Olivia Andersen
Chariton High School
Chariton, IA
India, Factor 6: Sustainable Agriculture

India: Improving Soil Quality and Promoting Conservation Practices

With a growing economy and population, India is rising to compete in the global market. Since being liberated from Britain in 1946, India has faced many adversities (Facts-About-India). Over the past 200 years, plagues and extreme drought have affected the country (The Editors of The Encyclopædia Britannica). Now, home to nearly 1.2 billion people, India holds another problem: hunger (Facts-About-India). Feeding the millions who go hungry each day is difficult due to the population increasing. Lacking a diverse diet, many people, especially children, do not receive proper amounts of minerals. Malnutrition has two sides: undernutrition and overnutrition. India faces both. Even being a top producer of rice, they struggle to fulfill their needs (The Countries). Overproduction causes many problems both above and below the surface. Erosion takes away topsoil, and heavy rain breaks down particles. Deep tillage and over irrigation bring more problems to already struggling farmers. Without proper education and funds, modern techniques by new technology cannot be applied.

Family is very important to Indians. Joint families live together under one roof and usually consist of several generations. Grandparents, parents, siblings, children, and sometimes aunts and uncles make up a joint family. Usually parents have two or three children, but a home can have upwards of 12 to 17 members. Once children have grown up, the home splits and property is divided (N.K. Chadha; Hodgson).

Providing enough food to feed a full house is no easy task. Farmers have about one hectare to produce enough to feed their family and surplus for selling to make a profit (Stirring the Pyramid). Rice, vegetables, eggs, seafood, spices, and a few meats are common staple foods (Stricker GbR). Too often, the necessary nutrients needed are not fulfilled. Furthermore, getting proper vitamin supplements to people is a challenge, due to lack of health care facilities.

Healthcare centers for rural families are few and far between. Government programs have been established, but the majority of the need is fulfilled by private organizations (Rural Healthcare Foundation). Requirements have been made for a primary health center per 30,000 people. Community health centers have 26 staff members and 30 beds to provide for 120,000 people. Sub-centers in the most outlying areas have only four to six beds to serve 5,000 people with a male and a female health worker on staff. Therefore, treatment is available, although not necessarily with adequate and prompt service (Panagariya).

India's education system has made large strides over the past few years. Currently 95% of all children receive primary education, but only 54% continue on to secondary schooling. This is true for the whole country, but the dividing line is at the city limits. Providing proper schooling for rural children is a challenge. Education is limited, so oftentimes, knowledge is passed down from elders. Also, literacy rates are low throughout rural India. According to UNICEF, only 73% of males and 48% of females can read, thus slowing down advancement (UNICEF).

Agriculture is the largest economic facet in India (Facts-About-India). 60% of India's 3.3 million square kilometers of land is in agricultural production (Trading Economics). Farmers usually have about one hectare of land. Each year the amount of land available to farm decreases, but the demands for holding shares does not (Stirring the Pyramid). By producing rice, wheat, maize, cotton, jute, sugarcane, tea, coffee, and oilseeds, the main portion of India's wealth is held together by the degrading land, outdated

practices, and little knowledge (Preserve Articles). Smallholders encounter many natural challenges, such as disaster and drought, and also technological difficulties. Proper irrigation methods and genetically modified crops are just out of reach for struggling farmers.

A lack of agricultural education makes it difficult to update practices (Preserve Articles).
India's average family income is around $3,000, substantially lower than comparable countries. India has cut poverty in half across the nation over the past 20 years; still, it remains as one of the poorest countries in the world (BS Reporter). Only 25% of people have a full-time job with a steady income. One third of the population is still below poverty level, with the majority living in rural areas (Trading Economics). The chronically poor live where natural disasters are prone. Depleting resources and a deteriorating environment cause their livelihood to vanish as well.

Throughout India, people have a hard time getting to markets. Families in rural areas have limited access to buy and sell goods, unlike urban living. A common overlooked feature is adequate roads. Plans have been made to have all-weather roads implemented into communities with over 500 residences. Progress is slow due to lack of funding and other struggles (Department of Rural Development). Providing for a family and raising crops becomes difficult when faced with so many adversities.

