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An Irrigation-Based Solution for Water Conservation

India is a country with a history rich in struggles. Throughout the decades, India has been colonized, taxed, reformed, and eventually left to rebuild itself from the rubble left behind. After the British left, India was vastly changed, with limited means to industrialize (Kumar). Citizens were left in great debt, unable to change their situations due to the vicious cost of loaning money. Over time, pressure placed on the government eased credit norms on loans and allowed some citizens to break free from their overwhelming debts (Kumar). Unfortunately, as the world is not a perfect place, their social infrastructure remains in tiers, with the lowest faction being those in agriculture who are so poor that they are unable to sustain themselves, even during the most profitable harvests. To alleviate some of the stress placed on the most impoverished, a system must be put in place to increase their harvests, lest there be a raise in the already large figure of those who die annually of starvation in India: an average of approximately 1200 people (Naqvi).

In modern India, there is a population of approximately 1.15 billion, with 25% living below the poverty line (CIA). India is supported primarily by agriculture, with 52% of the population being involved in this industry, whether as farmers or simple, non-land owning agricultural laborers (CIA). These farmers and workers represent the poorest of the social infrastructure. They often live in a joint family system, which is common in poor communities, with these families containing 8 to 10 people, all of whom contribute their income to the family budget (Vazir et al.). The members of these families typically make 20-25 Rupees (men) or 10-15 Rupees (women); the market value of 1 dollar is 32 Rupees (Vazir et al.).

The farmers today typically borrow the equivalent of $4000 in Rupees each year to pay for modifications to their land wells (Zwerdling). These wells are necessary to the irrigation systems currently in place in India. These systems are typically above ground, causing a great deal of water to be lost to evaporation and run-off (Agricultural System India). The use of ground water for irrigation is causing the water table to drop by approximately 3 feet each year, giving farmers a need for more and more powerful pumps to find deeper water levels (Zwerdling). This increase in water scarcity is a huge problem in India, and one that must be fixed.

With such an arid environment, a major factor impacting the size of crop yields is irrigation efficiency. It is a well known fact that, if plants do not get enough water, they will not survive, much less grow to their full potential. On the other hand, having too much water, or being water logged, will cause them to suffocate, their roots being cut off from oxygen. Making full use of the current water supply is especially important in the poor situation that India’s farmers are currently in. In an attempt to stimulate a higher production of crops, the government subsidized an intensive farming method, including the use of genetically modified crops. These crops were supposed to produce much larger yields, but instead only stuck farmers in a hole of unending debt. These crops used much more water than their non-modified counterparts (Zwerdling). They also used three times as much fertilizer to produce the same yield and drained the soil of essential nutrients (Zwerdling). Far from aiding in the shortage of crops, these GMO crops were, and are, a drain to India's agricultural base.

The main problems with irrigation in India are the salinization of the soil and the evapotranspiration occurring due to the excess of water used. Evapotranspiration is the movement of water into the atmosphere from the soil (evaporation) and the plants in it (transpiration). From the fact that water is entering the atmosphere, one can gather that this implies inefficient use of water: not all of it is being used by the plants. Salinization is the buildup of salt in the soil which is left behind when water evaporates and is a major effect of evapotranspiration. The excess of salt in the soil essentially dehydrates plants, increasing the amount of water needed to appropriately hydrate the plants and decreasing the amount of water that the plant cells are able to use for growth and the creation of nutrients.

In order to conserve as much water as possible, action must be taken to reduce the quantity of water used in irrigation and to increase the consumption of this water by plants at the same time; minimizing salinization is just one step to doing this. In any system, the concentration of water is dependent on the ratio of solute to solvent; in other words, the relative amount of water in a system is the amount of what is in the water compared to how much total water there is. The addition of large quantities of salt to soil lowers the concentration of water. Since water travels from areas of high concentration to areas of low concentration, water will be leached from the plants into the soil until equilibrium concentrations are reached; exactly the opposite of what is hoped to happen. In order to maximize the concentration of water outside of the cells, thereby causing more water to enter the cells, crops should be irrigated with purified water. This purified water can be made from the water originally allotted for crop irrigation or even from waste water; as long as the end result contains little or no solutes, the effect on plant intake will be the same.

The benefits of using purified water seem simple: when plants absorb more water, they are healthier and, therefore, will produce more. This effect has been proven by research done in the Republic of Macadonia by comparing crops irrigated with 'clean' water (uncontaminated yet unpurified) versus those irrigated with purified waste water; Those irrigated with pure water produced a much greater yield (Marinova et al.).

Purifying water in India will obviously have a relatively high price. Luckily, in today's world, there are countless companies working on the issue of water purification, and, with every step they take in research, the price drops. The issue of cheap purification could also provide more jobs in India. For the testing of these systems, research facilities would most likely be opened in parts of India, bringing with them more job opportunities or, at the very least, more people to stimulate the economy.

