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Nigeria, Food Loss
Nigeria's Paddy Predicament

As humanity continues to progress and advance in technology and research, historically problematic issues such as disease, education, healthcare, and many others have found stable solutions that have lasted for decades. Despite these changes in modern and urbanized areas, places that are less economically, politically, and socially stable have faced problems that are seen as less of a priority by many fortunate, first world countries. Specifically, one problem a third world country – Nigeria – faces is the loss of food; although first world countries such as the US face mass loss due to waste once the food has been put out to the public (Feeding America), many third world countries experience food loss due to insufficient processes directly after harvesting, meaning that much of the initial food does not reach shelves for customers to buy. Granting that this is more of a production issue, ergonomic changes can be made in order to increase yields and allow for crops to have a better chance to make it to markets and stores.

Nigeria is a populous, flourishing country. With about 206 million people, the country is one of Southern Africa's and the world's largest in terms of population (The World Bank, 2020). It has a federal presidential republic, with executive power in the hands of the president, the Constitution of Nigeria – which restored democracy to Nigeria – and three branches of government: the executive, legislative, and judicial branches (GlobalEDGE, 2019). The area is a geographic melting pot with deserts, plains, swamps, mountains, steamy jungles, and one of the biggest river systems in the world: the Niger Delta. With an average family farm size of 0.5 hectares and 88% of total farms in Nigeria being made up of small family farmers (FAO, 2018), Nigerians majorly harvest maize, cassava, guinea corn, yam beans, millet, and rice while exporting oil, rubber, and cocoa. Behind these beautiful and productive sceneries, however, hide the struggles of the country's backbone: the devastating loss farmers face every year; fortunately, there are a number of ways to solve the loss of rice and do so in ways that are economically and environmentally obtainable and sustainable.

In urban areas, families usually consist of a mother, father, and three to five children. The rural areas have families consisting of a mother, father, and seven to ten children; both types of households often have aunts, uncles, and grandparents living with them (AFS). Due to the food availability in the area, Nigerian family meals consist of soups or stews (such as egusi soup – a seafood soup thickened with ground egusi seeds – or tomato stew), jollof rice (a dish with long-grain rice, tomatoes, onions, and spices), and usually some type of tuber or root vegetables, such as yams or cassava (Food in Nigeria, 2009). Meats, such as fish, are fished from the Niger River; most of their meals are cooked over an open fire and are seasoned with spices, such as cinnamon and cayenne pepper. Due to a lack of available classes, education is lacking for most typical Nigerian households. In 2018, there were only 81.3 thousand pre-primary public classrooms available in comparison to the 146.5 thousand pre-primary public classrooms needed (Varrella, 2021). However, primary education is officially free and compulsory, making public education affordable. Healthcare, on the other hand, is severely underfunded; with 0.38 doctors for every 1,000 people and less than 10% of the country's budget being allotted towards healthcare, it is not greatly accessible for many people (Okunola, 2020). This statement includes the fact that over 70% of healthcare spending is out of pocket for most Nigerians, especially with the absence of widely distributed and inexpensive health insurance. Another considerable issue is the lack of access to food for many families. Poverty, population growth, and rising food prices have been the main culprits of negatively affecting the ability to access necessary nutrients and food; rapid population growth has made it harder to provide an adequate amount of food for every person leaving no room for the number of crops to adapt, and rising food prices directly impact families by preventing them from being able to buy the type and amount of food they need. This causes many families to be unsatisfied nutritionally and leaves them malnourished, leading to a larger host of health problems.

Food loss is defined as edible food that is fit for human consumption but is ultimately not consumed. “In African countries, these [food] losses have been estimated to range between 20% and 40%, which is highly significant considering the low agricultural productivity in several regions of Africa” (Kumar & Kalita, 2017). Every year, 40% of total food production or 35% of the land is wasted in Nigeria due to the inability to consume produced food, with those numbers staying similar throughout the years (FAO). Out of those losses, rice is an especially noticeable crop. Nigeria is one of Africa’s largest producers and consumers of rice; despite already being considered a large producer of rice – within the top 15 countries – the land has the potential to produce up to double the amount of rice being produced at the moment (Thrive Agric, 2020). Unfortunately, due to outdated methods and technology used by the many smallholder rice farmers, the country has been stunted in terms of rice production for the past few years, if not decades. Increasing rice yields can help in many different aspects of Nigerian life: the higher production of rice can assist in feeding the 14.6% of undernourished Nigerians (Knoema, 2020) and build the economy through exports. Although new methods and techniques have been spreading, they have been implemented at a very slow rate; this, paired with the incomplete policies and regulations executed, prevents crop yields from being raised.

