Ainsley Olson
Grand Rapids High School
Grand Rapids, MN
Egypt, Pollution
Uses of Waste From Rice Farming in Egypt

Egypt is a country located in North Africa, where the climate is hot and dry, predisposing it to a variety of agricultural challenges, such as having little arable land and extreme water scarcity. It has struggled with food security and various metrics of proper nutrition for decades, and a recent evaluation from the Global Nutrition Report shows that it has made very little progress on any of the issues. Despite these factors, it still has a strong agricultural industry, employing about 25% of the total workforce. There was a substantial increase in the amount of rice Egypt produced in 1999 in order to keep up with the growing population. Egypt's ability to grow rice along the Nile has contributed to the lowest rates of childhood malnutrition in the region. However, the increase in crop production also led to an increase in waste from harvesting. Traditionally, farmers in remote rural areas along the Nile burned their rice straw to dispose of it, which produced an acrid black smoke. Before the 1999 increase, the amount of smoke from this was not enough to cause any noticeable problem. However, the greater volume of straw that needed to be disposed of created much more smoke. This became what is referred to as the "Great Black Cloud". This has negative effects which are strongly felt by the people who live in affected areas, leading to problems for them with being able to work and provide for their families.

One problem that the country has made significant progress in is childhood malnutrition. The rates of malnutrition for children are kept low in relation to the rest of the region because rice can be grown in the Nile river valley.

Egypt has a population of 106,437,241 people, with 43% living in urban areas. The other 57% are spread out along the Nile, where the only arable land is located. Egypt's total land area is 1,001,450 square kilometers, but only 3% of the land is arable. Egypt's major crops include cotton, rice, maize, wheat, sugar cane, sugar beets, fava (broad) beans, tomatoes, potatoes, citrus fruits, grapes, and stone fruits. They are one of the world's biggest exporters of cotton. Rice and beans are staple crops, vital to the diets of Egyptians (although they are also major exports). Egypt has one of the lowest child malnutrition rates on the continent (just 9% of children under the age of 5 are malnourished), due to the ability to grow rice in the Nile river valley. The consistency of the Nile's flooding and receding is the basis of farming there. The water is vital for crop growth, and the flood pushes fertile silt up the shore. The cycle of rising and falling has existed for as long as people have cultivated the land, forming traditions and techniques that are still used today. These include an irrigation system where fields are linked to the river, allowing them to fill with water when the river floods, which also carries fertile, nutrient-rich soil with it

Farming is done on small private farms by individual farmers. In 1952, the government began to regulate the amount of land that could be owned as a single plot, allowing more people to make their lives running their own smaller farms. The farms are clustered along the Nile. People live in villages of 500 to 10,000 people, in houses built of mud. The villages are reached by dirt roads, which makes traveling to or from cities inconvenient. The average household has historically included a large extended family, including as many as three generations. Now that is not always the case, as the houses of poor farmers are generally too small for so many people, and many people in cities live in apartments (*Life in Modern Cairo*). The average farm size is 2.5 feddans (an Egyptian measurement equivalent to 1.038 acres), and the average income is 915 Egyptian pounds (LE; equal to about 52 USD) per week.

Rice is one of the most important crops grown in Egypt, and a staple in Egyptians' diets. However, the amount of rice grown (4.3 million tonnes in 2016) means that a lot of waste is also produced (roughly 30

million tonnes per year). Agricultural land is divided amongst individual farmers/families, rather than large companies. As the farmers are poor and spread out along the Nile, they lack the ability to dispose of the waste produced when they harvest their crops, so they have historically burned the waste. This is a major source of pollution (about 80,000 tonnes of carbon dioxide per year), which the wind blows down the Nile to the already heavily polluted Cairo. Additionally, the smoke from the rice straw is much more intense than the pollution that is always in Cairo, which is smog from cars and industrial plants. The smoke produced when the rice straw is burned is very thick and dark, leading people to call it the "Great Black Cloud" (Kenyon, 2008). It has been an annual event since 1999, when rice crops were dramatically increased to feed Egypt's booming population. While the usual smog from factories and cars is bad, the Great Black Cloud makes the situation much worse. It irritates peoples' eyes and damages their respiratory systems, especially those with asthma and other preexisting conditions. ""The number of bronchial asthma patients doubles at this time of the year," [said] Mahmoud Abdel Majeed, head of Abbasiya Chest Diseases Hospital…"