While purified water is a solution to eradicate future salinization, India currently suffers from large areas of salinized land which will not magically disappear once irrigation using purified water is put in place. In the gap period between which the use of purified irrigation water is enforced and regulated and the time when the excess salt has been washed out of the systems, there must be a method which can be used to decrease the salinization, effective immediately. In order to start decreasing the concentration of salt right away, or at least to decrease the adverse affects the high concentrations have, a few various methods can be put in place: 'salt-eating bacteria' may be used or salt-tolerant hybrids planted.

‘Salt-eating bacteria’ are just as they sound: bacteria that break down salt into substances which are less harmful to the soil and the plants. These microorganisms are sold especially for use in agricultural areas where high salt concentrations are troublesome. Unfortunately, these beneficial bacteria are mildly expensive, costing approximately $50 per Ha (Spectrum).

In an attempt to alleviate the issue of lowered crop production, salt-tolerant hybrids have also been created. Using the genes of those plants able to survive in environments with high concentrations of salt, varieties of rice, wheat, and maize, three of India’s food grains, have been created with this tolerance (CSIRO; Salt-Tolerant Rice). While also potentially costly for farmers, the large yield would be beneficial in the long run. If taken into account the fact that approximately 2 to 5 tons of salt are added per Ha per year, perhaps some thought will be given to the implementation of these methods (Salinity).

Studies done on drip irrigation also suggest that it minimizes the effects of salinization. When subsurface drip irrigation methods are used, results show that the concentrations of salt in the area approximately 6 inches around the tubing are a great deal lower than the rest of the soil, particularly the areas around the edges and surface of the field (Hanson et al.).

Subsurface drip irrigation is a method of irrigation in which perforated, flexible plastic tubing is placed under the surface of the fields, directly next to the roots of the crops. It allows for water to be applied directly where it is needed, without wasting it on areas where it is not. The tubing is connected to a water supply, such as a large tank of water, much like a traditional above ground irrigation system. The potential difficulty with this system is that the water pressure in the tubing on the far end of the field may be lower than that on the end closest to the water storage unit, causing the crops on that end of the field to get an inadequate supply of water. To solve this problem, I would suggest connecting the far end of the tube with a second water storage tank so that water is flowing from both sides of the tube. This ensures that the water pressure is equal throughout the tubing, without any area of the fields getting too much, or too little, water.

Drip irrigation also has a very significant role in the conservation of water. The use of drip irrigation drastically decreases the loss of water by evaporation, run-off, and deep percolation, or water lost by moving deep underground (Shock). Since subsurface drip irrigation places a tube directly underneath the surface of the soil it is ensured that, rather than being given the chance to evaporate or flow away from the field unused, water is transported directly to the roots of the crops. Drip irrigation also decreases the amount of water used. By releasing a small, constant amount of water into the soil, it ensures that the soil stays appropriately moist without using excess or water logging the plants.

Apart from the conservation of water and the decreased effects of salinization, drip irrigation provides a host of other benefits. By denying the surface of the soil proper irrigation, it prevents weeds and other competitive plants from taking root. It also allows for the direct transfer of fertilizers, insecticides, etc, to the roots of the plants for more efficient absorption. Drip irrigation can cost anywhere from $1000 to $3000 per Ha, but with so many benefits and such a drastic improvement to the conservation of water, this renovation may very well be worth the cost.

When approached with the idea of subsurface drip irrigation, it is important to think about the method of tilling the fields. While subsurface drip irrigation tubing can be removed and then recycled or reused, it seems more convenient to adapt a style of seeding and planting which does not disrupt the irrigation system: no till agriculture. No till agriculture is a method of farming in which the soil is not turned by a plow (Wagner). Not only does this allow the drip irrigation tubing to remain underground, but it provides a host of benefits for the soil itself. Tilling soil causes a loss of the element Carbon, a nutrient which is essential for healthy plant growth (Wagner). Without Carbon, there is an increase in erosion due to the unhealthy plant life and a large need for fertilizers which, in turn, may be washed into waterways, polluting the environment (Wagner).

Unfortunately, like most other solutions, a switch to no-till agriculture would require the addition of various pieces of equipment to the arsenal of machines already used by farmers, many of which would be difficult to afford. Every solution seems to need an input of money before it will work while, at the same time, every solution is working to help those without money. A solution for this economic crisis would be government subsidizing. When GMO crops were first developed, the government in India subsidized them, hoping for a tangible increase in production; sadly, the crops turned out to be a failure, instead sucking money from the citizens who are now trapped in a circle of debt (Kumar). These solutions would produce substantial results and have been scientifically proven to do so. In a matter of years, it is hoped that the increase in crop yield would be enough to earn back the cost of transferring to this new system of agriculture, at a minimum.

An increase in water scarcity throughout the world is a very real threat, one every nation is facing. In such arid environments such as India, the risks posed by this problem are even worse. With an already limited amount of water and the disadvantage of heat, it seems that India is among the underdogs in the race for improved agricultural production. In such a pursuit as this, efficiency is key, and methods such as subsurface drip irrigation and purified water are the way to go.