One major issue stems from the harvesting process itself, and its damaging effects on the rice granules. The outdated and improper use of harvesting techniques results in a loss of over one-tenth of the initial crop yield, which if sustained over longer periods, could lead to a deficit in Nigerian rice production (FAO). To tackle the problem, it must be handled directly and at the source, starting with the harvest and post-harvest processes taking place. Maturity and moisture contents of the paddy must be properly assessed; taking the extra time to thoroughly examine crops, as well as taking measures to yield precise information is important. Maturity can be assessed through multiple visual indications; aspects such as skin color, shape, size, aroma, and many other optical properties can help to determine correct harvesting times (FAO). Harvesting a crop before it reaches maturity can increase drying costs, insect infestations, broken grains, and susceptibility to mold growth (NCBI, 2017). On the other hand, harvesting a crop past maturity can expose it to birds and rodents and put it at further risk of being affected by abiotic factors such as the weather. By harvesting the rice in close proximity to the indicators of maturity, the crop will be put at a lower risk for damage in the post-harvest process, reducing the risk of infection sites and bruising.

After the initial harvest, proper threshing, cleaning, and drying protocols must be followed in order to prepare the harvested, healthy crops for storage. At the moment, most smallholder farmers in Nigeria dry, thresh (remove the grain from the stem), and clean all their crops manually. The farmers take a cheap and natural approach towards the drying process: they allow their rice to dry by the sun. This, however, can cause problems if done incorrectly. Because this is done by the sun, unpredictable weather and temperatures can stall the drying process for days or weeks at a time. In addition to the spontaneity of weather, the uncontrollable temperature also makes it difficult to exactly calculate how long a certain batch should be left out to dry, leading to the need for constant monitoring over the batch, a risk of under or overdrying, and a game of guess-and-check for most of the process. Sun-drying can be improved upon by making batches two to four centimeters thick, stirring the grain every 30 minutes until fully dried, and by preventing the contamination of the rice through contact with animals and other materials (Rice Knowledge Bank).

Despite the fact that sun drying is able to complete the task, employing solar bubble dryers may be a better option. Solar bubble drying is a drying process that is mobile and independent of fuel or a power grid. A tunnel transforms energy in sun rays to heat, increasing the temperature of the drying air within a sealed tarp. In addition, it contains a photovoltaic system that moves air through the tunnel, inflating it and removing water from the grain (Rice Knowledge Bank). Using solar bubble dryers would help to build off of traditional drying techniques while simultaneously making the process more efficient and being cheaper than utilizing mechanical dryers. After drying comes threshing; the majority of rice farmers

also thresh manually. Threshing by hand is cheaper while being gentler on the crop than a large machine; however, it takes too much time, leaving some crops waiting on the threshing process for long periods at a time. Instead of threshing primarily by hand, using a treadle thresher (which utilizes your foot and a pedal) to remove the stem is beneficial towards both the farmer and the rice; treadle threshers are able to thresh 20% more grain in the same timeframe while providing the sensitivity needed for the delicate, low moisture rice grains (Khadatkar, Abhijit, et al. 2018). There are multiple processes that can be used to aid in the post-harvest care of the grain. However, there are a few processes that should be avoided if possible. Many farmers use trampling and threshing racks to thresh their newly harvested plants. Although cheap, the racks and trampling process cause much damage and breakage to the grain, hindering the grain from being used. In addition to using manual processes, mechanical driers should be less of a priority. Despite the ability to efficiently thresh the crop, they are often more expensive and require the installation of infrastructure to be used by farmers, aided by the resistance they face from farmers who are more set on the use of traditional methods. Although these extra mechanizations would ultimately need more hands, these processes can be taught to the youth – who tend to work for lower wages – making it more cost-efficient to hire younger workers, and giving predecessors for the agricultural practices to be adopted by.

Another contributor to the rapid loss of rice yields is improper storage methods. Despite the changes made to the harvest and post-harvest process, improper food storage can lead all that progress into ruins; food that was correctly and healthily yielded will have to be discarded if damage occurs to it during the storage process, including but not limited to mold and fungi outbreaks, rodents, temperature and humidity difficulties, and insect infestations (NCBI, 2017). Currently, many farmers are using indigenous storage structures made of locally available materials (grass, wood, mud); although they may be more easily accessible and cheaper to obtain, most designs cannot guarantee the protection of the grain. Swapping out these methods for scientifically-backed ones can aid in prolonging the storage life of the rice. Using metal silos in place of outdated methods can provide a space that not only stores but properly protects the grains. Metal silos are simple metal structures that prevent biotic and abiotic exposure to the grains. If it is closed and covered properly, these can keep out rodents, insects, and birds, and sufficiently dried grains should face no problems with moisture condensation. These metal silos can be made to fit the size of regular yields, so larger farms can obtain larger silos while smaller farms or even homes can have them scaled down to fit their usual needs.

Unfortunately, many farmers are unaware of the different technologies available to them. In order to gain exposure and make changes to the different methods used in the agricultural field, farmers need to be educated on the various ways to farm. Additionally, many farmers are resistant to change and would rather keep their traditional ways instead of adapting and utilizing technology that may make farming easier in some manners. To prevent uprising and resistance between farmers and the implementation of new technology, slowly introducing new technologies and making small changes to simply improve on traditional methods may assist in making a seamless transition. Utilizing technology that builds upon tradition, such as the solar bubble dryer, can more easily persuade farmers due to the increased familiarity between technology with small changes versus completely different technological methods that requires the education and knowledge of the farmers to be uprooted and redirected.

