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### **Benin: The Road to Agricultural Success**

As individuals begin to look toward the future of Earth and the people on it, the issue of food security poses perhaps the single greatest challenge to the fate of humankind. Across the world, billions of people currently struggle with hunger and poverty, and this number will only increase as the global population continues to grow. Although it is not well known by most, the Republic of Benin, a small nation in West Africa, is one of the countries most affected by this severe issue. Benin is currently one of the poorest countries in the world, with over one third of its population impoverished and food insecure; however, it also has the potential to create a thriving agricultural sector that can bolster both the success of the nation's economy and the welfare of its population. In order to confront the growing threat of food insecurity in Benin, the nation's government and other countries throughout the world should cooperate to foster more sustainable agricultural practices, such as crop diversification and innovative fertilizer usage.

Before understanding the significance of sustainable agriculture in Benin's food security, one must first consider the country's unique political and economic conditions. Benin possesses one of the most stable democratic governments in Africa, which actively promotes domestic improvements and interacts amicably with other nations. Additionally, Benin has a beneficial location on Africa's western coast, with access to overseas commerce at its southern border and to trade with the larger and more prosperous country of Nigeria at its eastern border (Adotevi et al.) Despite these advantages, however, Benin still struggles with widespread economic problems. Benin's population is estimated at over 11 million people, with about forty percent presently living below the poverty line (Barry et al.). According to the USDA's report on Benin, almost seventy percent of Benin's citizens are employed in the agricultural sector, working on small farms that average to about one to two hectares, or about two and a half to five acres. Most of these agricultural workers are subsistence farmers, growing crops such as corn, rice, cassava, and yams; however, many farmers also produce crops for export. The country's main cash crop is cotton, which generates over seventy percent of export earnings, but cocoa, palm oil, and coffee are also important export products (Lagos). In Benin, small-scale farmers face economic struggles because of their vulnerability to unpredictable weather, dependence on fluctuating external economies, and declining productivity due to soil issues. Currently, the government of Benin hopes to transform the nation into a major agricultural exporter; however, the country must first confront these challenges faced by its agrarian workers.

Since the majority of Benin's population is involved with agriculture, the typical Beninese family's welfare is also closely tied to the nation's economic problems. Only fifty-five percent of households in Benin are considered food secure, and rural areas have significantly lower rates of food security (Lagos). In rural areas, the typical family consists of about five people and lives in traditional African mud houses or in traditional thatched-roof houses, while urban families usually live in small dwellings built in a colonial European style (Adotevi et al.). A typical family diet in Benin consists of any crops that the family grows as well as any food that they can afford from the local market. In food insecure households, families mainly consume cereals and tubers, but some wealthier families buy animal proteins and sugar if they have the money (Lagos). One of the main problems with food security in Benin is that many families lack a diverse, nutritional diet because they can only afford to eat the crops that they grow. This poverty often stems from farmers' dependence on unpredictable and inefficient agricultural practices. In Benin,

almost all families' incomes rely on agriculture in some way, so one of the most practical methods of confronting the nation's rampant poverty and food insecurity is to improve the productivity of the small-scale farms that dominate the country's economy.

Considering the prominence of agriculture in Benin's issues with poverty and food security, sustainable agricultural practices will be vital for the nation's future. Since a large percentage of the nation's households rely on small-scale farming as their main source of income and nutrition, farmers must ensure that the nation's environmental resources are not compromised for future generations. Currently, many farmers face severe problems from soil erosion caused by harmful agricultural practices, so sustainable agriculture is crucial for helping these farmers protect their source of income. One recent study found that over ninety percent of Benin's soil suffers from high levels of soil degradation (Fulajtar & Liou). Soil deterioration presents a huge problem for Beninese farmers because it decreases crop yields and threatens future productivity. In order for Benin to continue on its path to becoming a strong agricultural economy, farmers must begin to implement sustainability measures that can preserve the nation's arable land.

In addition to protecting the environment, more sustainable farming methods can also aid Benin's long-term economic success by increasing farmers' productivity. Currently, the outdated techniques used by many of the small-scale farmers in Benin greatly limit the amounts of crops that they can produce (Barry et al.). If farmers can increase their yield, they can begin to augment their income through trade instead of only farming for subsistence. This can both aid in the rural farmers' struggles with poverty and supply new sources of food for urban families combating food insecurity. The majority of small-scale farmers in Benin lack education about modern agricultural practices that could benefit their crop yields and mitigate their vulnerability to external factors. If these Beninese farmers can learn about more sustainable and efficient methods of cultivating their crops, they can greatly improve their output, both helping their own standards of living and supporting their nation in its path to becoming a strong export economy in the future.

