Meghana Reddy
Francis Parker School
San Diego, CA
India, Factor 2: Water Scarcity

India: The Effects of Water Scarcity on Agriculture Production and Improving Irrigation Systems and Conservation Practices

India is a land of contrast. From the holy Ganges river that flows thousands of miles from the Himalayan mountains in the north to the warm blue sparkling ocean waters in Kanyakumari at the southern tip, it is made up of regions of lush green countryside, deserts, mountains, and lakes. One can live through history just by observing the panoply of architectural diversity that is embodied in old temples, mosques, churches and synagogues. India is the second largest country in the world, with a staggering population of 1.27 Billion and is home to some of the oldest civilizations known to man, encompassing various religions, cultures, and ethnicities (India's Population). About 70% of the Indian population lives in small rural villages (India: Achievements). Typically, the tiny villages spread among the hills, valleys and mountains are populated by metal craftsmen, bricklayers, carpet weavers, and farmers. The land is rich in beauty and grandeur, but the people in rural villages are poor and primitive in many ways. This presents an unparalleled opportunity to introduce the latest technologies in farming that could alleviate some of the water scarcity issues.

There are around 7 billion people in the world and nearly 1 billion people lack access to clean water. 70% of the earth is covered with water. Of that only, about 2% of the water is freshwater, and 0.36% is groundwater (How). India has 16% of the world's population, but only 4% of the world's fresh water resources (Food). Water is needed to ensure food security, for industrial production, to feed livestock, and to conserve the biodiversity and environment. About 70% of global freshwater withdrawals are used for irrigation (United). The lack of clean water causes agriculture production to slow down. Another reason water scarcity is becoming an increasingly critical issue in India is because of the need to feed an exploding population. India's groundwater is being depleted, rainwater is getting wasted, and surface water is being polluted (Prakash).

Most families in rural India tend to be large. It is because people usually live in huge joint families, consisting of three generations. The families are usually patriarchal, and they work as a team when farming (Characteristics). Education in farm families is quite low, as it is not seen as a necessity. Children help the family on the fields, and tend to miss school. As a result, the literacy rate in rural India is about 68% (Yadav). There is inadequate healthcare in rural parts of India because rural citizens do not have easy access to healthcare compared to the urban population. Only about 33% of government doctors are in rural India, when 70% of India's population lives in rural areas. This causes many patients to depend on alternative medicines such as homeopathic and ayurvedic remedies. For this reason, India's healthcare system is ranked 112 out of 190 countries (Sharma). Diet in India varies from region and religion. Flat breads are common in the northern India, whereas in the south, rice is more prevalent. In coastal regions, seafood dishes are popular (India). Religion also influences diet in India. Hindus do not eat beef, and Muslims do not eat pork. About 50% of Indians are vegetarian, mainly because of religious reasons (Saglimbene). About 58% of small farmers are considered undernourished (National).

Subsistence agriculture is self-sufficiency farming in which the farmers focus on growing enough food to feed themselves and their families. These family farms in India are very small in size. The average size is about 2.4 acres (Case). Major crops harvested include rice, wheat, sugarcane, and tea (Important). Farming practices in subsistence family farms are traditional. Due to poverty and small farm size, there is little to no mechanization. Many jobs done on the field are labor intensive. Most subsistence farm families own their land. However, some are tenants to landowners and pay them with a share of crops. Any

surplus crops are sold (Case). 60% of Indians living in rural India live on less than 35 rupees a day (about 50 cents). Poverty is also a factor in slowing agriculture production in India. Small farmers cannot afford big machinery, so they stick to traditional farming methods such as using cattle plows. These methods are inefficient, labor intensive, and take up a lot of farming time. Additionally, these farmers cannot afford quality seeds and fertilizers (India: Issues). Limited access to proper storage facilities also decreases agriculture productivity as farmers cannot store their crops properly to sell it at a good price. Additionally, they do not have water storage tanks to tap into during a dry spell (Shiya).

Although there are many factors that cause low agriculture production in India, the most fundamental one is the lack of water. I learned this in a personal interview that I conducted in India with Dr. Annapareddy, a professor at Bapatla Agricultural University. He states, "The lack of water is the leading factor in slowing agriculture production in India...Water supply used in agriculture competes with the usage of domestic, industrial, and environmental uses" (Annapareddy). Besides, 70% of India's water is polluted (India). Therefore, many farmers depend on rainfall. In fact, half of the cultivated land in India for all crops depends on rainfall. This tends to be risky and unreliable as India suffers many droughts. If farmers consume unclean water, they can get waterborne diseases such as hepatitis A, cholera, dysentery, and typhoid. These diseases adversely affect agricultural production even further (Chabba). About 37.7 million Indians are affected in some way by waterborne diseases annually. Also, about 80% of rural illnesses and 20% of deaths among children from 1 to 5 years old are linked to consumption of unsafe water (Prakash). As a result of reduced water supply, the rural family will face a decrease in crop yield, difficulties in field operations, low literacy level, restriction in the use of fertilizers and pesticides, health issues, and limitation in crop planning (Food).