All of the air pollution reduces food security and hinders the agricultural production abilities in Egypt for a few reasons. The physical harm it does to people decreases their potential for working and therefore either earning money to buy food or farming to produce food, which has impacts reaching from their families to the whole country (reducing their abilities to provide food for their families, and their abilities to produce food for the whole country). The pollution is damaging to the environment because it increases the levels of ammonia and other nitrogenous compounds in the soil, which worsens its ability to support plants and animals. In this way, the very act of engaging in agriculture is lowering the future potential of the land for food production. This alone is a compounding issue, but when considered with the fact that the population is going to continue to grow, it could be disastrous, leading to higher levels of hunger. Of course, some farming practices are not as bad for the environment as others, but there must be systematic changes to ensure that they are implemented and food production is continually able to keep up with global demand as the population grows.

Using the waste instead of burning it is a very profitable option, besides being better for the environment. In the past few years, rice straw has been discovered to be useful in the production of a variety of things, including paper, bricks, and furniture, both for its chemical and physical properties.

There are several solutions already in progress. Each one centers on recycling the straw in different ways, which is beneficial because it reduces the need to use other materials, besides utilizing what would otherwise have to be disposed of; but it also means that the straw has to be transported from farms along the Nile where it originates to processing facilities where it is repurposed. This is an issue because the farmers lack the vehicles —and time— to move the waste. The government has started sending vehicles to retrieve the material, but it is not as efficient as it needs to be. There are not enough vehicles, and they don't make it to villages as often as they need to in order to keep up with the production of rice waste. To fix this, two things that could be done are improving the roads to the villages, and creating a better system for picking up the straw. Improving the roads would make it easier to access the villages, but it would be difficult because of the cost. Creating a more efficient system, with more vehicles and a more regular schedule for transporting the straw from farms to facilities would resolve any issues that might remain for the farmers in terms of disposal of the rice waste, but this solution also has challenges. Egypt's problems with pollution don't start or end with rice straw. More pollution is produced by vehicles in cities than burning rice waste (the impact of the Great Black Cloud is just felt so strongly because there is such a huge volume of waste being burned, and it happens all at one time), so in order to avoid compounding that, the new vehicles would have to be newer, cleaner models.

Another possible remedy for the transportation issue is building more facilities to process rice straw into useful materials along the Nile. They would be located where multiple villages could access them relatively easily, and they would have to have the capacity to manage all of the waste from each village

during the harvest. This solution would create jobs, as well as help with the issue of pollution production from driving trucks full of straw hundreds of miles between cities, villages, and processing facilities.

Some issues that arise when considering this include the cost of building the facilities, and the land they use. There is very little arable land in Egypt, so it must not be used for anything except agriculture. Hundreds of thousands of acres of arable land has recently been lost to cities and industrial plants, so the government is already promoting the concept of building cities further out in the desert. This would also work in the case of straw processing facilities. However, many people are resistant to the idea of moving to a desert city, because staying close to and living on water is such a strong part of their culture.

When the government started looking at alternatives to burning rice straw, using it to make fertilizer was the first method they implemented. It was an important development, as increasing the production of rice and other crops is vital to ending malnutrition and increasing profits from cash crops. However, it also costs more than it is worth. Straw costs 300 LE per tonne, and 2 tonnes of it make 1 tonne of fertilizer worth 150 LE. The government has implemented monetary incentives for companies to use the straw, which is good because it works (companies are utilizing the straw), but it is also an issue because "[i]ndustries can't be built on subsidies because if you remove the subsidy the industry will collapse," (Amr Helal, board member of the Egyptian Chamber of Industry and Engineering). This means that the waste will always need to be dealt with, and if another increase in production is necessary, the problem will only be intensified again. Another issue with this is that it doesn't give any incentive for farmers to stop growing rice, which would actually be the best thing to do in Egypt in order to protect the environment and ensure adequate nutrition for the whole population.