One of the main solutions for developing sustainable agriculture in Benin is crop diversification, or the production of a variety of different crops. In the past decade, the government of Benin has made frequent efforts to promote crop diversification in the nation's small-scale farms. This sustainable method was the main component of the country's 2006 agricultural reform program, and it aids farmers in several ways (Barry et al.). First, it helps to conserve the environment, which will be necessary in order for farmers in Benin to be able to continue their agriculture for several generations to come. According to the SARE Program, crop rotations can reduce soil erosion, a severe issue in Benin, as well as conserve the soil's moisture, which would help tremendously in Benin's dry seasons ("Why Diversify?"). Secondly, crop diversification can reduce farmers' vulnerability to certain unpredictable factors such as climate volatility, since different crops are better suited to various weather patterns, and fluctuating crop prices, since farmers are no longer reliant on a single market (Adjimoti & Kwadzo). These benefits combined can help farmers economically by increasing their overall yield and the amount of goods that they can sell. Lastly, crop diversification can assist in households' food security by creating a more diverse diet. Since most rural families' diets are limited to the food that they grow themselves, families can gain access to a more nutritional food source by diversifying the types of crops that they produce. One recent study investigated the results of Benin's crop diversification program and found that there was a significant positive correlation between crop diversification and food security, demonstrating that crop diversification is one promising solution for Benin's food security dilemma (Adjimoti & Kwadzo).

With regard to the specific crops that should be included in a crop diversification program, Benin could improve its food security by promoting a transition to an assortment of nutritional food crops as well as

helpful cover crops. Although cotton is a major cash crop in Benin, its cultivation is very land- and pesticide-intensive, contributing greatly to many farms' soil degradation (Honfonga). In addition, many cotton farmers suffer from poverty and food insecurity because they lack a stable supply of food, so diversifying into crops such as maize, rice, and vegetables could help them both gain a new source of nutrition and employ more sustainable agricultural practices. Along with the production of a variety of different food products, the institution of green manure cover crops can also benefit farmers in Benin. These crops support soil health by providing ground cover, which prevents erosion and nutrient loss, and many also inhibit weeds. Mucuna, a legume cover crop, became popular in Benin in the 1990s and has demonstrated a considerable increase in maize yields for farmers that adopted it in southern regions; furthermore, other cover crops such as soybeans, cowpeas, and porcupine jointvetch can thrive in various other climates and soil types in Benin (Kinyua et al.). By trading monoculture for a diverse farming system that includes a variety of different food and cover crops, farmers in Benin can protect their land while simultaneously improving their yields and food security.

In order to implement this solution, Benin would require some kind of extension program to educate small farmers about the benefits of crop diversification. In the past, the Government of Benin has promoted this practice by using demonstration plots in populous agricultural regions and by training specialized agents to teach individuals in various farming communities throughout the country (Kinyua et al.). In addition, the Food and Agriculture Organization of the United Nations, or FAO, has used a system of "farmer field schools" to teach small farmers about the importance of diversifying their agricultural systems. This program has currently educated 9,590 farmers in Benin, but a more widespread system like this could significantly benefit the nation's farmers ("Integrated Production"). With the help of either the FAO again or another organization, which Benin is also partnered with, the government of Benin could initiate a more thorough education system that visits major farming communities throughout the country and teaches them about the importance of growing different crops.

Another extension practice that the Government of Benin could consider would be to cooperate more closely with local farmers' organizations throughout the country. In the rural areas of Benin, there are strong farmers' associations that engage in research and extension services, the most prominent being FUPRO, a national federation of cotton farmers, and ACooBéPA, a union for cashew growers ("Major Institutions"). If agricultural experts can get into contact with those organizations, ordinary citizens could become involved with the spread of information throughout their communities. According to the United States' Central Intelligence Agency's factsheet on Benin, only about twelve percent of Benin's citizens have access to the Internet, with considerably lower numbers in rural areas; however, almost eighty percent possess subscriptions for mobile telephones ("Benin"). A communication system via telephone could help to transfer information such as the benefits of crop diversification and the techniques for farming various crops from experts to leaders in farmers' associations, who could then disseminate the information around the community. Along with the more comprehensive farmer field schools, this more local system of extension could help farmers in Benin adopt crop diversification and confront their food insecurity and poverty crises.