Of all the possible damages, insect infestations are one of Nigeria's largest problems, with 10%-15% of all rice yields lost due to insects (NCBI, 2017). To combat these pests, one option is to apply insecticides; however, using synthetic insecticides can be difficult, as certain types need technical mastery and can be expensive. Due to this, natural insecticides would be the easier and safer route to go. In particular, neem – known chiefly for its medicinal and healing properties – has been shown to repel insects effectively, whether applied pre-harvest or post-harvest. Neem is a populous plant in North Nigeria that can be used as a cost effective and holistic approach to pest-prevention. Due to its complex mix of active ingredients, such as azadirachtin and other triterpenoids, it is able to fight effectively against native and foreign pests

by attacking the different life stages, leading to a smaller likelihood of developing resistance to the plant (Salako et al. 4759). With neem trees being an abundant, underexploited plant in Nigeria (Kabeh & Jalingo, 2007), adding the leaves to the silos, covering the floor underneath the bags of grain with neem leaves, or adding neem leaf water extract into the stored grains can all sufficiently reduce the numbers of species and overall individuals of insects found in the batches of stored rice while being cost efficient. In addition to using neem, being more accurate with the dosage of pesticides used in general in Nigeria may help with agricultural outcomes. There have been many incidents of pesticide misuse that can hinder the growth of crop as well as pose as a hazard to those who come in unprotected contact with the pesticide (Ojo, 2016). This can be prevented by using protective equipment and properly educating farmers on the importance of correct pesticide usage.

The mentioned solutions and mechanisms above are able to set a Nigerian farmer up for success; however, many farmers across the country may have not been able to obtain these necessities due to a lack of or convenience issue. To solve this drawback, a census of the farmers in Nigeria would be helpful; knowing how much equipment and supplies will be needed can help the government out in terms of estimations and over or underspending. By having a record of the farmers that provide for the country, the government can work towards prioritizing those individuals – since they actively farm to feed more people than sustenance farmers – and making sure that those that much of the population is dependent on is able to have the best chance to grow healthy and sustainable crops. In addition to knowing how much equipment will be needed, the government can also work towards physically supplying them with the necessary materials and know how much transportation will be needed in order to reach the farmers with the supplies.

These changes require investments and money, but there are financially responsible ways to obtain these goals. The Nigerian Budget of 2021 contained N13.6 trillion (around \$32 billion USD), allotting 24.5% to debt-servicing, 5.8% to the ministry of education, and 4.4% to the health ministry (Joel-Osoba, 2021). The Nigerian budget currently puts less than 2% of its national budget into its entire agriculture department (Izuaka, 2021). At the same time, the country used 1.27% of its budget for rice imports alone in 2017, which was accurately predicted to increase through the coming years. By gradually reducing the importation of rice and slowly starting to redirect that money towards agriculture, more focus can be put on producing rice and becoming more self-reliant on the nation's agricultural capabilities. This reduction may strain the availability of rice during the transition, so utilizing the previously mentioned storage techniques to preserve the imported rice would help cushion the absence of the rice. Nigeria also receives international funds, some for the sole purpose of improving its agrarian department from organizations such as the African Development Bank (Reuters), the USAID (USAID), World Bank (The World Bank), and many other international collaborators; these funds include via educational aid, loans, internationally-run programs, and many other forms of aid. These funds also need to be put to correct use, focusing a large portion of loans onto the long-term sustainability that is possible for the country instead of using the money to bring in more imports, which puts a bandaid on a deeper and complex problem, while allocating many more hand-on approaches towards helping workers within the agrarian economy.

That being said, although agricultural growth can be fostered through foreign aid, it can be fairly easy to become dependent on the international funds flowing in. To prevent a further dependency on foreign aid, Nigeria should continue accepting and using foreign aid for their agricultural sector while widening their range of exports. Currently, oil accounts for more than 80% of Nigeria's total exports (The World Bank); instead of relying heavily on a non-renewable source, shifting more of their exports into agrarian exports can help them become more economically efficient. Particularly, tapping into the country's overabundance of neem can aid in bridging this gap. The country of India was able to reap \$2.5 billion USD between 1985 and 1995 from the production of neem oil with a population of 20 million neem trees: Nigeria is estimated to have more than 100 million neem trees, meaning that the country could potentially

be losing \$12.5 billion USD based off of India's prosperity (Daily Trust 2017). Tapping into these naturally available resources along with other renewable or nonrenewable resources can help sustain Nigeria's economic growth while encouraging expansion across different types of exports.

This country has a long way to go with building and sustaining its agricultural – and specifically, rice – yields. Implementing new techniques and methods can diminish generational practices passed down and may take compromise and adjustments for many farmers to become familiar with. Despite these difficulties, utilizing new and modern solutions can greatly help in combating food loss and aid in contributing to the resolution of many other health, humanitarian, and economic problems within the land. Through the modernization and growth of its agricultural community, Nigeria can eventually unleash its overflowing potential and further develop into an economically, agriculturally, and socially prosperous country.

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