Across India, widespread land degradation is taking place. Rice farming requires five inches of water to stand in fields at all times (California Rice Commission). This causes waterlogging, a main factor for salinity. Also, poor quality water is used for irrigation. India's location is a major factor too. From coastal planes to dry interiors, the country is diverse in soil types. Often in semi-arid countries, irrigation is used to help produce the high amounts of food needed to feed everyone. A short-term effect is created. In the long run, however, accumulations of salts decrease soil productivity and harm plant growth (U.S. Department of Agriculture). Land degradation happens everywhere, not just in India. Even leading countries, such as the United States, deal with these issues.

Soil salinity occurs due to several reasons. The two most common are natural weathering and excessive irrigation. Naturally, elements in the soil break down releasing salt ions, but the majority of salts come from improper irrigation. Waterlogging lets the salt stay on upper horizons. Without proper filtration, particles are unable to move through the soil profile. This ultimately destroys land, making it unusable by future generations. A buildup of salts further kills organisms that are needed in healthy soil. As a result, crops have trouble growing, plant life is lost, and extreme erosion occurs (Brady and Weil). Not only are farmers facing a problem below the ground but now above as well.

Salted water decreases yield, and likewise, is unsafe for human and livestock consumption. Salt ions are toxic to roots of crops and other vegetation. New rice plants have been made salt tolerant but this does not help maintain healthy soil for future generations. Land becomes weak and susceptible to erosion. During heavy rains, run-off ends up in drinking water sources along with topsoil. Unfiltered water is used again for irrigation, thus, continuing the cycle. Without proper resources needed to prevent these issues, health problems continue to build (Thompson).

The Central Soil Salinity Research Institute reports that salinity currently affects 7.3 million hectares of land in India (Central Soil Salinity Research Institute). Fifteen million hectares is considered potentially salt affected, due to improper irrigation. Often, land that is lost must be put out of production. By letting it sit fallow, natural processes will reclaim the land, eventually reversing detrimental effects (U.S. Department of Agriculture). When doing this, profit declines because nothing can be grown for production. Different agricultural methods can be used to prevent this income loss.

Salinity is and will continue to worsen over time. Worldwide, 10 million hectares of land is taken out of production each year due to soil salinity (Thompson). Many countries are studying this issue such as

Australia, which has set up contact information for farmers and other tools to address soil salinity issues on their land. The Central Soil Saline Research Institute is based in India with several branches around the country to work in different soil types. This government organization and others, provide information, soil and water samples, and publications to farmers (Central Soil Salinity Research Institute). Getting the resources needed out to farmers is difficult with low budgets.

By reducing the problem of salinity in India, crop production would be even higher. Agriculture is the main economic facet in India (Facts-About-India). Increased yields would allow for more schools, hospitals, and further education for adults. Along with governmental and farmer's profits, industry would grow and land would improve, making a bright future for India's agricultural community.

Flooding of rice patties and over irrigating does the most damage to land. Being in a semi-arid region, drought is not uncommon. Irrigation is used to increase crop production, but as more water is applied, more salt builds up. Currently, canals are implemented for irrigation purposes as a surface system from nearby rivers. This method works well, with the only problem being training. Knowing exactly when to run and when to shut off the system is key. Without proper education and knowledge, irrigation cannot be used to its fullest potential. Drip irrigation systems are most practical in semi-arid regions, even though it is not cheap. This method keeps only the root systems wet, saving water (Tilman, Cassman and Matson). A different form of irrigation is specialized systems that have sensors to detect when water is need. This kind of technology is not used much in the United States, and is unavailable to third world countries. Despite costs, investing in education and new technology would only help India's situation.