In addition to crop diversification, another sustainable agricultural practice that would greatly help Benin's farmers would be the utilization of appropriate fertilizers in an innovative new technique known as micro-dosing. Currently, most farmers in Benin lack access to proper fertilizers for their crops and land types, contributing to the erosion of their land; however, if farmers gained access to sustainable fertilizers, they could greatly increase their productivity (Lagos). In Zimbabwe, another African country that faced similar agricultural problems, over 170,000 families tested the new fertilization method of micro-dosing, in which they used smaller amounts of fertilizer in specific areas rather than broadcasting large quantities

of fertilizer throughout the entire field. When the University of Illinois investigated the results of these trials, it found that the internal rate of return of the investment was projected to be greater than forty percent (Larson). Despite using less fertilizer, this technique significantly increased the productivity of the participating farms and reduced the farms' soil erosion. One farmer reported a fifty percent increase in crop yield while using micro-dosing even in spite of a terrible drought (Bafana). In Benin, the solution of micro-dosing with organic fertilizers could considerably aid the crop yields of small-scale farmers, prevent further soil degradation, and mitigate the effects of unpredictable weather conditions.

In the United States and other countries outside of Benin, further research into sustainable uses of fertilizers can continue to aid farmers in West Africa. At the Florida Youth Institute, Dr. Charles Barrett discussed research into micro-dosing, or spoon-feeding as he called it, that is currently being performed in the North Florida Research and Education Center. They compared linear plots with varying amounts and placement of fertilizer and used soil-moisture sensors to find the best management practices for farmers. Currently, the micro-dosing practices tested in Zimbabwe are most successful in semi-arid climates, but if scientists like Dr. Barrett keep studying this practice in the United States and other parts of the world, they could find more efficient and sustainable fertilization techniques that could benefit Benin as well as all of the other countries also struggling with the global issue of food insecurity.

After new information is discovered in these research programs, these best management practices will also need to be extended to farmers in Benin. Like with crop-diversification, micro-dosing relies on education as a vital component of its success, since most farmers in Benin are not aware of the method's advantages. In order for this solution to function, farmers must be aware of how much fertilizer they should use and where they should use it. In order to solve this informational issue, a similar education system to the one proposed for crop diversification could be applied in rural areas.

Unlike crop diversification, however, the solution of micro-dosing is much more complex in terms of funding. In order for this project to be successful, farmers would need access to high-quality fertilizers as well as education. Currently, the supply of inputs such as fertilizers and seeds to farmers is mainly controlled by the private economic sector, with the Government of Benin acting in a regulatory role ("Supplementary Financing"). In the past, SONAPRA, a parastatal cotton marketing system, distributed most of the fertilizers used by farmers in Benin on a credit-based system; however, this business only sold fertilizers for cotton, which are often used on other crops with adverse environmental effects (Minot et al.) Moving into the future, the Government of Benin could set up a framework for a distribution system where farmers can gain access to more sustainable fertilizers that are suited to the crops that they grow. Through another system of credit, farmers could gain access to the initial fertilizers they would need to start the process of micro-dosing. Then, with those fertilizers, the farmers could begin to increase their crop yields with a considerable rate of return, as shown by the research in Zimbabwe, and pay back the suppliers.

If private sellers are hesitant to participate in this credit-based system at first, Benin could also find funding from organizations that it is already working with. Many ongoing projects, such as Germany's "One World, No Hunger" Initiative and the World Bank's Country Partnership Framework in Benin, already include fertilizer distribution as a part of their main objectives. By teaching farmers how to apply these fertilizers in more efficient practices, the Government of Benin could use the foreign aid that it is already receiving to start the transition to micro-dosing in some farming communities. Although this project may be difficult at first, it could assist greatly in Benin's goal of becoming a major agricultural producer. A switch to affordable micro-dosing with sustainable fertilizers is another possible long-term solution for pulling rural families out of poverty and improving food security in Benin.

Despite its current economic dilemmas, Benin has great potential to create a flourishing agricultural sector in the future that can improve food security throughout its population. Currently, a large proportion of Benin's farmers suffer from poverty due to outdated agricultural practices, soil issues, and dependence on weather and market prices; however, there are several possible solutions that can help to minimize the impact of these problems. In the near future, perhaps the most practical solution for Benin's food security issue is to continue supporting crop diversification in its small-scale farms. For a long-term solution, however, a switch to micro-dosing with sustainable fertilizers could aid farmers' productivity immensely, improving their standard of living and access to nutritional food. As the crises of poverty and food insecurity continue to intensify worldwide in the future, solutions through sustainable agriculture have the potential to help millions of families in Benin to obtain the food and livelihoods that they need to survive.

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