Efficient irrigation and the conservation of water admittedly will not solve all of India's problems in terms of agriculture; for that to happen, it will take mass cooperation in the fields of genetically modified engineering, fertilization, and much more research on topics such as salt eating bacteria and tolerant hybrid breeds. These areas of study must be extensively explored if the costs of these projects are to be lowered enough to be available without government aid. India is slowly working towards a better future, one in which the poverty line is raised and the poorest farmers can live with as little debt as possible. These implementations are merely on piece of the puzzle towards achieving the dreams of those hoping to see brighter days.

Countries with extremely arid environments must work the hardest towards maintaining adequate levels of nutrients in their soil, but this is something they have to do to survive. As Franklin D. Roosevelt said, "The nation that destroys its soil destroys itself," and this is particularly true for those nations that support themselves with agriculture. India will one day live in a time where farmers can control their own lives, not work endlessly to pay off debts and, at this time, when the citizens are benefitting from an era of plentitude, the rest of the world will be too; eventually, the great minds of the world will come together and solve the greatest problems in food security, including those of water conservation.

Works Cited

"Agricultural System India." *A Parent's Guide to Internet Safety ::Indianchild.com*. Web. 23 Sept. 2010. <http://www.indianchild.com/agricultural_system_india.htm>.

"CIA - The World Factbook." *Welcome to the CIA Web Site — Central Intelligence Agency*. Web. 25 Sept. 2010. <https://www.cia.gov/library/publications/the-world-factbook/geos/in.html>.

CSIRO. "Researchers Develop Highest Yielding Salt Tolerant Wheat." *PhysOrg.com - Science News, Technology, Physics, Nanotechnology, Space Science, Earth Science, Medicine*. 15 Apr. 2010. Web. 23 Sept. 2010. <http://www.physorg.com/news190536748.html>.

Hanson, Blaine, and Warren Bendixen. "Drip Irrigation Salinity under Controls Soil Row Crops." July-Aug. 1995. Web. 18 Sept. 2010. <http://ucce.ucdavis.edu/files/repositoryfiles/ca4904p19-69973.pdf>.

Kumar, Pankaj. "Problems of Indian Agriculture." *NowPublic.com | The News Is NowPublic*. 20 Aug. 2010. Web. 18 Sept. 2010. <http://www.nowpublic.com/world/problems-indian-agriculture>.

Marinova, Svelta, Stanislav Torma, and Peter Dimitrov. "Potentiality of Using Plant Treatment Stations' Sludge and Water in Agricultural Practices." 25, 29 May 2010. Web. 21 Sept. 2010. <http://www.balwois.com/balwois/administration/full_paper/ffp-2114.pdf>.

Naqvi, Mukhtar Abbas. "4800 Starvation Deaths in India in Last 4 Years: Naqvi." *News.outlookindia.com*. 2 Aug. 2009. Web. 20 Sept. 2010. <http://news.outlookindia.com/item.aspx?663772>.

"Salinity Hazard." *Water Treatment and Purification*. 2009. Web. 20 Sept. 2010. <http://www.lenntech.com/applications/irrigation/salinity/salinity-hazard-irrigation.htm>.

"Salt-Tolerant Rice." *IRRI Home Site*. Web. 22 Sept. 2010. <http://beta.irri.org/projects15/en/stresses/salt-tolerant-rice>.

Shock, C. C. "An Introduction to Drip Irrigation." *OSU Malheur Experiment Station Home Page*. Aug. 2006. Web. 18 Sept. 2010. <http://www.cropinfo.net/drip.htm>.

"Spectrum." *Sunlightbioelectric.com, the Official Website for Sunlight, Inc. Located in Sandpoint, Idaho*. 2010. Web. 19 Sept. 2010. <http://www.sunlightbioelectric.com/Tainio/spectrum.htm>.

Vazir, Shahnaz, Uma Nayak, Vinodini Reddy, and P. Pushpamma. "India: The Rural Community of Sheriguda in Andhra Pradesh: International Development Research Centre." *INTERNATIONAL DEVELOPMENT RESEARCH CENTRE.* Web. 23 Sept. 2010. <http://www.idrc.ca/en/ev-137780-201-1-DO_TOPIC.html>.

Wagner, Holly. "No-Till Farming Offers A Quick Fix To Help Ward Off Host Of Global Problems." *OSU Research News Index Page*. 2004. Web. 24 Sept. 2010. <http://researchnews.osu.edu/archive/notill.htm>.

Zwerdling, Daniel. "'Green Revolution' Trapping India's Farmers In Debt." *NPR : National Public Radio : News & Analysis, World, US, Music & Arts : NPR*. 14 Apr. 2009. Web. 20 Sept. 2010. <http://www.npr.org/templates/story/story.php?storyId=102944731>.