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Ethiopia, Food Shortages and Soil Fertility

Foliar Fertilizer, an Innovative Way to Increase Crop Production and Soil Health; Reviving the Economy of Ethiopia

In many third world countries, food scarcity and high poverty rates are endemic, with low production and decreasing trade market providing little hope for any resolution. In Ethiopia, 70% of the population has a profession connected to raising crops and livestock (Anderson), yet millions are left without consistent access to nourishment. Ethiopia, and other countries like it, often lack both the technology and the resources necessary to reach the optimization of crop production seen in much of the industrialized world. When exploring possible solutions to assist countries struggling under the burden of hunger, one promising technique is foliar feeding. Foliar feeding is an innovative, cost-effective way to raise yields and provide a long-term plan for increased soil fertility. Improved soil conditions will in turn allow farmers to produce a higher quality plant, reducing food shortages while also improving the economy.

To understand how vital increasing crop production is, it's important to understand the breadth of the problem. Ethiopia, the second largest country in Africa, is growing approximately 3% annually. 80% of the population of 102 million rely on their own agricultural practices to sustain themselves (World Bank Data). Of these 102 million, 40% are under the age of 16, with the average life expectancy being 62 years (CIA World Factbook). These staggering numbers prove that stress on the food supply will only become more prevalent in the future.

Farming practices in Ethiopia are vastly different from modern day practices in more advanced countries like the United States. The most striking difference is the land management program. In countries with democratic governments, land purchased belongs to the buyer. Ethiopia has a federal democratic government. A tenant of this government style is that all land belongs to the People of Ethiopia, or the government (World Atlas). Land allocated for farm use is distributed yearly by the government. As long as the land is in the same providence as the farmer lives, it can be anywhere and often varies in location from year to year. This does not encourage the use of the farming practices that causes long-term positive results as growers do not want to invest in soil that is not theirs.

Another unique factor of Ethiopia's land distribution system is land use during non-production seasons. From late autumn to early spring, all ground usually assigned for crop production becomes communal fields for grazing. This practice prevents growers from planting cover crops, cereals, or grasses that could protect and enrich the soil. Wind erosion is one of the leading causes of depleted topsoil, the nutrient-rich soil preferred for growing high-quality crops. Cover crops are a common and effective way to combat topsoil erosion, and their absence has contributed to poor soil quality. Ethiopia often experiences heavy winds during cooler months, damaging the countries' topsoil and their ability to grow higher yielding crops (Global Edge).

Ethiopia is also currently experiencing one of its longest droughts which negatively impacts yields. Water shortages caused by insufficient rainfall results in an inability to irrigate crops. If a traditional, high volume,

commercial fertilization and chemical program was implanting into their farming practices, runoff would contaminate precious water supplies, becoming detrimental to crops, the environment, and the citizens who rely on it every day.

Through a combination of poor soil management, drought, lacking technology, and wind erosion, Ethiopia has not been able to successfully produce the crops it needs. This has implications for both foreign and domestic trade. Common crops used for in-country trade lack high nutritional value, and therefore require greater quantities to be consumed just to meet daily food needs. Poor crop quality and low production affect more than human consumption, they can make it difficult if not impossible for most in the country to produce livestock. As livestock could be another crucial key to eliminating hunger, their lack is deeply felt. Once sufficient livestock and crops are being produce for the needs of citizens, surplus could start being used for foreign trade to enhance the economy.

Ethiopia's international trade market has also been affected by poor crop production, and is quite precarious. Coffee accounts for 55% of all exports from the country, and over 15 million people derive their livelihood from this crop (USDA). If a crop failure were to occur, it could cause their -7% trade market to plummet, crippling their already strained economy (CIA world factbook). The country also faces the concern that if another country with access to better technology were able to increase their coffee yield, it would increase the number of available goods, lowering demand and dropping prices.