Getting information and resources out to farmers is key in using irrigation to its fullest potential. Needs change from each location depending on the crop, climate, evaporation timing, seepage, and runoff. Otherwise, irrigation is doing more harm than good (Hill and Williams). By introducing a different rooting crop, natural changes could be made, requiring less chemicals and a more biological method to restore organic matter. This would preserve land for future generations while making up for past.

By planting a deep rooting crop in a rotation with existing crops, the soil would be able to replenish nutrients. Because rice has a very short root system, particles are unable to move, staying in the upper horizons (Rost). Deep rooting crops open up macropores, letting salts move down and out of the soil profile, by water (Brady and Weil). It is important to have water filtrate to lower horizons to be cleaned of salts, reduce waterlogging, and increase microbial life.

A short root system does not loosen soil to allow for downward movement, thus making salt particles stay in the upper horizons. As water evaporates, those particles are left in top levels, exactly where the next plant's root system will be. A crop rotation allows soil to change and not be depleted of resources. Which is similar to how corn is planted following soybeans. Each benefits from the other and soil is not weakened. In the long run, soil will produce better crops and create higher revenue (Brady and Weil). By varying crops, farmers would still be able to produce rice but not cause the buildup of salt and would not force land to go fallow. This would also bring another product to market, while at the same time, reviving the soil for better rice production.

Sugar beets are high in nutritional value, have a longer root system, and are very salt tolerant. Even though they grow best in a cooler climate, sugar beets have been modified to withstand many different environments and also different soils. Sugar beets could be grown across the country not just in a certain region. Planting a different salt tolerant crop, such as barley, dietary needs would not be fulfilled. (Cattanach, Dexter and Oplinger).

Uses for sugar beet are just as wide as the ability to grow them. The most common product is sugar, containing 13 to 22% sucrose. Pulps, high in fiber, have many uses, such as nutrient supplement pills,

breakfast cereals, livestock feed, and molasses. By-products from sugar beet production are baker's yeast, alcohol, and pharmaceuticals (Cattanach, Dexter and Oplinger).

Little waste is made when producing sugar beets. Green tops can be used as fertilizer or made into livestock feed and water used during processing can be recycled. Also, processed parts of the plant can be used to raise pH due to its high lime content, another problem India faces. Sugar beets are a versatile crop that has limited waste product (Cattanach, Dexter and Oplinger).

According to The Vasantdada Sugar Institute, during the 1960's, sugar beet production was tested in different soils and climates across India. Outcome was a success. Sugar and alcohol were made along with bi-products. Despite positive results, production stopped and the processing factory was shutdown when the government stopped leasing property and machines (Deshmukh). Now, fifty years later, sugar beet research has started again. The mill used for production in the 1960's was reopened and became the Rajasthan State Ganganagar Sugar Mills. Processing sugarcane and sugar beets, buying and selling sugar, and producing alcohol are the goals of the mills. Crops are shipped in from around the state of Rajasthan to be made into alcoholic beverages (Rajasthan State Ganganagar Sugar Mills). By expanding this production across the country, farmers would have a market for the sugar beet crops. The Research and Development Initiative for Sugar Beet in India Industry has begun studying production with modern techniques. They are encouraging farmers to become aware of future needs. Ethanol is currently the featured bi-product. Possibilities are endless with new discoveries. A bio-fuel industry is now within reach. Growing sugar beets to revive the soil is a step towards ending hunger in India (IIRS News).

There are fifty-six agricultural universities across India with extensions throughout the country. Their work is extremely important to the future of agriculture in India. Different schools specialize in different areas, such as agronomy, horticulture, animal science, and new technology. Many of them hold local classes for farmers and families to learn basic and new techniques (Indian Council of Agricultural Research). This is vital for improving and conserving land. Syngenta Seed Company through Hilleshog's sugar beet seed has been working in India since 2004. With research fields, laboratories, development centers, and eight offices around the county, Syngenta strives for growth of crops and farmers (Syngenta). In Tamil Nadu, sugar beet production was researched for eighty months through Syngenta with modified seeds. Despite doubts, production thrived and a bountiful crop was harvested. Research showed sugar beets were easier on the soil than sugarcane and required a third less water than sugarcane. The crop was able to withstand drought, high temperatures, grew well in saline soil, the green tops provided a nice cover crop, and no new machinery was needed to be bought (Pimprikar). Expanding sugar beet production throughout India would help solve soil salinity issues. Universities and Syngenta are working towards improving land and resources for the future of India and the world.