A global survey indicates that about 40% of agricultural land is degraded due to lack of water. Consequently, soil salinity, water logging, and other forms of land degradation reduce food production (Andhra). About 85% of Indians depend on groundwater for their water requirements. Groundwater is declining 33 centimeters every year, due to use of water without replenishment. About 17% of Indians lack safe drinking water (Bajaj). 161 out of 600 districts in India have been declared drought affected areas (Prakash). Many family members skip their education as they are forced to help fetch water. Farm women in rural India are particularly disadvantaged. They walk an average of 10 miles a day for 6 days in the burning sun to get water for farming, while the men work on the fields. Because of this, many girls are pulled out of school at a very early age to fetch water (Sentlinger).

The trends for water scarcity are getting worse. The projected water per capita availability for 2025 is to decline by 476 m^3 from 2001's. Currently, India is unable to make good use of water due to poor infrastructure and lack of awareness. Only 35% of lands receive irrigation (National). India suffers through food price inflation. According to the Diplomat, monsoons play a significant role in India's food price inflation. Since 2009, food prices have risen 51.5% (Priya). The Government of India claims that most Indian states will have reached the water stress condition by 2020 and water scarcity condition by 2025 (India). However, there are some ongoing efforts in trying to resolve the issue. Mihir Shah, a member of India's planning commission for water management, has written a 10 point agenda for India's 12th Five Year Plan. The main goals of the plan are to restructure India's irrigation systems, and to stress watershed and groundwater management (Government).

There are other major issues that affect water scarcity in India. For example, arable land, rivers, and wetlands are slowly degrading and becoming more scarce and expensive as a result of India's booming population and urbanization. And with population growth, consumption of water is expected to increase 50% in the next 15 years, but supply is expected to only increase by 10% during the same period (National). Population growth also has an effect on water scarcity. In 1951 India's population was 361 million and the per capita water availability was 5,177 m^3. As India's population soared to 1,027 million in 2001, the per capita of water reduced to 1,820 m^3. The projected population in 2025 is 1,394 million,

and the per capita of water will be decreased to 1,341 m^3. With a high population, there is not enough fresh water to sustain everyone. Decreased water availability also leads to decreased hydropower generation (National).

Climate change also affects water scarcity. Warm weather causes rivers to evaporate. Rising temperatures also require crops to be fed more water due to evapo-transpiration. Higher temperatures caused by climate change result in the additional melting of snow in the Himalayas, which cause heavy floods in the rivers that originate from them, thereby causing water issues and suppressing agriculture production (National). According to some models provided by the Global Water Partnership, India's GDP may decrease 2% due to climate change (Global Water). "Climate change can be seen as a multiplier of already existing risks. Where people are vulnerable today, they will be even more vulnerable tomorrow," said FAO's Müller. Many experts have said that in the agriculture sector, adaptation to climate change is of the utmost importance, and water is at its centre. A warming planet is widely predicted to result in extreme weather patterns, resulting in frequent and intense droughts, flooding and heavy rainfall events (Rowling).

Some of the most common approaches for increasing water usage efficiency are: (a) use of sprinklers and drip-irrigation systems because flood irrigation is very inefficient (b) use of "afforestation" (converting bare land into forest) reduces floods, soil erosion, and groundwater retention while increasing the biomass (c) implementing Organic farming to enhance production, and maintain the soil fertility while minimizing water pollution (d) use of "Agroforestry or agro-sylviculture" techniques, where trees are planted next to crops, where the trees help retain surface and groundwater, minimizing the need for irrigation water.

One way to tackle this issue in a significant manner would be to implement new technologies and techniques in agriculture such as:

(1) Using data from AQUASTAT / AQUACROP. According to the International Food Policy Research Institute, every rupee (2 cents) spent on agricultural research returns 9.5 rupees (Agriculture). India should seek help in the field of research and agriculture trade from the global food security program which is part of the World Bank. The Indian agricultural organizations should conduct research on data that is readily available. For example, a large amount of data is collected by AQUASTAT (a global information system on water and agriculture) and AQUACROP. This organization collects, analyzes and disseminates secondary data and information by country and region (Food). Using this data, farmers can choose the suitability of crops (based on the water resources) to improve productivity and ensure food security (Andhra). So, it would be very beneficial if an education outreach is conducted by a national or international organization (FAO) for training the farmers on utilizing the FAO's Models and Decision Support system (MDS) for crops and water. This will help the farmers choose the type of crop based on the soil and water requirements.

(2) Using Global Food Trade (also known as Virtual Water Flows). This has proven to alleviate water scarcity. In 2005, it lead to a freshwater savings worth 2.4 billion dollars. The reason for this is, certain crops require different amounts of water in different countries. Importing crops that take a lot of water to grow in India versus another country could save a lot of water in India. Also, the price of some crops would be reduced and more affordable if imported (Global). Currently, 80% of India's agricultural area is taken up by rice and wheat, the two most water intensive crops. India could grow crops that are less water intensive such as basmati rice, baby corn, and sweet corn to save water, and then import rice and wheat from other nations (Perveen). Further, the United Nations could also play a big role in creating partnerships for Global Food Trade and work with local state governments in India. Recently, World Bank approved billions of dollars in assistance to the Indian government for agricultural development, and some of the funds could be used to invest in recommendations made in this paper.