Ethiopia has a tropical monsoon climate with wide topographic-induced variations. This type of climate is characterized by warmer temperature and light rainfall year round. The average yearly temperature is 67 degrees Fahrenheit and there are typically 43 inches of rain (Journey by Design). In the Eastern region, the geography is very desert like, the central section is very mountainous, while the South is more tropical especially in the Summer. Usually, during the growing season, there are about 6 inches of rain per month with approximately 60-70 degree temperatures. (Journey by Design). While the overall climate for the year might be slightly warmer, the weather conditions for a growing season in Ethiopia is very similar to the growing season throughout the Midwest, especially Iowa. This means that many crops that favor Iowa's Summer climate should be considered for research in Ethiopia.

Macronutrients such as nitrogen, phosphorus, and potassium (N.P.K.) are the most commonly found elements in the soil. Despite their abundance, crops frequently need an application of N.P.K. and other micronutrients to reach their full potential while growing. One way to deliver these needed elements is through foliar feeding. Foliar feeding is a type of nutrient application where a slightly diluted liquid fertilizer is applied to the leaf of a plant and is absorbed through the stomata (Reeves). This is less common than a dry broadcast application, where a granular fertilizer is applied to the soil where it breaks down and is absorbed by the roots. Foliar fertilizer is more concentrated than a traditional broadcast, meaning a smaller volume of fertilizer needs to be applied to provide. (Dyna). This type of application is favorable for preventing chemical runoff that harms rivers and streams (Rhem) a frequent concern for countries that experience drought. A foliar application is done at a higher pounds of pressure, so it binds to the plant better, becoming less likely to get to the soil where it could be washed away by the rain (Midwest Laboratories).

Proponents of broadcast say that it is cost-effective, but when broken down per acre foliar fertilizer has a lower cost per acre by at least $3 (Livesay). This makes it an especially good fertilizer option for producers with a very low budget.

In a scientific experiment performed in the summer of 2017, a researcher found that compared to broadcast, foliar fed Zea maize (corn) had an increased yield of 34% (Livesay). This partially was due to the ears having the smallest number of ears to "miss the knick", or not pollinate properly because the shed from the

tassel did not make direct contact with white silks. This often happened in the broadcast plot which significantly decreased yield.

The foliar fed plot also experienced a quicker growth cycle than the broadcast plot, more rapidly reaching milestones such as developing ear shoots, tassels, and silks, pollinating, finishing growth, and reaching the final moisture content of about 15%-18% to be ready for harvest (Livesay). Throughout growth, the plants in the plot receiving the broadcast application were a lighter green or almost yellow in color at the top, showing that they were deficient in phosphorus. In contrast, the foliar plants had a very dark green color, showing they had sufficient levels of all necessary nutrients. This allowed them to attract more sun which in turn increased photosynthesis. The foliar plot had substantially more stalks that developed brace roots. These roots originate out from the stalk of the plant at the bottom and help to support the plant. They also aid in water and nutrient retention (Dyna). After the harvest was completed a final analysis showed that the corn had an increased base diameter, length and weight of the ear, total plant, and root mass. All of these factors resulted in an increased profit per acre of over $265 US Dollars (Livesay). This is an additional 7,344.09 Ethiopian Birr per acre. (XE)

Since the average citizen is already living on the most bare essentials, any additional income could profoundly improve quality of life, which is the ultimate goal of any solution. With this supplementary revenue, growers could expand their operation or upgrade equipment. These funds could also go towards things like purchasing livestock to raise and sell.

An analysis of the soil was also done before and after plant growth and showed no significant change occurred in a control plot that received no additional nutrients. The broadcast plot showed a drop in P2 values, or phosphorus that will become available to the plant in the future. Not only did the foliar plants see a raise in P2, but there was also a raise in pH values, meaning the soil became less acidic (Livesay). This would be helpful for Ethiopian farmers who often struggle with high soil acidity levels. Seeing these increases in only one growing season would imply that over the long term, the soil would dramatically improve.