Rice straw can also be used to make insect repellent (Badr, 2011), which can help solve another pressing issue in Egypt (and around the world). Mosquitoes carry many diseases, especially in Africa, infecting and killing an estimated million people every year— in Africa alone. Rice straw contains a chemical that is harmful to mosquitoes, but not humans, making it an excellent natural defense. Rice straw is extremely cheap and easy to obtain, so this solution is widely applicable and could save millions of lives. Another benefit of this particular solution is that the repellent could be exported to other countries that struggle with mosquito-borne diseases, which could help Egypt's economy and save lives abroad.

One of the more unique uses for rice straw is as active carbon ("Eco-Friendly and Cost-Effective Use of Rice Straw in the Form of …"). Active carbon is used to purify water, effectively filtering out a variety of chemical impurities. This is an important solution, because of the water scarcity in Egypt and the bad quality of the available water (the Nile is heavily polluted with industrial waste). It is also the most profitable one, because 1 tonne of active carbon imported from China can cost 1500 Egyptian pounds, while 1 tonne of rice straw costs only 300 LE. This could therefore be used within the country to save thousands of pounds, or straw could be sold throughout the MENA region for profit, as no other country has yet capitalized on this potential.

A more permanent solution to the issue of rice waste (and the issue of rice's high water consumption) would be to switch to a different crop with similar nutritional values but less waste from harvesting. There are also many options that are substantially more conservative when it comes to water, which would help solve the issue of water scarcity as well.

Rice is not the best crop for Egypt because it is so water-intensive and nutrient-poor compared to alternative crops. Quinoa, for example, has almost twice as much protein, and is a good source of many vitamins and minerals. It also uses just half as much water as rice.
Quinoa needs to be processed before it can be sold and eaten, but so does rice, so there shouldn't be any major changes needed for the existing facilities. That should ease the transition, at least in terms of technological requirements.

Many other countries, including Australia and the UAE, have been conducting research on the possibility of growing quinoa as an alternative to the crops they have historically grown. It is gaining popularity around the globe for its nutritional value, hardiness, and environmental friendliness.

Egypt has improved greatly in dealing with childhood malnutrition since 1999, but the solution —increased production— created a new problem —extreme air pollution. This first appeared in the harvest season of 1999 and has been aggravating the respiratory systems of those living in affected areas ever since. While the government has already implemented measures to mitigate the smoke, they are inefficient and ineffective. The solutions outlined here deal more directly with the waste from harvesting, and many of them provide additional opportunities, including repurposing the straw into materials which could be used to solve other issues within the country and region.

Improving the current system of collecting rice straw by building more processing centers and modernizing the vehicles in order to protect the environment would be the solution that is the least revolutionary, so it could be the one that Egyptians are most willing to accept. However, it would cost millions of USD to construct and run the facilities, which would likely make most people resistant to the idea.

Some other solutions include using the rice waste to make other helpful materials, including activated carbon to filter water, and insect repellent to protect against deadly mosquito-borne diseases. Each of these also have the potential to bring more money into the country, if they are sold to other countries with the same problems. An issue with both of these, though, is that the rice must be processed, and that would then mean that more facilities would have to be built, the obstacles for which have already been outlined.

The most permanent solution to reducing rice waste —and taking advantage of other possible improvements to Egypt's food production— is to switch to a different crop. The government is already trying to implement quinoa as an alternative to rice, because it is much less water intensive than rice. It also has significantly more protein and other nutrients, which is an important factor in ensuring food security for the population, because even if everyone in the country gets enough food, if it does not give them the nutrients they need, they will still become malnourished. It is vital that something is done to ensure a sustainable future for agriculture in Egypt, for the sakes of both the growing population and the environment.

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