations can be trained and mentored to provide negotiating power and business capabilities to their members.

Having recognized the importance of farmers' associations, the Mozambican government passed a law in 2006 making official and legitimate agricultural organizations easier to form (Pitkänen). This strong first step into farmer organization should be parlayed into creating even stronger associations which can bring more benefits to their smallholder members. These benefits can be seen in IFAD's program: the Agricultural Markets Support Program, PAMA. Its goal is to commercialize small farming by opening access to markets and connecting with private sector traders. One obstacle farmers faced when accessing markets was their lack of business skills, including the ability to create and send invoices and receipts. Organizing into a farmers' association could facilitate the development of business abilities. PAMA worked with farmers to form legal organizations. Subsequently, farmers could now negotiate with buyers and sell for the prices they wanted. Strong farmers' associations have negotiated a deal with South-African based Shoprite, Africa's largest food-retailer, to sell local produce. Currently, around 25 percent of the products in Shoprite are locally grown by smallholders ("Small-scale Farmers").

Improving extension services benefits farmers by providing them agricultural knowledge and technology. In the late 1960s, India was importing around 10 million tons of cereal a year. However, once its government began a Green Revolution policy, Indian agriculture experienced a drastic change and India stopped importing cereals. Agricultural extension played a significant part in India's green revolution by disseminating Green Revolution knowledge and technologies to smallholder farmers (Rena 118). Once farmers were armed with a variety of techniques and technologies, they could devise a solution to any problem and maintain profitable productivity. Agricultural extension educates farmers on agricultural techniques, practices, and research to increase farm intensification. Mozambique's government-backed rural extension service covers, at most, an idealized maximum of 14 percent small farmers in the country, and even with an extension office in the village, 80 percent of smallholders would not benefit due to the distance both farmers and extension workers must travel to reach each other. Also, extension workers often repeat the same messages that smallholder farmers have already adopted and do not provide the equipment to use the knowledge. Additionally, since extension workers focus on more highly populated and easily accessed areas, knowledge is not spread to farmers in other regions either (Gatu and Rodman 39).

Under the Mozambican Research Institute, the agricultural extension services only serve a third of districts and only 13 percent of rural households (The World Bank 2006 20, 79). Although non-governmental organizations have also provided extension services, they rely on unsustainable donor funding. One solution would be for governments to train private sector workers who "who could …provide extension advice while retailing their inputs" (The World Bank 2006 80). If these advisory meetings were hosted by a farmers' association, farmers could work together and learn together as well, increasing overall efficiency (Coughlin 58).

A popular and effective extension method comes in the form of Mozambique's farmer field schools (FFS) which were launched in 2003. Similar to FFS programs in other countries such as Kenya and Tanzania, the farmer field school in Mozambique stresses the importance of farmers experimenting and learning with actual fields so that they can apply learned techniques and skills to their problems in the future. Farmers become empowered to intensify farm production with increased knowledge, improved critical skills, and greater collective enablement (Dzeco, Amilai and Cristovao 117).

In the past several years, Mozambique has demonstrated its potential for agricultural growth. However, smallholder farmers still need help. Through improved infrastructure, smallholder farmers will be able to access inputs, irrigation, storage, markets, credit, and knowledge and enjoy much greater food security, agricultural productivity, and commercial profitability. The Mozambican government must make improvements in infrastructure to empower its smallholders and allow them to contribute to the nation's economy. Infrastructure provides extensive support for smallholder farming in every stage of its agricultural process. Better rural financial structures give small farmers access to capital, allowing them to take out micro loans. Feeder roads allow subsistence farmers to use their micro-capital to access inputs for less money and also provide agricultural knowledge from extension agents who now can reach many more farmers. Small-scale irrigation will allow for increased crop yields and biodiversity, carrying smallholders through the country's frequent droughts. Once smallholders have produced a surplus of higher quality produce, they can store it in improved storage silos and warehouses to prevent loss from pests and rot. Roads allow for individual small farmers to sell produce to markets and dealers, and smallholders will also receive support to form effective farmers' associations. Stronger associations will negotiate for better sales prices and benefit every member.

To catalyze an improvement in infrastructure that will aid the rural smallholder farmers, the Mozambican government must make effective investments and policies such as focusing on rural feeder roads and small-scale communal irrigation and encouraging bank investment in rural finance. Moreover, there are a variety of programs the government can partner with. Innovative sand dams offer communal irrigation. One aspect of WFP's Purchase for Progress helps Mozambican smallholders set up a storage system to protect their produce. Legitimizing farmers' associations was a step in the right direction by the Mozambican government, but Mozambique's leaders need to work even more closely with farmers' associations to help smallholders achieve greater profitability. Finally, NGO-backed extension programs such as Farmer Field Schools can spread agricultural techniques and technologies to otherwise unaware farmers; a government or farmers' association partnership would amplify the beneficial effects to more smallholders. By working together closely with these programs, the Mozambican government and aid organizations can help its smallholders become resilient and profitable.

Clearly, Mozambican smallholders face many problems. The scope of this paper deals with improving the current infrastructure. Some solutions have been proposed that will empower smallholders to build their capacities, but Mozambique should also consider further studies in such fields as local seed quality, alternative farming methods, and women's roles in farming. First, not only do smallholders need better conditions for their crops, but they also need better seeds suited for their specific climate and soil. Through the ground-breaking research of scientists such as Dr. Gebisa Ejeta of Ethiopia, who created weed-resistant sorghum hybrids, smallholders will be more equipped to handle disease, drought, and increase productivity ("Dr. Gebisa Ejeta"). Similar research conducted with other crop varieties in Mozambique could contribute to food security and productivity. In addition to localized seeds, Mozambican smallholder farmers may want to consider other innovative farming methods that utilize less water and soil. One such system is aquaponics, a hybrid system allowing users to farm both fish and soil-less plants. The fish provide fertilizer for the plants, which then purify the water for the fish ("Aquaponics Overview"). It may take years to implement, but research on its successes in conserving water and soil should be considered. Finally, the role of women must be elevated so that they can make

positive choices for the country. The Mozambican government should increase the number of female extension agents to provide advanced and relevant training for smallholder women, assist women to form their own farmers' associations, and encourage more young girls to attend school. When smallholder women are empowered, they can take an active role and break the barriers between Mozambique and the rest of the world.

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