(3) Building rain catchment systems. Over 80 percent of waste water worldwide is not collected or treated, according to the U.N. water report (United). Conservation of rainwater and surface water is also important. Much of India's rainwater gets wasted (Prakash). The Water Project is currently building rain catchment systems in Africa. The same project can be implemented in India. The water catchment systems connect gutters into a water tank that can hold up to 100,000 liters of water (Sentlinger). Also, interlinking rivers will help in preventing floods, and can improve water distribution in the country (National). Again, the Government of India has to be involved in working with the UN agencies such as FAO and World Bank to implement this project. There is a perpetual dispute in sharing the water from the Cauvery River between the states of Karnataka and Tamilnadu. And there could be other similar disputes between adjoining states in India that could pose a big problem in implementing this recommendation.

(4) Implementing Germplasm conservation. This is yet another aspect in achieving agriculture sustainability. Basically, it is a collection of genetic resources for an organism. For plants, the germplasm may be stored as a seed collection, and for trees, in a nursery. Following traditional agriculture, every year some seeds of native varieties must be kept for sowing next year, so as to conserve native germplasm. In some adverse conditions, local and native varieties perform much better than the improved varieties (Andhra). Local NGO's would have to take the lead in implementing this strategy. Farmers have to be educated in this method in order to get their cooperation. As farmers only speak the local language, local researchers and university faculty would have to take the lead in providing the training.

(5) Using current innovations in Agricultural technology. Recently (May 2014), a high school student (Namal Udara Piyasiri) from Sri Lanka received one of the top awards from International Science and Engineering Fair (ISEF) for his project "Versatile Field Construction Machine for Paddy Cultivation", a device that can carry out soil preparation and harvesting in addition to the standard functions such as plowing, harrowing, leveling of soil. It has a novel way to cut water ways for wet cultivation of rice. He was also awarded a $10,000 prize from the U.S. Agency for International Development (ISEL). Upon his arrival in Sri Lanka, he was received at the airport by the Prime Minister. I would like to follow up with this student next summer to determine how this device can be mass produced and put to use in the Indian subcontinent. This can be used in India, Bangladesh, Pakistan, Sri Lanka and China. Additionally, one recent invention from the University of San Diego called "Rice Pollution Solution", was awarded $20,000 in seed money (Barbara) for further development. This device filters out metal from irrigation water. This invention is of great significance, because about 10% of China's rice is contaminated with high levels of heavy metal. This same number would also hold good for other countries in the Indian subcontinent. By using such high tech devices, a lot of food could be saved.

Assistance from local, national and international government agencies and organizations can also help to acheive the goal of water conservation:

Local Policies:

- Preventing groundwater exploitation by charging fees based on effective usage of water.
- Stopping subsidies on power supply for pumping water.
- Charging by the amount of water usage, instead of land based.
- Placing restrictions on the quality of fertilizers and pesticides used.
- Implementing regulations on the treatment of industrial waste water.
- Implementing policies that require preserving rainwater.
- Providing education on water usage and conservation.
- Spreading awareness about water scarcity and conservation.

National Policies:

- Implementing policies on constructing dams, afforestation, flood control systems, and irrigation infrastructure.
- Resolve water disputes among states.

Global Policies:

- Implementing policies on Global Food Trade.
- Stabilizing food prices in developing countries through policies by the World Trade Organization.

The U.N. Food and Agriculture Organization (FAO) says the world will have to produce up to 70 percent more food to feed a global population expected to reach 9 billion people by 2050, from the current 7 billion (Food). Water scarcity is a current problem which will likely to get worse in the future and will affect food security. Explosive population growth, urbanization and industrialization will put more demands on the water supply. Climate change will also pose a threat to water availability. Unless we address these issues immediately, water scarcity problem will pose a serious threat to the sustainability of the environment. There are many simple methods that can be used to improve agricultural production. However, I have outlined a few of the more sophisticated and large scale systems that could impact the agricultural production in a significant way. Resolving the issue of water scarcity in India could lead to many benefits. Farmers would not have to depend upon rain and the monsoon season to grow crops. Instead, they would have a reliable harvest. This would make India more food secure. Also, farm children and women would have the time to get a proper education instead of spending their time to fetch water. With more water, food would become cheaper and more affordable for the poor. Since most of the poor live in rural areas, and a significant part of their income is spent on food, agriculture growth caused by increase in water access can reduce poverty faster than any other method (Agriculture). Additionally, problems such as child labor and malnutrition amongst rural farmers could be minimized or even eliminated.

In a global sense, water scarcity already affects more than 40 percent of people on the planet, and two-thirds could be living under water-stressed conditions by 2025 (Rowling). Specifically, water scarcity in India has been and continues to be a major problem. Projections show that it will only get worse in India and in many other developing countries around the world. Apart from conservation, major initiatives need to be implemented before clean water runs out. Hopefully, we can solve these issues by implementing the major initiatives I have outlined in this paper.

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