During the formly discussed experiment, it was hypothesized that the increased soil health was due in part to the application style of macronutrients (Livesay). A foliar application delivers nutrients directly to the leaf which has many benefits (Midwest Laboratories). Not only does it allow for a quicker absorption time, but it also allows for a reduced chance of runoff. With a broadcast style, pellets are delivered directly to the ground but must wait to breakdown (Midwest Laboratories). If rainfall occurs during this interval the fertilizer is washed away to pollute rivers and streams, harmful to the environment and catastrophic to water supply during a drought. During the time required to break down, chemical residue could leach into the soil, lethal to organisms that help crop growth. This problem would only intensify after many years, becoming harder to reverse.

While the overall yearly temperature might vary between Ethiopia and Iowa, the weather conditions during the growing season are almost identical. In both places, the same temperatures and rainfall from May to July can be expected. While corn was used in the previously stated experiment, corn has a very similar growth cycle to coffee, the major export of Ethiopia.

As previously discussed, Ethiopia is a country critically in need to improvements to their agricultural practices. Because of Ethiopia's poor economy, new farming techniques would not only need to be low in cost but would also need to become profitable quickly, as opposed to needing many growing seasons to see a significant return on investment. To raise the quantity and quality of crops, the introduction of a foliar application would be beneficial to producers, as well as the economy. Over 90% of Ethiopia’s crop is produced from smallholder farms. That means that the majority of growers have less than 2.5 acres, which is

approximately the size of 2 football fields (Journey by Design). Because of its concentration, foliar fertilizer can make drastic differences and is available for purchase by the pint or quart, whereas its necessary to purchase broadcast fertilizer by the ton. This makes foliar fertilizer an even better fit because the farmers could purchase small volumes of specific macronutrients based on soil analysis. The cost is very efficient, making it advantageous for farmers who have little available capital.

Since the average Ethiopian farmer is largely producing food for the sole purpose of feeding themselves and their families, any increase in their annual income could drastically improve their lives. Not only does foliar feeding produce a higher quality plant, but it produces a higher quantity of plants. These plants also show a quicker growth cycle which could potentially allow for double cropping, or have 2 crops grown consecutively in one season, which would double profits. These factors alone could allow growers to expand their operation and improve quality of life. One potential downside to double cropping could be over farming and fertility loss. However, in a situation where the plant is receiving extra nutrients like a foliar application, this is less of a concern because the extra nutrients being used by the second plant are being replaced. Double cropping with a short season cover crop in place of a long season cover crop could also help prevent soil erosion and aid in water retention, exceedingly important during a drought.

Foliar feeding also leaves no residue of harmful chemical in the soil but instead continues to enhance the presence of essential nutrients over the long term (Livesay). This component is favorable for soil without cover crops, common in Ethiopia. Foliar feeding also increases the rate of growth, allowing crops to be harvested sooner. As a plant dries down after growth it recycles any nutrients in its stalk or leaves into the soil. Foliar feeding also raises the number of crops that can be produced, which would help bring Ethiopia out of its negative trade market. As well as higher production, there is also higher quality, which would help raise the nutritional value of crops sold in local markets, potentially decreasing malnutrition among those who live in Ethiopia.

Reducing hunger, improving foreign and domestic trade, enhancing soil fertility; there are all vital aims for the country of Ethiopia. For these goals to be met, both the government and the citizens will have to work together with a common vision in mind. The introduction of foliar feeding technology is no different. The launch of this technology could potentially take government funding, maybe through a loan based system. While capital might be needed to start this system, the support of the farmers is crucial to make foliar feeding a successful solution.

Ethiopia is a country in desperate need of change. The establishment of foliar fertilizer could be the very answer to the problems. At a low cost to the farmer, not only would plants increase in yield, but soil would increase in fertility for a long-term strategy to increase growing circumstances. These changes would increase intercountry trade, as well as international trade, raise the caliber of food for citizens, and help get farmers, the majority of the population, out of poverty. Solving short-term problems, while planning for long-term problems is the best way to assist any third world country, and the introduction of foliar feeding to crops does both

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