Erosion occurs all over and can only be prevented by changing practices. Wind, water, and natural erosion are the most common types. India faces each one. Deep tillage exposes earth, making it most susceptible. Modern methods that reduce erosion are no-till and conservation tillage. These forms replenish the ground, preserving microbial life and organic matter (Brady and Weil). Overgrazing causes plant loss, leading to topsoil being washed away. Sediment then ends up in water sources and cannot be replaced.

In semi-arid regions of the United States, sugar beets are being grown under no-till techniques. No-till reduces erosion by water and wind. Irrigation would still need to be used but with less damage to soil. Although there is no major opening of soil when no-till is used, water is still able to move through the soil profile. This will cause salt formations to break down and move out, thus preserving land (Lyon and Smith). This mode of production would greatly impact the Indian nation and their soil.

Across the world, salted soils are a major issue. Countries such as the United State and Australia are working on solutions to improve farming techniques. Although research is new on using deep rooting crops as a solution, it holds a promising future (Government of Western Australia). Any place with semi-arid conditions is going to face saline soils. India's government is working on connecting with farmers, but there are many financial setbacks. Striving to salvage natural resources should be everyone's goal. Communities can save their water source by reducing irrigation to prevent contamination from salts. Drinking water is a valuable resource. Getting information out to farmers and then teaching them to apply new methods is no easy task. Other countries could get involved in India by sending educated scientists to work with residents alongside non-government groups. Several non-government groups are currently in India, spending years to relate with locals. The Foundation for Ecological Security works with small rural villages to educate and achieve sustainable agricultural practices. They have helped farmers improve grazing practices, reduce erosion, and increased families income (Davila). The Energy and Resource Institute has been working in India since 1974 on preserving and dealing with small and large problems the country is facing. From water quality projects to rural development, this non-government organization has changed the face of India. The Energy Resource Institute continues to grow and has a bright future ahead (TERI). Up scaling both of these foundations projects would make an even greater impact. Reaching out and working on a crop rotation project would save another facet of India.

Soil salinity issues are mostly at the control of farmers. Community members can make an impact by conserving water resources. Salt water is unsafe to drink for humans and livestock. Also, land should not be overgrazed. With no plant life, land is most suitable to erosion by wind and water. Standing water too allows for salts to build up. A small puddle might not seem harmful but effects on a large scale are detrimental. Change will not come by just one person. When communities come together, the future can be preserved.

India is a rising country with great potential, though many adversities still stand in the way. Currently, having the second highest population in the world, hunger is their biggest concern. Feeding everyone is proving to be a difficult struggle. Producing enough food and still staying as a leading producer of rice, is taking a toll on land. Widespread land degradation causes lost profits and lower yields. Deprivation of plant life then causes erosion; land that cannot be replaced. Attempting to increase production, over irrigation has put excessive amounts of salt in the soil. In the long run, this damages crops and future farming. Without a deep root system, plant water does not move through the profile. Instead, salts sit in upper horizons, and then as water evaporates, particles are left exactly where roots sit. Crop rotation allows farmers to still produce rice while at the same time improving production. By planting sugar beets, a deep rooting crop, water would filtrate out, taking salt particles with it. Soil salinity causes a loss of profit in an already struggling country. Farmers try to make both ends meet but a lack of government funds to solve issues does not help. Universities and seed companies are committed to paving a way for the future of agriculture. Non-government organizations are successfully working to better the Indian environment, and change lives along the way. India has the potential to become a leader in agriculture, but, as technology continues to advance, they will soon be left in the dust. India's economy rests in the hands of struggling farmers with failing land, neither of which can hold on much longer.

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